tion that luminous bodies are continually throwing out infinitely small and imponderable corpuscles, which, being propelled in all directions and in straight lines, on reaching an eye make the object visible. When applying this theory to the facts now known, grave difficulties are encountered; and the French philosopher Biot devoted nearly his whole life to the explanation, according to this theory, of the various phenomena of reflection, refraction, polarization, etc. He often had recourse to the most ingenious and intricate mental devices. The fourth volume of his "*Traité sur Physique*," an octavo book of 600 pages, entirely devoted to the subject of polarization of light, as far as its phenomena were known in the year 1810, is a lasting monument of wasted ingenuity, as this whole theory was utterly upset by the phenomena of interference, which definitely established the undulatory theory, and this theory is further being confirmed by the details of spectroscopic observations at the present day.

This undulatory theory, as defended by Young, Malus, Fresnel, Brewster, and others, consists in the assumption that light is transmitted by undulations or vibrations in some medium, without the onward progress of anything, in the same way as the transmission of sound takes place: with the difference, however, that in sound the undulations take place by longitudinal compressions and expansions of the air: that means that the sonorous masses have their motion in the direction in which the sound is transmitted, while in light the undulations in the transmitting medium take place transversely to the direction of the ray. Some of our philosophers are dissatisfied with this theory. Thus, for instance, Professor Silliman, in his "Physics," says: "It is difficult to explain all the phenomena of light even on this theory;" and further on he closes some paragraphs, under the head of "No Theory of Light entirely Satisfactory," by stating that certain objections to the undulatory theory have as yet not been satisfactorily answered. Other writers express themselves in the same strain; but we may as well object to the undulatory theory of sound (of the correctness of which there cannot possibly be any doubt) on the ground that some difficulties have not yet been satisfactorily answered. In fact, in the case of sound, we have even more complexity than in that of light, as various rates of velocity produce pitch in the first and color in the second, and degrees of amplitude of vibration produce in both various intensities; and in both time is needed for the propagation. It is true that light moves in the planetary space one million times faster than sound travels in air; but both need time, and in neither of them is there such a thing as an instantaneous transmission, as is the case with the transmission of gravitation. In both, the phenomena of reflection, refraction, and interference may be observed; and further, the rays of either propagate and may cross each other in all possible directions without the least mutual interference. Various other similarities may be cited; but then, in sound we have the range of nine or ten octaves, while in light we have only one, or at most three, if we consider the heated and chemical rays at the respective extremities of the spectrum as two octaves. And in sound, we have difference in character, independent of velocity and amplitude, namely, that which the French call *timbre*, a peculiarity which is unknown in light, and is exemplified in the sounds of various musical instruments, voices of singers, etc., which differ from each other so plainly that each may be recognized even in a full orchestra and chorus. The familiar voice of a friend may be identified even among a great number of voices singing together in a choir. If we consider that all these vibrations not only differ in velocity and amplitude, but also in a multitude of other ways, of which the nature is as yet a mystery to us, and reserved for future study, and that all these are transmitted simultaneously without interfering, not alone through air, but may be even transmitted through solid rods, we are startled at the complexity of the nature of the form of all these various sonorous waves; and we may with good authority state that many difficulties in acoustics have not yet been satisfactorily explained by the undulatory theory of sound; but nobody has for that reason ever asserted that the undulatory theory of sound is not satisfactory, because it is established beyond the shadow of a doubt, and any other acoustic theory is absolutely impossible.

We may therefore safely maintain that any remaining difficulty in the explanation of the phenomena of light is due only to our imperfect knowledge of the nature of the various possible kinds of vibrations, which are often of the utmost complexity. Mathematical investigation has already done a great deal in this direction, and promises to do a great deal more. The labors of Lissajou in the determination of various sound curves, and the resulting pendulum apparatus to delineate them, called the sympolmograph, is a move in the right direction, and the prosecution of such labors will no doubt enable posterity to explain clearly much that is as yet a mystery to us.

In this connection, we ought to mention the modification the undulatory theory proposed by Rankine. He assumes that the particles of the medium which transmit the light (whatever that medium be or may be called) rotate on their axes by the action of a kind of magnetic polarity. This theory is intended to overcome the difficulty of assuming that the light-transmitting medium has the properties of an intensely elastic body, or, as Tyndall expressed it, is, in a certain sense, as dense as a jelly. The beauty of Rankine's hypothesis is that the same mathematical formulæ may be employed as for the other form of the undulatory theory, which is a strong argument in its favor.

PHOTOGRAPHS IN THE EYE.

There has long existed a popular superstition that the human eye after death bears the picture of the scene on which it last gazed. Abundant romantic stories are current of how murderers have been recognized through the imprint of their features on the pupils of their victims; and not very long ago many believed that a substantial proof of the supposition had been afforded by the eye of a murdered man, whose body had been found under a hedge, exhibiting a ramified appearance, a likeness between which and that of the tangled branches above the organ some imagined they could trace. It is certainly startling to meet with the grave assurance that the above superstition, although not literally true, possesses a very strong foundation in fact; but the recent wonderful discoveries of Drs. Boll and Kuhne leave no reasonable doubt but that our retinas are sensitive photographic plates, inasmuch as they contain a substance which, under the influence of light, undergoes chemical changes which vary in intensity according to the intensity and character of the luminous rays.

Not very long ago Dr. Boll, Professor of Physiology in Rome, directed the attention of the Berlin Academy to the curious fact that the external layer of the retina, which the microscope shows to be made up of rods and cones, is in all animals of a purple color. This color, he pointed out, is during life being constantly destroyed by the light which enters the eye. Darkness, however, restores the color, which vanishes forever almost immediately after death.

The very remarkable nature of these statements induced Dr. Kuhne, Professor of Physiology in the Heidelberg University, to undertake a repetition of the experiments; and the results of his researches he has lately communicated in a paper addressed to the Heidelberg *Natur-Historisch Medici isches Verein*. Kuhne's observations were made upon the retinæ of frogs and rabbits; and by examining as soon as possible after death the retinæ of animals which had been kept in darkness, he found "that the beautiful purple color persists after death if the retina be not exposed to light; that the bleaching takes place so slowly in gaslight that by its aid the retina can be prepared and the changes in its tint deliberately watched; and that when illuminated with monochromatic sodium light, the purple color does not disappear in from twenty-four to twenty-eight hours, even though decomposition has set in." These facts, obviously going to disprove one of Boll's important statements, at the same time removed many difficulties of investigation; and Dr. Kuhne, carrying on his researches by the monochromatic light of sodium, proceeded to investigate the conditions necessary to the destruction of the vision purple (*Sehpurpur*, as he terms it), as well as some facts relating to its restoration or removal. These observations yielded the discovery: first, that, under yellow light or in the dark, the retina may be dried on a glass plate without its color changing; second, that the color is not destroyed by strong solution of ammonia, saturated solution of common salt, or by maceration in glycerin for 24 hours. On the other hand, it is destroyed by alcohol, glacial acetic acid, strong solution of sodium hydrate, or a temperature of 212° Fah. It was also determined that the more refrangible rays of the spectrum have the greatest influence on the color, while red light is as inoperative as yellow light.

Dr. Kuhne next showed that, even after the living eye had been exposed to daylight, its retina, on being examined in the sodium light room, still showed a fine purple, thus negativing another of Boll's assertions; while he further noted that the fading of the purple occurred only after the eye had been exposed for some time to sunlight. The curious result was also reached that, while a retina removed from the eye lost its purple color under diffused daylight, another retina, left in the eye but exposed by an equatorial section, turned a dark red, which bleached when the retina was exposed in naked condition to the daylight. A still more remarkable experiment was that showing how the vision purple is restored. On making an equatorial section through a recently extirpated eye, and lifting a flap of retina from the underlying choroid so as to expose the flap to the light, the purple color of the flap was found to be destroyed, while the color of the rest of the retina persisted. But on replacing the flap, a complete restoration of the vision purple occurred. Dr. Kuhne concludes, therefore, that this restoration is a function of the living choroid, probably of the living retinal epithelium; and it appears to be independent of the black pigment which the retinal epithelium normally contains. Thus, not only does the retina contain a substance capable of being acted upon by light, but connected with it are structures which, so long as they are alive, are able to provide fresh stores of sensitive material.

After concluding this first series of researches, Dr. Kuhne endeavored to obtain, on the retinæ of freshly killed animals, images corresponding to objects looked at during life. And he showed that, in order to obtain a permanent photograph or, as he terms it, an *optogramme*, the effect of the light would have to be so prolonged or so intense as to destroy the balance between the destruction of the vision purple and the power of the retinal epithelium to restore it. In order to test the matter thoroughly, he fixed the head of a living rabbit, so that one of the eye balls would be 58·5 inches from an opening 11·7 inches square in a window shutter. The head was covered for five minutes by a black cloth, and then exposed for three minutes to a somewhat cloudy sky. Instant decapitation was then effected, and the eyeball was rapidly extirpated under yellow light and plunged in a five per cent solution of alum. Two minutes after death, the second eyeball, without removal from the head, was subjected to exactly the same processes as the first, namely, to a similar exposure to the same object, then extirpation, etc. On the following morning, the milk-white and now toughened retinæ of both eyes were carefully isolated, separated from the optic nerve, and turned. They then exhibited, on a beautiful rose-red ground, a nearly square image, somewhat larger than 0·0016 square inch in size, with sharply defined edges. The image on the first eye was somewhat roseate in hue, but less sharply defined than that on the second, which was perfectly white. In brief, the hole in the window shutter was photographed on the rabbit's eye. What further investigations into this subject are likely to show, it is difficult to surmise; but it is certain that no results that may be adduced can be more astonishing or unlooked-for than those already reached. They bring out in the strongest relief the fact of how little we really know of our own organization; while they add to the already long catalogue of marvels pertaining to that most wonderful of optical instruments—the human eye.

AN EDITOR'S PERPETUAL MOTION.

Mr. Morgan, the editor of *The Phœnix*, a sprightly newspaper at Columbia, S. C., has invented a perpetual motion, which is to operate as follows: Upon the periphery of a large wheel are arranged a series of rubber bags, one half of which are filled with water. As the wheel rotates, the bags on one side of the wheel become filled with water, while the bags on the opposite side are emptied; a preponderance of weight being thus maintained on one side of the wheel, the latter will continue to rotate until something wears out, or the world comes to an end.

Mr. Robert Tozer, who, Mr. Morgan says, is one of the principal machinists of the place, has given a public certificate setting forth his belief in the practical success of the machine; and on the strength of this certificate Mr. Morgan has issued a very flattering financial prospectus. It is modestly headed "The Morgan Self-Producing Motive Power. No Fire! No Steam! No Explosions! No Engineer! No Expense! Nature's Forces Utilized! The Power that is to Revolutionize the World! There's Millions in it!"

To aid in procuring means to construct a working model, the inventor issues certificates of one hundred dollars each, payable at par as soon as success is insured and the money therefor realized. These certificates he is now ready to sell for one dollar each, or one cent for each dollar of their actual face figures. It is plain that Mr. Morgan is a better inventor than financier, or he would never have put his shares on the market at so low a figure. He evidently needs the assistance of an able person who has had experience in financing similar enterprises: like Mr. Charles B. Collier, for example, the learned agent for the Keely Motor Deception, who at one swoop drew in a hundred thousand dollars from New York merchants in payment for shares in that absurd bubble. Should Mr. Morgan be unable to secure the personal services of Mr. Collier, he may at least derive practical hints from a reading of Collier's own statement of the way he raised the wind for Keely, as published in the SCIENTIFIC AMERICAN, July 17, 1875.

THE COMMISSIONER OF PATENTS.

General Ellis Spear, the new Commissioner of Patents, has entered upon the supervision of the Bureau; high subordinate positions in which, he has already ably filled. Either on the principles of civil service reform, whereby long experience in a lower grade is deemed one of the best qualifications for advancement, or through his personal fitness for the office, General Spear's appointment meets approval of the country, while it is also one upon which we think all inventors may be congratulated. An inefficient or poorly informed commissioner has it in his power to impede the efforts of inventors through lack of a proper appreciation of the importance of their work; and thereby he may, however innocently, act adversely to the interests of that great class, and ultimately to those of the public. For this reason, the office should never be regarded in the light of a political emolument, but rather as a high honor bestowed on the possessor of the rare qualifications which should be brought to it.

We are satisfied that the selection of General Spear for the post is in the above respects a wise one; and it is to be hoped that he will regard the position as a trust, to be administered for a longer period than some of his predecessors have found it to their personal interests to do.

Poisonous Peas.

French canned peas are now so commonly sold by grocers that it is not at all pleasant to learn that in England some recent cases of poisoning have been traced to copper put in the cans in order to preserve that beautiful green color of the vegetable. There is not enough of the deleterious metal in any one can probably to do harm; but where the peas are used on the table regularly, an English chemist says, there is sufficient of the poison to affect the health seriously.

CANCELLING POSTAGE STAMPS.—J. C. E. writes to suggest that the government should stimulate inventors to produce an indelible cancelling ink by offering a reward for the invention.

WHAT IS SCIENCE?—"Science to the general public," says a witty contemporary, "is everything you can't comprehend: directly you begin to understand it, it ceases to be Science."