which tend to increase, and others to decrease the corrosion. In a solution of potassic cyanide pure silver is always protected by being made a cathode. The influence of variations of strength of acid was tried in several cases.

The results, which at first were apparently contradictory, were found to depend upon a number of conditions, and it would require an extensive research to determine the limits of those conditions, and what the proportions are, in which all those separate influences participate in producing the effect. Unequal capillary action is one of them, and its effect is described in a separate paper entitled, "The Electrolytic Balance of Chemical Corrosion." Another is unequal corrodibility of the metal itself. This was investigated, but how it arose was not clearly ascertained. Traces of certain kinds of soluble impurity in the liquid was also a disturbing circumstance. The altered chemical composition of the liquid around the cathode, caused by substances set free or formed by electrolysis, was another influence; this was investigated in the case of a silver cathode in a solution of potassic cyanide, and the protective influence of the current upon the cathode was found to be partly due to the formation of potassic hydrate; the current, however, operates also in some other manner. The effect of temperature was also examined, and it was found that the current exercised a greater protective power when the liquid was hot than when it was cold; the corrosive effect without a current was also greatest (as might have been anticipated) in the hottest liquid. The effects were further influenced by the degree of strength of the current; the greatest strength of current exercised the most protective power, and a large number of experiments were made expressly to test the question whether difference of electro-motive force alone, independently of difference of strength of current, affected the rate of corrosion, but the difficulty of insuring perfect uniformity in all the other conditions which affected the corrosion was so great that sufficiently decisive results were not obtained.

THE MOVEMENTS OF AIR IN FISSURES AND THE BAROMETER

FROM time to time attention has been called to the property exhibited by certain wells in different parts of this country of maintaining an active and permanent circulation of air. It was observed that currents alternately entered or issued from fissures in the sides of the wells, and though in some cases the first emission on sinking the well consisted of choke-damp, the gas subsequently passing consisted of no more than atmospheric air. While it was clear that the currents were not due to the evolution of any gas by chemical action in the rock or the water, an explanation of the phenomenon was found in the fact that the changes in the direction of the circulation coincided precisely with the changes of movement of the barometer, the current being outwards with a falling glass, inwards when the barometer was rising, and ceasing altogether when no change in the atmospheric pressure was taking place. The strength of the currents moreover was found to be proportionate to the rapidity of the barometric movements.

The name of Blowing Wells has come to be applied to such wells in consequence of these properties. From their extreme sensitiveness to changes in the atmospheric pressure, they have been found to give useful indications of the approach of bad weather. Their warnings are rendered audible by fixing horns or whistles in an air-tight covering, in such a way as to sound readily to the outward current, or to give a different note for an outward or inward movement of the air.

The first blowing well of which we have an account appears to have been of an entirely artificial origin. A well was sunk at Whittingham, near Preston, to a depth of eighty feet, and being afterwards abandoned, was covered with a large flagstone pierced by a small hole. Currents of air were observed to enter or issue from this hole, according as the barometer was rising or falling, and a tin horn fixed in it became audible at a considerable distance. Similar phenomena were exhibited by a cesspool, intended to receive offensive residue from some chemical works. The pool was arched over, a small hole being left for the passage of the refuse; a fall in the barometer was made unpleasantly evident by the issue of offensive vapours.[1]

Subsequently it was noticed that three wells in the New Red Sandstone, in the neighbourhood of Northallerton exhibited the same peculiarity. The wells "blow" through fissures in the sandstone just above the water-level. The changes in the direction of the currents coincide precisely with the movements of the barometer, and the outward current is made to blow a "buzzer," which is said to be audible at a mile distance.[1] In the years 1879-80 a series of interesting experiments on one of these wells, situated near Solberge, three and a half miles south of Northallerton, was made by Mr. Thomas Fairley, F.R.S.E.[2] After stating that the water has a composition similar to that coming from chalk or limestone, and that, though on the first opening of the fissure a violent outburst of choke-damp had taken place, the gas subsequently issuing did not differ appreciably from common air, Mr. Fairley gives a detailed account of observations made on the volume of air passing. The currents passed through fissures in the sandstone at a depth of forty-five feet from the surface of the ground, and just above the level of the water. The measurements were made firstly by a vane-anemometer, and subsequently by two large dry meters, constructed to pass 3,000 cubic feet per hour; these had been substituted for two of the largest meters in the possession of the Leeds Corporation, which had been thrown out of gear by their incapacity to pass the air fast enough. As a result of these experiments it was found that a fall of the barometer of 0·26 inch was accompanied by an outflow of 83,900 cubic feet of air, and by an application of Boyle's law it was calculated the total capacity of the fissures must amount to nearly 10,000,000 cubic feet.

The existence of currents obeying the same laws is equally obvious in a well at Langton at a few miles distance. The well has been long disused, and the water is exceedingly foul, notwithstanding which a candle burns clearly at the bottom. A third instance occurs at Ornhams near Boroughbridge, where the roar of the air-currents passing into the crevices of the rock has been compared by a workman to that of the water in a mill-race. No observations, further than those necessary to prove the existence of the currents, have yet been made on these wells.

At Hopwas a well has been sunk for the supply of Tamworth to a depth of 168 feet, the water standing naturally a depth of 129 feet. The shaft passes through alternations of shale and sandstone, one of the beds of the latter, met with at a depth of ninety-six feet eight inches, being described as "light fissured sandstone thirty feet four inches."[3] From a fissure in this bed, at 115 feet from the surface, there issued a violent rush of atmospheric air, which soon spent itself, and was succeeded by currents showing variations coincident with the barometic changes. The currents have been noticed in one fissure only, an irregular opening, of two and a half inches in height by one inch in width, in a nearly close-sided vertical joint. Experiments on the amount of air traversing this fissure are now in progress.

The same properties are exhibited in an equally well-marked degree in a well belonging to Mr. A. Potts at Hoole Hall, near Chester. The well is eighty-one feet deep and contains ten feet nine inches of water; it is sunk through glacial deposits, consisting of a tough clay overlying a sand of variable thickness, into the New Red Sandstone, but, being an old well and lined with brick to the water-level, the exact nature of the strata and the position of the fissures is unknown. Communicating with the interior of the well by pipes, are two whistles of a different tone, and a pressure gauge; the deeper-toned whistle sounds to an inward, the shriller-toned to an outward current, and were they allowed to act freely during unsettled weather, these whistles would render sleep in the adjoining house impossible. It is stated by Mr. Potts that changes in the atmospheric pressure are shown more rapidly by the pressure gauge of the well than by a mercurial barometer, and that whenever there is a sudden change for rain, the water in the well becomes agitated and slightly discoloured. An appearance of ebullition was noticed also in the Solberge well, but has been attributed by Mr. Cameron to the falling of fragments of mortar. The movements of the water in the Hoole well are being made the subject of experiment by Mr. Potts. Similar, though less powerful, currents have been observed in two other wells within a distance of 500 yards of Hoole Hall. The wells are in a situation where a similar sequence of glacial deposits probably exists, but further particulars are at present wanting.

The fissures from which the currents in blowing wells issue occur usually near, but just above, the water-level. Above them there is provided an air-tight covering in the glacial clays,

[1] J. Rofe, F.G.S., *Geological Magazine*, vol. iv. p. 106, 1867.

[1] A. G. Cameron, *Geological Magazine*, vol. vii. p. 95, 1880.
[2] *Proc.* York Geol. and Polyt. Soc., N.S., vol. vii. p. 409, 1881.
[3] Mr. H. J. Marten, Eighth Report on the Circulation of Underground Waters to the British Association, 1882.

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or in beds of shale interstratified with the sandstone, cutting off communication with the open air in this direction. Fissures traversing a dry sandstone in such a situation constitute an air-chamber which may clearly be of great capacity. On cutting one of a system of connected fissures, the first effect is frequently to liberate a quantity of pent-up air or choke-damp, as at Solberge; subsequently the opening becomes the sole channel by which equilibrium is preserved between the enclosed air and the atmosphere. It would however seem as probable that the opening should occur below the water-level as above it. In such a case the first effect of an expansion of the pent-up gases would be to force out water, and raise the level of the water in the well. The agitation of the water noticed in the well at Chester is probably due to the openings being partly above and partly just below the surface of the water. That they not infrequently are wholly below appears probable from observations on springs and wells, for it has been noticed that in certain chalk-springs there is an increase in the amount of water flowing when there is a rapid fall in the barometer, though no rain may have fallen, and that under the same circumstances water recommences to flow from land-drains and percolation gauges. The gaugings of deep wells in the chalk have confirmed these observations and show that there is a rise in the water-level under a decrease of atmospheric pressure. These movements have been attributed to the expansion of the dissolved gases.[1] It is probable that the gases when given off by the water, rise into and occupy cavities from which there is no escape upwards.

It is noticeable however that five certainly, and two probably, of the blowing wells described above derive their properties from fissures in the New Red Sandstone; no case is known in either chalk or limestone, though these are soluble rocks peculiarly liable to contain caverns or widened joints. It is not improbable that the fissures are too numerous in these rocks, so that wherever large hollows occur, there are also communications upwards with the open air. In sandstone on the other hand large hollows are of extremely rare occurrence, and in view of this difficulty it has been suggested that the Magnesian Limestone which underlies it about Northallerton, at a depth of about 400 feet, and is known to be extremely cavernous, may have given way in places, and led to the formation of hollows in the sandstone. This explanation however is not applicable to the wells at Tamworth or Chester, where the sandstone is not underlain by limestone. It seems more probable that the strength of the air-currents should be taken in connection with the copiousness of the water-supply as indicative of the great extent of small ramifying fissures in some of the triassic sandstones. That the united capacity of such fissures must be very great to account for the phenomena is undeniable. The volume of air contained in the cavities at the Solberge well was estimated at about 10,000,000 cubic feet, or as much as would fill a chamber measuring 217 feet each way, length, width, and height.[2] In making this estimate no allowance was made for aqueous vapour, or for air held in solution in the water, both of which would come off in increased quantities with a decreasing pressure. The former was known by the state of the meter to have been present in large quantities. But making every allowance for these causes of error, it is impossible to escape the conclusion that the fissures, small as they are individually, must in the aggregate form a reservoir of immense capacity.

In concluding these remarks we may refer to the practical application of the knowledge of these properties in fissures. It has been noticed that the drains of large works begin to smell on the approach of rain, and there can be little doubt that this is partly due to the setting up of an outward current corresponding to a fall in the barometer. In fact every network of covered drains, and every covered cess-pool, where special provision for ventilation is not made, must constitute a natural blowing well. It is not our intention to discuss here the engineering details of drainage. It is sufficient to point out that by a faulty system of ventilation, or by the derangement of a system originally good, sewer-gas might be forced into a house with every fall of the barometer.

Lastly we would allude to the effect of the barometer on the escape of fire-damp from coal-seams. Coal is a rock subject to jointing; seams are not only broken through and displaced by faults, but for some distance from the main fracture are traversed by joints and smaller shifts resulting from the general strain. A brief visit to a fiery portion of a mine is sufficient to show the part played by these small clefts. On every side is heard the monotonous hissing or bubbling of the escaping gas, often accompanied by the deeper note of a "blower," or one of those larger channels often observed in connection with faults. The gas is continously given off as a result of a slow decomposition taking place in the coal, and the amount that comes off indicates a great extent of connected fissuring. For though cavities charged with gas under pressure and liable to exhaustion are found, yet large "blowers" commonly continue active for years, and must therefore drain a large area of the seam. While the movement of the gas in the blower differs from that of the air in sandstone fissures, in being always in one direction, namely outwards, it is at the same time evident that the same cause which induces an outward current in the well would cause an increase in the outward current from the coal. The increase would be proportional to the capacity of the fissures; a fall in the barometer from thirty to twenty-nine inches for example would cause $\frac{1}{30}$th of the body of gas stored in the fissures to be added to the ordinary outflow. The liability to explosion with a falling glass has long been a subject of observation. When it is considered that a wide margin is usually allowed in the ventilation to ensure the sufficient dilution and removal of fire-damp, and that a number of other contingencies may bring about an explosion, it becomes evident that a powerful cause must be operating to make the influence of the barometric changes perceptible.

A. STRAHAN

[1] Baldwin Latham, Report of the British Association for 1881, p. 614.

[2] *Proc.* York Geol. and Polyt. Soc., *op. cit.*

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 25.—"Internal Reflections in the Eye," by H. Frank Newall, B.A.

The author in this paper describes the appearance and investigates the cause of a faint light seen under certain circumstances now to be related:—Stand opposite a uniformly dark wall in a darkened room. Direct the eye to any point in front, and keeping the eye fixed, and being ready to perceive any appearance out of the line of direct vision without moving the eyes towards it, hold up a candle at arm's length, and move it to and fro over about two inches on a level with the point fixed, and a little to the right or left of it. The faint light may be seen moving with a motion opposite to that of the candle on the other side of the point of direct vision.

Near inspection of the light shows it to be an inverted image of the candle, about equal in size, very faint.

Reasons related in the paper lead the author to offer the following explanation: the physical cause of the faint light or "ghost," is light which, proceeding outwards from the image of the candle, formed on the retina by the lens, is reflected back on to the retina by the anterior surface of the lens. This second image is "referred" outwards, and seems as if produced by a faint source of light outside the eye.

The effects of alterations of the state of accommodation on the appearance of the ghost are described; the question as to whether the retina is to be regarded as a screen or as a *regular* reflector is discussed; and the results of calculations based on numbers given by Helmholtz for his schematic eye are noted as forming a difficulty in the explanation.

If the candle be replaced by sunlight, further observations are to be made: (1) signs of the faulty centering of eye-surfaces, as shown by the fact that the sun and its ghost do not arrive at the centre of the field of vision together; (2) signs of oblique reflection at a concave mirror, as shown by the fact that the ghost is circular in only one state of accommodation, whilst in other states it is extended either in a horizontal direction for near focus, or in a vertical direction for distant focus.

To about four out of fifteen persons the author has failed to show the ghost; but no relation is as yet observed between the visibility of the ghost and the kind of sight of the observer, as defined by the ordinary terms, long- and short-sightedness.

A second "ghost," probably due to reflections entirely within the lens, is referred to in the paper: but this, on account of its indistinctness, has not been investigated, except to establish the fact that its motion is the same in direction as that of the candle in the circumstances above related.

February 1.—On the Electrical Resistance of Carbon Contacts, by Shelford Bidwell, M.A., LL.B.

The experiments described in the paper were undertaken with the object of investigating the changes of resistance occurring in carbon contacts under various conditions.

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