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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.

HUGE PROPORTIONS OF THE NEW GOVERNMENT IRRIGATION DAMS.

In the presence of the vast irrigation dams and reservoirs which are being built by the government for the reclamation of the arid lands of the West, our eastern reservoirs, such as the Croton and the Wachusett dams for the water supply of New York and Boston, look positively small. The largest of these reservoirs are the Shoshone, the Pathfinder, and the Roosevelt. The Shoshone dam, which will be the highest in the world, is being built in northern Wyoming, the Pathfinder dam in southeastern Wyoming, and the Roosevelt dam in Arizona. All three structures are greatly favored by the natural configuration of the country, which is such that, by damming up a comparatively narrow cañon, the water is impounded in vast natural basins, which widen out above the sites selected, and afford unusual storage area. The new Croton dam is 297 feet high from the lowest foundation course to the crest, 1,168 feet long on the crest, carries a depth of water at the dam of 157 feet, and contains 833,000 cubic yards of masonry. Its total cost was $7,600,000, and the cost of the dam per million cubic feet of water stored therein was $1,900. Comparing these figures with those of the three irrigation dams, we find that the Shoshone dam is 175 feet along the crest; Pathfinder, 226 feet; and Roosevelt, 650 feet. The height above foundations is, respectively, for Shoshone, 308 feet; Pathfinder, 210 feet; and Roosevelt, 280 feet. The depth of water at the dam at Shoshone is 240 feet; Pathfinder, 190 feet; and Roosevelt, 230 feet. While the new Croton dam can store 4,000 million cubic feet of water, Shoshone can store 19,863, Pathfinder, 43,560, and Roosevelt the enormous total of 61,000 million cubic feet of water. The great economy resulting from the advantages of lofty height and narrow width of the cañons at the site of the dam is shown in the comparative cost per million cubic feet stored; for while the new Croton dam cost $1,900, Shoshone cost only $35.25, Pathfinder $13.78, and Roosevelt $32.80 per million cubic feet of water.

A feature which broadly distinguishes these western dams from our large eastern structures is that the outlets, instead of passing through the masonry of the dam, are being formed in large tunnels, which are driven from the interior of the reservoir into the solid side walls of the cañon, and carried through the rock entirely around the masonry, finally discharging into the cañon below. This has the advantage of allowing the dams to be built in one solid monolithic mass.

SUCCESS OF THE INDEPENDENT RAILWAY MOTOR CAR.

Further proof of the ability of the independent motor car to meet the most severe requirements of railway service has recently been afforded by the performance of the gas-electric car, which was illustrated in the SCIENTIFIC AMERICAN SUPPLEMENT of March 10 of the present year. The new car is distinguished from others of its class by the novel character of its motive power. Practically all of the independent railroad motor cars are driven by steam or gasoline engines; but in this car the equipment includes a gasoline engine, a generator, a storage battery, and motors. The storage battery receives the surplus power from the generator when the load is light, and it is drawn upon for the extra power required in starting the car or in climbing steep grades. The interposition of the generator and storage battery between the engine and the car axle was made principally to overcome the difficulties of mechanical transmission, and to realize the well-known economy which is secured when the peak of the load is taken care of by a storage battery. Since the publication of our article, the car has traveled over 18,000 miles without any cost for repairs, except that due to the renewal of brake shoes. After being used in preliminary service on eastern railroads, it was sent from Philadelphia to Kansas City under its own power, and since its arrival it has been in continuous service on the Missouri and Kansas Interurban Railway. During the run to Kansas City the average speed for a considerable part of the distance was 45 miles an hour. During a round trip of 550 miles on the Santa Fé system an average speed was maintained of 40 miles per hour; and on a round trip of 118 miles over the Burlington branch, where the grades run as high as 3½ per cent and curves of 16 degrees are encountered, the average speed was 27 miles per hour. The advantage of reserve power, which is a distinguishing feature of this system of propulsion, was seen during a snowstorm early in the year, when, although the regular trains were delayed, the motor car was able to force its way through the drifts and maintain schedule time.

The continued success of the independent-unit car will tend to modify the present system of running long trains at considerable intervals and substitute a system of shorter trains, or single-car units, running at more frequent intervals. The elaborate and costly electric installations which are being carried out by the New York Central and Pennsylvania Railroads are expected to result in a great development of traffic, and a wide extension of the suburban radius, mainly because of the frequent short-train service which will be rendered possible. Where the density of the traffic is not sufficient to warrant the heavy expense of third-rail or trolley equipment, the independent motor car is certain to find an ever-widening field of usefulness.

THE CALIBER OF A GUN.

There is surely no word in the nomenclature of guns, big and little, which has caused, and is causing, so much confusion in the lay mind as the word *caliber*. Evidence of this is to be found in the large number of letters which we receive, asking for the exact meaning of the word as used in its different applications. The majority of these letters indicate that the confusion arises chiefly from the use of the term in an adjectival sense to indicate length, as when we say, a *50-caliber*, 6-inch gun. The word *caliber* as applied to artillery signifies essentially and at all times the diameter of the bore of a gun measured diametrically from face to face of the bore, the diameter measured on the rifling being, of course, somewhat larger. A gun, then, of 6-inch caliber is a gun whose bore is just 6 inches. For convenience, and because the power of a gun, when once its bore has been decided upon, depends so greatly upon its length, artillerists are in the habit of defining the length of the gun in terms of the caliber. Thus, the 12-inch United States naval gun, which is 40 feet in length, is spoken of as a 40-caliber, 12-inch, the length being just forty times the bore. The 6-inch rapid-fire gun, as mounted on the latest ships of the navy, is a trifle under 25 feet in length and is, therefore, known as a 50-caliber gun. From this it will be evident that the term may refer either to the diameter of the bore, or to the diameter of the bore used as a unit of length. In the case of small arms, the caliber is expressed in hundredths of an inch, as when we say a 22-caliber or 32-caliber pistol, meaning that the bore is 0.22 or 0.32 of an inch in diameter.

A NEW PROBLEM AND ITS SOLUTION.

The unlooked-for rise of temperature in the New York Subway, due to the operation of the trains, proves, once more, how essential it is, in planning a new work of this kind, to consider carefully the effect of any novel conditions that enter into it. It is seldom that a great engineering project of this magnitude receives such exhaustive consideration as was given to the preliminary plans for the Subway. Moreover, no expense was spared either in the construction of the tunnel or in its equipment, to render it in every particular absolutely first-class. And yet, it was discovered, as soon as the first spell of hot weather was encountered, that instead of the air in the Subway being, as was confidently predicted, cooler than that of the streets above, it was considerably warmer. The trouble was found to be due to the radiation of heat from the powerful motors. That electric motors, doing such heavy duty as those which drive the Subway trains, become heated and radiate a large amount of heat into the surrounding atmosphere was, of course, well known; but until the opening of the Subway, electrical traction in New York had been confined to the street-car and elevated-railroad service; and since the cars were run in the open, where the heat was quickly dissipated, no inconvenience resulted, and there was nothing to suggest that heat from the motors might, under other conditions, become a serious problem.

As the result of a very thorough investigation of the problem, the Rapid Transit engineers have installed a system of ventilation and cooling which, up to the present, has been showing highly satisfactory results. A plant for cooling the air has been established at the Brooklyn Bridge station, and a series of ventilating chambers has been built between the Bridge station and Ninety-sixth Street. The ventilating openings are placed midway between the stations. Each consists of a large chamber, opening out from the side of the tunnel, equipped with a series of shutters arranged somewhat after the plan of Venetian shutters, which are so balanced that normally they remain closed. At the approach of a train, the pressure of the air which is being driven forward in front of the train raises the shutters and the heated air is driven out into the chamber. The vacuum created at the rear of the train causes the shutters to close as the train passes by, and the same suction tends to draw the air in through the openings at the station which the train has just left, the double action of expulsion and suction thus serving to renew continually the whole body of air within the Subway. At each ventilating chamber there is an electrically-driven exhausting fan, which is used during the night when traffic is light, the combined capacity of the fans being sufficient to exhaust the heated air and bring in fresh and cold night air from the outside.

The Bridge station was selected for the experiments in air cooling for the reason that it is the warmest station on the whole system. The plant consists of four driven 6-inch wells, 45 feet deep, which take water from a level about 20 feet below the station platform. The water is pumped at a temperature of 61 deg. F., and distributed through two large cooling coils, which contain an aggregate length of nine miles of one-inch pipe. The coils are inclosed in sheet-iron casing, and air is forced through them by four motor-driven fans capable, together, of delivering 150,000 cubic feet of air per minute. After passing through the coils the air is forced through two large distributing ducts, which are suspended from the ceiling, immediately over the two platforms. The cooled air is finally discharged from the bottom face of the ducts and flows directly down upon the platforms. The plant has proved to be a great success, as is shown by the fact that, whereas before it was put in, the Bridge station was always several degrees warmer than Fourteenth Street station or that at Forty-second Street, the conditions are now reversed, and the Bridge is always cooler than the other stations, on some occasions by as much as 6 degrees. Tests taken during one of the warmest days of the summer showed that the temperature had been lowered as much as 8 deg. below what it would have been before the cooling plant was put in. With the erection of similar plants at Fourteenth Street and the Grand Central station, and the completion of the system of ventilating chambers, it is confidently expected that the temperature of the Subway will be restored to normal conditions.

A NEW PROCESS FOR THE COMMERCIAL UTILIZATION OF ATMOSPHERIC NITROGEN.

Nearly ten years ago—to speak more accurately, in 1898—Sir William Crookes, then president of the British Association for the Advancement of Science, compiled a series of disheartening statistics, the purpose of which was to present a picture of the fate that awaited us if something were not done to augment the world's wheat supply. At the time when Sir William delivered himself of his remarkable foreboding, about 163,000,000 acres of the globe were cultivated for wheat, yielding annually 2,070,000,000 bushels, on the assumption that 12.7 bushels could be grown on each average acre. In thirty years, the president of the British Association pointed out that 3,260,000,000 bushels would be required, that only by increasing the yield to 20 bushels for each acre would future demands be satisfied, and that 150 pounds of sodium nitrate must be annually mingled with the soil of every acre in order to encourage it to this greater activity. Inasmuch as the 12,000,000 tons of nitrate thus required were not then available, Sir William was not inclined to take a very cheerful view of the world's future breadstuff supply.

Fortunately, Sir William's gloomy forecast has not been fulfilled, but it had at least the effect of prompting chemists to devise ways of utilizing the nitrogen of the atmosphere. Perhaps the method of attaining this end with which Americans are most familiar is that of Bradley and Lovejoy, who built a plant at Niagara Falls, but never attained a commercial success. Bradley and Lovejoy, it will be recalled, employed potentials of 10,000 volts, securing steadiness in the discharges by the use of a rotating framework and of projecting electrodes. Arcs were produced and interrupted at the rate of 414,000 a minute, although the apparatus was only of five-kilowatt size. The technical obstacles encountered in the utilization of this apparatus proved a sufficient cause for abandoning the plant, notwithstanding the fact that much nitric acid was produced.

In Norway Birkeland and Eyde have attacked the problem in a different way, and apparently with such success that their plant at Notodden (described on another page), started in May, 1905, may be destined to endure. The high-tension arc in this Norwegian process is produced between water-cooled electrodes of copper tubing, which electrodes are held in the middle of an electro-magnetic field and are connected with a high-tension alternator. With a working potential of 5,000 volts and an alternating current of 50 periods per second, disk-flames are produced, which are inclosed in furnaces. By means of blowers 2,649 cubic feet of air are gently forced through each furnace every minute, which amount of air after leaving the furnace is charged with about one per cent of nitric oxide. The temperature of the hot air is reduced from 1,292 deg. F. to 122 deg. F. by sending it first through a steam boiler (the steam from which is used in making calcium nitrate) and then through a special cooler.

After converting the nitric oxide into nitrogen peroxide, nitric acid is formed by sending the gases through towers filled with broken quartz over which water trickles. The solution is conveyed to tanks containing limestone, with which it reacts and produces neutral calcium nitrate. After evaporation, concentration, and solidification the nitrate is obtained in marketable form.

It is stated that by this process calcium nitrate containing 13.2 per cent of nitrogen can be produced at a cost of $20 per ton, and sold for $40. This very respectable profit undoubtedly explains the erection of a 30,000-horse-power plant, which it is said will be shortly in operation.

CARBON DIOXIDE POCKETS IN FRANCE.

In the Auvergne region of France a large amount of carbonic acid gas comes from the soil, and is one of the last traces of the former volcanic activity of this region. All the springs contain a large quantity of the gas. These springs are found generally in the fissures of the ground which allow the water to rise. One of the Montpensier springs in the Puy de Dome region has been long known as the "poisoned spring." Animals which descend into the cavity to drink are soon asphyxiated by the gas which is given off by the water and accumulates here. Bodies of birds, rabbits, dogs, sheep, and other animals are found, and even persons have narrowly escaped. Vegetation is also affected by an overdose of the gas. Spots can be seen running in a line across the fields, where the plants have suffered from gas coming up through the fissures of the ground at different points. Soundings show the presence of a great quantity of gas, and it is usually in a very pure state. Such gas forms a source of commercial value, and could be utilized practically, as is done in Germany at present in Westphalia and other regions. At present the amount of carbonic acid gas given off per day is estimated at one million cubic feet, and this could be much increased. Aside from the gas production we have other interesting phenomena here. The fissures containing the springs occur in a calcareous marl in which the fauna consist of mammiferous animals such as the rhinoceros, crocodile, turtle, and others. Two of the springs are remarkable. Both of them come from cavities from 8 to 10 feet deep, in the midst of clay and mud. Excavations made at 15 feet depth show Gallo-Roman vases, one complete human skeleton, several skeletons of horse, cow, sheep, which have commenced to fossilize. Two feet below this were found remains of the mammoth, with skin and tusks, which indicate an unusually large specimen. Debris of bison bones is found. The cavities form veritable bone-pockets, coming from the local enlargement of the fissure by the action of the spring. The original depth of the pocket seems to be at least 60 feet. Different epochs from 50,000 years to 2,000 years are shown by the various layers of bone deposits in the cavity, which has been filled up by the deposits from the spring, and the water continued to flow through this. The animals and human beings do not seem to have been drawn into the cavity by the stream of water, but they must have descended into it in order to drink, for the access is easy, and were then asphyxiated. Such a fossil-bed in the form of a pocket seems to be unique.

HOW TO STUDY INDUSTRIAL CHEMISTRY.

The recent announcement by the New York University School of Commerce, Accounts, and Finance of an entirely new course in industrial chemistry for the school's first-year students of Business Management raises anew an interesting question. The distinctive feature of the course is that it is to be given to men who have not had any previous training whatever in scientific studies. Not even a knowledge of physics or of the most elementary chemical laws is to be presupposed by the instructor. Nevertheless, the school officials believe that students can obtain from the course a knowledge of the chemical principles involved in the more important industrial processes, which ought to prove of considerable advantage to them in whatever line of technical work they may be engaged. The question is, can so broad and difficult a subject as industrial chemistry be taught profitably in a one-year course?

The circular of the School of Commerce describes the course as follows: "A practical study of the chemical processes involved in the production of various commodities, including iron and steel, copper, and other metals, soap, glass, dyes, and the like. The work will be adapted especially to the needs of men who are connected with manufacturing concerns and do not have a technical education." The instructor is Prof. Martin A. Rosanoff, of the university faculty, who has long been a student of this subject, particularly in its more practical aspects. The course is to have a two-hour session every Thursday evening throughout the college year, and the instruction is to be given principally by lectures and experiments before the class. How widely the New York University plan differs from the ordinary method of teaching the subject, is made evident by a brief comparison with the corresponding courses in other universities and in the technical schools.

The usual arrangement in a four years' college or scientific school curriculum, where considerable stress is laid upon the study of chemistry is somewhat as follows: In the first year the student has one lecture course in inorganic chemistry running through the year for say two hours or three hours per week. Generally there is a first year laboratory course also, in which students perform a prescribed set of introductory experiments. During the second year the student continues his lectures and laboratory work in inorganic chemistry and begins qualitative analysis. In the third year he attends lectures in organic chemistry, and takes up quantitative analysis in the laboratory. In the fourth year his laboratory practice is devoted to organic chemistry, and his lecture work probably to industrial chemistry.

At the end of such a four years' curriculum, wherein the student's time is devoted largely to the study of chemistry, he is entitled to rank as a fairly well-trained chemist. But suppose he should abandon his chemical work at the end of the third year's study. In that case he would still be ignorant of the most important branch of chemistry, namely, the application of chemical laws to industrial processes. Suppose he should stop at the end of the second year's work. He would have no knowledge at all of the chemistry of sugar, the alcoholic beverages, colors and dyes, explosives, and so on through a long list of important products, all of which are outside the range of inorganic chemistry, and therefore still unknown. There are many college and scientific school graduates holding the Bachelor of Science degree who have had two or perhaps three years' work in chemistry, and still have no chemical knowledge that could be of any practical use to them in business life. They do not know the difference between the chemical composition of iron and of steel, or between coal gas and water gas. They have no idea how glass is made, how artificial dyestuffs are produced, or how they should be used; how wood pulp is transformed into sheets of smooth paper; or how basic steel is now made from the impure ores which have lain useless for generations.

Their ignorance, which usually strikes the practical self-educated man as quite incomprehensible, is due simply to the fact that their studies have been based on a wrong idea. They have started out as if they were about to learn all that is to be known of chemical laws and processes, and have broken down before they obtained even a small measure of useful knowledge. Nevertheless, thousands of young men in the colleges and technical schools are to-day following in their footsteps, and will accomplish just as little. Indeed, under the usual college plan of reserving a study of the practical applications of chemistry until the very end of the college course, it is difficult to see how those students who are not specializing in the subject could be expected to derive anything except a certain amount of mental cultivation from their courses in chemistry.

That Prof. Rosanoff is strongly in favor of a simpler and more direct method of training is evident from a recent interview, in which he says: "It seems to me that we ought to discriminate between a knowledge of the essentials of a subject and an exhaustive knowledge of both fundamental principles and details. Just this lack of discrimination makes the education of many men one-sided. Being afraid to ignore anything, they start out to acquire a general education, with the apparent intention of learning everything about everything. The result is that they generally miss just the information and training that would do them most good. In the course in industrial chemistry planned for the School of Commerce an earnest attempt will be made to guide the students in learning essential facts which a thoroughgoing business man ought to know, and in avoiding the pitfalls of fruitless, desultory study. We are not expecting to develop scientists or practical chemists, but we do expect to give useful and needed help to many a young man who is ambitious to increase his technical or commercial efficiency."

The need of such a course as the New York University School of Commerce has instituted is obvious to anyone who has ever been connected with almost any manufacturing establishment. Even those concerns which carry on purely mechanical processes frequently find their operations handicapped by a misunderstanding of chemical laws. It would probably be difficult to estimate how much time and cash has been lost by manufacturers on account of the ignorance of their clerks and salesmen as to the technical features of manufacturing. For this reason the outcome of the New York University experiment will unquestionably be watched with great interest by the officials of progressive industrial corporations. If Prof. Rosanoff succeeds with his students, as we expect and as we sincerely hope, he will have performed a valuable service in pointing out a new pathway for many young men toward efficiency and advancement.

ACTION OF RADIUM ON ORGANISMS.

Experiments to show the action of radium upon the organism have been carried on at Paris by C. Bouchard and V. Balthuzard. In the first experiment, they introduce 30 grains of radiferous sulphide of barium, contained in a collodion bag, into the peritoneal cavity of a rabbit. The substance gives but a small amount of rays, but on the contrary produces an emanation which keeps passing through the collodion bag to the outside. The rabbit decreased in weight from 1.2 to 0.94 pound in five days, and succumbed on the tenth day, after being paralyzed. The autopsy showed a congestion of the lungs and entrails. A guinea-pig used in another experiment died in eight days, while a second animal used as a check, to which ordinary collodion bags were applied, thrived and even gained in weight. On the eighth day the blood taken from the check animal showed 16,000 white and 5,200,000 red corpuscles in proportion to 5,600 white and 4,600,000 red corpuscles for the radium-treated animal. The action of the radium is clearly seen. A small dose, if the emanation is continuous, will kill the animal. The presence of the emanation is found in the tissues of the animal, or localized in the organs, and a photographic plate shows this, especially in the lungs and the super-renal capsules. A closer method is to measure the emanation by extracting it from each organ by the mercury pump and then finding the electric conductivity of such gas. A guinea-pig was treated by radium and the gas extracted from the different organs. After one hour the gas was observed by the electric method to measure the amount of emanation, and under identical conditions. By volumes, the order for the largest amount of emanation is the following: lungs, kidneys, super-renal capsules, spleen, skin, liver. But when taken by weight, we find that one grain of the super-renal capsules contains as much emanation as 4.7 grains of the spleen, 11.4 grains of the lungs, 15 of the skin, 60 of the liver, and 100 of the kidneys. In the above case the animal had been given a subcutaneous injection of 1.5 cubic inches of gas containing the emanation given in four days by 0.4 grain of radium, and it was killed after four hours. The researches showed that the radium increases the zymotic action of pepsin, pancreatin, and the ferments in general. The localizing of the emanation on the secreting glands is to be noticed, and is not without importance in therapeutics. It explains perhaps the stimulating action given by mineral waters upon the secretions, when the water has been taken at the springs. Mineral springs have already been found to give off radium emanations in considerable quantity.

A NEW WIRELESS TELEPHONE.

The Paris journals report that M. Maiche, a well-known inventor, has made a sensational discovery in the field of wireless telephony. His new apparatus consists of two posts which are placed in his premises. Each post consists of a telephone, battery, a special form of induction coil and a frame which is formed of a series of insulated wires. One post is placed in the garden and a second one in a room in the building some distance off, about 100 feet, and several walls, doors, and windows come between the posts. Conversation can be carried on easily, and the sound is clear. The inventor started five years ago to work on the question. At the chateau of Marchais, belonging to the Prince of Monaco, he made experiments using the earth as a conductor, and these were successful at a distance of two miles. One year afterward he was able to communicate between Toulon and Ajaccio in Corsica, over the sea at 180 miles distance, using the sea as a conductor for the waves. These experiments were kept secret, however. As the new apparatus works without the use of ground, the results are more important. He expects to increase the distance indefinitely by giving more power to the apparatus, which is only in its first stages. Submarine boats could use the system to good advantage.

Pre-eminent among the skilled craftsmen of China, the carpenter still maintains the leadership. Though almost invariably wedded to the use of the tools of his ancestors and to their methods, judged by results he is more efficient in his line, says the Engineering Magazine, than are the average of the foreign-trained fitters and machinists in theirs.