wheel on the line-shaft, which is a foot in diameter and about fifty feet long. The line-shafts of both plants may be coupled together, so that either engine may be used to drive either section. Each section carries two pairs of cable-drums, either pair of which may be thrown into or out of action by clutches. Thus either engine may be

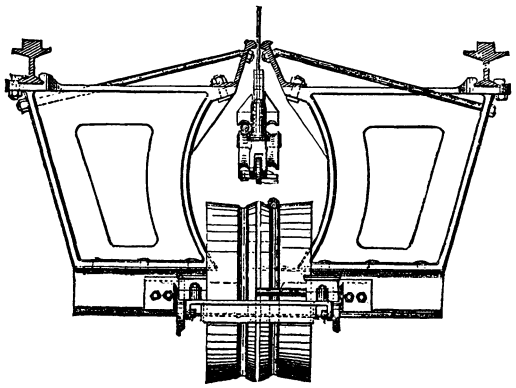

FIG. 9.

used to run any of the four cables shown in the engraving. The section at the right actuates the duplex cables running out Tenth Avenue ; that on the left will be used for the 125th Street branch of the company's line.

The cable, coming from one of the guide-pulleys in the street, shown at the right of the en-

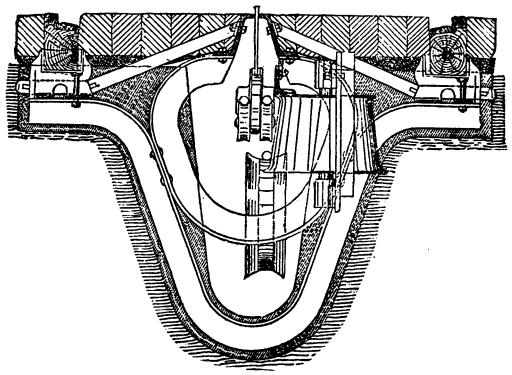

FIG. 10.

graving, passes several times around both cable-drums, thence around a 'slack-pulley,' shown in the foreground, from which it passes back around one of the guide-pulleys in the street, and back on its way through the tube. The 'slack-pulley' is mounted on a car which is moved by a differential lever in such a manner that the cable is always kept at a uniform tension. Thus the lengthening and shortening of the cable through variations of temperature, etc., is compensated for.

The grip used for the duplex system, as well as the tube, pulleys, and track-supporting framework, is shown in fig. 9, which is a transverse section of the Tenth Avenue road. The framework and tube used on the Chicago cable-railway is shown in transverse section in fig. 10, which also shows one of the guide-rollers for carrying the cable around a curve. The road-bed of the cable-railway in this city has a framework of iron, as shown in fig. 9, concrete forming the sides and bottom of the conduit or tube. The transverse trusses are placed five feet apart, with the slot-rails and track-rails bolted to them. The slot-rails form the sides of the longitudinal slot of the tube, and they are held firmly in place by tie-rods which connect them with the outer edge of the truss. Pulley-vaults are provided at intervals of thirty-five feet, affording access to the carrying-pulleys. A system of drainage-pipes connects these vaults with the city sewers, thus securing perfect drainage, which cannot be affected by any dirt that may accumulate in the conduits. The carrying-pulleys are twenty-two inches in diameter, and are placed in pairs, one a little in advance of the other, to support the two cables independently.

The first cable street-railway, that on Clay Street hill, San Francisco, was looked upon as an experiment to a great extent; but after a satisfactory trial of three years, the system having proved itself a mechanical and financial success, a second road was constructed, also in San Francisco. This was followed by others in rapid succession, until that city has at present upward of twenty miles of cable-road in operation. Other cities followed the lead of San Francisco, St. Louis with sixteen miles, Philadelphia with twelve, Chicago with ten, Kansas City with eight, and many more with shorter lines, so that at present the total length of double-track cable street-railway in the United States will not fall far short of one hundred miles. Taking into consideration with this the fact that cable-roads are making rapid headway in Europe, Mexico, Australia, and New Zealand, it will be seen that the new system of street-car traction has proved its right to a prominent position in railroad economics.

THE PHYSICAL BASIS OF AESTHETICS.

AESTHETIC impressions may be conveniently divided into two classes: in the first it is the appreciation of qualities furnished immediately by sensation that gives rise to beauty, while in the second class the sense-impressions are interpreted and made significant by a guiding thought or emotion. Though the two often go together, there is

a class of aesthetic impressions depending pre-eminently on the sensations furnished by the great aesthetic educators of the race, — the eye and the ear. It is to the explanation of these simple forms of beauty that M. J. L. Soret devoted an address delivered before the Swiss society of natural science.[1] The field is by no means a new one, but perhaps so convenient a statement of the problem has not before been available.

The arts depending upon the eye are those in which form is the predominant element, — sculpture, architecture, etc., — and those in which color plays the important *rôle*. If we look for the physiological basis of beauty of form, we find one great principle in symmetry, especially in symmetry about a vertical axis. If we stand in this plane of the vertical axis, and look at the symmetrical object, the impression on the retina of the right eye will closely correspond to that on the retina of the left eye. The recognition of similarity, so essential and useful as a logical habit of mind, seems at the same time to furnish the emotional element of aesthetic pleasure. The fact that we recognize and enjoy symmetry when not standing opposite the centre of the object is the result of our education: we recognize that the two retinal impressions would be alike if we assumed that position.

It may be well to introduce here a distinction between intellectual and aesthetic pleasure, in which M. Soret has great confidence. It is this: the pleasure caused by the solution of a problem is due to a conscious reasoned analysis; an aesthetic pleasure is caused by an unconscious intuited analysis. The one is laboriously and slowly wrought out: the other is readily and suddenly revealed. This distinction is best illustrated, as will be seen, in the analysis of tone: the analysis of form is so simple that we can readily perform it consciously.

Proceeding with this analysis, we find a second principle in the repetition of design. It leads to the mathematical conception of a periodic function. We see it represented in friezes, in a series of columns, in ornaments, etc., even in those belonging to the most primitive periods of art. As before, there is the recognition of similarity; and, as before, this similarity may be greatly diversified, so long as the artistic education of the beholder enables him to recognize the fundamental regularity. A third character of beauty of form is continuity of lines and surface: a straight line is an important artistic element. This is again a repetition of design, for the several parts of a straight line are again straight.

What, then, is the origin of this intuition that gives rise to aesthetic pleasure? It is the recognition of equality, — the simplest conception furnished by the senses. The ear recognizes when two sounds are of the same pitch, as well as when two intervals of time are alike: equalities of space are appreciated by sight as well as by touch. This recognition of equality, of the identity or the repetition of two sensations, reveals an order in the objective world, and the intuition of this regularity gives pleasure. The degree of pleasure depends on the universality and importance of the regularity thus revealed, and on the vividness and the variety of the sense-impressions. And what we mean by ugliness is not the lack of regularity which we see in a stone, for example: that is aesthetically indifferent. But that is ugly in which we recognize a law, but see that law violated. An unsuccessful attempt at symmetry is ugly. A piece of goods in which the pattern to be repeated shows irregularities in size and execution belongs in the same category.

Passing now to sounds, we have simply to translate the language of space into that of time. The repetition of design finds its parallel in rhythm, and both are capable of endless complications. When we consider that poetry, music, dancing, even ordinary speech, that the organic functions such as the pulse, respiration, sleep, locomotion, and many of the acquired habits of mind and body, are all subject to a periodicity, the importance of rhythm is strongly impressed. Again: the continuity of the straight line is paralleled by that of the musical note. But here and in the consideration of melody we touch upon a fact unparalleled in the world of sight (though there is a slight analogy with color), and which owes its complete discovery to the genius of Helmholtz. The musical notes are not simple in their character, but each is accompanied by a certain series of overtones or harmonics which bear a definite relation to the fundamental note; and it is a wonderful fact that it is just this series of harmonics that give rise to the octave and the musical scale; and the relative importance and distinctness of the notes composing this series of harmonics is exactly mirrored in the historic development of the scale from the earliest times to the present.

Long before it was known that sound was a periodic motion of vibrating air particles, in times when the counting of these minute vibrations would have been regarded as a miracle, the intuitional instinct of the untutored ear had already selected that pair of notes the vibration rates of which had the simplest ratio of one to two, as the basis of aesthetic sounds. It had performed unconsciously but correctly that analysis for the conscious discovery of which we required all the

[1] *Revue scientifique*, Sept. 2, 1886.

refinement and skill that centuries of scientific education could furnish. Does this not suggest a conception of law, of rationality, of an adaptation between the human mind and the external world, which is not yet fully appreciated?

Besides the repetitions due to rhythm and the scale, there are the more complicated ones due to the repetition of phrases and arias. The *Leitmotiv* and the variations of a theme are examples of more complex modes of musical repetition. The laws of harmony reveal the same tendency towards a recognition of identity, in combination with those numerical relations which underlie the formation of the scale. The appreciation of the more complicated harmonies depends on natural gifts as well as on musical training.

M. Soret considers the aesthetic aspects of color as regards mixture, juxtaposition, repetition, in a similar way; and, though there are many suggestive analogies thus brought out, the subject is hardly sufficiently well known to warrant precise statements.

The final portion of the address is devoted to the beautiful in nature. In the animal world symmetry is certainly evident; and though this symmetry is not perfect in various attitudes, still we readily recognize its nature; and, in fact, this mobility is itself pleasure-giving. In the lower forms of life, repetition of design, as the stripes of a zebra, the markings of a caterpillar or a butterfly, is abundant. Continuity and roundness of outline is certainly a prominent feature of animal forms. The mutilation or natural defect of parts of the body spoils the regular effect, and is thus ugly. Of course, as regards man, the animal which we know so intimately, the psychic elements play an active part in the conception of beauty; but these are not now under consideration. By comparison we erect a type, an ideal, and judge of beauty by its conformity to that ideal.

Turning to the vegetable world, we find exquisite symmetry, graceful outline, and repetition of design, represented as before. And into that combination of foliage with sky and earth which forms scenery, these elements enter, but do not sufficiently explain the enchanting effect of beautiful landscape. In short, there is a physical basis of aesthetics; but it is far from perfectly understood, and in part is so closely connected with higher aspects of beauty, that its nature remains unrevealed. J. J.

THE Lehigh valley railroad is to be equipped with the Phelps system of train telegraphy, by which moving trains can be kept in constant communication with headquarters or with any station on the line of the road.

RECENT PALEONTOLOGICAL PUBLICATIONS.

Revision of the Palaeocrinoidea. Part iii. By C. WACHSMUTH and F. SPRINGER. Philadelphia, *W. P. Kildare, pr.*, 1886. 8°.

WACHSMUTH and Springer have issued separately an extract from the Proceedings of the Academy of natural sciences, forming an octavo of some two hundred pages, and containing a discussion of the classification and relations of the brachiate crinoids with the conclusion of the generic descriptions, errata, and a full index. This important work forms part iii. of their revision of the Palaeocrinoidea, and will be indispensable to all students of that remarkable group of animals. The total number of genera recognized is 156; of species, 1,276. Sixty-one of the genera are exclusively American; forty-eight, exclusively European; forty-six are common to both hemispheres; one is peculiar to Australia. The authors do not claim that all the species included and referred to their proper genera in their list are actually well founded: on the contrary, many may prove eventually synonymous with previously described forms. However, there are numerous undescribed species; and the writers claim that at least one hundred such are contained in their own collection, to be hereafter described and completely illustrated in a monograph of the Palaeocrinoidea of North America. The group formerly described by them as the family Ichthyocrinidae, with the addition of Crotalocrinus and Enallocrinus, is now erected into a sub-order, Articulata, containing two families, — the Ichthyocrinidae and Crotalocrinidae. Further indication of the details of a work which is in itself a synopsis are impracticable within the limits to which we are restricted, — a fact which we regret the less, since all those directly interested will, without doubt, possess and profit by the original.

Geological survey of Alabama. Parts i. and ii. By T. H. ALDRICH and O. MEYER. Tuscaloosa, *Geol. surv.*, 1886. 8°.

Bulletin No. 1 of the geological survey of Alabama, directed by Prof. E. A. Smith, forms the first contribution toward a work undertaken by Mr. Truman H. Aldrich, illustrating the paleontology of the tertiary formation in Alabama. This work, which is to be the gift of Mr. Aldrich to the state of Alabama, will embrace figures and descriptions of all the shells found in the tertiary deposits of the state, including reproductions of figures published elsewhere, and, when finished, will be one of the most complete works of the kind published by any state.

In the preparation of this bulletin, Mr. Aldrich has personally gone over the greater part of the ground, and has collected a large part of the ma-