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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

DIVERSION OF NIAGARA RIVER.

Thanks to the initiative of the Merchants' Association of New York, acting in conjunction with the American Civic Association, it is likely that the preservation of Niagara Falls will be made a matter of joint international control. The President of the United States has expressed his great interest in the subject and favorable opinions have been obtained from former Attorney-General Griggs, Attorney-General Moody, and former Attorney-General Knox. The concurrence of these opinions leaves no doubt that the necessary action must take the form of a treaty between the United States and Great Britain, a point of view which seems to be shared by the authorities on the Canadian side of the border. Former Attorney-General Griggs expressed the opinion that whatever jurisdiction the State of New York has over the waters of the river and their use, is subject to the power of the national government, in two respects: First, with respect to navigation, as to which the laws of Congress are supreme; and second, as to the subject of boundary between this State and Canada, in respect to which the United States and Great Britain have the right by treaty stipulation to impose such conditions and regulations upon the use of the river and its waters as they deem mutually proper.

The ethics of this question of the preservation of Niagara Falls are very simple; for it resolves itself into a contest between the claims of a few people who see in the stored energies of the Falls a means of producing merchantable electric power more cheaply than it can be produced by an ordinary steam plant, and the interests of those unnumbered thousands the world over who, if they visit the Western Hemisphere, set down a visit to Niagara Falls as one of the indispensable features of their programme of travel. The widespread sympathy with the movement to protect this majestic and most beautiful spectacle of nature is a refreshing sign that mercenary and utilitarian considerations have not obtained the absolute sway, which the trend of recent events has seemed to suggest.

TWO IMPORTANT TUNNEL PROPOSALS.

Some of our more important railroads are considering the question of reducing the height of the summit elevations on the main line of their systems by the construction of lengthy tunnels. According to recent dispatches, the Pennsylvania Railroad Company is about to lower the summit of the Alleghany Mountain division by driving a great tunnel, which will be either 9 miles or 11 miles in length, according as one or other of two alternative surveys is adopted. On the eastern slope the road would enter the tunnel in the vicinity of the Horseshoe Curve; on the western slope the portal would be in the neighborhood of Crescent. At present, the enormously heavy traffic of this road has to be hauled over a summit which is 2,160 feet above mean sea level, and by the construction of the tunnel, this would be cut down probably to about 1,500 feet. The importance of the reduction is not shown by the mere statement of reduction of vertical height; for on the eastern slope the grade is particularly steep, and the portion of the summit line that would be eliminated has an average grade, we believe, of something like two per cent. Another road, which has an important tunnel under consideration, is the Lehigh Valley Railroad, which by a change in the location of its line, and the construction of seven miles of tunnel through the mountain range in which the Lehigh River has its source, will eliminate many miles of heavy grade and reduce its summit elevation by several hundred feet.

STEAM TURBINE ECONOMY.

Rooted prejudices die hard, even in a field of effort as barren of sentiment and so essentially practical as that of steam engineering. In proof of this, witness the belief, which even to-day is held by many engineers, that the steam turbine requires an extravagant amount of steam and increases the coal bill to an extent that more than neutralizes its other economies in space, weight, and labor. As far as our observation is a guide, the only conditions under which the steam turbine has failed to show a marked economy over the reciprocating engine are those in which the speed of revolution has to be cut down in order to accommodate certain speed conditions imposed by the nature of the work that is to be done. The one case in which this has occurred has been in the application of the steam turbine to ocean liners of the largest size, in which the design of the propeller governs the design of the turbine. The rather low (for a turbine) speed of revolution increases the size of the turbine to a point at which it does not as yet appear to be able to show the remarkable efficiency which has been achieved by the marine steam turbine in vessels of moderate dimensions. With this exception, the data of turbine performance which are at hand prove that it is markedly superior, compared on a basis of steam consumption, to the reciprocating engine, when both are doing similar duty. This is true of the steam turbine when used in stationary plants, irrespective of its size, and it is also true of the marine steam turbine until it comes to be built in sizes of 10,000 horse-power and over. In one of the largest central power stations recently erected in this city the turbines, which are of 7,500 horse-power capacity, were built under a guaranteed steam consumption, when using 175-pound dry saturated steam at the throttle, of 11.47 pounds of steam per horse-power hour. This may be compared with the guarantee given for reciprocating engines of the same capacity in another large power house in this city, which was 12.25 pounds per horse-power per hour.

A most significant proof of the strong confidence which marine engine builders have in the steam economy of the turbine, has lately been afforded in connection with the letting of a contract for an 18-knot mail steamer for the Roumania State Railway service. The specifications called for a 1,500-ton steamer driven by twin-screw engines of 7,000 indicated horse-power. The contract requirements were extremely severe, and heavy penalties were provided for. It was stipulated that with reciprocating engines the consumption should not exceed 1.454 pounds of coal per indicated horse-power per hour, which works out for the given horse-power and speed at 10,801 pounds per hour. Among the designs was one for a triple-screw vessel driven by Parsons steam turbines, for which the bidders guaranteed a coal consumption of 7,716 pounds per hour. Here, then, was a firm which was prepared to guarantee for its alternative design with turbines a fuel consumption less by 30 per cent than the maximum allowed by the railroad for reciprocating engines of the same horse-power.

THE SHIPPING BILL IN A NUTSHELL.

Since there appears to be some uncertainty as to the present status of the shipping bill framed by the President's Merchant Marine Commission, we give the following digest of this important measure. The provisions of the bill are as follows: First, the creation of a volunteer naval reserve of 10,000 officers and men of the merchant marine and fisheries, trained in gunnery, etc., subject to the call of the President in war, and receiving retainer bounties as 33,500 British naval reserve men do.

Second, subventions at the rate of $5 a gross ton a year to all cargo vessels in the foreign trade of the United States, and to craft of the deep-sea fisheries, and $6.50 a ton to vessels engaged in our Philippine commerce—the Philippine coastwise law being postponed till 1909. But these cargo vessels in order to receive subventions must be held at the disposal of the government in war, must convey the mails free of charge, be seaworthy and efficient, carry a certain proportion of Americans and naval reserve men in their crews, and make all ordinary repairs in the United States. Ships lose their subventions if they leave our trade for that of foreign countries, or if, like the Standard Oil craft, they are not engaged exclusively as common carriers.

Third, subventions to new mail lines from the Atlantic coast to Brazil, Argentina, and South Africa; from the South Atlantic coast to Cuba; from the Gulf coast to Cuba, Brazil, Mexico, Central America, and the Isthmus of Panama; from the Pacific coast *via* Hawaii to Japan, China, and the Philippines, and to Mexico, Central America and the Isthmus of Panama, and from the North Pacific coast direct to Japan, China, and the Philippines, with increased compensation to one existing contract line from the Pacific coast *via* Hawaii and Samoa to Australasia. All ships receiving subventions must be already American by register or American-built—thus excluding the foreign-built fleet of the Atlantic Steamship Combination. Not one dollar is given to fast passenger and mail lines to Europe. Ships constructed for foreign commerce to receive these subventions can under the Dingley tariff be built, equipped, and repaired of materials imported free of duty. The maximum annual cost of the proposed mail subventions will be about $3,000,000; of the other subventions and retainers to the naval reserve, from $1,550,000 in 1907 to $5,750,000 in 1916. If tonnage taxes are increased, as originally proposed, the legislation will cost nothing the first year, but turn $616,000 into the Treasury, and the annual average net cost for ten years, with the building of new ships, will be $4,625,000. Great Britain next year will pay $6,000,000 or $7,000,000 in shipping subsidies, France $8,000,000, Italy $3,000,000, and Japan about $4,000,000. This bill was passed by the Senate on February 14, and unless the friendly attitude of the individual members of the House should give place to a collective hostility, it is likely to become a law before the close of the present session.

IS LEAD A FORM OF RADIUM?

Radio-activity is a property intrinsic to the element, and, therefore, to the atom or smallest part of the element. The radio-elements possess the heaviest known atoms. If the lightest, hydrogen, is taken as unity, uranium is 238, thorium 232, and radium 225, while the next heaviest known are the inactive elements bismuth 208, and lead 207. The element helium is the second lightest known and its atomic weight is 4. Now, if the alpha-particle is an atom of helium, the expulsion of one alpha-particle from an atom of radium will reduce its atomic weight from about 225 to 221. This must, therefore, be a new atom and represent an unknown element, for the nearest known element has the atomic weight 208.

The chemical elements run in families. Radium, for example, is the missing "big brother" of the alkaline-earth family of elements, which consists of three elements, calcium 40, strontium 87, and barium 137, and chemically radium is an almost exact copy of its nearest relation, barium. Helium, in turn, is the lightest member of a family of gaseous elements, exactly similar in chemical nature. The family forms the well-known group discovered by the joint labors of Lord Rayleigh and Sir William Ramsay. The series runs, helium 4, neon 20, argon 40, krypton 82, and xenon 128. It happens that the heavy residue of the radium atom posessing an atomic weight of about 221, left behind after the expulsion of the light helium atom, turns out to be one of the missing big brothers of helium itself, being nearly twice as heavy as the heaviest (xenon) previously known. It is new, and a gas of the same chemical nature as the others, and is produced at a steady rate from radium, one atom for every alpha-particle expelled. It is, in fact, the radium emanation.

A quantity of radium, although it is sending forth its shower of alpha-particles continuously from year to year, does not grow appreciably less. The most sensitive balance has not yet succeeded in showing any change of weight. Hence it is obvious that although the actual number of alpha-particles and of new atoms of emanation may be, indeed must be, enormous, they only represent an unrecognizably small fraction of a minute amount of radium. The radium atom turns into a new atom, the atom of the emanation, by expelling an atom of helium. If the emanation expels another helium atom another new residue atom of weight 217 will be left. This is the solid form of matter which is deposited as a film from the emanation and is the cause of the phenomenon of the imparted activity. It is called by Rutherford *radium A*, and it also is recognized solely on account of the alpha-particles it expels. So the residue from radium A is another new atom of weight 213; it is called radium B. Rutherford, as the result of a series of observations elucidated with consummate skill, has recently arrived as far as radium F, in the analysis of the later slow changes of radium. But an alpha-particle is not expelled in each case; sometimes it is the beta-ray or electron only, as in the case of the change of radium E into radium F; sometimes no radiant particle is expelled at all, and we have a *rayless* change, as for example when radium B turns into radium C, but then the next change, that of radium C into radium D, makes up by expelling both alpha- and beta-particles. Reverting to radium F we find it also gives an alpha-particle and so must change into a radium G. Now radium F, the seventh successive product of the disintegration of radium, has been shown to be the polonium of Mme. Curie, found by her as a constant companion of radium in the uranium mineral pitchblende. Polonium gives alpha-rays, but no detectable other product. We have at length reached the apparent end of the process. Radium G does not expel either alpha- or beta-particles, and so we have only a theoretical reason for believing it to exist. We can, however, make a good guess as to what radium G is. Counting the total number of helium atoms expelled in the series, we find they amount to five, or a loss of the atomic weight of 20 units, which leaves a residue about 205. Remembering that the atomic weight of radium is uncertain to at least a unit, and that, if anything, the atomic weight of helium is likely to be less than four, it is not impossible that lead (207) may well be radium G. This is as much as can be said for the moment.

BLUE LIGHT AND ELECTRICITY AS ANÆSTHETICS.

A few months ago attention was called in these columns to a method of producing anæsthesia by means of blue light. It was not claimed for the method that it would answer for any but minor surgical operations; still it seemed sufficiently promising for the painless extraction of teeth. The patient was submerged, as it were, in a bath of blue light. The rays, it was thought, influenced the brain through the optic nerve. Perhaps there was also something of hypnosis in this supposed effect.

Dr. J. C. Watkins, a southern dentist, has conducted some experiments which have certainly added much to a true conception of the cause and effect of blue-light anæsthesia. He used the blue light, not for the extraction of teeth, but for "the reduction of swelling and the alleviation of pain." The system that he advocates is simple. It consists merely in applying the blue rays directly to the part affected.

The apparatus which he employs comprises a sixteen-candle-power blue electric-light globe arranged in a funnel-shaped tin shield which at its mouth is about four inches in diameter. This is extended about four inches, and has at its end a ground blue glass and convex lens. The ground blue glass is used to disseminate the blue rays so that the patient may not know the simplicity of the apparatus; no especial virtue is to be attributed to the lens.

A clinical history of cases which he has treated and which he has enumerated and discussed in the Dental Cosmos more than bear out the doctor's claims for the anæsthetic effect of blue rays.

Still another method of producing anæsthesia is that of Prof. Leduc, whose studies with electric currents of low tension have attracted not a little attention. Dr. Louise G. Robinovitch, of New York, one of his assistants, has continued his work and has recently published the results of her investigations. Thus far chiefly animals have been used for experimentation. With 110 interruptions per second, the animal receiving about 1.3 milliamperes, at 5½ volts, complete anæsthesia results. The preliminary contractions seem to be painless. General and special sensibility and consciousness are soon abolished. When fully under the influence of the current, the animal may be picked up by a fold of its skin, turned from side to side, pinched or pricked without provoking any reaction on its part. Hearing and sight are lost. The animal remains limp and senseless so long as the current is kept up, sleep being immediately interrupted by the opening of the circuit. Once awake, the animal shows no untoward symptoms. A large number of these experiments made in Prof. Leduc's laboratory were accompanied by no objectionable manifestations. In some instances the same animal has been subjected to the experiment several times during the same day, without causing the animal any apparent discomfort or fatigue. Prof. Leduc, Prof. Rouxeau, and Dr. Robinovitch subjected one animal to electric sleep during a period of three hours and ten minutes, without having caused it any discomfort. Prof. Leduc has himself performed the experiment on dogs over one hundred times and on rabbits a good many times, obtaining good results in all the cases. He has studied the current in its various phases, and cautions against its application for the purpose in question with a lower frequency of interruptions. A higher frequency is also useless.

Prof. Leduc submitted himself to experiment, and the description he gives of his sensations during this sleep is interesting:

"Although disagreeable, one can readily stand the sensation produced by the excitation of the superficial nerves, as this sensation gradually dies away in the same manner as does the sensation produced by a continuous current; after reaching its maximum, the disagreeable sensation commences to wane, although the potential is still increasing. The face is red, and slight contractions are visible upon it, as well as on the neck and even the forearms; there are also some fibrillary twitchings, and tingling sensations extend to the hands and tips of the fingers as well as to the feet and toes. As regards cerebral inhibition, the center of speech is first to be affected, then the motor centers become completely inhibited. There is impossibility of reaction even to the most painful excitations. At this stage it becomes impossible to communicate with the experimenter. Without being in a condition of complete resolution the limbs present no rigidity. Some groans are emitted, but not on account of any pain; excitation of the laryngeal muscles seem to cause the sound. The pulse remains unaltered, but respiration is somewhat disturbed. The current was gradually increased to 35 volts, and its intensity in the interrupted circuit was 4 milliamperes. When the maximum of the current was turned on I could still hear, as if in a dream, what was being said by those near me. I was conscious of my powerlessness to communicate with my colleagues. I still retained consciousness of contact, pinching and pricking in the forearm, but the sensations were stunted, like those in a limb that is 'asleep.' The most painful impression was that of following the gradual dissociation and successive disappearance of the faculties. This impression was similar to that experienced in a nightmare, in which one feels powerless to cry out for help or to run away when facing great danger."

Prof. Leduc regrets very much that his colleagues did not increase the current sufficiently for complete suppression of sensibility and inhibition of consciousness. The experiment was performed twice, lasting twenty minutes each time. In both instances awakening was spontaneous, with a feeling of well-being.

As the experiment on Prof. Leduc was not complete, it may be of interest to remark that anæsthesia is absolute when a current of sufficient potential is used. Dr. Robinovitch experienced herself complete anæsthesia of the forearm, hand and fingers from a local application on the forearm of this current, 25 volts being used. Anæsthesia was perfect.

THE ADVANTAGES OF PRODUCER GAS FOR LARGE POWER PLANTS.

When the theoretical and practical efficiency of the internal-combustion engine is considered (an efficiency from two to five times greater than that of the average externally fired heat engine) and when we take into account the fact that the smallest gas engines have a thermal efficiency from 20 to 24 per cent, while the largest steam engine, with all the modern refinements known to the art, turns into work only 12 per cent of the heat supplied at the furnace under normal conditions, one wonders why we are not using gas engines in our large power plants. To be sure the first cost of a large producer-gas engine plant is not far from that of a steam plant; for the first cost of a generator, coal-handling apparatus, piping, scrubbers, cleaners, compressor, and engines is about equal to that of boilers, engines, pumps, condensers, chimney piping, and all accessories. On the other hand there are inestimable advantages in favor of the producer-gas engine which should commend it to the notice of the modern engineer. In an excellent paper read by Mr. C. E. Sargent before the Western Society of Engineers these advantages are admirably discussed, and on his paper we base these observations.

Largely because the pressures maintained in gas-engine installations are not as great as those in boiler plants, the depreciation from internal strains and corrosion should be considerably less. Gas engines wear out no more quickly nor are they more exacting in the way of repairs than steam engines. On the other hand, gas producers are long-lived. Mr. Sargent instances one installation of two 200-horse-power producers which have been continuously driven for seven years and in one of which the fire has never been drawn. One can hardly imagine the condition of a boiler after such continuous work.

The waste heat of a producer, amounting to about 70 per cent of the heat supplied, can be used for heating very much in the same way as exhaust steam from the steam engine. It must be remembered, however, that a higher temperature can be maintained with exhaust gases than with exhaust steam. Furthermore, the gas holder of the gas plant provides for the peak of the load, even though the producer is run at a uniform rate. With sufficient capacity of holder the gas producer may be run with a uniform output for every hour out of the twenty-four although the engine load may very widely. Add to this the fact that there are no losses from radiation or leakage as would exist in a boiler plant under pressure, and we have a rather complete picture of the efficiency of a large producer-gas plant.

VALUE OF COMMERCIAL CULTURES FOR LEGUMES.

Great interest was aroused among agriculturists in this country by the newly-developed inoculation process of supplying bacteria for the promotion of the better growth and nitrogen gathering powers of legumes. The investigations undertaken by the Department of Agriculture were apparently crowned with success and much was expected from this method in the betterment of agricultural conditions. From a Bulletin lately issued by the New York Agricultural Experiment Station, at Geneva, N. Y., it appears, however, that these commercial cultures for legumes are exceedingly unreliable. The Station undertook a series of exhaustive tests in consequence of the numerous inquiries which were received as to the quality of the commercial packages of the culture, and the results were anything but favorable; not only so far as the commercial product was concerned, but in the case, as well, of the package received from the government. These extended and careful tests in five different laboratories, using many packages of the cotton prepared at different times, kept under favorable conditions, all comparatively fresh, and used in accordance with the directions, appeared to prove that such packages are worthless for practical inoculation. This must not be ascribed to dishonesty on the part of the company preparing the cotton, for, as mentioned above, the Department package tested gave no better growth than the commercial specimens. The trouble lies in the method itself. The legume inoculating bacteria, dried on cotton and exposed for a limited time to the ordinary changes of temperature and humidity, die or lose vitality so that they do not develop satisfactorily when used as indicated by the directions.

That such cultures rapidly deteriorate on cotton under laboratory conditions was proven by preparing fresh, vigorous cultures, saturating cotton with the bacteria-charged liquid, drying the cotton, and testing portions of it from time to time. In the earlier examinations, within a week or so after drying, a few colonies would develop, but generally the culture plates were found practically sterile at the end of seven days.

These experiments, with their surprising and disappointing results, do not condemn inoculation. They merely show how and why many recent attempts to inoculate legumes have failed. Inoculation as such has not come into question at all; as it cannot be considered inoculation unless living and vigorous bacteria are brought into contact with the plant to be inoculated. The use of the dried cotton cultures has been in most cases only an unsuccessful attempt to inoculate.

The principle of inoculation remains unchanged. There can be no doubt that the introduction of bacteria where lacking and under proper conditions for their growth will benefit legumes.

But it is certain that the commercial packages of cotton as distributed in 1905 are not reliable agencies to secure such inoculation.

SCIENCE NOTES.

In a paper presented to the Académie des Sciences, Messrs. Guntz and Roederer mention their researches upon the preparation and properties of the metal strontium. The properties of this metal are but little known up to the present, and seem to differ according to the authors who treat the question. Therefore, it seemed of interest to take up the study of this body. The authors prepare it by the method which they already used in preparing barium. At first the hydride of strontium is formed, which is free from mercury by the continued action of hydrogen upon a strontium amalgam. When placed in a vacuum produced by the mercury pump and heated to 1,000 deg. C. this body is decomposed and we are able to condense the vapor of strontium on a cooled steel tube without any difficulty. The authors mention some of the properties of the metal which they have observed. Their product contained 99.43 per cent of the pure metal. It is of a silver white color and is crystalline in form, but it tarnishes almost instantly when in contact with the air. It melts at about 800 deg. C. and volatilizes at a higher temperature. Dry carbonic acid gas has no action upon it in the cold. At a red heat this gas is absorbed with formation of a carbide and also of strontia. Ether and benzine have no effect on the metal, but absolute alcohol dissolves it easily and hydrogen is given off. Water is also decomposed by the metal, forming strontia, which is dissolved. In the test which they made to find the heat caused by the oxidation of the metal, they find that this lies between the figures for calcium and barium, as the chemical analogies lead us to suppose.

Henryk Arctowski, a member of the Belgian Antarctic expedition, is planning to go to the South Pole in an automobile. He declares that one may go by ship to the lower end of Ross Sea, at 78 degrees latitude, to the foot of Mount Erebus and Mount Terror, proceeding thence to the point already reached by Scott. This explorer was forced to proceed on foot for five months. He could have continued on his way over the icy plain, but did not have sufficient provisions, and was compelled to retrace his steps. It is now a question, therefore, of finding out how one can accomplish this journey in an automobile, and advance even farther. The distance from Mounts Erebus and Terror to the South Pole is 1,296 kilometers (about 805 miles). Mr. Arctowski believes that he can accomplish this distance in three trips of 432 kilometers (about 268 miles) each. A first automobile will depart loaded with provisions, and will arrive at the first station. A second will be dispatched to restock the first with gasoline, and will return to the point of departure. A third automobile, making two trips, will restock the first automobile at the second station, permitting it to proceed to the actual pole. Returning, one automobile will be abandoned at the pole, and another on the way, it being impossible to do otherwise. They will cover 10 kilometers (6.2 miles) an hour, or 20 at the most, and will be specially constructed, after experimenting on the Alpine glaciers, for instance on the Aletch Glacier in Switzerland. The expedition will depart in August, 1907, for the Antarctic regions.