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#### JAMES YOUNG, FOUNDER OF THE PARAFFIN OIL INDUSTRY.

"It would certainly be esteemed one of the greatest discoveries of the age if any one could succeed in condensing coal gas into a white dry solid odorless substance, portable, and capable of being placed upon a candlestick or burned in a lamp," says Liebig in his "Familiar Letters on Chemistry," dated 1843. Soven years later James Young, the subject of the accompanying portrait, completed a long series of experiments with the successful extraction of paraffin from Boghead coal, and then, patenting his discovery, opened to the | leum, is now pumped into large iron pans, where it is boiled world a great and growing industry.

Mr. Young began life as a joiner, loarning his trade in his father's shop. His spare time, however, was devoted to the study of chemistry and he eventually adopted that profession, becoming at first assistant to Professor Graham in the London University, and subsequently manager of Muspratt's and after wards of Tennant's chemical works. In 1848 he resigned his position in order to embark in the manufacture of lubricating and burning oil from petroleum; but as his spring became exhausted, he began a series of investigations in order to find an artificial substitute for the natural oil.

From his own internal consciousness Mr. Young evolved the conclusion that petroleum, or its substitute, might be produced by the action of heat on the coal, the vapor going up into the sandstone to be condensed. The ultimate result of his researches was that, out of a cannel that came to be mixed with the soda ash for making the alkali, he got a quantity of liquid that contained paraffin.

Patenting his discovery, Mr. Young, with ten others, established works for the manufacture of paraffin at Bathgate. Scotland, in the center of the Torbane Hill coal field, a district peculiarly rich in cannel, and began the manufacture of which he is the founder.

Commencing with the raw material, which is principally a stone of slaty texture and a dusky brown color, we may explain that shale pits are generally worked in juxtaposition with the crude oil manufactories. The shale pits vary indepth from twenty to forty fathoms. The best quality is that which, when cut with a knife, does not splinter, but gives off a continu

veyed to the condensers, which, as a rule, are similar to those used in gas works. As it passes through the condensers, the vapor is reduced to a liquid form, in which state it is run off into reservoirs, some of which contain as many as 100,000 gallons.

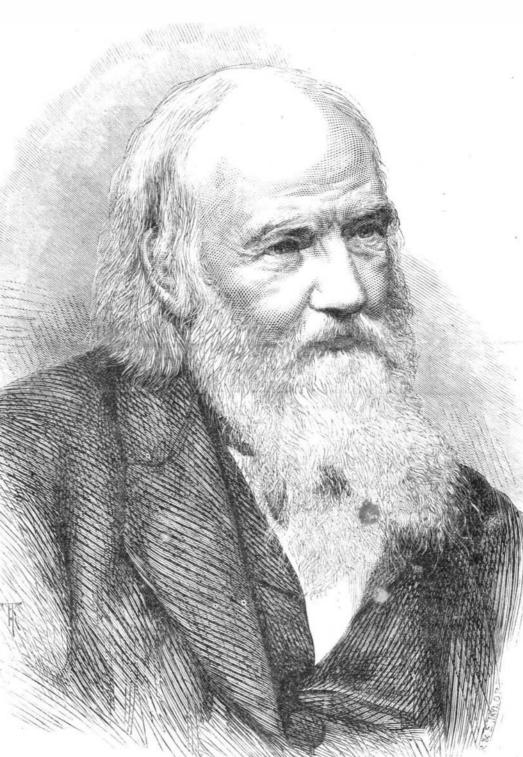
On leaving an apparatus called a separator, in which the two components of oil and water are parted from each other, the process of purification commences by a second distillation. The dark green fluid called crude oil, which at this stage has an appearance not unlike natural rock oil or petro-

ture, thus enabling solid paraffin to be produced in the hottest summer weather. Remaining in solution at a temperature of 60°, paraffin coagulates into the solid form when the temperature is reduced to 32°. Crude solid paraffin is now worth from \$150 to \$175 per tun in England. Paraffin candles, from which a clear, lustrous, and perfectly odorless light is obtained. are made at most of the principal Scotch oil works.

ting machine. The air thus refrigerated is brought to be ar

on a stream of brine, which it converts into a freezing  $m^{i}x$ .

In addition to the Bathgate works, Mr. Young also proto dryness. In this way the hydrocarbons are once more | jected the Addiewell works, on a very extensive scale. The



land leased for their requirements extended to some three or four thousand acres, all containing shale and other minerals; while some forty acres were set apart for the site of the works. The retort sheds are upwards of 200 yards in length, and each shed contains a double row of retorts. There are altogether close on 400 retorts at these works. This represents a capacity for distilling over 3,000 tuns of shale per week, and producing 120,000 gallons of crude oil, yielding 50,000 to 60,000 gallons of burning oil, in addition to about 12 tuns of refined paraffin, and a large quantity of lubricating oil. To accomplish these results, the appliances are necessarily on a large scale. The heavy vapors are collected in two und erground tanks. each capable of containing 12,000 gallons. Any vapor which does not liquefy in the condensing main is passed through a four inch cast iron tubular condenser, which is made up of 1,300 nine feet lengths, or a course of nearly two and a quarter miles! For the purposes of distillation upwards of twenty 2,000 gal lon stills, made of malleable iron, are erected. There is a similarly large number of refining stills, each capable of containing 4,000 gallons. A number of immense store tanks, each capable of containing 15,000 gallons, are fitted up contiguous to the refining kilns, being so situated that they can collect the oil as it passes from one stage of the refining operations to another. The building in which the various oils are subjected to chemical treatment is four hundred feet in length and eighty feet wide. It has two fireproof gables, cutting off in the center the engine house from which the machinery is actuated. Underneath the roof of the building the altogether upwards of a hundred large cast iron vessels, with a capacity varying from

ous shaving, such as would be got from a piece of soap or wax. On reaching the pit

bank, the shale is turbled into a crusher, in passing through | driven off in the form of gas, which, when condensed, yields which it is ground to pieces, sufficiently small to pass easily down the retorts. The more common retort is a flattened cylinder of cast iron, about twelve feet long, which contracts towards the ends, both of which are open, and its lower end dips two or three inches into a shallow pan filled with water. After the retort has been filled with broken shale, the furnace is brought into operation, so as to raise its middle zone to a low red heat. The process of distillation then goes on continuously. At a temperature of 300°, the hydrocarbons contained in the shale are given off in the shape of gas, which is, to a large extent, condensible. At most of the crude oil works, the incondensible vapor is collected in a gas hold-., and used for lighting the workshops. The oil obtained from the decomposition of the coals, having assumed the form of vapor, is collected in a large main having connections with the retorts. Through this main the vapor is con- The solid paraffin is made by the application of a refrigera-

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## JAMES YOUNG. FOUNDER OF THE PARAFFIN OIL INDUSTRY.

3,000 to 500 gallons. Upwards of 1,000 hands are employed an oil still rather green in color, but much thinner, lighter at Addiewell, and in the shale pits adjoining over 500 miners and purer than before. The oil in this state is taken to a set are at work. One and a quarter million cubic feet of gas of closed vessels, where it undergoes a sort of scouring proare produced at the works daily. The Addiewell shale yields cess, by being stirred up wik sulphuric acid. Run off into from thirty to forty gallons of crude oil per tun, of the spea settler, still further purified, it rises to the top, where a cific gravity of 0.870.

black tar, formed by the combination of sulphuric acid with various impurities, subsides to the bottom. Being again similarly treated with caustic soda, the oil is still further refined, previous to being passed on by pumps to undergo a third distillation, which is pursued with vitriol and soda, until it becomes a thin, light, and perfectly colorless fluid. This is paraffin oil.

Solid paraffin is obtained from the thicker and heavier oil, of which about twenty gallons are evolved from every hundred gallons of crude oil put through the refining process.

Within the comparatively short space of twenty years, the mineral oil trade has attained such a magnitude that it gives employment to over 7,000 workmen, who earn weekly something like \$50,000 in wages. At the present time about 800,000 tuns of shale oil are annually distilled, producing nearly 30,000,000 gallons of crude oil, while the quantity of refined burning oil obtained from the crude product is close upon 12,000,000 gallons per annum, in addition to solid paraffin, naphtha, and other chemical products.

Of Mr. Young's more personal history we have left our selves little room to speak; but this is the less to be regret-

number of years past he has held the office of President however, so trustworthy as to leave no doubt of the practiof the Andersonian University, in Glasgow. Surrounded by the members of his own family and by those of his lamented friend Livingstone-for he has really been in loco parentis to the children of the African traveler-Mr. Young, for whose portrait we are indebted to the Practical Magazine, now spends the great bulk of his time at his beautiful estate of Kelly, near Greenock, Scotland, or at his no less fine and romantic estate of Durris in Aberdeenshire. But he also mixes to some little extent in public life, contributing liberally to all movements of a patriotic or charitable character, and aiding by every means within his power the progress of scientific knowledge.

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#### VELOCITY OF NERVOUS IMPULSES.

In his suggestive lecture on the sun, our English visitor, Mr. R. A. Proctor, makes use of several striking illustrations to give an idea of the immense distance between us and our great luminary. One of these supposes an infant with an arm of the inconvenient length of ninety-one millions of miles, who should stretch forth his hand and touch the sun. Naturally the darling would have his finger burnt; but, so slow is the transmission of feeling, he would have to wait until he was a hundred and thirty-five years old before he could be conscious of the fact. In this estimate Mr. Proctor evidently adopts the rate of nerve motion obtained some twenty years ago by the observations of Dr. Hirsch-that is, about one hundred and eleven feet a second. The later and more elaborate researches of Dr. Schleske show a rapidity of conduction by the sensory nerves of about ninety-seven feet a second, which would require our sunburnt infant to wait some years longer before discovering his indiscretion. If he trusted his sight in the matter, he might become aware of the danger of his distant member in the short space of eight minutes, so much more rapid is the speed of light than the movement of feeling along the nerves. The passage of volition along the motor nerves appears to be still slower; so that upwards of a century and a half, perhaps, might elapse before the mental order to withdraw the finger could be carried out.

However slow the rate of nervous movement may be, as with his finger on a signal key, with which he announced compared with the velocity of light or the still fleeter mothe perception of an electric shock as soon as possible after tion of electricity, it is nevertheless so rapid that until quite feeling it, thus closing an electric circuit which had been recently it was thought to be immeasurable, within the limbroken by the shock. The minute interval between the ited range in which our observation of it is possible. The breaking and closing of the circuit measured the time taken by the transmission of the shock to the brain, the time remost widely separated points in the course of any nerve allow but a few feet of difference at best for timing the quired for the perception of the sensation, time for willing periods of sensation or volition; and the nervous impulse the movement of the signal key, time for the transmission travels so quickly that such small distances would seem to of this volition to the proper muscles, time for the contracbe wholly annihilated. To our consciousness a prick on the tion of the muscles, and finally the time lost in the physical great toe is discovered as promptly as one on the cheek; and process of signaling. Obviously all these parts, except the it is only by the intervention of the most delicate and infirst, must be substantially the same in all experiments by genious of mechanical contrivances that the difference in the same person, using the same finger for making the sigtime is made apparent. nal. Any difference in the whole time must therefore be The first step toward making the solution of this interest owing to the greater or smaller distance of the particular ing problem possible was taken in the antiphysiological art point of impression from the brain. This difference being of gunnery. In the development of that art, it became measured with tolerable exactness, it is possible to calculate necessary to measure the speed of projectiles, both in the pretty closely the rate at which the nervous impulse is gun and during the several stages of their flight. For this transmitted. The estimate first made by Dr. Hirsch was, as purpose Pouillet's chronoscope was devised, by means of already noted, 111 feet a second. More recent determinawhich an electric current was made to indicate the duration tions give averages ranging from 97 feet, by Dr. Schleske, to 136 feet, Wittich's estimate for a nervous impulse excited Buel, in the article referre ! to, demonstrates that the locoof the most rapidly transient processes. Thus the passage of a bullet along the barrel of a gun was found to occupy by electricity. With a mechanical stimulus, he found an average velocity of 124 feet. These figures, of course, are to the hundred and fiftieth part of a second. It quickly occurred to Helmholtz that here, possibly, was a means of meas-be taken relatively. The rate varies in different individ to be desirable. We give a brief summary of the principal uring the speed of nervous action. His application of the uals, and, doubtless, in the same individual, with varying statements, omitting all mathematical work :

ted, as his has been essentially a scientific career. For a method was too complex for description in this place; it was, cal accuracy of its results. His object was to measure the intervals of time, if there were any, between the excitation of a nerve at two different points and the corresponding contractions of the muscle. The difference between such intervals would, of course, be the time required for the passage of the nervous impulse over the space between the two points of excitation. Experimenting with the leg of a frog, two sets of observations were obtained, differing from each other by a small but constant quantity. For the more distant point of excitation, a measurable fraction of a second longer was uniformly required to make the muscle contract. The difference of distance being exactly measured, the rate of propagation of the nervous impulse was easily calculated. Instead of rivaling the velocity of electricity, as had hitherto been supposed, the rapidity of conduction in the motor nerves of the frog was found to be no more than eighty five feet a second. All this was as early as 1851. To test the accuracy of the result thus obtained, Professor Helmholtz devised another and more simple apparatus, which he called a myographicon. In this the contracting muscle was made to directly register the beginning and successive stages of the contraction by means of a style working against a rotating cylinder. This confirmed the general correctness of the estimate obtained with Pouillet's apparatus, the rate demonstrated being a little over 89 feet a second.

> Various improvements of the myographicon were soon suggested by Du Bois Raymond and others, whose observations. while differing slightly in result, were not conflicting with previous results, due allowance being made for temperature and other disturbing conditions. The maximum rate obtained by the last named observer was 30 meters a second, or 98<sup>1</sup>/<sub>4</sub> feet. This was the estimate on which he based his widely quoted illustration of the harpooned whale. If one of these sea monsters, a hundred feet long, were struck in the tail, he said it would take a full second before the sense of pain could reach the victim's brain; and, omitting the time necessary for perception and volition, another second must pass before an order could be telegraphed to the tail to retaliate by upsetting the harpooner's boat.

In all the experiments on motor nerves thus far, the leg of a frog had been used. In 1867, Baxt and Helmholtz applied the test to man, using an improvement of the myographicon suggested by Du Bois Raymond. The result gave the rate of conduction for the motor nerves of man, corresponding to that already obtained by Hirsch for the sensory nerves. A very careful series of experiments by the same its effects. The autopsy was made in the interests of science observers, in the summer of 1869, showed a mean rapidity for the motor nerves in man very much greater, or about 254 feet a second. But this by no means invalidated the result already obtained, since, as Helmholtz had shown, the rate varies greatly with temperature, being not more than one tenth as great at 32° as at 60° or 70°.

More recently it has been established by Dr. Munck that the velocity of nervous impulses is different in different nerves, and in different parts of the same nerves, the rapid ity increasing as the termination of the nerve is approached, and by Marey's observation, that fatigue of the muscles has the effect of seriously reducing the rate of nervous conduction; while Wittich has found that the rate is in some degree dependent on the mode of excitation, being greater when electricity is used than when the stimulus is mechanical. The same observer also reports a considerable difference between the rates of motor and sensory nerves, the latter excelling by at least a third.

The measurement of the rate at which the nervous impulse travels brainward necessarily involves a process very different from any employed in the study of the motor nerves. The problem was first attacked by the Swiss astronomer Dr. Hirsch. Soon after Helmholtz took up the other branch of the investigation, and his solution of it was as ingenious as it was successful. It involved the measurement, with the delicate chronometric instruments employed by astronomers, of the difference in time between the appreciation of impressions made at a distance from the brain, say on the great toe, and others nearer, as on the cheek. Roughly described. the plan adopted was substantially this: The observer sat

conditions of health, temperature, and so on, the general average being about that of a high wind, a race horse, or a locomotive. Light excels it about ten million times, and electricity more than fifteen million times.

But, it may be asked, what is the use of all these investigations? Of what account is a delay of the hundredth part of a second, more or less, in the perception of a sensation or the transmission of a volition, so long as we are not conscious of it? In astronomy, it has proved to be of material account; and it is more than probable that the knowledge of the normal rate of nervous impulses thus obtained may some day be of the greatest help in the diagnosis of nervous diseases.

With the nicest appliances for observing and timing phenomena, there still remain discrepancies between the reports of different observers, however skillful. Time is required for the act of perception, for willing the pre-determined signal, and yet more for executing the volition, all of which directly affect the accuracy of the observation; and since these intervals differ with different observers, the exact moment of an occurrence cannot be fixed without knowing and allowing for them.

## THE AUTOPSY OF PROFESSOR AGASSIZ.

Dr. Morrill Wyman, of Cambridge, Mass., has published a report on the autopsy recently made upon the body of Professor Agassiz, from which it may be deduced that the disease to which the great naturalist succumbed was one of long standing. The arteries at the base of the brain showed evidence of extensive chronic disease of their lining membrane, and also several important changes which were fatal. In the left ventricle at the lower third, a firm.organized clot.of the size of a peach stone, attached to the wall at the anterior portion near the septum, was found, and around this clot a more recent one had formed, its center softened and granular. From this, probably some small portions had been carried by the blood to the arteries at the base of the brain, doing their part in obstructing them and causing the fatal alterations above noted. The lungs showed evidence of old inflammation. The entire weight of the brain was 53.4 ounces avoirdupois, and its greatest weight, between the ages of 35 and 40 years, was estimated at 56 5 ounces.

Without entering into the technical details of the investigation, the result shows that the trouble began with inflammation of the lining membrane of the lungs, and that the morbid processes, carried by the blood from heart to brain. there disorganized and checked the circulation. The malady was too deeply situated to have admitted of surgical aid, nor could any effort of human skill have averted death from and in deference to the expressed wishes of Professor Agassiz, long since placed on record.

#### MICROSCOPIC CRYSTALS IN PLANTS.

Besides the familiar bundles of needle-shaped crystals, called raphides, dispersed throughout the cellular structure of certain plants, there are in the seed covers and leaves of several orders of plants, and in the pods of the bean family, multitudes of prismatic crystals of extreme minuteness. which have hitherto escaped detection. In the horned poppy, these crystals are as small as the 8,000th of an inch in diameter. In the gooseberry and elm, they are  $\frac{1}{3000}$  of an inch; in the black currant, about half as large; in the black bryony, they are about  $\frac{1}{1500}$  of an inch in diameter, thickly set at regular distances throughout the seed covers. In the gooseberry, they are so distinctly and regularly placed in the outer skin-each crystal in a separate cell-that they present the appearance of crystaline tissues. In plants of the bean family, the size is variable, the average being about  $\frac{1}{3}$  for of an inch. In the garden pea, they are much larger These crystals appear to consist chiefly of oxalate of lime, sometimes carbonate. Raphides are mainly phosphate of lime.

Plants most relished by animals are found to be especially rich in these microscopic crystals. In a piece of the midrib of a clover leaflet,  $\frac{1}{70}$  of an inch in length, Mr. Gulliver, who has added more than any other to our knowledge of these minute but important products of vegetable action, has counted 10 chains of crystals with 25 in a chain, making 250 in all, or no less than 17,500 to the inch. In like manner 21,000 crystals were reckoned for one inch of the sutral margin of a single valve of a pea pod. The pod had four such margins, each three inches in length; so that in a sin. gle pod there must have been as many as 250,000 crystals, In view of the marvelous number of these crystals, as well as their regularity and constancy. Mr. Gulliver believes it n

longer possible for physiologists to maintain that such structures are accidental freaks of nature, of no relation to or value in the life and use of the species.

### THE FIRELESS LOCOMOTIVE.

Mr. Richard H. Buel, a well known consulting engineer in this city, has recently published in the Railroad Gazette an account of a trial trip with one of the engines of the Fireless Locomotive Company. This article is interesting as being the first in which the theory of the action has been fully set forth. We have, on several occasions, made mention in our columns of the fireless locomotive, and have pointed out the advantages it possesses in many cases, such as greater comparative safety, less need of skilled attendants, and the absence of smoke and other products of combustion. Mr. motive can be operated successfully, if properly designed and managed; and he points out such improvements as seem