currents keep entirely to the outer skin, penetrating only a fraction of a millimetre into iron, and they make this skin intensely hot. But the central core keeps cool until conduction has time to act; and consequently, unless the wire is so thin as to be bodily deflagrated by the discharge, its continuity is not likely to be interrupted. Thickness of wire is thus more needed in order to resist ordinary deterioration by chemical processes of the atmosphere than for any other reason.

But the liability to intense heating of the outer skin should not be forgotten, and care should be taken not to take the wire past readily inflammable substances for that reason. For instance: it would be madness to depend on Harris's notion that a lightning-conductor through a barrel of gunpowder was perfectly safe, especially if said conductor were an iron wire or rod.

In the old days a lightning-conductor of one or two hundred ohms resistance was considered dangerously obstructive, but the impedance really offered by the best conductor that ever was made to these sudden currents is much more like 1,000 ohms. A column of copper a foot thick may easily offer this obstruction, and the resistance of any reasonably good earth connection becomes negligible by comparison. A mere wire of copper or iron has an impedance not greatly more than a thick rod, and the difference between the impedance of copper and iron is not worth noticing.

But although, in respect of obstructing a flash, copper and iron and all other metals are on an approximate equality, it is far otherwise with their resistances, on which their powers of dissipating energy into heat depend. It is generally supposed that iron resists seven times more than copper of equal section, and so it does steady currents; but to these sudden flashes its resistance is often a hundred times as great as copper, by reason of its magnetic properties. This statement is quite reconcilable with the previous statement, that in the matter of total obstruction there is very little to choose between them: the apparent paradox is explicable by the knowledge that rapidly varying currents are conveyed by the outer skin only of their conductor, and that the outer skin available in the case of magnetic metals is much thinner than in the case of non magnetic.

Questions about shape of cross-section are rather barren. Thin tape is electrically better than round rod, but better than either is a bundle of detached and well-separated wires (for instance, a set of four, one down each cardinal point of a chimney); but it is easy to overestimate the advantage of large surface as opposed to solid contents of a conductor. The problem is not a purely electrical one: it is rather mixed. The central portion or core of a solid rod is electrically neutral, but chemically and thermally and mechanically it may be very efficient. It confers permanence and strength; and the more electrically neutral it is, the less likely is it to be melted. Its skin may be gradually rusted and dissolved off, or it may be suddenly blistered off by a flash; but the tenacity of the cool and solid interior holds the thing together, and enables it to withstand many flashes more. Very thin ribbon or multiple wire, though electrically meritorious, is deficient in these commonplace advantages.

There were two functions attributed to high conducting-power in the old days, — first, the overpowering of all other paths to earth; second, the avoidance of destruction by heat. The first we have seen to be fallacious: on the second a few more explanations can be made. In so far as fusion by simple current strength is the thing dreaded, it must be noticed that a good conductor has no great advantage over a bad conductor. It is a thing known to junior classes, that, when a given current has to be conveyed, less heat is developed in a good conductor, but that, when an electromotive force is the given magnitude, less heat is developed in a bad conductor. The lightning problem is neither of these, but it has quite as much relationship to the second as to the first. There is a given store of energy to be got rid of, and accordingly the heat ultimately generated is a fixed quantity. But the rise of temperature caused by that heat will be less in proportion as the production of it is slow; and though by sudden discharge a quantity of the energy can be made to take the radiant form, and spread itself a great distance before final conversion into heat, instead of concentrating itself on the conductor, yet this cannot be thought an advantage, for, just as in the old days a lightning-rod was expected to protect the neighborhood at its own expense by conveying the whole of a given charge to earth, so now it must be expected to concentrate energy as far as possible on itself, and reduce it to a quiet thermal form at once, instead of, by defect of resistance and over-violent radiation, insisting on every other metallic mass in its neighborhood taking part in the dissipation of energy.

The fact that an iron wire, such as No. 5 or even No. 8 B. W. G., is electrically sufficient for all ordinary flashes, and that resistance is not a thing to be objected to, renders a reasonable amount of protection for a dwelling-house much cheaper than it was when a half-inch copper rod or tape was thought necessary.

A recognition of all the dangers to which a struck neighborhood is liable, doubtless prevents our feeling of confidence from being absolute in any simple system of dwelling-house protection; but at the same time an amount of protection superior to what has been in reality supplied in the past is attainable now at a far less outlay, while for an expenditure comparable in amount to that at present bestowed, but quite otherwise distributed, a very adequate system of conductors can be erected.

Only one difficulty do I see. In coal-burning towns galvanized iron wire is, I fear, not very durable, and renewal expenditure is always unpleasant. It is quite possible that some alloy or coating able to avoid this objection will be forthcoming, now that inventors may know that the problem is a chemical one, and that high conductivity is unnecessary.

NOTES AND NEWS.

THE seventh annual meeting of the Association of Official Agricultural Chemists, by a vote of a majority of the executive committee, is called to meet in Washington, in the lecture-room of the National Museum, at 10 A.M., on the 28th of August proximo.

— Professor R. S. Woodward, for many years chief geographer of the United States Geological Survey, has been appointed assistant in the Coast and Geodetic Survey. Professor Woodward was for ten years assistant engineer on the United States Lake Survey, and was assistant astronomer of the United States Transit of Venus Commission previous to his connection with the Geological Survey. He was chairman of the Section of Mathematics and Astronomy of the American Association for the Advancement of Science in 1889, and is widely known for his investigations in mathematics, astronomy, and physics. His appointment to the Coast and Geodetic Survey is a subject for congratulation on both sides.

— Records have been received, at the office of the United States Coast and Geodetic Survey, of observations made during the last cruise of the "Pensacola." The stations include the West Coast of Africa, and some islands in the North and South Atlantic. The work was done by an officer of the survey, Assistant E. D. Preston, aided by members of the ship's company. Gravity and magnetic measures were made at St. Paul de Loanda (Angola), Cape of Good Hope, St. Helena, Ascension, Barbadoes, and Bermuda. In addition, magnetic observations alone were made at the Azores (Fayal), Cape Verde Islands (Porto Grande), Sierra Leone (Freetown), Gold Coast (Elmina), and in Angola at Cabiri. The pendulums used in the gravity work were the ones employed in 1883 in Polynesia, and in 1887 at the summit of Haleakala and other stations in the Hawaiian Islands. The computations are now under way at the office in Washington.

— Mr. Ward McAllister called at the office of the Cassell Publishing Company, New York, the day before he left New York for his farm at Newport, and delivered the manuscript of his book, "Society as I have found it," into the hands of the president of the company. Since he decided to write the book, Mr. McAllister has worked on it every day, and only completed it in time to leave town before the Fourth of July. A glance at the manuscript shows that it will more than fulfil the expectations of the public. No more interesting volume of its kind has been written since

Lord Chesterfield's letters, which it strongly resembles, for it combines reminiscence with instruction, precept and anecdote running side by side through its pages. A portrait of Mr. McAllister, taken expressly for the purpose, will form the frontispiece of the book.

— At the third summer meeting of university extension and other students, which is to be held at Oxford in August, as stated in *Nature*, Mr. E. B. Poulton, F.R.S., will lecture on the influence of courtship on color, and Mr. Francis Gotch on the physiology of the nervous system; Professor Patrick Geddes will deal with problems of evolution, organic and social; Professor Green, F.R.S., will give a course on geology; and Mr. C. Carus-Wilson lectures on geological phenomena. "The Teaching of Geography," by Mr. H. J. Mackinder; "Protective Adaptations in Plants," by Mr. J. B. Farmer; and "Some Aspects of Light," by M. V. Perronet Sells, — are also subjects announced in the programme.

— It will be remembered that a set of metric standards, furnished by the International Bureau of Weights and Measures near Paris, was brought to this country last autumn, and that they were formally received by the President of the United States, in the presence of a number of distinguished men. The other set allotted to this government, consisting of Metre No. 21 and Kilogram No. 4, has just been brought from Paris by Assistant O. H. Tittmann, and has been deposited at the office of United States Standard Weights and Measures in the Coast and Geodetic Survey building at Washington.

—Under the auspices of the Royal Dublin Society, and partially aided by government, a scientific investigation of Irish fishing-grounds is now being carried on upon the south-west and west coasts of Ireland, as stated in *Nature* of July 3. The Rev. W. Spotswood Green, her Majesty's inspector of fisheries, Dublin, and Professor A. C. Haddon of Dublin, organized the expedition, which is expected to last four or five months. The screw steamer "Fingal," of Glasgow, 160 tons register, chartered for the cruise, left Queenstown on May 7, having on board Mr. Green, Professor Prince, Mr. T. H. Poole of Cork (special surveyor to the expedition), and a crew of seamen experienced in trawl, net, and line fishing. Professor Prince, who has conducted elaborate investigations upon the embryology of food-fishes at St. Andrews, and, later on, Mr. E W. L. Holt, also of St. Andrews Marine Laboratory, superintended the zoölogical department until Professor Haddon was able to join the steamer. Dr. R. Scharff of the Science and Art Museum, Dublin, and other gentlemen, have temporarily assisted on board. The "Fingal" has been specially fitted up for the work. Several beam-trawls (including patent forms), a quantity of mackerel-nets, thirteen miles of long lines, large tow-nets (after Professor McIntosh's pattern), microscopes and instruments for zoölogical and physical research, are included among the appliances. The coast from Cape Clear to Killybegs Bay (Donegal) has already been traversed, and about thirty stations have been tested, and results of value obtained. In the open sea and in inshore waters the eggs and larval stages of mackerel, ling, gurnard, haddock, turbot, witch, and other species of food-fishes, have been obtained; and a great variety of invertebrates, including some rare echinoderms, annelids, mollusks, etc., have been brought up in the dredge and trawl, the greatest depth tested so far being about a hundred fathoms. The estuary of the Kenmare River, Dingle Bay, Smerwick, Birterburg, and Roundstone Bays, and the harbor of Clifden, proved to be very rich in invertebrate forms, specimens of *Synapta inhærens* being abundant, while *Bonellia*, *Priapulus*, and many rare mollusks, *Lyonsia*, *Philine*, and various nudibranchs, were procured. Copepods, larval crustaceans, medusæ, echinoderms, and ascidians occurred in such quantities as to frequently cause great inconvenience. A fine example of *Orthagoriscus mola*, nearly nine feet in dorso-ventral measurement, was shot by Mr. Green, and secured; and the rare pleuronectid, *Arnoglossus gröhmanii*, was obtained in Clifden harbor, the second specimen captured in British seas. Deep-sea dredgings will be taken, and it is expected that the reports to be presented at the end of the cruise to the Royal Dublin Society, to the Irish Fishery Department, and the government, will be of unusual scientific interest.

— Mr. W. C. Macdonald, a merchant of Montreal, has just made a munificent contribution to McGill College, says *Nature* of July 10. He has given $150,000 to the law faculty for the endowment of the dean's and another chair, and also $50,000 for the endowment of a chair of experimental physics, and has offered to erect buildings for the faculty of applied science, to include class-rooms and laboratories. Altogether the value of Mr. Macdonald's gift is about $400,000.

— The July number of the *Kew Bulletin* contains further information on the cultivation and preparation of the coloring-substance known as annatto. The present instalment deals with the West African seed, which does not appear to possess the qualities of that from Jamaica. A new method of preserving grain from weevils is suggested, while there is a long correspondence on Colombian india-rubber. The letters contain an account of a tree which yields rubber, and which is known in commerce as *Colombia virgen*. It has the peculiarity of growing at high elevations, and therefore in a comparatively cool climate. Another section deals with the fibre-industry of the Bahamas; and particulars are given of the establishment of the botanical station at Lagos, the first of its kind on the West Coast of Africa. A letter from the curator, Mr. McNair, gives interesting information respecting some of the plants under experimental cultivation there.

— We learn from *Nature* of July 10, that according to the report of the Oxford University extension scheme which has been issued, and which comes up to the commencement of July, "since June, 1889, 148 courses have been delivered in 109 centres by 25 lecturers. Examinations were held at the conclusion of 119 courses, and the examiners have awarded certificates of merit or distinction to 927 candidates. The courses were attended by 17,854 students, and the average period of study covered by each course was 10 weeks." In 1885–86 the number of courses delivered was 27 only, and the number of lecture centres, 22. Among the chief signs of progress recorded are (1) a great extension of university teaching in small towns, (2) a marked increase in the number of working men attending the lectures, (3) the arrangement of a number of successful and well-attended courses during the early summer months, (4) the establishment of 36 students' associations at various centres, and (5) the federation in two new districts of the various lecture centres. The students' associations are very valuable, inasmuch as "they encourage the students to undertake regular reading throughout the year in preparation for, or in continuation of, the courses of lectures." The federation movement is also extremely helpful. It enables the difficulty sometimes experienced in procuring lecturers to be more easily surmounted, and it fosters and stimulates local interest in the study undertaken. The committee regrets that a greater proportion of students do not present themselves for examination; but those who do go through the ordeal appear, on the whole, to come out very creditably. Scholarships are given to the writers of the best essays on a number of subjects connected with those studied during the course; and "among the successful essayists," we are told, "were two carpenters, two clerks, a fustian weaver, an artisan employed in a government dockyard, and three elementary teachers." In an examination recently held, those who were awarded certificates included "a national school-mistress, a young lawyer, a plumber, and a railway signalman." Again, we are informed that "a course of lectures on zoölogy recently given by an Oxford lecturer in Devonshire was attended by a student whose essays convinced the lecturer of her singular powers of accurate and original observation. She was encouraged by the lecturer to undertake a course of systematic study, and at his suggestion became a candidate in the examination for scholarships at Somerville Hall, where she was elected to the second scholarship."

— The latest information of the Russian expedition to Thibet, under the command of Col. Pevtsoff, is contained in the following letter from the mining engineer Bogdanovitch, published by the Russian newspaper the *Messenger of the Volga*, and republished in *Nature* of July 10: "Having happily passed through the winter at Nia, the expedition set out on April 24 to traverse the defile of Idjelik-Khanoum, and thus reach Thibet. Col. Pevtsoff had sent half his camels, carrying 23 bales with his col-

lections, to the banks of the Cherchen River, where they could recover their strength with the abundant pasture. These animals are intended to facilitate our return to Russia. Our baggage will be carried into Thibet on oxen hired for the purpose. We ourselves are riding thither on horseback, carrying with us the light portion of our effects. We left Nia with 30 horses. During the winter M. Roborovsky made an excursion to Cherchen, and I made one to the mountains of Karangon-Fag, south of Khoten. During my tour I met Grombchevsky, who came with me to Khoten in February, and thence returned for a short time to Nia. The health of all the members of the expedition is perfect; and during the winter we have received all our letters and papers from St. Petersburg, thanks to the good offices of M. Petrovsky, our consul at Kashgar. We shall send our collections to Russia through his agency." M. Grombchevsky has informed the military governor of the Syr-Darya district that the time of his journey has been extended until Jan. 15, 1891. His expedition has already traversed about 3,315 miles. M. Grombchevsky will pass the summer in exploring Thibet between Polon-Lhasa and Rudok.

—The occurrence of St. Elmo's fire at sea has been lately studied by Capt. Haltermann of Hamburg, who made examination of a number of ships' log-books for 1884 and 1885, reporting 156 cases in 800 months of observation. He finds, according to *Nature*, a greater number of cases in north than in south latitudes; and of 63 cases observed in the North Atlantic (the stormiest sea in winter), 49 occurred in the months November to April, and only 14 in the other half of the year. Of the total (156), only 27 were unaccompanied by thunder and lightning, and only 6 by precipitates of some kind. Snow and hail showers, with strong wind, seemed specially favorable. Of 133 cases accompanied by rain, there were only 15 without also thunder and lightning; while of 32 with hail, 18 were without thunder and lightning; and of 14 with snow, 12 without thunder and lightning. As to wind, there were instances with all degrees of intensity. The wind was in most cases (beyond 35° latitude) from equatorial direction; and this, with the commonly observed decrease of pressure, indicates that the cases mostly occurred in the front part of depressions. In 46 cases the barometer rose, and in 8 it was unaffected. In most cases the thermometer fell. Between the equator and 10° north latitude, 12 cases were observed, and not one in the corresponding region to the south, where the trade-wind generally prevails. In the region of the constantly blowing trade-wind, St. Elmo's fire is never met with. The western half of seas extending polewards from 30° latitude seems to afford the best conditions. On the whole, the occurrence of St. Elmo's fire may probably be ascribed to the same causes as give rise to thunder and lightning.

— The Lucayan Indians, who inhabited the islands now called the Bahamas, were the first Indians seen by Columbus. In less than twenty years this interesting people, numbering, according to the estimate of the conquerors, forty thousand persons, was wholly exterminated. The hammock was found among the Lucayans; and both the word and the thing were adopted by the Spaniards, through whom they were passed on to other nations. Various skulls have been recovered from caves in the Bahamas, and have been made the subject of a valuable paper by Mr. W. K. Brooks. This paper was read some time ago before the National Academy of Sciences, says *Nature* of July 10, and has now been reprinted as a separate memoir, with carefully executed illustrations. Columbus testifies that the Lucayans were "of good size, with large eyes, and broader foreheads than he had ever seen in any other race of men;" and Mr. Brooks says this agrees perfectly with the results he has reached, the most conspicuous characteristics of the skulls he has examined being the great breadth noted by Columbus, and the massiveness and solidity of the head. "We may therefore unhesitatingly decide," says Mr. Brooks, "that they are the remains of the people who inhabited the islands at the time of their discovery, and that these people were a well-marked type of that North American Indian race which was at that time distributed over the Bahama Islands, Hayti, and the greater part of Cuba. As these islands are only a few miles from the peninsula of Florida, this race must at some time have inhabited at least the south-eastern extremity of the continent; and it is therefore extremely interesting to note that the North American crania which exhibit the closest resemblance to those from the Bahama Islands have been obtained from Florida."

— Mr. James Bennett has, according to the *Colonies and India*, been commissioned by Lord Knutsford to proceed to Lagos, to make full inquiry into and report upon the mineral and vegetable resources of the colony with a view to their further development. Mr. Bennett is the inventor of a special process for extracting, by means of chemicals, pure rubber from the milk of the wild fig-tree, of which several species are to be found in Lagos and the neighborhood, and it seems likely that considerable advantage will accrue to the colony from his visit. Mr. Bennett will devote particular attention to such products as rubber, gums, fibres, and minerals, in which it is thought that the present trade of the colony may be largely increased, or which are considered likely to become subjects of local manufacture.

— The *London Times* gives some details of the new expedition to the north pole, for which the Norwegian National Assembly voted 200,000 kroner on June 30, and which will be under the charge of M. Nansen. Hitherto, with one possible exception, all attempts to reach the north pole have been made in defiance of the obstacles of Nature. It has been an open campaign between the endurance of man and the icy barrier of the Arctic Seas, in which Nature has always been triumphant. On this occasion a systematic and well-organized attempt will be made to ascertain if Nature herself has not supplied a means of solving the difficulty, and if there is not, after all, a possibility of reaching the north pole by utilizing certain natural facilities in these frozen seas of which all earlier explorers were ignorant. The circumstances on which these new hopes are founded may be thus summarized. The "Jeannette" expedition of 1879–81, and the loss of that vessel, seemed to sound the knell of all expeditions to reach the pole by Bering Straits; but in the end the results of that effort are shown to have been more satisfactory and auspicious than any of the officers of the "Jeannette" could have hoped for, when, with extreme difficulty, they succeeded in reaching Siberia across the ice from their wrecked vessel. In June, 1884, exactly three years after the "Jeannette" sank, there were found near Julianshaab, in Greenland, several articles which had belonged to the "Jeannette," and been abandoned at the time of its wreck by the crew, and which had been carried to the coast of Greenland from the opposite side of the Polar Sea on a piece of ice. This fact at once aroused curiosity as to how it accomplished the journey across the Arctic Ocean, and as to what unknown current had borne the message from Bering Straits to Greenland. However these objects reached Julianshaab, they could not have come in an eastern direction, through Smith's Sound, for the only current which reaches Julianshaab is that from the eastern coast of Greenland *via* Cape Farewell and the north. Nor is there much probability that they were borne in a western direction from the place where the "Jeannette" sank, for all the currents round Nova Zembla, Franz-Josef Land; and Spitzbergen are known, and it seems impossible for the ice bearing the relics of the unfortunate "Jeannette" to have traversed the intervening distance in the space of three years, even if it were possible at all. There remains only the alternative, that there is a comparatively short and direct route across the Arctic Ocean by way of the north pole, and that Nature herself has supplied a means of communication, however uncertain, across it. Increased significance to the discovery of the "Jeannette" relics in 1884 was given by the identification in 1886 of bows found on the coast of Greenland with those by the Eskimo in the vicinity of Bering Straits, at Port Clarence, Norton Sound, and the mouth of the Yukon River. M. Nansen's expedition will endeavor to realize these hopes of a direct route across the apex of the Arctic Ocean. A specially constructed boat of one hundred and seventy tons will be built, and provisions and fuel taken for five years, although it is hoped that two will suffice. The expedition will consist of ten or twelve men, and M. Nansen proposes to leave Norway in February, 1892.