where it would seem to have proved a great success, although coupled with conditions which would hardly have been accepted by an American artisan. I do not know what interest our railway-companies take in the personal welfare of their employees; but the examination of what is done by the Western railway of France, as exhibited and explained to the association, is suggestive of a philanthropic as well as of a business institution. Bedrooms, baths, eating-rooms, medical attendance, savings bank, and life-insurance are among the privileges provided by the company, of which each and every employee may avail himself according to circumstances.

The prominence of engineering questions was due to a cause which shows that human nature is much the same through the civilized world. Rouen is engaged in river improvements, of which the object is to make it a great seaport; in fact, to make it to Paris what Liverpool is to London. Great pains were therefore taken to secure the attendance of distinguished engineers from abroad as well as from home; and harbor improvements, especially those of Rouen, formed the most prominent subjects of discussion in the section of engineering. How far the French association is ready to go beyond its fellows in this direction, is further shown by the fact that one of the prominent papers in the engineering section was devoted to the exposition of a scheme for a metropolitan railway in Paris, similar in its object to those of London and New York, which could be built at a cost of two hundred million francs. No one hinted that the subject was not germane to the objects of the society.

There is at least one custom of the meeting worthy of imitation by the American association; namely, evening lectures by members, on subjects of general scientific interest. These lectures are not gotten up at hap-hazard on the spot, but are arranged by the secretaries, long enough in advance of the meeting to admit of careful preparation. Those of the Rouen meeting were: The transit of Venus, by Mr. Hatt, chief of one of the French expeditions; and on the Transmission of energy, by Professor Comberousse. The general character of these lectures was the same so familiar to us at home; but it was noteworthy, that French science was almost exclusively considered. Occasional references to the works of other nationalities were rather to show that the speaker knew something about them, than to give full information respecting them.

In two points the French association makes a decidedly more favorable showing than our own. One has already been mentioned, — the absence of the respectable gentleman who writes interminable essays on scientific subjects of which he knows nothing except from current literature. In the mathematical section, the papers read were of decidedly greater importance than those to which the American association is accustomed. The other is the financial condition of the society. In few respects does American science show to greater disadvantage, beside that of Europe, than in its power of raising money to promote its objects. The income of the French association for the current year was reported at 85,000 francs. It has already an invested capital of about 450,000 francs. It expended 39,000 francs in printing its proceedings, 20,000 in administrative expenses, and 14,000 in grants for researches of various kinds.

Let us compare this sum total with the income of the American association.

Income of French association	$16,600
" American "	8,943
Difference in favor of France	$7,657

And we must remember that this is not a case in which the excess is due to greater age; for the French society is only one-fourth the age of the American. The comparison will afford us food for profitable reflection.

EVIDENCE FROM SOUTHERN NEW ENGLAND AGAINST THE ICEBERG THEORY OF THE DRIFT.[1]

In presenting to the association evidence from southern New England with regard to the insufficiency of the iceberg theory of the drift, I shall have to say some things that have often been said before, and by various investigators. But I may claim for what is here brought forward, that it is, in my own mind, the fortified conclusion of long-continued investigation.

The arguments on the subject are derived from three sources, —

I. The scratches and groovings over the rocks.

II. The transported bowlders and other material.

III. The facts as to the relative level of the land and sea.

I. The scratches or grooves over the rocks.

Under this head there is, first, the old argument based on the universal distribution of the scratches over the region of all New England. These effects of abrasion are to be

[1] Read at the Minneapolis meeting of the American association for the advancement of science.

found everywhere beneath the soil, each fresh exposure of the rocks bringing them to light. This was said years ago; and the conviction of its truth has been gaining force with every year of additional observation.

a. In view of this fact, it is urged rightly that only an abrading agent that pressed heavily against the broad rocky surface could have produced the effects; and such is not an occasionally grounding iceberg, or a succession of them. Neither is it the still more locally acting shore-ice.

b. Floating ice would have found little bare rock over the sea-bottom to be abraded. Like the bottom of existing seas, and eminently those of the continental borders, the submerged region would have had for the most part a bottom of detritus, its former detritus, and additional detritus from later depositions. The removals would have been local, and relatively of small area. Consequently, the drifting ice would rarely have reached down to the rocks. Shore-ice carried along by the currents would have had a better chance, and yet a poor one, for the work to be done.

c. The character of the groovings and ploughings is, to a great extent, such as floating ice could not have produced. As has been often said, the close uniformity of direction and parallelism over large areas, which so generally prevails, is not a possible result of iceberg action. The needed pressure and steadiness of movement are wanting. Troughs in hard granite even six inches deep are the work of one and the same moving tool for a long period; and one year would be long for the steady action of an iceberg. If grounded, it would do almost nothing; if floating free, absolutely nothing; and a nice adjustment to depth would be required for any steady abrasion, much nicer than would have long continued anywhere over the uneven bottom.

In the triassic sandstone of East Haven, Conn. (just east of New Haven), at a place where the sandstone is a very firm, thick-bedded, gritty rock, the ploughing ice ploughed out a piece of moulding, somewhat like the *ogee* of the carpenter, which was 8 feet deep, 25 feet wide, and over 150 feet long, and perfectly even in surface as well as direction.

d. The currents that would have borne along the icebergs over submerged New England, in case of a submergence sufficient to cover the highest striated surfaces, — 3,000 to 5,500 feet, — would have been those of the present ocean, the Labrador current, and Gulf stream; and, with less submergence, the same in part, modified by the courses of the valleys and the tides.

It is to be noted, that the New-Haven region, in Connecticut, is the southern extremity of the Connecticut valley. The mean trend of this valley in Connecticut is about S. 15° W., and, in southern Connecticut, S. 18° W. Now, the numerous scratches over the *eastern* portion of the New-Haven region average in direction S. 16° W.; but along its *western* border, where the rapidly rising slopes give the region rather an abrupt limit 150 to 350 feet high, the scratches have an average course of S. 33° W., the extreme being S. 27° W., and S. 55° W.; and S. 33° W. is the almost uniform trend over the undulating surface of the country for six to nine miles west. It is, as far as I can see, impossible that the valley stream should have had on its west side so wide a divergence from the direction of the Connecticut valley: all the features of the region oppose it. The scratches are well exposed over the metamorphic rocks in many places; and large and perfect examples of *roches moutonnées* here occur.

Again: over the higher lands of western Connecticut (and of New England generally, according to the observations of Prof. Edward Hitchcock, Prof. C. H. Hitchcock, and others), the direction of the scratches is south-eastward. To have produced them, if icebergs were the agent, the submergence should have exceeded 2,500 feet, and this would have given a chance for the full play of the oceanic currents; and yet the above direction does not correspond with that of either of the great currents.

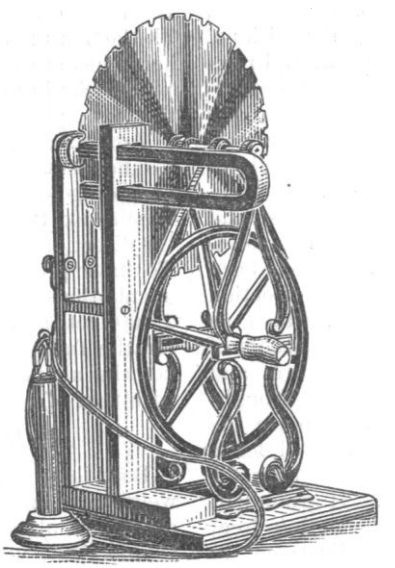
II. Distribution of the drift.

Bowlders of trap, from 50 to 1,000 tons in weight, are numerous in the New-Haven region, especially along its western border. All are Connecticut-valley travellers; for the trap ridges of the valley — 400 to 1,300 feet in height — are the only possible source. They were gathered up by the ice from these trap ridges, and were carried 15 to 60 miles down the valley. It is mechanically impossible that the larger bowlders should have been taken up, or gathered in any way, by floating ice; either shore-ice, where the water was but 1,000 feet deep and less, or by that of icebergs, where the depth was greater.

It is well known, that the distance of drift transportation is in general less than 20 miles. Hills of but 100 feet often have their long trails. A moving glacier would easily gather and carry along the material from hills, high or low, wherever loose or detachable masses of rock or gravel existed to be gathered; while floating ice would be very poor at gathering, and hence inefficient in distributing.

III. Relative level of the land and sea.

I have examined carefully along southern New England for proofs of the quaternary submergence which the iceberg theory assumes to have existed in the glacial era. I thought at one time that I saw evidence about New Haven of a submergence of 45 to 50 feet. But the terrace that afforded the evidence was situated six miles back from Long Island Sound, adjoining the rivers; and on further examination I found that the deposits had precisely the structure of those along the river-valleys farther north, and that, in fact, they were nothing but fluvial formations. The highest terraces on or near the shores of the sound, in the vicinity of New Haven, have a height above mean tide of 23 to 26 feet; and on Milford bay, nine miles west, a similarly situated terrace has a height of 30 to 33 feet. Along the hills facing the waters, and the southern extremity of the valleys, no traces of any higher level exist. Twenty-five to thirty-five feet is the greatest amount of submergence the facts sustain. Sea-border deposits exist at a higher level on the coast of Maine and on the shores of the St. Lawrence, and show what was the position of the shore-line in those regions. But the level along southern New England is not proved by the facts there gathered, neither is it established by the demands of the iceberg theory.



In conclusion, if icebergs, or floating masses of ice, were not capable of covering with scratches great continuous areas, and would have had a chance for little rock-abrasion on account of the covering of detritus; if they could not have made, in their hitching and swinging way of action, when touching bottom, scratches over great areas, that had the even course and parallelism characterizing those of drift regions, or could not have ploughed out the deep furrows; if they could not have gathered the great bowlders for transportation; and if the sea along the sound did not cover the land, in any part of the era of ice, to a greater depth than 30 or 35 feet, — the iceberg theory of the drift may be reasonably pronounced unsatisfactory for southern New England; and similar facts show that it is equally unsatisfactory for the rest of New England.

James D. Dana.

THE MAGNETOPHONE.[1]

The experiments of Bell,[2] Preece,[3] Mercadier,[4] and others on the radiophone, suggested to me the possibility of interrupting, or at least periodically modifying, the lines of force proceeding from the poles of a magnet, by means of a disc of sheet iron, perforated with a series of equidistant holes, and rotated so that the holes should pass directly in front of the magnetic pole. It is well known that an armature, placed on the poles of a permanent magnet, diminishes the strength of the external field of force by furnishing superior facilities for the formation of polarized chains of particles from pole to pole. This is the case even when the armature does not touch the poles, but is in close proximity to them.

If a piece of sheet iron be placed over the poles of a magnet without touching, and the magnetic curves be developed on paper above the iron, they will be found to exhibit less intense and less sharply defined magnetic action than when the sheet iron is removed. If, however, a small hole be drilled directly over each magnetic pole, the screening action of the sheet iron is modified in much the same way as when a hole is made in a screen opaque to light; for the developed curves show distinctly the outline of the holes. If, therefore, the sheet iron in the form of a circular plate, pierced with a number of holes, be rapidly rotated between the pole of a magnet and a small induction bobbin, the action of the magnet on the core of the bobbin will be periodically modified because of the passing holes; and hence induced currents will flow through a circuit including the bobbin. A disc of sheet iron was pierced with two circles of quarter-

[1] Read at the Minneapolis meeting of the American association for the advancement of science.

[2] Proceedings Amer. assoc. adv. sci., xxix. 115. Smithsonian misc. col., xxv. 143.

[3] Proceedings Royal society, xxxi. 506.

[4] Journ. phys. x. 53.