tions as dancing, scanning, and even the fluctuations of sensation. For example: a star just visible to the eye fades away and reappears. The intervals of this attention wave have been measured, and, according to one observer, are from 2.5 to 3 seconds for sensations of electrical shock, 3 to 3.4 seconds for light sensations, and 3.5 to 4 seconds for sensations of hearing; or 24 to 20, 20 to 18, and 17 to 15 fluctuations per minute, — a rate strikingly similar to the rate of breathing. It would be interesting to find whether these sensation "waves" vary essentially in persons with abnormally high or low respiration rates. Again, the relation of the rate of scanning to pulse and respiration may be tested. One subject, when his pulse tells 77 per minute, reads 113 feet per minute, but, with a pulse of 83, reads 140. Individual differences in pulse and respiration may affect the normal rate of reading. One subject, with a pulse of 86 and a respiration of 26 per minute, makes 55 double steps, and reads 126 trochaic feet, in a minute; while another, with a pulse of 66 and a respiration of 22, makes 51 steps and reads 120 feet in the same time. Verse-reading in schools might be similarly tested. In a preliminary test a pupil with a pulse of 85 read 107 feet per minute, another with a pulse of 98 read 129.

In one case Professor Leumann made a distinct test, measuring the pulse at frequent intervals, and also the rate of scannings as the subject was reading. Comparing the rates before an intermission with those after, he finds an almost exact correspondence of scanning rapidity with pulse rate. When 40.1 feet are read per minute, the pulse is 85⅗; when 38.8 feet are read, the pulse is 82⅓.

It is noteworthy, too, that a large range of association times varies between .7 and .8 of a second, — the period of a normal pulse-beat. In reproducing time intervals, the period reproduced with least error is also this same period. These, however, are mere suggestions. The outcome of the paper is to accentuate the importance of noting these physiological conditions when studying psychic phenomena, and particularly when making time measurements of them.

DISTANCE AND SIZE. — One of the most vexed questions of psychological optics relates to the inference of distance when the size of an object is known, or the inference of size when the distance is known. Psychologists are agreed that the process is not immediately given in sensation, but the result of experience. The young infant reaches for things entirely beyond its grasp. Under ordinary circumstances, our inferences of size, though unconsciously performed, are extremely complicated. The estimation of half a dozen different kinds of perspective, together with what real knowledge we have of the sizes of the objects in question, enters into the result. To study the question scientifically, we must arrange the observation so as to exclude all but a single variable. When this can be done, as, for example, in the gradual removal of an object from the eye, under proper conditions, the general assumption has been that the result depends on the size of the retinal image, or by the angle made at the centre of the eye by the extreme contours of the object. In the last number of the *Philosophische Studien* (vol. v. No. 4), Dr. Götz Martius describes a few experiments that lead him to question the correctness of this view. At a constant distance of 50 centimetres from the eye of the observer he placed a rod 20, 50, or 100 centimetres long. At a much greater distance (either 2½ or 5¼ metres) he had a variety of rods, differing from one another slightly in length only. Both were viewed against a continuous and uniform brown background, and the problem of the observer was to judge when the distant rod seemed equal in size to the near one. Even here the fact that we are accustomed to interpret the far in terms of the near, and pay attention only to estimating the actual size of the object, makes it difficult to separate judgment and impression; to answer, not whether, if the distant rod were brought side by side with the near one, it would be equal to it in length, but whether the retinal impressions of the two as they are seem the same. After a little practice, this can be done, though the result does not point to a definite length, but to a narrow range of lengths any one of which seems equal to the near rod. Taking the average values, one observer, with 5.25 metres between the two rods, judges the distant rods of 21.67 centimetres, of 57.62 centimetres, and of 106.62 centimetres to be equal to near rods of 20, 50, and 100 centimetres: at 2.50 metres between the rods, the former lengths become 20.62 centimetres, 53.87 centimetres, and 107.75 centimetres. Similar results for Dr. Martius are 21.92 centimetres, 59 centimetres, 110 centimetres, and 21.62 centimetres, 56.62 centimetres, and 109.25 centimetres. What these figures show, apart from the facts that such observations are possible and that the result varies with the individual, is that a distant object, to seem equal to a near one, increases in size with the distance, but increases very slowly; much slower, that is, than the visual angle decreases. It is probable, too, at the same difference of distance, the ratio between near and distant objects of various sizes remains constant. The result requires further corroboration and extension, but, even as it is, is important in rendering improbable the usual view of the matter.

SENSIBILITY TO TONE INTERVALS. — The ear has been called the mathematical sense, because the perception of musical interval involves the nicest appreciation of definite numerical relations between the vibration rates of the tones forming the interval. The very slight deviations from a true interval recognized as such by skilled musicians, which Helmholtz has satisfactorily explained as due to the relations of the overtones of the two tones, shows us that the interval sensibility must be very fine. The accurate determination of this sensibility for the various intervals has been attempted by a few methods, but with results individually different, and containing sources of error. The whole topic has been rigorously re-investigated by Iwan Schischmánow in the psychological laboratory at Leipzig (*Philosophische Studien*, v. No. 4). The method consisted in adjusting a movable weight on a tuning-fork until (1) it just formed a certain interval with a constant fork, (2) it just appreciably diverged from it above, and (3) just appreciably diverged from it below. The results are then grouped, and an average formed, expressing in fractions of a vibration per second the difference between the vibration rate of the true interval and the tone just distinguishable as not a true interval. For two observers, S and K, of whom S is a good amateur musician and K is not musical, the results thus expressed were as follows: for the octave whose ratio is 2 : 1, S 0.220, K 0.356; the fifth (ratio 3 : 2), S 0.332, K 0.374; the fourth (ratio 4 : 3), S 0.419, K 0.403; the third (ratio 5 : 4), S 0.485, K 0.559; major sixth (ratio 5 : 3), S 0.502, K 0.506; the second (ratio 9 : 8), S 0.548, K 0.716; minor third (ratio 6 : 5), S 0.607, K 0.640; minor sixth (ratio 8 : 5), S 0.672, K 0.740; minor seventh (ratio 9 : 5), S 0.678, K 0.763; major seventh (ratio 15 : 8), S 0.861, K 0.902. A comparison of these with former results leads to the conclusion that practise and individual traits contribute to the result, but that in general the order of delicacy of the various intervals as shown by S, especially the order of the four "best" and the "worst" perceived intervals, may be taken as fairly normal. This order corresponds nearly with that elaborated by Helmholtz on the basis of relative consonance of overtones, but it shows that perceptions of intervals are possible without such an aid. The numbers show, too, the great accuracy of the sense of musical interval. Another result is that the sensibility for the lowering of an interval is finer than for an increase of the interval, though it must be noted that the variable tone in these experiments was always lower than the constant tone.

ELECTRICAL NEWS.

Siemens's Five-Lead System.

THE municipal authorities of Königsberg, in Prussia, in conjunction with the representatives of the citizens, resolved this spring to carry out, at their own expense, an electric central station for the town, which was calculated for a supply of 30,000 16-candle glow-lamps, though arrangements are to be made at first for 8,000 lamps. The entire installation, as it is now about to be executed, merits the attention of the entire electro-technical world, and of all persons interested. A correspondent of the London *Electrical Review*, therefore, briefly gives the chief points which will be brought forward in executing the installation. The current will be supplied from four groups of slow-speed dynamos, arranged in series, and connected directly with the steam-engine. Between these dynamos and the conducting net there is placed a battery of accumulators of suitable capacity and tension. For the net of conductors, in consequence of the extended line of streets to be traversed, the five-lead system has been selected. The leads are not cables, as has hitherto been customary, but uncovered rods of copper, resting on insulators of porcelain, and laid in channels of cement. These channels will be mostly carried underneath the flags of the footway. The distribution of the current takes place so that each of the four successive current circuits formed by the five-lead system shows a working tension of 110 volts. The execution of the entire electrical installation, original and in many respects interesting, is intrusted to the firm Naglo Brothers of Berlin, who will use for storing up electric energy "Tudor" accumulators made by the firm Müller & Einbeck of Hagen. The above-mentioned Siemens "five-lead system" has not yet been practically applied in any electrical installation; but the firm Siemens & Halske is executing two extensive installations on this system, — one at Vienna, and the other at Trient. These two installations will be shortly in operation, and as many doubts have been raised concerning the practicability of this system, which is a further development of the three-lead system, and is hence regarded as too complicated, the inauguration of the Siemens installations is awaited in technical circles with no little interest.

LENS IMAGES MADE VISIBLE BY ELECTRIC CURRENT. — In the *Photographisches Archiv*, Herr R. E. Liesegang, son of Dr. Liesegang of Dusseldorf, describes an apparatus with which it is possible to render lens images visible at an indefinite distance from the original object by means of the electric current. The instrument is based on the well-known principle that an electric current is produced by light-waves. If light strikes upon one or two platinum, silver, or copper plates, which are arranged in the form of a galvanic element, this gives rise to an electric current. If the exposed plate consists of a large number of insulated metal wires of small diameter, lying very closely together, and if some of these wires are exposed, others not, then, of course, the electric current is produced only in these exposed wires. If the wires are conducted to another analogously constructed plate, which may be placed at any distance from the first one, then the electric current will also here be produced only at the parts correspondent with the exposed wires of the first plate. By coating the second plate with any substance which by galvanic decomposition undergoes a visible change, exposed parts of the second plate can be easily distinguished from the unexposed ones. If, therefore, an image is projected by means of a lens upon the first plate, the same image will be obtained on the second plate.

AN ELECTRIC RADIATION METER. — At the meeting of the London Physical Society, Nov. 1, Mr. W. G. Gregory read a paper on "A New Electric Radiation Meter." He stated that the meter consists of a long fine platinum wire attached to a delicate magnifying spring of the Ayrton and Perry type, and stretched within a compound tube of brass and glass. At the junction between the wire and spring a small mirror is fixed. When the tube is placed parallel to a Hertz's oscillator in action, the mirror is turned in a direction indicating an extension of the wire. The arrangement is so sensitive that an elongation of $\frac{1}{2000000}$ of a millimetre can be detected; and, when placed at the distance of a metre from the oscillator, the apparent extension is such as would correspond to a change of temperature of 0.003° C. By its aid the author has roughly verified Hertz's statements, that at considerable distances the intensity of radiation varies as the inverse distance; but, before he can proceed further, it is necessary to greatly increase the sensibility of the apparatus, and, with a view of obtaining some suggestions in this direction, he exhibited it before the society. Professor Perry asked if the electro-motive force required to produce the observed results had been calculated; he also believed that the sensibility might be increased by using copper instead of platinum, and replacing the spring by a twisted strip. Mr. Blakesley inquired whether the effect of increasing the capacity of the ends of the wire had been tried. Mr. Boys said, that, if the observed effect was due to rise of temperature, he would like to see it measured thermally. He also thought the effect might be due to extension caused by rapid electric oscillations in some such way as the elongation of an iron bar caused by magnetization. In answer to this, Professor S. P. Thompson said the matter had been investigated experimentally, but with negative results. Professor Herschel suggested the use of a compound spring such as is used in Breguet's metallic thermometers. In reply Mr. Gregory said that he had estimated the electro-motive force by observing that a Leclanché cell through 50 ohms produced about the same result. No improvement in sensitiveness was obtained by using copper wire or by increasing its capacity, and attempts to measure the rise of temperature by an air thermometer had been given up as hopeless.

DRIVING TUNING-FORKS ELECTRICALLY. — Mr. W. G. Gregory, at the meeting above mentioned, also read a paper on "A Method of Driving Tuning-Forks Electrically." In order to give the impulses about the middle of the stroke, the fork is arranged to make and break the primary circuit of a small transformer, the secondary circuit of which is completed through the electro-magnet actuating the fork. The prongs of the fork are magnetized and receive two impulses in each period. Another device was suggested, where the prongs respectively operate contacts which successively charge and discharge a condenser through the coils of the actuating magnet. Professor S. P. Thompson said the methods, if perfect, would be of great service, and suggested that a fork so driven be tested optically by comparison with a freely vibrating one. He regarded the mercury contacts used as objectionable, for their capillarity and adhesion would probably cause the impulses to lag behind the appointed epochs. Professor M'Leod remarked that Lissajou's figures gave a satisfactory method of testing the constancy of period, and could be readily observed without using lenses, and in reference to liquid condensers, suggested by the author for his second device, said that platinum plates in sulphuric acid were found to disintegrate when used for this purpose. He thought lead plates would prove suitable. Professor Jones, who read a paper on a similar subject in March last, said he now used bowed forks, with which to synchronize the speed of the disk there described; and the frequency is determined by causing the disk to complete the circuit of his Morse receiver once each revolution.

ON ELECTRIFICATIONS DUE TO CONTACT OF GASES AND LIQUIDS. — A paper on this subject was read by Mr. J. Enright before the Physical Society above alluded to. For some time past the author has been studying the electrical phenomena attending solution by connecting an insulated vessel in which the solution takes place with an electrometer. As a general rule, no effect is observed if nothing leaves the vessel, but, when gases are produced and allowed to escape, the vessel becomes charged with positive or negative electricity, depending on the nature of the liquid from which the gas passes into the air. As an example, when zinc is placed in hydrochloric acid, the deflection of the electrometer is in one direction, while the liquid is chiefly acid, but decreases and reverses as more and more zinc chloride is produced. From such observations the author hopes to obtain some information relating to atomic charges. Owing to the lateness of the hour, the latter portion of the paper and the discussion on it were postponed until the next meeting. For the above reports of the papers read at the meeting of the London Physical Society, we are indebted to *Engineering*.

NOTES AND NEWS.

A MR. M. W. DEWEY of Syracuse, N.Y., has patented an electric refrigerator, based on the well-known fact that a current of electricity passed in the proper direction across the junction of two dissimilar metals cools the joint. While Mr. Dewey's apparatus is all right as far as the principle is concerned, we would rather not express any opinion on its practical value just yet.

— Beginning with January 1 next, the Rev. T. De Witt Talmage, D.D., will become one of the editors of *The Ladies' Home Journal* of Philadelphia. The famous preacher will have a regular department each month, written by himself, with the title "Under My Study Lamp." His first contribution will appear in the January number of the journal. Dr. Talmage's salary is said to be one of the largest ever paid for editorial work.