periments which this discovery subsequently induced him to make proved to him that for the hydrogen in organic compounds other elements could be substituted, atom for atom, and that every organic compound was, therefore, a step to every other organic compound. No generalization has contributed more to the progress of organic chemistry than this law of substitution.

Such anecdotes can be told *ad infinitum*. Enough have been given to show clearly how simple things are often straws which have guided the current of scientific thought to epoch-making discoveries.

EROS, THE CELESTIAL RANGE FINDER.

The first stage in a fresh attempt to compute with accuracy the sun's distance from the earth is now drawing to a close. For six months or more the astronomers at fifty observatories, well distributed over the globe, have been making photographs of the sky, which would show both the tiny asteroid Eros and a few stars in its vicinity. At many of these institutions the weather has permitted work on fifty or sixty nights, and as often as possible two pictures have been made, one early in the evening and the other just before dawn. Sometimes one has been taken at midnight, too. In the aggregate, fully 5,000 or 6,000 plates have now been exposed.

The next important step in the enterprise will be the measurement of the photographs, to ascertain the distance, in minutes and seconds of arc, between the asteroid and the neighboring stars. And then a number of comparisons must be made. One will show an apparent difference in the position of Eros at a given moment, due to simultaneous observations from places that are widely separated, like Pulkowa and Washington. Another will reveal a similar shifting, in consequence of a single observer's change of position through the rotation of the earth. Finally, with the two sets of base lines thus obtained, triangulation will give the distance of Eros from the earth, in miles, at a number of points along its orbit. The ratio between the asteroid's distance from us and the sun's having been ascertained—and this is an easy matter—the rule of three will tell us how far away the sun is. This distance, though closely approximated, has never been determined, with precision, and yet it is the celestial yardstick by means of which all others are compared by the astronomer.

The method here described is an old one. The moon and the nearest planets, Venus and Mars, have been utilized in the same way to solve the great problem of the sun's distance, but unforeseen difficulties have embarrassed each of these ventures. Eros, though much smaller—it is probably not more than twenty miles in diameter—is much more available. Its place can be determined with greater exactness. Besides, at times it comes nearer to the earth than do Venus or Mars, a fact that facilitates accuracy in measurement.

Eros was discovered scarcely more than three years ago. Something like 450 other asteroids are known. But, with the exception of the first few, none of them created such a sensation as the one which, temporarily designated "D Q," was subsequently named after the Greek God of Love. The reason for this peculiar interest is its remarkable orbit. Most of the asteroids keep entirely outside of that of Mars—the planet next beyond the earth in the solar system. But this little fellow's path not only overlaps the orbit of the ruddy planet, but it spends more than half its time inside. At one point the paths of Eros and the earth are nearly 60,000,000 miles apart, and at another they come within 13,000,000 miles of each other. The earth reaches the latter place every year, of course, and Eros gets there once in 21½ months. But unfortunately we do not both arrive simultaneously more than once in about forty-five years. Late in December last we came within 30,000,000 miles of the asteroid, and since that time we have been leaving it slowly behind. Yet, since there will not be so close an approach again before 1917, the astronomers have made the most of this opportunity. They began photographic operations early in the autumn, and now are about to end them. The undertaking has involved co-operation on an exceptionally large scale, and it will be consummated by months, perhaps years, of the nicest kind of mathematical work.

THE AUTOMOBILE IN THE KLONDIKE.

We have received some most interesting letters from John W. Fox, of East Cleveland, Ohio, in which he relates some notable particulars about the introduction of the automobile into Dawson City, the venture being in the hands of Edmund H. Clear and George W. Dunham, of Cleveland, Ohio. The machines are built like a three-seated surrey, each seat to accommodate four people. They are propelled by 15-horse power motors, and use about one gallon of gasoline per hour. They run on the trails and climb the hills without the slightest difficulty. They carry ten or twelve passengers each, and also have room for small packages for the different mining camps on the daily runs. The winter has evidently been a severe one in the Klondike, and this more than ever demonstrates the value of an automobile for an Arctic climate. In the United States we read frequently of deaths from freezing at temperatures nearly a hundred degrees warmer than are found in the Klondike. During the last 187 miles of the journey of Mr. Dunham, the temperature ranged from fifty-five to seventy-one degrees below zero, and the government thermometer registered seventy degrees below zero for three days in Dawson City. Mr. Dunham says: "I started up the river December 30, and did not get back until January 21, being delayed by a run of cold equaled by nothing experienced by the old inhabitants. For over a week the temperature never rose above fifty-five below zero, and one time was as low as seventy-two. We traveled every day, however, going slow, making from five to twelve miles, according to the conditions of the trail. To make matters worse, the horses' nostrils would clog up with frost, and had to be cleared from time to time when they began to stagger for want of air. Our loads consisted of two four-horse teams, pulling about 5,000 pounds each, and the wagons were 9½ feet wide, so you see we had to chop ice wherever it was rough. Some nights we did not go into the roadhouses until nearly twelve. We have one machine erected, and we take it out every day, and are getting it in pretty good shape. Dawson is highly excited, and every one is urging us to hurry so they can ride." Another letter says: "The stage lines, or rather their owners, are beginning already to tremble, but after they see the 'gas buggies,' as one fellow called them, they will want to go out of business altogether, for the stages are only bob-sleds with seats, horribly cold and uncomfortable."

EXPERIMENTS WITH ANIMAL TISSUE.

The method of finding out whether a given animal tissue is living or dead, recently discovered by Dr. Augustus Waller, has awakened considerable interest. It will be remembered that this method consists in sending a current through the tissue in question, and then connecting it to the poles of a sensitive galvanometer, when a back rush of current is perceived in the case of living tissue, while in the contrary case no effect of consequence is obtained. Dr. Waller has recently made a series of experiments in which he follows out the same idea, but in this case applies it to discovering the first traces of life instead of its disappearance. In this he has been quite successful, and it will be interesting to follow a series of experiments made with eggs; up to the date of the present paper, three series of experiments upon eggs, good and bad, were made, and no exception was found to the general rule that a non-incubated, sterile, or putrefied egg did not give the back rush of current indicating the presence of vital phenomena, while an egg containing an embryo in a state of development always gave the indication which showed vitality. In the majority of cases, on account of the resistance of the shell of the egg to the passage of the current, a small portion was removed from the upper and lower sides, the egg being placed horizontally, and the electrodes (impolarizable) were applied to the membrane thus laid bare, so that the blastoderm floating at the upper pole was traversed by the exciting current. The eggs were placed in an incubating oven, which was regulated to a constant temperature of 37 deg. C. The following series of experiments shows the results obtained. First egg.—The egg at the beginning of incubation gave no back rush of current, but only small and negligible currents of polarization, which were in the contrary direction to the exciting current. Second egg.—After 24 hours' incubation the egg showed a small back rush of current, that is, ascending across the blastoderm. Upon opening the egg, it was found to be but little developed, with the vascular area scarcely apparent. Third egg.—After 48 hours' incubation, currents in the positive and negative direction were shown, of +0.0010 to 0.0022 volt and —0.0006 to 0.0012 volt. Upon opening, the vascular area was found to be well developed, and the heart beat vigorously. Fourth egg.—Incubation, 72 hours. The back rush of current was well marked in both directions. Upon opening, the normal development was observed. Fifth egg.—Incubation, 72 hours. In this case the results were negative. It was expected that a series of increasing currents would be found, according to the stage of development. In the present instance no current was obtained, even upon repeated trials; however, this apparently anomalous result was explained upon opening the egg, when it was found that no development had taken place, the egg being evidently sterile. Sixth egg.—After 72 hours' incubation, the normal reactions were given, with positive and negative currents of +0.0010 to 0.0019 volt and —0.0023 to 0.0026 volt. Upon opening, its development was found to be normal. The seventh and eighth eggs, with 96 hours' incubation, gave increased reactions of +0.0028 and —0.0044 volt; these were annulled by an elevation of temperature to 45 deg. C. The ninth egg, after 144 hours, gave a reaction of +0.0050 and —0.0025 volt, which was annulled by an injection of a 2.7 per cent bichloride of mercury solution. The tenth egg, after 12 days, showed no action, but only small currents of polarization of ± 0.0001 or 0.0002 volt. Upon opening the egg, it was found to be completely putrefied. This series serves as an example of a number of similar experiments which were made, with like results. It may be added that the effect was also observed in the case of eggs in the same mass such as frogs' eggs; the reaction has the same value for the two directions of the exciting current, being ± 0.03 volt; it is entirely effaced by heating to 40 to 45 deg. C. In the case of certain animalcules, which, when dried, seem to possess no sign of life, but in which, upon exposure to moisture, the vital activity is developed, the current indications follow the same order; in the first case no current is given, but upon the development of vital activity the characteristic current is always given. In the case of tissues, it was found that tissue which had been rendered insensible by anæsthetics gave no reaction, thus likening it to dead tissue. When the anæsthetic action was removed and vitality became apparent, the characteristic electrical reaction followed in all cases observed.

THE LONGEST SUBTERRANEAN TELEGRAPH CABLE IN THE WORLD.

The British Postal Telegraph Department has recently completed the laying of the underground telegraph cable, in place of the overhead wires, between London and Birmingham, a distance of 117½ miles—the longest underground telegraph cable in the world. The overhead telegraphic wire system in England, especially in the midland counties, suffers considerably from the effects of storms, notably in winter when the wires are often broken down by the weight of the snow, completely disorganizing the telegraphic communication for hours and sometimes days. In view of the fact that the principal great north trunk telegraph lines to Manchester, Liverpool, Glasgow and the other important industrial centers, radiate from Birmingham, some of the magnitude of the block caused by such a disruption of the lines may be conceived. Then again enormous expense is entailed in the constant repairs of the wires, since some disaster invariably occurs even in a moderate gale. In view of these circumstances the postal authorities determined four years ago to bridge over as far as practicable these exposed zones where overhead wires suffered so severely from storms, by laying the cables underground. The most important and largest section of this scheme proved by the survey to be that between London and Birmingham.

The cable consists of 76 wires, each of which is insulated in specially desiccated paper, and the whole inclosed in a leaden sheath to prevent the admission of moisture. It is laid in cast iron socket pipes, built in sections of 150 yards each. These pipes are buried at a depth of about 4 feet below the roadways, and where the cable passes beneath the pathways, at a depth of only two feet. The cable was manufactured in sections of 152 yards, thus leaving a yard at either end of the pipe sections, to enable the connections between the sections to be made.

When a section of pipes had been laid the drum containing the cable was brought to the end of the conduit, a pulling clip fixed to the end and the cable pulled through the pipes. As the cable passed off the drum into the pipes it was freely lubricated with petroleum jelly.

Great care had to be exercised in joining the sections, so that the insulation was rendered perfect. The lead covering at the ends of the two cables to be joined were first removed, to lay bare the ends of the conductors which were laid back in flakes to facilitate the process of separately joining each pair of wires. The joints were effected by means of a split copper tube tinned inside, with paper wrapped longitudinally round the exterior, and the wires secured tightly together with thread. No two joints were made in the same place, so that the wires did not present a bulged appearance at one spot. More paper insulator was then wrapped round and a lead sleeve pulled over the exposed wires and sealed up thoroughly at each end, so that the cable was converted into practically one length.

At intervals of five miles throughout the whole route, test boxes are placed on the roadside. They are built upon a foundation of 9-inch brickwork, set in cement mortar, forming an underground chamber through which the cable passes into the connection box inside the test pillar. By this means the individual wires may be tested and crossed quickly and readily.

At Weedon, which is a junction of several lines from the north, there is a test box where the wires cross from the open to the underground. When a breakdown, therefore, occurs beyond Weedon, the wires are immediately crossed, and the underground portion of the cable utilized, by which means all delays are avoided. The work has been executed throughout with great skill and care, so that the possibility of a breakdown between London and Birmingham is now very remote.