to be allowed. Two ideas presented themselves to my mind as to the possible origin of the beading. One was that it might have something to do with the way in which the path crossed a series of electromagnetic waves, like those of light, except as to the scale of wave-length. Another, which seems more probable, is that they are of the nature of the stratified discharge in exhausted tubes. This supposition indeed is not free from difficulty, though I do not think the difficulty fatal. In an ordinary tube it requires a very good exhaustion to get strata as much as an inch thick. But here, at full atmospheric pressure, we have strata a foot or more in thickness. However, in a Geissler tube the strata are closer in the capillary part, where the current is concentrated, than in the broad part. It may be that in the discharges, for example, represented in Fig. 1, which are unconfined laterally, these wide strata are possible, and if so, the density of the current is small. It has already been remarked that the intensity decreases as we go from the lamp to the ground. It seems that the current is gradually spent in electrifying the air. If this explanation be correct, the local discharges represented in Mr. Webb's photographs may not be so dangerous as some of them look. Still, until we know more about the subject, it might be prudent in a thunderstorm to keep a little away from arc lamps in a street.

If the wireless telegraphy theory which I have ventured to throw out be the true account of the Webb discharges, it seems that by imitating with any necessary modification the receiving apparatus, and introducing a telephone, as has been done with great advantage by M. Turpain in his researches, it might be possible simultaneously to see and to hear a flash of lightning.

Cambridge, January. G. G. STOKES.

The Mathematical Tripos.

ON February 15 the recommendations of the Special Board for Mathematics on the Mathematical Tripos will be voted on by the Senate of the University of Cambridge. With regard to the changes proposed in the general arrangement of the examinations there can be scarcely any difference of opinion. About twenty years ago the advances in mathematical science had reached such a pitch that it was impossible to cover the whole range of mathematics in a single examination, and many a promising mathematician found himself seriously fettered by the necessity of having to confine himself to those parts of the subject which would best enable him to obtain a high place in the examination, and to spend his time in attaining proficiency in rapidly solving certain classes of problems rather than devote himself to specialising in the higher branches of mathematics. It was under these conditions that the Tripos was divided into two parts, the first covering the less advanced subjects, and the second enabling a candidate to specialise in those portions of higher mathematics for which his enthusiasm and ability best qualified him. The further developments of the last twenty years have necessitated an extensive reconstruction of the schemes, and the framers of the present regulations have been at great pains to bring the Mathematical Tripos into line with modern requirements. At the same time it is becoming daily more and more evident to those competent to judge that a sound training in mathematical methods is of paramount importance in the study of applied science, and the regulation allowing candidates to take Part i. in their fifth term should prove of great value to those who wish to study mathematics as a preparation for the subsequent study of physics or mechanical science or even, nowadays, chemistry.

The abolition of order of merit in Part i. is a logical outcome of the fact that this part does not represent the highest knowledge of mathematics. In late years the title of Senior Wrangler, which is often regarded in the outside world as the highest honour which Cambridge can confer, has often been bestowed on men who have proved unequal to the task of securing the highest place in Part ii. The announcement that a lady had been placed "above the Senior Wrangler" caused the greatest excitement throughout the country; but the fact that on another occasion the only candidate who secured a first division in Part ii. was a lady passed almost unnoticed. Still, it cannot but be regretted that because the Senior Wrangler has not always subsequently proved himself the best man of his year, the University should contemplate altogether abolishing the old title of Senior Wrangler, and that even "wranglers," "senior optimes" and "junior optimes," may soon be a thing of the past. When the Tripos was first divided into two parts, one of the mathematical authorities best qualified to judge considered it desirable that the title of Senior Wrangler should be given to the best candidate in Part ii. This was not done, and hence the position of Senior Wrangler has for many years been an anomalous one, and we have been irresistibly drifting in the direction of abolishing the title altogether. But why should not the first division in Part ii. be called "Senior Wranglers?" The number who obtain a first division in any year is very small, often not more than two, and these are surely no unworthy successors to the senior wranglers of the past. Moreover, by this means the competition for place would be avoided, each candidate being judged on his merits irrespective of whether he was in a strong year or a weak one, and the present anomaly of the second or third or even lower wranglers in a strong year being better than the senior in a weak one would be obviated.

Such a proposal is not inconsistent with the changes in the examinations proposed by the Board. The plea for the retention of the old titles is no question of sentiment. The mathematical school of Cambridge has, under the "coaching" system, taken a unique position in the educational system of the country, and it is but right that Cambridge honour-men should retain the marks of distinction which at present distinguish them from graduates of modern Universities. These marks of distinction are well known to the world at large, and may enable their possessors to carry greater weight in insisting on the importance of providing efficient mathematical teaching in our schools, and adequate endowments for the mathematical schools of our provincial University Colleges. Too often these schools and colleges are controlled by councils and governors consisting of business men, with whom the name "Senior Wrangler" carries weight, but who only look to the "main chance," and who see no use in encouraging mathematics because they do not understand it and think it "unpractical." In encouraging the purely experimental side of science there is a danger of neglecting that training which is needed to enable logical conclusions and practical applications to be deduced from experiments. It is, therefore, important that the old titles should be retained, not only to enable their bearers to point out that they have been trained in the same school which has produced so many of our best physicists, including a Maxwell and a Kelvin, and has thus contributed so greatly to the advancement of Applied Science, but also to encourage others to submit to that rigorous mathematical training without the fruits of which even the most practical of "practical men" would soon come to a standstill. G. H. BRYAN.

Floating Stones.

THE correspondence on "Floating Stones" brings to my mind a phenomenon I often noticed about ten years ago, when my work caused me to spend a good deal of time on the upper reaches of the River Mersey, of patches of earth floating down the river on the surface of the water. This occurred during the early part of the ebb tide and on water obviously contributed by the river. I concluded that this earth was detached from the banks during the quiescent period of high water, and that the surface tension of the water was so increased by the strength of the effluents from the manufactories and other sources, that lumps of earth, often several inches in area and of appreciable thickness, were enabled to float. Unless the conditions have since changed, no doubt the same thing may still be observed.

Coopers Hill, February 3. A. W. BRIGHTMORE.

ENGINEERING AT CAMBRIDGE.

ON Friday, February 2, a large and important addition to the Engineering Department of the University of Cambridge was inaugurated by Lord Kelvin, as a memorial to the late Dr. John Hopkinson, and his son, John Gustave Hopkinson. In August 1898, only a few days before the terrible accident by which he lost his life, Dr. Hopkinson had discussed with Prof. Ewing the rapid growth of this department, and the urgent need for its extension, and had expressed his intention of starting a fresh movement among engineers to secure the necessary funds. In October of the same year, Mrs. Hopkinson communicated to the Vice-Chancellor of the University the desire of herself and her son and daughter to give

5000*l.* towards the extension of the laboratory, regarding this as a "peculiarly fitting memorial" to one who from the first had been warmly interested in the school, and who had so lately expressed a strong desire to assist in furthering its development.

A site was at once available, as a plot adjoining the existing laboratory had previously been assigned to the department. The design of the new buildings was entrusted to Mr. W. C. Marshall, of Messrs. Marshall and Vickers, and on November 29, 1898, the Senate of the University authorised a syndicate to proceed with the erection of the new wing at a cost not exceeding 5000*l.*, and decreed "that the gift of Mrs. Hopkinson and her family be applied to this purpose, and that the wing be called the Hopkinson Memorial Wing." It was at the same time agreed that 500*l.* should be provided by the University to cover the cost of certain structural alterations to the existing laboratory and other subsidiary works. It is understood that the whole of the work now completed has, if at all, only slightly exceeded the estimate of 5500*l.*

The Hopkinson wing is a block about 92 feet long and 40 feet wide. On the ground floor is a large laboratory, which has been assigned to elasticity and hydraulics, and a smaller room, which will be used as a dynamo room. On the first floor is the new lecture theatre, with preparation room adjoining, and a large room, which at present is occupied partly as an additional lecture room and partly as a supplementary drawing office. On the third floor, three smaller rooms, adapted to purposes of research, have been provided. A wedge-shaped space between the old building and the new has been roofed over with glass, and forms a very useful addition to the large elasticity laboratory.

The opening ceremony on Friday last was presided over by the Vice-Chancellor (the Master of Emmanuel), and was attended by a large number of residents, by a considerable gathering of well-known engineers, and other friends of the late Dr. Hopkinson, and by many present and former students of the department. The Vice-Chancellor, in opening the proceedings, referred to Dr. Hopkinson's distinguished career at Cambridge, and conveyed to Mrs. Hopkinson, on behalf of the University, "the assurance of their sympathy and of their gratitude to her and to her children for the noble benefaction with which they have enriched the University in the name of husband and father."

Lord Kelvin, in his address, spoke of Dr. Hopkinson's rare power of grasping a scientific truth and of applying it practically to mechanical art for the use of mankind. He illustrated this power by reference to his work on dynamo-electric machines and on methods of distribution of electric light and power, to his discoveries in nickel and steel alloys, and to his group-flashing light, "a splendid application of scientific optics now in use in lighthouses and light-ships all over the world." Touching on the growth, at Cambridge, of the study of physical science, both on its theoretical and its practical side, he mentioned that when Dr. Hopkinson was an undergraduate, less than thirty years ago, the only experiments he had an opportunity of seeing were those with which Sir G. Stokes illustrated his lectures. Since then matters had progressed, and we had seen, on the one hand, the development of the Cavendish laboratory, founded by the late Duke of Devonshire, and conducted by Clerk Maxwell, by Lord Rayleigh, and now by Prof. J. J. Thomson; and, on the other hand, the establishment of the engineering workshops by Prof. James Stuart, and their development under Prof. Ewing into an organised school for the study of scientific engineering and of engineering laboratory practice.

Lord Kelvin further made reference to the great value of Prof. Ewing's work, to his researches in magnetism and electricity, and in many other branches of science, to his admirable text-books on steam, on strength of materials and on magnetism, to his untiring energy in developing the work and resources of the engineering department, and to the excellent research work now being done in it under his direction. In conclusion, Lord Kelvin announced that he was commissioned by the directors of the Linotype Company to offer, for the acceptance of the University, a bust of Dr. Hopkinson.

In proposing a vote of thanks to Lord Kelvin, Prof. Ewing expressed his sense of obligation to the many friends, both in the University and without, who, by gifts of money, had made it possible for a laboratory to exist, and by gifts of apparatus that assisted so much in its development and growth. He announced that he had received by telegram the promise of a valuable set of polyphase plant from the British Westinghouse Company. The vote of thanks was seconded by Principal Hopkinson, of Owens College, Manchester.

The Master of Trinity then unveiled an excellent portrait of Dr. Hopkinson, painted by Mr. T. B. Kennington, and presented to the laboratory by subscribers. This has been hung in the principal room of the new wing, and a replica has been presented to Mrs. Hopkinson. For this, thanks were returned to the subscribers by Mr. Bertram Hopkinson. A vote of thanks to the Master of Trinity, proposed by Sir Douglas Fox, President of the Institution of Civil Engineers, closed the formal proceedings. Prof. and Mrs. Ewing afterwards held a reception in the laboratory, and the guests were enabled to examine at leisure the large collection of apparatus with which both the old and the new parts of the building are furnished.

A short account of the growth of the Engineering School in Cambridge may not be out of place. A professorship of mechanism and applied mechanics was founded in 1875, and the first holder of the chair, Prof. James Stuart, established workshops, which afterwards became the property of the University. In these, practical instruction was given in pattern-making, forging, turning and fitting. About the same time an examination in mechanism and applied science was established as one of the special avenues to the ordinary B.A. degree.

Prof. Ewing was appointed to succeed Prof. Stuart in 1890, and at once took up the task of forming an engineering laboratory, and of organising a more complete school of applied science. A site was granted by the University; a sum of 5000*l.* was raised, largely by the efforts of a strong committee of prominent engineers; and this, with an additional 1000*l.* granted by the University, was applied to adapting and extending the buildings of the old Perse School. At the same time a great impetus was given to the work of the department when the University sanctioned the granting of honour degrees by the establishment of the Mechanical Sciences Tripos. The new laboratory, which was opened by Lord Kelvin in 1894, though sufficient for the seventy students then in attendance, soon became overcrowded, until, during the last few years, a considerable proportion of the lectures have been delivered in rooms borrowed from other departments. The growth of the department may be seen at a glance at the following table:—

Year.	Number of Students.	Amount paid in fees. £
1892	39	546
1893	71	1269
1894	73	1541
1895	84	1706
1896	88	2043
1897	103	2338
1898	112	2534
1899	123	2915
1900	150 now in attendance.	

The work of the department has been carried on mainly on the lines of the syllabus for the Mechanical

Sciences Tripos Examination as established in 1893. Regular courses of lectures are given in mathematics, mechanics, principles of mechanism and machine dynamics, strength of materials and theory of structures, heat and heat engines, and applied electricity. Instruction is also given in geometrical and mechanical drawing, and in graphic statics. In the laboratory there are regular courses in mechanics, elasticity, heat, the testing of steam, gas and other heat engines, applied electricity, and hydraulics. In the summer term there are lectures and field-work in surveying. Practice in the use of tools for wood-work and metal-work forms a regular part of the course, and at the same time the workshops, in which a considerable staff is employed, constitute a very useful adjunct to the laboratory.

During the past few years research has been taking a more and more prominent place in the work of the department, and with the larger space and special rooms now available further development in this direction may be looked for. At present a number of research students are at work in the elasticity, the electrical, and the steam laboratories. Evidence of the value of this work may be found in the current volume of the Royal Society's *Transactions*, where two papers, one, by Prof. Ewing and Mr. Rosenhain, on "The Microscopic Structure of Metals" (the Bakerian Lecture), the other, by Mr. J. Muir, on "The Recovery of Metals from Overstrain," deal with work which has been entirely carried on in the department.

The University grants an annual sum of between 1200*l.* and 1300*l.*, from which are paid the salaries of the Professor and the two University Demonstrators (1000*l.* in all), part of the wages of the workshop staff, and some other expenses. From the students' fees, which form the main source of revenue, are paid the salaries of four or five assistant demonstrators and lecturers, as well as the greater part of the wages of the workmen and laboratory attendants.

Many valuable gifts of apparatus have been made to the department during the past six years, and many pieces of heavy machinery have been supplied by engineering firms on specially favourable terms. A high speed compound combined engine and dynamo set, on which regular tests are made, was presented by Messrs. Mather and Platt in 1894. Recently a coupled set of two dynamos arranged for the Hopkinson test has been given by Messrs. Siemens Brothers and Company, and a gas engine of about ten horse-power by the Forward Engineering Company of Birmingham. A very valuable microscope, specially designed for the microscopic study of metals, was lately presented by Mr. Thomas Andrews, F.R.S. Among other recent additions are a five-ton testing machine by Messrs. Buckton and Co., presented by past and present pupils; and a set, comprising turbine, motor and pump, supplied by Messrs. Mather and Platt. Towards the further equipment of the laboratory a sum of 1200*l.* has recently been subscribed, and there is now on order from Messrs. Robey and Co. a compound horizontal engine of about fifty horse-power, specially arranged for testing purposes. This will form a very useful addition to the steam laboratory.

There can be no doubt that the Engineering Department has established for itself, under Prof. Ewing, a firm foothold among the scientific schools of the University. At the same time, if it is to take, as it may reasonably aspire to do, a foremost place among British Schools of Engineering, it must look to provide a wider curriculum. The laboratories necessary for the proper teaching of such subjects as mining, metallurgy and naval architecture, as well as for keeping abreast of the latest developments of the subjects already represented, cannot be founded or maintained without an endowment of an amount far exceeding the sums already so generously contributed.

While it is admitted that the establishment of the department was looked upon by some with misgiving, as an encroachment on the more purely academic studies of the University, it is certainly true now, as the Vice-Chancellor said on Friday last, that the great majority of resident members welcome the establishment of the department, and rejoice in its flourishing and successful state; and it is also true that the growth of this cordial recognition is due in no small degree to the support which has been so freely given by the engineering world outside the University. This view of the matter is supported by the *Times* when it says, in reviewing the inauguration we have just described, that "it is pleasant to see one of our old Universities, while remaining faithful to all the traditions of its venerable past, at the same time displaying an intelligent appreciation of the wants of the future, and affording to the most modern forms of learning the nurture and support which for many centuries it has afforded to those forms with which alone our forefathers were familiar."

THE NATURAL HISTORY OF THE SHORES OF BARENTS SEA.[1]

IN the summer of 1895 Mr. H. J. Pearson and a party of fellow naturalists visited the Barents Sea to study the birds that nest upon its shores. The party landed on Kolguev and Novaya Zemlya, and at one of the promontories on the Murman Coast. Many interesting observations were made on the natural history of the region, but work was hampered by the small size and limited coal capacity of their yacht, the *Saxon*. Two years later Mr. Pearson returned in a larger and more powerful vessel. The main object of the second journey was the investigation of the avifauna of the coastlands of north-eastern Russia, between the Pechora and the Urals, an area which the author describes as "ornithologically unknown." In the summer this country is accessible only from the sea, owing to the vast extent of flood and swamp. Mr. Pearson accordingly chartered the *Laura*, and, accompanied by Colonel Feilden and Mr. F. Curtis, left Tromso for the Pechora coastlands in June, 1897. The scheme was to land near the mouth of the Karataikha River. But the *Laura* could not approach nearer than twenty miles from the mouth of the river, and it was not considered safe to leave the steamer in the open bay for eight hours while the entrance was reconnoitred in the launch. Mr. Pearson was therefore reluctantly compelled "to abandon the chief object of the expedition as impracticable from the sea." The steamer was turned northward, and the rest of the season was spent in visits to Dolgoi Island, "Waigatch" and Novaya Zemlya.

"Beyond Pechora Northward" would therefore have been a more accurate title for the book, as except at the port of Habarova, the expedition did not alight on the mainland east of the Pechora. But in the islands of the Barents Sea, Mr. Pearson and his colleagues did excellent work, some of the results of which have been published in the *Ibis* and the *Journal* of the Geological Society. Mr. Pearson's book gives a detailed narrative of the two cruises, with appendices on the botanical and geological results by Colonel Feilden, Prof. Bonney and Messrs. E. T. Newton and A. C. Seward. It is no disparagement of Mr. Pearson's work to say that the appendices contain the greater amount of new information, as this is one of the indications of the more advanced state of ornithological knowledge. Owing to the wide range of the Palæarctic fauna, the discovery of new birds was not to be expected. There was even

[1] "Beyond Petsora Eastward: Two Summer Voyages to Novaya Zemlya and the Islands of Barents Sea." By H. J. Pearson. With Appendices on the Botany and Geology by Colonel H. W. Feilden. Pp. xiv + 335. (London: R. H. Porter, 1899.)