him, as may be necessary to bring the recorded figures in line. To assist in this, the runner is used.

It is impossible to give here a full description of the process, but it seems to be little more than finding and aligning certain figures in the two concentric tables. It is claimed by its inventor, Mr. Walter Hart of this city, that with it the simplest as well as the most complicated problems in multiplication, division, proportion, compound proportion, common divisor, common multiple, interest, involution, evolution, compound percentages, averaging of accounts, etc., can be readily solved. He has prepared for distribution a pamphlet giving a full description of the device, and of the method of using it.

OIL AND IRON IN NEW ZEALAND.

THE New Zealand Government have recently published a report upon the petroleum-deposits of the Taranaki district, which apparently have a great future before them. The oil comes to the surface in many places near New Plymouth, besides impregnating the surrounding country to such an extent that farmers have had to abandon many wells, on account of the petroleum gushing into them with the water. To ascertain whether there was a probability of these oil-deposits proving a mercantile success, the government of New Zealand deputed Mr. Gordon, inspecting engineer of the Mines Department, to visit the locality. Mr. Gordon made a careful survey of the country, and in his lengthy report he affirms that "petroleum exists over a large area, and that it is only a question of boring to the requisite depth to get at the source." According to *Engineering*, these deposits have a twofold advantage: if successfully developed, they not only have at their disposal the Australasian market, now dependent on America for oil, but they would further provide with fuel the local iron industry, at present resting upon limited supplies of coal and charcoal.

Along the shores of the Taranaki district stretch the famous iron-sand beaches of New Zealand, — beaches composed almost entirely of pulverized iron ore. Countless millions of tons of this material lie along the western coasts of the North Island of New Zealand. The ore produces splendid iron, but is somewhat refractory. This would be a trifle, however, if an abundant supply of cheap fuel were available for smelting purposes. This seems to be now forthcoming in the shape of petroleum. For some time past oil has been largely used for smelting in America, and there is no reason why it should not be successfully adopted in New Zealand; the Taranaki oil having plenty of body, and being admirably adapted for fuel purposes. It may be noted, that, while the oil-deposits of America and Russia are several hundred miles inland, those of New Zealand are actually on the coast; so close, indeed, that the beach at New Plymouth is pitted with petroleum oozings. What is now wanted is some trial drills to test the quantity and character of the oil-supply. A few drills in the vicinity of New Plymouth ought to bring to the surface not only enough oil to provide the locality with smelting fuel, but also sufficient for several refineries.

It is curious, that, while millions are invested by the public of this country in purely speculative gold-mines, hardly any funds are devoted to sinking wells for petroleum in Burmah, Canada, and New Zealand. In America, hundreds of times over, a single well has proved as remunerative as a gold-mine; yet, although petroleum can be easily enough turned into gold, such is the demand for it, English investors have hitherto ignored petroleum undertakings. Presently they will rush into it, just as shippers have rushed into the oil-steamer business, building sixty tank-vessels in less than five years, after a prolonged period of similar indifference.

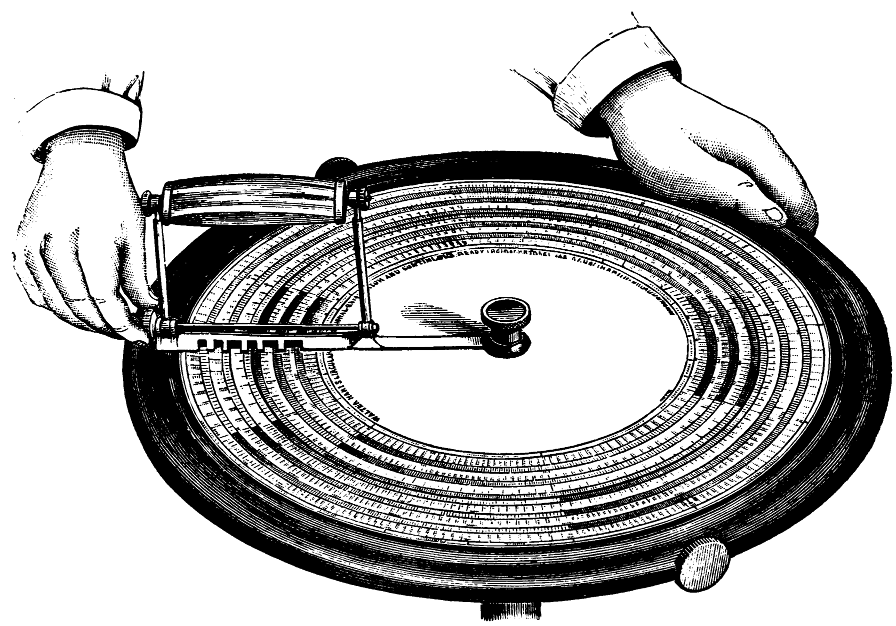

FIG. 3. — THE PROPORTIOR.

THE ORIGIN OF PETROLEUM.[1]

THE enormous consumption of petroleum and natural gas frequently raises the question as to the probability of the proximate exhaustion of the supply; and, without doubt, many fear to adopt the use of oil, from a feeling that if such use once becomes general, the demand will exceed the production, the price will rise indefinitely, and old methods of illumination and old forms of fuel will have to be reverted to. From this point of view, it is most interesting to inquire what are the probabilities of a continuous supply; and such an investigation leads at once to the question, "What is the origin of petroleum?" In the year 1877, Professor Mendeleeff undertook to answer this question; and as his theory appears to be very little known, and has never been fully set forth in the English language, I trust you will forgive me for laying a matter so interesting before you. Dr. Mendeleeff commences his essay by the statement that most persons assume, without any special reason, — excepting, perhaps, its chemical composition, — that naphtha, like coal, has a vegetable origin. He combats this hypothesis, and points out, in the first place, that naphtha must have been formed in the depths of the earth. It could not have been produced on the surface, because it would have evaporated; nor over a sea-bottom, because it would have floated up and been dissipated by the same means. In the next place, he shows that naphtha must have been formed beneath the very site on which it is found; that it could not have come from a distance, like so many other geological deposits, and for the reasons given above, namely, that it could not be water-borne, and could not have flowed along

[1] Extracted from Mr. Anderson's presidential address to Section G (Mechanical Science) of the British Association.

the surface; while in the superficial sands in which it is generally found no one has ever discovered the presence of organized matter in sufficiently large masses to have served as a source for the enormous quantity of oil and gas yielded in some districts; and hence it is most probable that it has risen from much greater depths under the influence of its own gaseous pressure, or floated up upon the surface of water, with which it is so frequently associated.

The oil-bearing strata in Europe belong chiefly to the tertiary or later geological epochs; so that it is conceivable that in these strata, or in those immediately below them, carboniferous deposits may exist, and may be the sources of the oil. But in America and in Canada the oil-bearing sands are found in the Devonian and Silurian formations, which are either destitute of organic remains or contain them in insignificant quantities. Yet, if the immense masses of hydrocarbons have been produced by chemical changes in carboniferous beds, equally large masses of solid carboniferous remains must still exist; but of this there is absolutely no evidence while cases occur in Pennsylvania where oil is obtained from the Devonian rocks underlying compact clay-beds, on which rest coal-bearing strata. Had the oil been derived from the coal, it certainly would not have made its way downwards; much less would it have penetrated an impermeable stratum of clay. The conclusion arrived at is, that it is impossible to ascribe the formation of naphtha to chemical changes produced by heat and pressure in ancient organized remains.

One of the first indices to the solution of the question lies in the situation of the oil-bearing regions. They always occur in the neighborhood of, and run parallel to, mountain-ranges: as, for example, in Pennsylvania, along the Alleghanies; in Russia, along the Caucasus. The crests of the ranges, formed originally of horizontal strata which had been forced up by internal pressure, must have been cracked and dislocated, the fissures widening outwards, while similar cracks must have been formed at the bases of the ranges; but the fissures would widen downwards, and would form channels and cavities, into which naphtha, formed in the depths to which the fissures descended, would rise and manifest itself, especially in localities where the surface had been sufficiently lowered by denudation or otherwise.

It is in the lowest depths of these fissures that we must seek the laboratories in which the oil is formed; and, once produced, it must inevitably rise to the surface, whether forced up by its own pent-up gases or vapors, or floated up by associated water. In some instances the oil penetrating or soaking through the surface layers loses its more volatile constituents by evaporation, and in consequence deposits of pitch, of carboniferous shales, and asphalt, take place; in other cases, the oil, impregnating sands at a lower level, is often found under great pressure, and associated with forms of itself in a permanently gaseous state. This oil may be distributed widely, according to the nature of the formations or the disturbances to which they have been subjected; but the presence of petroleum is not in any way connected with the geological age of the oil-bearing strata, it is simply the result of physical condition and of surface structure.

According to the views of Laplace, the planetary system has been formed from incandescent matter torn from the solar equatorial regions. In the first instance, this matter formed a ring analogous to those which we now see surrounding Saturn, and consisted of all kinds of substances at a high temperature; and from this mass a sphere of vapors, of larger diameter than the earth now has, was gradually separated. The various vapors and gases which, diffused through each other, formed at first an atmosphere round an imaginary centre, gradually assumed the form of a liquid globe, and exerted pressures incomparably higher than those which we experience now at the base of our present atmosphere. According to Dalton's laws, gases, when diffused through each other, behave as if they were separate: hence the lighter gases would preponderate in the outer regions of the vaporous globe, while the heavier ones would accumulate to a larger extent at the central portion; and at the same time the gases circulating from the centre to the circumference would expand, perform work, would cool in consequence, and at some period would assume the liquid or even the solid state, just as we find the vapor of water diffused through our present atmosphere does now. That which is true of changes of physical condition, Henri St. Claire Deville, in his brilliant theory of dissociation, has shown to be equally true with respect to chemical changes; and the cooling of the vapors forming the earth while in its gaseous condition was necessarily accompanied by chemical combinations, which took place chiefly on the outer surface, where oxides of the metals were formed; and, as these are generally less volatile than the metals themselves, they were precipitated on to what there then was of liquid or solid of the earth, in the form of metallic rain or snow, and were again probably decomposed, in part at least, to their vaporous condition. The necessary consequence of this action is that the inner regions of the earth must consist of substances the vapors of which have high specific densities and high molecular weights, — that is to say, composed of elements having high atomic weights, — and that the heavier elementary substances would collect near the centre, while the lighter ones would be found nearer the surface. Our knowledge of the earth's crust extends but to an insignificant distance; yet, as far as we do know it, we find that the arrangement above indicated prevails. Hydrogen, carbon, nitrogen, oxygen, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, potassium, calcium, — substances whose atomic weights range from 1 to 40, — became condensed, entered into every conceivable combination with each other, and produced substances the specific gravity of which averages about $2\frac{1}{2}$, never exceeds 4, and are found near the immediate surface of the globe.

But the mean specific gravity of the earth as determined by Maskelyne, Cavendish, and others, certainly exceeds 5, and consequently the inner portion of our globe must be composed of substances heavier than those existing on the surface; and such substances are only to be found among the elements with high atomic weights. The question arises, "What elements of this character are we likely to find in the depths of the earth?" In the first place, since gases diffuse through each other, a certain proportion of the elements of high atomic weight will also be found on the surface of the earth. Second, the elements forming the bulk of the earth must be found in the atmosphere of the sun — if, indeed, the earth once formed part of its atmosphere. Of all the elements, iron, with a specific gravity exceeding 7, and with an atomic weight of 56, corresponds best with these requirements, for it is found in abundance on the surface of the earth; and the spectroscope has revealed the very marked presence of iron in the sun, where it must be partly in the fluid and partly in the gaseous state, and consequently iron in large masses must exist in the earth: so that the mean specific gravity of our planet may well be 5, the value of which has been determined by independent means.

It is not easy, however, to define in what condition the mass of iron which exists in the heart of the earth is likely to be. Iron is capable of forming a vast number of combinations, depending on the relative proportion of the various elements present. Thus, in the blast-furnace, oxygen, carbon, nitrogen, calcium, silicon, and iron are associated, and produce under the action of heat, besides various gases, a carburet of iron and slag, the latter containing chiefly silicon, calcium, and oxygen; that is to say, substances similar to those which form the bulk of the surface of the earth. But these same elements, if there be an excess of oxygen, will not yield any carburet of iron; and the same result will follow if there be a deficiency of silicon and calcium, because of the large proportion of oxygen which they appropriate. In the same way, during the cooling of the earth, if oxygen, carbon, and iron were associated, and if the carbon were in excess of the oxygen, the greater part of the carbon would escape in the gaseous state, while the remaining part would unite with the iron. It is certain that in the heart of the earth there must have been a deficiency of oxygen, because of its low specific gravity; and the argument is supported by the fact that free oxygen and its compounds, with the lighter elements, abound on the surface. Further, it must be presumed that much of the iron existing at great depths must be covered over and protected from oxygen by a coating of slag; so that, taking all these considerations into account, it is reasonable to conclude that deep down in the earth there exist large masses of iron, in part at least in the metallic state, or combined with carbon.

The above views receive considerable confirmation from the composition of meteoric matter; for it also forms a portion of the solar system, and originated, like the earth, from out of the solar atmosphere. Meteorites are most probably fragments of planets, and a large proportion of them include iron in their composition, often as carbides, in the same form as ordinary cast iron; that is to say, a part of the carbon is free, and a part is in chemical union with the iron. It has been shown, besides, that all basalts contain iron, and basalts are nothing more than lavas forced by volcanic eruptions from the heart of the earth to its surface. The same causes may have led to the existence of combinations of carbon with other metals.

The process of the formation of petroleum seems to be the following: It is generally admitted that the crust of the earth is very thin in comparison with the diameter of the latter, and that this crust encloses soft or fluid substances, among which the carbides of iron and of other metals find a place. When, in consequence of cooling or some other cause, a fissure takes place through which a mountain-range is protruded, the crust of the earth is bent, and at the foot of the hills fissures are formed; or, at any rate, the continuity of the rocky layers is disturbed, and they are rendered more or less porous, so that surface waters are able to make their way deep into the bowels of the earth, and to reach occasionally the heated deposits of metallic carbides, which may exist either in a separated condition or blended with other matter. Under such circumstances, it is easy to see what must take place. Iron, or whatever other metal may be present, forms an oxide with the oxygen of the water. Hydrogen is either set free or combined with the carbon which was associated with the metal, and becomes a volatile substance; that is, naphtha. The water which had penetrated down to the incandescent mass was changed into steam, a portion of which found its way through the porous substances with which the fissures were filled, and carried with it the vapors of the newly formed hydrocarbons; and this mixture of vapors was condensed wholly or in part as soon as it reached the cooler strata. The chemical composition of the hydrocarbons produced will depend upon the conditions of temperature and pressure under which they are formed. It is obvious that these may vary between very wide limits; and hence it is that mineral oils, mineral pitch, ozokerite, and similar products differ so greatly from each other in the relative proportions of hydrogen and carbon. I may mention that artificial petroleum has been frequently prepared by a process analogous to that described above.

Such is the theory of the distinguished philosopher, who has framed it not alone upon his wide chemical knowledge, but also upon the practical experience derived from visiting officially the principal oil-producing districts of Europe and America, from discussing the subject with able men deeply interested in the oil industry, and from collecting all the available literature on the subject. It is needless to remark that Dr. Mendeleeff's views are not shared by every competent authority; nevertheless the remarkable permanence of oil-wells, the apparently inexhaustible evolution of hydrocarbon gases in certain regions, almost forces one to believe that the hydrocarbon products must be forming as fast as they are consumed, that there is little danger of the demand ever exceeding the supply, and that there is every prospect of oil being found in almost every portion of the surface of the earth, especially in the vicinity of great geological disturbances. Improved methods of boring wells will enable greater depths to be reached; and it should be remembered, that, apart from the cost of sinking a deep well, there is no extra expense in working at great depths, because the oil generally rises to the surface or near it. The extraordinary pressures, amounting to three hundred pounds per square inch, which have been measured in some wells, seem to me to yield conclusive evidence of the impermeability of the strata from under which the oil has been forced up, and tend to confirm the view that it must have been formed in regions far below any which could have contained organic remains.

AT Reykjavik a society has just been established, under the presidentship of Professor B. Grondal, called the Icelandic Naturalists' Society, the chief aim of which is to found a museum of natural history for Iceland, to be the property of the country. For this purpose it is not only intended to collect specimens of the fauna, flora, and mineral deposits of Iceland, but also to obtain by exchange, or in any other convenient manner, specimens from abroad.

OPEN-AIR TRAVEL AS A CURER AND PREVENTER OF CONSUMPTION, AS SEEN IN THE HISTORY OF A NEW ENGLAND FAMILY.[1]

"For my own part, I intend to hunt twice a week during my stay with Sir Roger; and I shall prescribe the moderate use of this exercise to all my country friends as the best kind of physic for mending a bad and preserving a good one." — *Sir Roger de Coverley*, chapter xiii. p. 101, Goldschmidt, Edinburgh, 1889.

IT is a curious coincidence, that, at the same meeting of the Climatological Association, the president should give you some information gleaned from my recorded cases as to the connection of pleurisy with phthisis, and I should present the history of my father,[2] cured, as I believe, of severe phthisical symptoms by a journey in an open chaise, and by persistent daily walking of from five to six miles during the rest of his life. In connection with this, I shall endeavor to show, that, by the same persistent open-air treatment of his children during their periods of growth, he was able to prevent the occurrence of the same disease in a large number of his descendants, who, in consequence of himself and his wife being tuberculous, and also first-cousins, must have been very strongly predisposed to it.[3]

I have a record of this journey as kept by my father in 1808, when he was thirty-five years of age. I found it recently, tied up in a bundle of old papers which had been resting quietly hidden for over half a century. It is a very compact, precisely written statement of that journey, showing, indirectly at least, its benign effects upon him.

It is eminently suggestive to me of the proper treatment of certain cases of phthisis; and, in the hope that it will be suggestive to others also, I now lay it before this society. To some sensitive minds it may seem to be of too private and personal a character to be placed thus freely before any public assembly. I have no such feeling when questions of human health and happiness are involved.

In 1808 my father was undoubtedly threatened with consumption. He had cough, hemoptysis, anorexia, diarrhœa, and general malaise, with fever and great debility. On Aug. 29 of that year, when thus ill, he started, with a friend as his companion and driver, in an open, one-horse chaise for a tour through New England. At that time it will be recollected that there were no cars, and travel was had in one's own carriage or in public coaches holding nine persons. These were driven over turnpikes or private roads. There were hotels, more or less comfortable, at which travellers could sleep and get food, in every town. This record lets us more or less distinctly into the feelings, physical and mental, of every day of the month during which the journey lasted. A glance at the map[4] will show that the travellers went from Salem, Mass., down into Rhode Island, thence by way of Connecticut up through the hills of western Massachusetts to Albany and Troy, and back through Massachusetts to New Hampshire, Vermont, and Maine, and then to the home from which he started. During the trip he travelled 748 miles, passed through 113 towns and cities, and the time spent in this daily open-air exercise was thirty days. During that time he went through all stages of feeling of mental discouragement and of physical weakness up to a real enjoyment of life.

Allow me to refer briefly to these changes. Starting from Sa-

[1] Read before the American Climatological Association, June, 1889, by Henry L. Bowditch, M.D., of Boston, Mass.

[2] Capt. Nathaniel Bowditch, the father of American mathematics.

[3] I am well aware, that, since the brilliant discovery by Koch of the bacillus tuberculosis, some writers deny that phthisis can be inherited. But surely this opinion I cannot think true. All my medical experience is directly against it. Moreover, we all admit that a certain deterioration of the vital power of the whole, or an abrasion of a part, of the body, is necessary for the life and propagation of the bacillus and consequent production of tubercular phthisis. Hence, as far as active out-of-door life tends to the production of perfect health in a person or a family, it would seem, *a priori*, that the course pursued by my father, which undoubtedly was of such infinite service in his own case toward the cure of phthisis, must have been of great use to his children as a preventive, by making them all robust from their earliest years. By so doing he opposed any tendency to poor constitutions, impressed on them from their births; which tendencies, if they had not been counteracted from early life, would, I believe, have made his descendants easy recipients of phthisis.

[4] A large map was shown at the meeting, marked by circles on the towns where the nights were passed. These circles were entirely black at first, indicating great depression of mind and body, and they became gradually lighter as the patient got better. Those over the last half of the journey were not only free from any shade, but were surrounded by a red border, indicating the comfortable feeling of returning health.