The Eruption of Krakatoa

The Krakatoa committee of the Royal Society has made its final report, which forms a large quarto volume, and contains a mass of material of the greatest interest. After the remarkable phenomena following the eruption of Krakatoa on Aug. 27, 1883, became first known, and when the optical phenomena attracted increasing attention of the whole civilized world, the Royal Society of England, on Jan. 17, 1884, passed the following resolution: "*Resolved*, That a committee . . . be appointed, to collect the various accounts of the volcanic eruption at Krakatoa, and attendant phenomena, in such form as shall best provide for their preservation, and promote their usefulness." . . . [Their] work is divided into five parts: 1. 'On the Volcanic Phenomena of the Eruption, and on the Nature and Distribution of the Ejected Materials,' by Prof. J. W. Judd; 2. 'On the Air-Waves and Sounds caused by the Eruption,' prepared in the Meteorological Office, and presented by Lieut.-Gen. R. Strachey; 3. 'On the Seismic Sea-Waves caused by the Eruption,' by Capt. W. J. L. Wharton; 4. 'On the Unusual Optical Phenomena of the Atmosphere, 1883-86, including Twilight Effects, Coronal Appearances, Sky Haze, Colored Suns, Moons, etc.,' by the Hon. F. A. Rollo Russell and Mr. E. Douglas Archibald; 5. 'Report on the Magnetical and Electrical Phenomena accompanying the Eruption,' by G. M. Whipple.

The most interesting part of Professor Judd's account is his theory as to the part played by water in causing or aiding eruptions. He believes that the disengagement by heat of volatile substances actually contained in the lava is the primary cause of volcanic activity. He proves that the melting-point of all lavas of Krakatoa of different ages, although of the same chemical composition, vary to a great extent according to the amount of water contained in them, their fusibility being greater when water is present. In this case, on melting, they develop a great amount of gases. . . .

In the second part, General Strachey discusses the remarkable atmospheric oscillations, which, starting from Krakatoa, moved as many as seven times over the earth. Their propagation from the volcano to its antipodes and back is shown on a number of interesting maps. The principal results of the inquiry into the movements of this disturbance are, that it had very nearly the characteristic velocity of sound, ranging from 648 to 726 English miles an hour, and that its mode of propagation by an aerial oscillation of comparatively short duration was also closely analogous to that of sound. . . .

"The path of the wave that passed over the Canadian and United States stations, and Havana, lies nearly on the meridian drawn through Krakatoa, and must have crossed both the polar circles near the poles." . . .

In the second part of General Strachey's report a list of places is given at which the sounds of the explosions at Krakatoa were heard on the 26th and 27th of August. In all directions the sound was heard at a distance of two thousand miles from the volcano, while south-westward it was even noticed at Rodriguez, very nearly three thousand miles from Krakatoa. . . .

In the long discussion on the proximate cause of the unusual twilight phenomena, F. A. Rollo Russell arrives at the conclusion that a dry haze at a great altitude was their cause. The physical conditions of this phenomenon were the reflection of sunlight on small vitreous surfaces when the intervening air is darkened. . . . [T]he structure of the haze resembled more that of smoke than that of the highest clouds; and previous effects seen in years of great eruptions, and in places affected by an excess of dust in the air, are very much like those observed in 1883 and the following years. In the same section of the report the colored appearances of sun and moon, which were confined to the tropics, the sky haze, and the corona, are discussed. E. Douglas Archibald, who is the author of the last-mentioned part of the report, describes the corona, which is generally known as 'Bishop's ring,' very thoroughly, and shows that it was probably formed in the haze stratum, and that it was formed by diffraction. Its great size proves that this haze was composed of exceedingly small particles, the diameter of which is computed at .00159 of a millmetre.

Excerpted from *SCIENCE*, vol. 12 (old series), 9 November 1888, pp. 217-219

100 YEARS OF

The Coal Question in England

The very serious problem of coal-supply has received a thorough review in a recent number of *Nature*. In 1861 the question was considered by Mr. Hull, who estimated that the available coal in Great Britain represented a total amount of 79,843,000,000 tons, which, consumed at the annual rate of 100,000,000 tons, would last about eight centuries. This estimate was later proved to be too high. . . .

In 1881, 154,000,000 tons were extracted. . . . The output shows considerable fluctuation from year to year—as might be expected from the variety of accidental circumstances, such as new inventions, the mean annual temperature, and the state of trade,—but, on the whole, a very rapid increase; the output for 1875 being double of that for 1854, and that for 1883 double that for 1862; and, if the amount extracted increases at this rate (3,000,000 tons annually), the supply will be exhausted in the year 2145 A.D. . . . One of four things must then happen,—either some new source of energy must be supplied, or a larger per cent of the coal must be utilized, or coal must be imported, or England must give up her manufactories. It is doubtful if any new source of energy on a large scale will be discovered, unless some explosive be used for the purpose. . . .

While it is hardly possible to use less coal, we may get more energy out of it; for at present, out of a theoretical 10,000,000 foot-pounds of work which one pound of coal can supply, we only get 1,000,000 foot-pounds. But instead of a decrease in the waste, there is likely, on the contrary, to be an increase; for each year faster speed is demanded by rail, and steamships are rapidly replacing sailing-vessels. . . . The idea of importation is hardly practicable, for the nearest coal-mines of any extent are in Canada and the United States. . . . To supply England with the necessary coal, 2,100 ships . . ., each carrying 6,000 tons and making thirteen trips a year, would be required. The cost would be necessarily greatly increased. In former times, England produced its own breadstuffs: now the greater part is imported. If coal becomes scarce, there will be no way of paying for food, emigration will begin, the death-rate will increase, the birth-rate decrease, and England will change once more to an open, cultivated country, devoid of all other industries.

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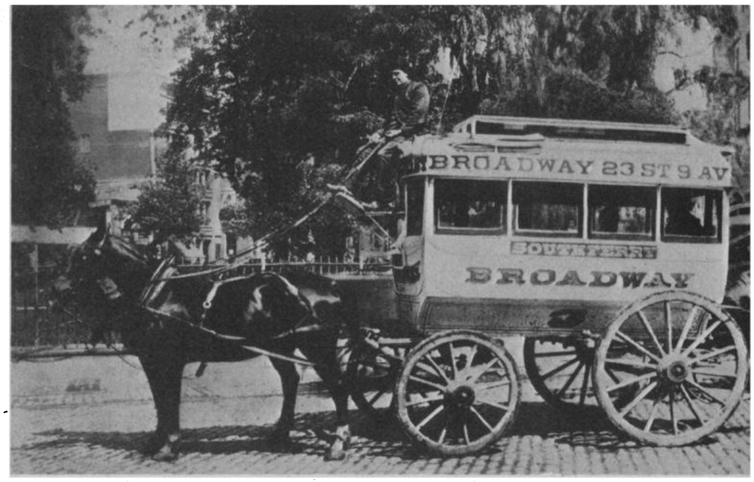
Electrical Science

The Solution of Municipal Rapid Transit



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The paper read by Mr. F. J. Sprague before the Institute of Electrical Engineers, on municipal rapid transit, is both valuable and timely. In the first part of the paper the inadequacy of the almost universal system of horse-car traction is pointed out, and a comparison is made between horses, cables, and electricity. Taking up horses, Mr. Sprague says: " Two distinct methods are recognized among street-car men in the handling of their stable equipments. In one the stock of horses is kept as low as possible: they are worked hard, making fourteen or fifteen miles a day, and the depreciation is heavy. In the other the stable equipment is increased, the horses are kept in excellent condition, their average daily duty is reduced to ten or twelve miles, and the depreciation is lessened." As an example of the equipment required, on the Fourth Avenue line in New York, run on the latter plan, the car day is eleven hours, and eight horses make about five trips, aggregating about fifty miles. To the number of horses is added ten per cent for illness, and ten per cent for emergencies; that is nearly ten horses for a car, making fifty miles a day. The average cost of motive power per car day throughout the United States is about four dollars, counting the cost of only those horses that are actually on duty. The cost per day per horse in New York is on the average fifty-four cents, and the cost for motive power per car mile ten cents.

For electric traction Mr. Sprague claims the following advantages. It will do the work more satisfactorily and at a less cost than horses; on levels and up and down grades electric-motor cars can be run much faster than horse-cars; they can be gotten under way and stopped much more quickly; the equipment will occupy thirty-five per cent less space than horse-cars, the horse space being saved, and this fact, together with the ability to back when necessary and to quickly gain headway, enables an electric car in a narrow and crowded street to work a passage through where horse-cars would be stopped. Electric cars can be run more safely on down grades, since if the brake-chain breaks the car can be controlled by the motors, reversing when necessary. The motion of an electric car is smooth, and its starting and stopping are easy; the cars are clean, they can be lighted and heated by electricity; the streets are cleaner, and objectionable stables are not needed. It becomes feasible to operate branch lines, and also combinations of grades, curves, and ill-conditioned streets, that would be prohibitory to any other system.

This road has been running long enough to allow reliable figures as to the expense being obtained. It is found that the cost of power is $1.48 per day, the car making eighty miles, and of material, labor, and depreciation, $1.98 per car day; the total being $3.46 per car day, or 4.32 cents per car mile. This is to be compared with the ten cents a car mile that horses cost, and in the latter estimate there is no allowance for depreciation of cars, etc. At present there is a saving on this line of $125 a day as compared with horses. The passengers carried are over 10,000 per day.

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The Digestibility of Cellulose

It is a well-established fact, that a considerable portion of the woody fibre which is consumed in such large amounts by herbivorous animals does not re-appear in their excrements, but is apparently digested. In what portion of the alimentary canal, or by means of what secretion, this digestion is accomplished, has been the subject of much speculation and of some experiments; but, until recently, neither had done much to illuminate the matter.

Hofmeister[1] seemed to have gone far towards solving the question when he found that a considerable solution of the cellulose of grass took place in the rumen of sheep. He first enclosed two small samples of fresh grass in cages of german-silver wire covered with muslin, and introduced them into the rumen of a living sheep. After three days the animal was killed, the cages removed, and their contents examined. It was found that seventy-eight and four-tenths per cent of the woody fibre originally present had been dissolved. Subsequent experiments showed that the fluid obtained from the rumen of a freshly killed sheep had also a powerful solvent action on woody fibre . . .

These results point unmistakably to the first stomach of ruminants as one place where cellulose is digested. . . . Tappeiner[2] took samples of the contents of rumen, small intestine, and large intestine, of a ruminant fed exclusively on hay. One sample from each portion of the alimentary canal was at once boiled; to a second some antiseptic (chloroform, thymol) was added, sufficient to stop the action of organized ferments; while to the third nothing was added. All were kept warm, and after a time their content of crude fibre was determined. Those portions from the rumen and large intestine, to which nothing was added, were found to have lost cellulose, while carbonic acid and marsh-gas were evolved. No loss was observed from the contents of the small intestines, nor from the samples treated with antiseptics. Further experiments showed that this fermentation could be produced outside the body. To hay or pure cellulose, mixed with extract of meat, and previously heated to 110°C., a drop of fluid from the rumen was added. After a few days, active fermentation began. Gas was freely evolved, consisting of about seventy-six per cent of carbonic acid and twenty-four per cent of marsh-gas, and the cellulose nearly all disappeared. A second kind of fermentation was also observed, which yielded carbonic acid and hydrogen. In both kinds of fermentation, only the smaller part of the cellulose was volatilized, most of it being converted into acids of the fatty series.

[1] *Biedermann's centralblatt*, Jahrg. x.p.669

[2] Thier. chem. ber., xi.303,xii.266 and 272; *Zeitschr. fur biologie*, xx. 52

Excerpted from *SCIENCE*, vol. 5 (old series), 2 January 1885, p. 11