a reed, which could be kept in continuous vibration by a stream of air. Musically, owing to Mr. Hamilton's immense enthusiasm and perseverance, the result appears to be a success, but is, I think, acoustically considered, something very different from what was originally intended. I believe that the instrument ought to be regarded rather as a modified reed instrument than as a modified string instrument.

Let us consider the matter more closely. The string and reed together form a system capable of vibrating in a number, theoretically infinite, of independent fundamental* modes, whose periods are calculated by Mr. Bosanquet. The corresponding series of tones could only by accident belong to a harmonic scale, and certainly cannot coexist in the normal working of Mr. Hamilton's instrument, one of whose characteristics is great sweetness and smoothness of sound. I conceive that the vibration of the system is rigorously or approximately simple harmonic, and that accordingly the sound emitted directly from the reed, or string, or from the resonance-board in connection with the string, is simple harmonic. On the other hand, it is certain that the note actually heard is compound, and capable of being resolved into several components with the aid of resonators.

The explanation of this apparent contradiction is very simple. Exactly as in the case of the ordinary free reed, whose motion, as has been found by several observers, is rigorously simple harmonic, the intermittent stream of air, which does not take its motion from the reed, gives rise to a highly compound musical note, whose gravest element is the same as that of the pure tone given by the string and resonance-board. One effect of the string, therefore, and that probably an important one, is to intensify the gravest tone of the compound note given by the intermittent stream of air.

The fact that the *pitch* of the system is mainly dependent upon the string, seems to have distracted attention from the important part played by the stream of air, and yet it is obvious that wind cannot be forced through such a passage as the reed affords without the production of sound. A few very simple experiments would soon decide whether the view I am advocating is correct, but I have not hitherto had an opportunity of making them properly. I may mention, however, that I have noticed on one or two occasions an immediate falling off in the sound when the wind was cut off, although the string and reed remained in vibration for a second or two longer. A resonator tuned to one of the principal overtones was without effect when held to the string, but produced a very marked alteration in the character of the sound when held to the reed.

It will be seen that according to my explanation the principal acoustical characteristic of the string—that its tones form a harmonic scale—does not come into play, the office of the string being mainly to convey the vibration of the reed itself (as distinguished from the wind) to the resonance-board and thence through the air to the ear of the observer. A second advantage due to the string appears to be a limitation of the excursion of the reed, whereby the peculiar roughness of an ordinary reed is in great measure avoided.

I should mention that I have not seen anything of the instrument for the last six months, in which time I understand great progress has been made.

RAYLEIGH

* In the *mechanical*, not the *musical* sense

ICE PHENOMENA IN THE LAKE DISTRICT

DURING the severe frost at the close of last year, some excellent opportunities were afforded of observing various phenomena in connection with the formation and fracture of large sheets of ice. After the ice had attained a thickness of some inches on Derwentwater and Bassenthwaite Lakes, the continued cold—with the thermometer for several days eight or nine degrees below the freezing-point (Fah.), even at mid-day—caused such shrinkage in the ice that cracks of great length were now and then produced with a noise almost like the firing of a small cannon. These cracks frequently passed quite across the lake, and presented many points of interest, especially to the geologist. In some cases two cracks met at an angle, as in Fig. 1; sometimes three cracks radiated from a central point, as we may often see in a cracked plate; and occasionally one long and wide crack would appear to have shifted others crossing it, just as a fault shifts beds or veins, as in Fig. 2, where the portions were shifted about two inches, and in the same direction in the case of several distinct cross cracks.

Some of the cracks were so much as two inches wide, and presented curious and interesting vein-structures. One class of crack was vertically veined, presenting the appearance of a number of thin sheets of opaque ice placed on end close to one another. Such cases reminded me strongly of vertically banded felstone dykes occurring a little north of Wastwater. Their formation may be explained thus:—The crack when first formed is exceedingly fine, but water soon finds its way into it, and freezing *quickly*, becomes a thin vertical seam of opaque ice. A second and a third opening of the crack occurs, and a new vertical sheet is formed each time. Thus the whole crack becomes filled, as it widens, with successive vein-like sheets of ice. At one spot on Bassenthwaite Lake I observed two of these veined cracks crossing one another, as in Fig. 4; the one of less width ran for about one foot in the direction of the other, and then passed out, maintaining the same general direction as it previously had. Here then was another example of what occurs so frequently among rock-veins, the newer vein conforming for a short distance with the direction of the older, and thus at first sight giving the appearance of its having been shifted by the latter. In this connection compare Fig. 4 with Fig. 2; in the latter case the smaller cracks seemed certainly to have been the first formed. At some spots quite a plexus of intersecting cracks were seen, and it was of interest to notice how frequently this combination resembled the faults laid down upon a geological map.

Another circumstance, suggestive on a small scale of geological phenomena, was the curious way in which the ice for about a mile and a half over the course of the Derwent, as it flowed into Bassenthwaite Lake, was raised into a low and broken anticlinal. For some time after the ice had formed over the greater part of the lake, a line, first of open water and then of thin ice, followed the river course for some distance, until its waters lost their distinctness in the general body of the lake. In the meantime, from the dryness of the weather and the continuance of the extreme frost, the ice subsided with the waters, and produced a gentle upheaval over the course of the river, which upheaval, however, seemed generally to have resulted in a more or less sharp ridge usually fractured in the direction of its length, and but seldom showing cracks of any size passing quite through from one side to the other.

Cracks showing a vertically veined structure have already been mentioned; these seem in all cases to have opened little by little, and to have been quickly filled with successive thin sheets of opaque ice; they probably never stood open and full of water for any length of time, but were the results merely of the contraction of the ice under the extreme cold. Another class of cracks, however, seem to have been wide and gaping during a thaw, and to have been suddenly sealed up by the freezing of the liquid contained between the sides. It is well known that as a general rule the more quickly a body solidifies from a liquid condition the greater the number of cavities—liquid and gaseous—it will contain, the liquid being frequently entrapped in the growing solid, and the gas not having time entirely to make its escape. In the case of many of these open cracks it would seem that the freezing took place so rapidly when it once began, that the air could not be all expelled, but the air-bubbles were lengthened out in their endeavour to set themselves free, and preserved in the form of very delicate tubes, pointing from the crack walls on either side slightly downwards and towards the centre, where solidification would last take place (Fig. 5). Along the central line of the crack occurred another series of perpendicular tubes caused by the elongation of the bubbles in the only direction then

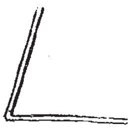

FIG. 1.

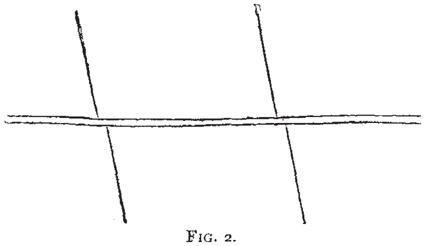

FIG. 2.

possible to them. Nothing could exceed the beautiful regularity of structure thus caused. In a few instances there was a double series of such an appearance as is represented in Fig. 5, the crack having again opened, apparently, along the same line, and a similar structure to the former having been produced. In this connection it is interesting to note the seemingly frequent evidence of fracture recurring along the same lines, especially if the explanation given above of the vertically-veined cracks be the correct one.

The drawn-out air-bubbles were also particularly beautiful around the stones and rocks in the shallow water at the edge of Derwentwater. Much of the very smooth ice which covered the lake on the morning of Wednesday, the 23rd of December, had been formed under a very sharp and sudden frost, the thermometer in a sheltered position registering 18° of frost. The ice would first form around the stones in shallow water, and form more quickly there than out in the open, where there were no marked centres of crystallisation; hence the number of bubbles entrapped were greatest around the stones and rocks close to the surface, at the lake-edge;

FIG. 3.

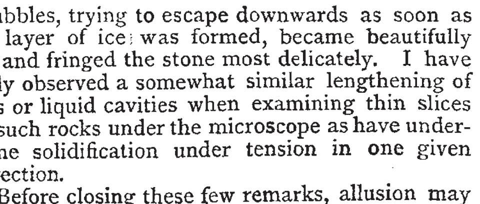

FIG. 4.

and the bubbles, trying to escape downwards as soon as the upper layer of ice was formed, became beautifully drawn out and fringed the stone most delicately. I have occasionally observed a somewhat similar lengthening of gas or liquid cavities when examining thin slices of such rocks under the microscope as have undergone solidification under tension in one given direction.

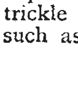

FIG. 5.

Before closing these few remarks, allusion may be made to two other effects noticed during the late frost. One of these is the precise analogy between the deposits of ice often formed on a rocky slope, or by constant dripping from above, and the deposits of carbonate of lime formed in caverns. The trickle of a thin stream of water over a rocky slope, such as may be seen in many parts of the Clapham Cave, deposits a wrinkled wavy layer of carbonate of lime, and over it the water seems ever to keep up a rhythmic flow. Upon rocks near the summit of Honister Pass I noticed during the late frost an icy sheet precisely similar, and with the same pulsating streamlet flowing over, while, hard by, there were sheets of icy stalactite and stalagmite only to be distinguished from those of limestone caverns by their greater clearness.

Another feature of great beauty was the effect of the bright sunshine on the icy crystals scattered broadcast over the snow of Skiddaw. Looking slightly away from the sun at a certain angle, and inclining one's head so as to look along the ground, there appeared scattered in boundless profusion thousands of brightly coloured gems, blue and green being the most marked colours, but many a ruby lying interspersed with these mountain emeralds. Assuredly Skiddaw top never showed to greater advantage than during those cloudless wintry days of the Christmas and following week; and it seems a marvellous pity that of the thousands who visit this favoured spot during the hot days of summer or the wet ones of autumn, so few should ever return to see their majestic friends

"Clothed in white samite, mystic, wonderful."

It may interest some to learn that something analogous to a Swiss glacier was once observed among our Cumberland mountains. Beneath the summit of Dale Head, 2,500 feet high, is an old copper mine, and many years since two miners entered the old workings in the month of June to obtain some mineralogical specimens. Great was their surprise to find the level, but a short way in, full of snow and ice. The mountain-slope is there very steep, but with many a hollow and rugged fissure in which the snow lies long, and doubtless it had found its way from above into the old level, as well as having been blown in at the mouth. The trickling of tiny streams among this snow, and the alternations of frost and thaw so frequent upon the mountain sides, must have produced an icy mass, which would be long ere it melted, and thus a natural ice-house was well supplied with ice far into the summer. The winter previous had, I believe, been a very snowy one, and it is not likely that the phenomenon is of very frequent recurrence.

J. CLIFTON WARD

SCIENCE AT BANBURY

AT the opening of a new Literary and Philosophical Society at Banbury the other day, Mr. B. Samuelson, M.P., gave an inaugural address in which he touched on various topics connected with the progress of science and scientific culture. We regret that our space prevents us from giving Mr. Samuelson's address at length; the following extracts, however, we believe, will interest our readers:—

"There have, doubtless, been times when the pursuit of learning was carried on with as much ardour, when as great sacrifices were made for the discovery of truth, or when there was at least an equal toleration for differences of opinion, as in our generation; but I think it may safely be asserted that at no period since the revival of letters in the fifteenth and sixteenth centuries have these conditions, essential as they are to the success of our objects, coexisted to the same extent as in our day. It may not be one of the least useful and interesting subjects of inquiry for our society how this favourable conjuncture has arisen. Probably it will be found to be one, and if so, certainly not one of the least important, of the results of the great material changes which have their origin in the substitution—begun in the age of Watt, and still in course of development—of machinery for manual labour. At any rate we may congratulate ourselves that the experience of the present age proves the dogma to be fallacious which