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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.

LARGE POWDER CHAMBERS AND GUN EROSION.

We direct attention to the significant facts regarding the relation between the size of the powder chamber and the pressures and velocities of guns, to which reference is made in a letter published in our correspondence column. The facts relate to the government tests of the Brown wire gun, which were recently completed at the army proving grounds at Sandy Hook. Simultaneously with these tests, another high-powered, wire-wound gun, designed by Gen. Crozier, was subjected to similar tests. Both of these guns developed powder pressures, velocities, and energies, far in excess of anything officially recorded, as far as we know, for guns of 6-inch caliber, at any of the government or private testing grounds either here or abroad. In both pieces, velocities were run up to a figure hundreds of feet per second greater than the generally accepted maximum service velocity of three thousand feet per second, which is considered to be about the limit for guns of this caliber. As was to be expected, in the case of both guns the high powder pressures developed produced severe erosion. This pressure in the case of the Brown wire gun reached the high limit of 32 tons to the square inch in the powder chamber, with a corresponding muzzle velocity of 3,740 feet per second.

Those of our readers who have followed the current discussion in our columns will remember that we have always considered that erosion was chiefly due to the escape of gases past the projectile, the leakage being due to the failure of the copper rifling bands to properly fill the grooves of the rifling. A strong presumption that this view is correct is offered by the experience gained during the tests of the two high-powered guns above referred to; for under the fierce heat and enormous pressures involved, the scoring was so excessive that, in the last rounds, the projectiles from one of the guns failed to rotate properly, and the shells tumbled end over end. In firing the last ten rounds with the Brown gun, under excessive pressures, the average for these rounds being 55,000 pounds per square inch, and the average velocity over 3,600 feet per second, Mr. Brown, the inventor of the gun, with a view to preventing the escape of the gases and securing a good grip on the already badly worn rifling, provided the shells with rifling bands of much greater size than those used in the earlier rounds. This experiment was highly successful, the projectile making a true flight, and the extraordinarily interesting and valuable fact being developed, that the progress of the erosion in that portion of the gun not already seriously affected, was practically stopped, the star gaging records of the government report showing that there was practically no erosion at all in the last fourteen feet of the muzzle end of the gun.

"One swallow does not make a summer"; but here, surely, is a fact which should give food for careful thought and prolonged investigation before gun erosion is placed among the class of incurable diseases.

To the ordnance expert, however, the chief interest will be found not so much in the last ten rounds at high pressures, as in the earlier rounds fired with lower pressures and more moderate velocities. For in these rounds the surprising fact was developed (although, strange to say, it seems to have been entirely overlooked) that in guns like those of the Crozier and Brown type, provided with unusually large powder chambers and charges, it is possible to secure high velocities with very moderate pressures, 2,879 foot seconds being obtained with only 28,475 pounds pressure, in the Brown gun, and, in the Crozier gun, 2,938 foot seconds with the very moderate pressure of 30,810 pounds to the inch. Now these velocities are considerably higher, and the corresponding energies greater, than those of the government 6-inch guns either in the army or navy, the latter 50-caliber piece having a service velocity of 2,700 to 2,800 foot seconds with pressures of not less than 18 tons to the inch, while the service velocity of the army 6-inch guns is to be lowered, we believe, to 2,600 feet per second, with a view to reducing powder pressures and so prolonging their life.

In view of the promising results obtained in the earlier rounds of these guns, we would suggest to the artillerists that the solution of the problem of erosion may, after all, be found in the direction of large powder chambers and greater length of gun, combined with a high average pressure along the bore and low maximum pressure in the powder chamber. It is our belief that a 55-caliber, 6-inch gun, using a heavy charge of slow-burning powder specially designed for it, in a powder chamber of capacity equal to those of the Crozier and Brown guns, and with its projectiles double-banded, would be able to maintain a service velocity of 3,000 feet per second for a sufficient number of rounds to give the gun a satisfactory term of life, before re-lining became necessary—if, indeed, the application of the above principle did not entirely cure the evil.

VALUE OF RARE EARTHS FOR ELECTRICAL PURPOSES.

In the improvements of electrical illuminants the demand for rare earths has greatly stimulated mining for them in different parts of the country. When carbon was employed almost exclusively in arc and incandescent lamps practically little value was attached to many of the long list of rare earths which in the past few years have become quite common in the electrical industry. The discovery that the rare earth oxides possessed unusually desirable properties for use as illuminants gave a new impetus to laboratory experiments, and the demand for these oxides increased rapidly under the development of the Nernst lamp, the incandescent gas mantles and the tantalum lamp.

Welsbach first used thoria and ceria for producing gas mantles, and this suggested the possibility of securing materials for electrical illuminants that would prove equal to, if not superior to, the carbon filaments. While carbon is practically infusible, it nevertheless slowly vaporizes at the high temperature maintained in the incandescent lamp, so that after being used from 400 to 600 hours it is necessary to renew it.

In tests with the rare earths it was found that they were more fusible than carbon, but their vaporizing properties were in some cases much less pronounced. It is this slower vaporizing quality of the rare earth oxides that makes the Welsbach mantle and the Nernst lamp possible. Connected with this quality of slow vaporizing at high temperature is the equally important one that many of the oxides conducted electricity at ordinary temperatures. Others only conducted electricity at very high temperatures, but were found to be very refractory. By mixing several different kinds of the oxides and baking them in the form of filaments a higher fusing point was obtained and greater electrical conductivity. The possible combinations of these oxides open a wide field for future experiment.

Thus, in the Nernst lamp a combination of 85 per cent zirconium oxide and 15 per cent of yttria earths is used; but yttria itself is a mixture of several oxides found in certain minerals. The early gas mantles were composed largely of zirconia, but these have been improved by combining other rare earths to increase the refractory nature of the glowers. The improvements are due entirely to a study and a long series of experiments with the different earths.

The value of a commercial glower depends upon its efficiency and its ability to operate at a high temperature for a considerable length of time. Thus, the Nernst glowers operate at a temperature of about 2,300 deg. C., and at about twice the efficiency of a carbon incandescent lamp. The ordinary life of these glowers averages 800 hours when the depreciation of the candle-power is sufficient to destroy its usefulness. Both the Nernst and carbon incandescent lamps have their period of usefulness rated by the number of hours required to decrease the candle-power by 20 per cent of the initial light. Similarly the value of the tantalum filament of the tantalum lamp is dependent upon the relative time required to depreciate its conductive and glower properties when used under high temperatures.

The experiments with the rare earths to secure higher illuminating efficiency are further emphasized by the difference in the quality of the oxides obtained from various parts of the world. Until comparatively recently most of the rare earths for electrical purposes were obtained from Europe, but deposits have been found in this country which possess superior qualities to those imported. Some of the best zirconium silicate is mined in Henderson County, North Carolina, and deposits have been discovered in other States within the past few years. The North Carolina deposit contains upward of 67 per cent of zirconium as oxide. It is found in a ball mill mixed with about twice its weight of crude acid potassium fluoride. The recovery of the ore by fusing in a graphite crucible and dissolving it in chemicals is not a very intricate or costly process. The zirconium thus obtained is reasonably pure. Test glowers from hundreds of lots of zirconia demonstrate that the best oxides can be obtained and purified from the American mines. Absolutely pure zirconia is not demanded, and the slight traces of silica left in the American product tend to improve the efficiency of the lamps.

In Llano County, Texas, considerable quantities of gadolinite in crystalline form associated with yttrialite, crytolite, fergusonite, rowlanite, allanite, and other minerals are found. Not many years ago the minerals gadolinite and yttrialite were obtained entirely from Norway and Sweden, and their cost made even laboratory practice with them rather expensive. The deposits in Texas are supposed to be of volcanic origin, and they are radio-active and contain a certain amount of helium gas.

Tests of these products in Texas show that the gadolinite is composed chiefly of 40 to 45 per cent of yttria earths, 23 per cent of silica, 13 per cent iron as oxide, and 9 to 12 per cent of beryllia. The yttrialite contains from 42 to 47 per cent of yttria earths, 30 per cent of silica, and 5 to 6 per cent of ceria, didymia, and lantham, with slight traces of urania. The fergusonite contains roughly from 30 to 42 per cent of yttria earths, 33 to 46 per cent of niobia; and rowlanite from 46 to 62 per cent yttria earths, 26 per cent of silica, and traces of iron and magnesia. Allanite has large percentages of iron, calcia, and alumina, with only traces of yttria and 26 per cent of ceria and didymia.

These natural combinations of the rare earths in the Texas deposits make it reasonably simple to recover what is desired, and the various ingredients are separated and used for different purposes. The recombining of the different earths for illuminant filaments is a work that possesses great fascination for the experimenter. So far it has been demonstrated that the yttria earths containing the greatest atomic weights produce the most satisfactory glowers. The relative value of the ores obtained from Norway and Sweden and those mined in Texas can be judged by the fact that the former has as low as 90 to 92 atomic weight compared to 115 for the Texas yttrialite, 107 for rowlanite, 163 for the fergusonite, and 100 for gadolinite.

The question of the actual amount of these deposits in this country is one that has not yet been definitely settled. Reports of equally valuable deposits in Colorado and other Western States have been made, but whether the quality of the rare earths is as good as those found in Texas is open to doubt. The actual demand for the ores has not in the past been sufficient to make them of great commercial value, but with their extensive use in electrical illumination important new industries promise to be built up. So long as their use was confined chiefly to laboratory practice and experiment there was little chance of their commercial development on a large scale.

The manipulation of the different oxides to secure better results suggests great possibilities in the field of experiment. The remarkable development of tantalum metal in the past few years is an indication of the advances made along this line. Until a few years ago tantalum metal was not known to possess the properties which make it of such service in electric illuminants. In some of the laboratories experimental lamps have been made with electrodes composed entirely of the rare earth oxides. From these experiments new filaments may be devised in time which will greatly increase the efficiency of the lamps and prolong their days of usefulness without renewals. In arc lighting the introduction of boron and tantalum in different proportions and forms is being pursued with tireless energy. In Europe the experiments with rare earths in electric arcs have been more energetically pursued than in this country, but with the discovery of new and rich deposits of these materials in this country it is not unlikely that considerable experimental work will be carried on in private laboratories and manufacturing shops. There is unquestionably a great future for further important developments in electric illumination in this direction.

PERHYDRASE MILK—A NEW STERILIZED MILK.

The problem of freeing milk from germs and yet retaining all its nourishing properties has probably been solved by Drs. Roemer and Much, both of whom have been associated with Prof. Behring in his bacteriological work. The process consists in the use of peroxide of hydrogen under conditions which kill the germs. To each liter of milk is added two to four drops of a ferment obtained from beef liver from which the blood has been expressed. This ferment, which contains minute particles of albumen, destroys the unpleasant taste given to the milk by the peroxide of hydrogen. To the forty grammes of albumen contained in one liter of milk under normal conditions there are, therefore, added minute quantities of homologous albumen.

"Perhydrase milk," as it is called, does not materially differ from raw milk. It can, however, be kept for a long period without deteriorating. Samples of the milk which were placed in an incubator for seven weeks remained sterile. Experiments made by mixing cow milk containing tubercle bacilli with perhydrase milk proved that the latter destroyed the tubercle bacilli. In contrast to heat sterilization, the amount of albumen remains unchanged. This was ascertained chemically, and by means of the addition of tetanus antitoxin. The renneting power does not change. Peroxide of hydrogen cannot be determined in the milk one-half hour after the addition of peroxydase. With paraphenylendiamine the reaction does not take place immediately, as in the case of raw milk, but only after four to seven hours. To the taste perhydrase milk does not differ from raw milk. The cost of the milk is increased four to five cents per liter. Perhydrase milk must be kept in a dark place. Exposure to light will give it a bitter taste, but there will be no appearance of germs. As the German law prohibits any addition whatever to milk, a general introduction of the method cannot now be made. At present its use is confined to agricultural practice.

RECENT PERFORMANCES OF THE FRENCH AIRSHIP "PATRIE."

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The new airship "Patrie," which was built for the French government on the same general plan as the "Lebaudy," and which we have already described, finished the series of military experiments which went on for some time in the region of Paris by a brilliant performance and one which speaks most favorably for this airship in particular as well as showing what can now be accomplished. On the 15th of December, having made all the trial flights around the balloon shed which were required, the airship started to its destination, the military aeronautic grounds of Chalais-Meudon, near Paris, and reached this point after a very good flight in a straight line of 52 kilometers. It started on the trip at 10 o'clock in the morning and attained high speed, seeing that it reached the aeronautic establishment at 11:12 A. M. The flight was made under the orders of the chief of the Etat-Major, and it was remarkable to see an airship start off at command and arrive without difficulty at a distant point and one which was difficult to light upon on account of the obstacles which surrounded it. We give a few details as to the flight, which is without doubt the most remarkable of the year for an airship. It was brought out of the balloon shed at 9:30 A. M. and then taken to the flat ground, where the preparations for the start were made exclusively under the direction of the army officers and the military aerostatic corps. In the car were Capt. Voyer, the pilot on this occasion, Lieut. Bois, aid, also the mechanics Duguffroy and Rey. At 10 o'clock the airship started up and commenced the flight toward Meudon. Well guided by the pilot, in spite of a rather stiff breeze of 45 feet per second which blew against the side of the balloon, it proceeded in a straight line toward its destination, being very well balanced in the air and keeping at about 656 feet altitude. Passing over the neighboring town of Mantes, then coming above Maule and Versailles, it finally reached Chalais-Meudon, where part of the corps of military aeronauts which had been stationed for some weeks at the establishment, was waiting for its arrival, under the orders of Commandant Boutheaux. Soon the long cigar-shaped balloon was seen above the woods which surround the Chalais balloon shed. It made a half-turn so as to bring the front against the wind, then headed for the point where the group of aeronauts was waiting, and they brought it down to the ground by hauling upon the cords. The landing took place at 11:12 and the 31.4 miles in a straight line had been made in 1h. 12m., which makes a speed of about 28 miles an hour. But the real speed must have been more than this, because the airship had to slow up for several minutes while making the evolutions before the landing. For the present, the "Patrie" will be housed in the Meudon balloon shed, while waiting for it to be transferred to the fortified post of Verdun, where the army corps is preparing a model balloon ground especially for it. It is thought that in the meantime it may make a trip to Paris, as the "Lebaudy" formerly did with such success. It will be remembered that the third balloon of the series, the "Republique," is to be built next year, and there is some talk of constructing a fourth airship the year following, which will be known as the "Democratie."

Quite a sensation was awakened in Paris by the flight which the great airship "Patrie" made above the city at a great height on the 17th of December. Soon after the arrival of the airship at the Chalais-Meudon grounds in the suburbs of town it was decided to give the Parisians an opportunity to see the new airship, and therefore it made the trip in spite of the somewhat foggy weather which prevailed that day. Preparations for the flight commenced at the Chalais grounds at 2:30 in the afternoon, and at 3 o'clock the airship left the establishment and directed its course for Paris, running against a rather strong northeast wind. Capt. Voyer piloted, and with him were Capt. Gaucher, another officer, and two mechanics. Soon the balloon disappeared in the fog, but upon reaching the city it re-appeared, and could easily be seen sailing along at what appeared to be a slow speed, but was in reality a good rate. Somewhat after three o'clock it was seen flying above the Grand Palais, where the crowds assembled on the occasion of the automobile show could observe it very well, and were much impressed with its appearance and the ease with which it made the evolutions in the air. The airship ran at a good speed keeping at a height of about 1,000 feet, and passed above the different government buildings such as the president's residence, the Chamber of Deputies and the War Department. Not more than three-quarters of an hour was needed for the whole trip, and the airship continued to keep about the same height, giving signals from a siren which were heard on the ground. Before four o'clock it had regained the military headquarters, where it came down and was put in the shed with the usual maneuvers with which the military aerostatic corps are now quite familiar. As usual, the airship distinguished itself for its remarkable stability in the air, which is one of its chief characteristics and speaks well for Engineer Julliot's design. A very good speed was also made and the airship was handled with ease.

FACTS ABOUT BLACK LEAD PENCILS.

BY KATHERINE E. CALHOUN.

It is difficult to determine the exact period in which "black lead" was first utilized as an instrument for writing or drawing, as it has been confused with other mineral bodies to which it bears no relation. The ancients used lead, but the metal was formed into flat plates, and the edges of these plates used to make the mark. If an ornamental design was desired, the transcriber drew parallel lines, and traced their illuminated designs, usually with a hard point but also with soft lead. That lead was known to the ancients is also proven by the fact that it is mentioned in the Book of Job.

During the year 1615 there was a description of the black lead pencil written by Conrad Gesner. He says that pieces of plumbago were fastened in a wooden handle and a mixture of fossil substance, sometimes covered with wood, was used for writing and drawing. About half a century later a very good account of this mineral was given, and it was then used in Italy for drawing and mixed with clay for manufacturing crucibles. We are informed in Beckman's "History of Inventions" that the pencils first used in Italy for drawing were composed of a mixture of lead and tin, nothing more than pewter. This pencil was called a stile. Michael Angelo mentions this stile, and in fact it seems that such pencils were long used in common over the whole continent of Europe. At this period the name plumbago or graphite was not in use, but instead the name molybdena or molybdoids, which is now applied to an entirely different mineral.

Graphite or black lead is formed in the primary rocks. In the United States it occurs in felspar and quartz, in Great Britain in greenstone rock and gneiss, and in Norway in quartz. The mine at Borrowdale, England, has supplied some of the finest black lead in the world, but the quantity varies, owing to the irregularity with which the mineral occurs.

The Jews were for a while the only manufacturers of pencils. It required great skill to perfect the manufacture, according to the degree of hardness or softness required. Of recent years the manufacture of pencils has increased to such an extent that the price of these articles has decreased proportionately. Graphite and pure clay are combined and used in the manufacture of artificial black lead pencils, and on the other hand the greatest perfection is attained in the making of the higher class pencils. Graphite is exposed to heat to acquire firmness and brilliancy of color. Sulphur is also used to secure a more perfect color.

THE YAWNING CURE FOR THROAT DISEASES.

A little book, recently published in Vienna, is devoted to a method of vocal culture, and also health culture, that has stood the test of practical experience in numerous cases but is not as well known as it deserves to be. It is based upon the vocal method of the concert singer Josephine Richter, the mother of the celebrated orchestra leader, Hans Richter, and consists essentially of peculiar movements of the jaws which ultimately give the pupil an astonishing command over the soft palate, besides strengthening the muscles of the face, neck and chest.

Herr Lanz, the author of the book, quotes a letter written to Mme. Richter by the late Prof. Helmholtz in which that famous physicist says: "I can readily understand, from theoretical considerations, that the flabbiness of the soft palate and the back of the mouth must act as a damper upon the voice and an obstacle to precision of attack and utterance. Hence if the command of the palate, tongue and larynx which you possess can be acquired by your method of exercising the muscles of the face and throat, as your own example appears to prove, the fact is clearly of great importance. It is physiologically probable that such exercises would have that effect."

That the exercises do have that effect is proved by an examination of an average untrained throat and the throat of a singer trained by the new method. In the former the soft palate and its conical extension, the uvula, hang limp and constrict the vocal passage, which is further narrowed by the prominent tonsil at each side. In a mouth so encumbered, as in a room filled with furniture, it is impossible for the voice to ring loud and clear. The tonsils and soft palate of the trained singer, on the other hand, are retracted and hardened and the pendent uvula has entirely disappeared, giving the voice a clear and wide passage with firm walls, and consequently increasing its volume and improving its quality.

The method is recommended for the cultivation of the speaking as well as the singing voice and for the prevention and alleviation of various diseases of the throat. "It gives astonishing relief in catarrh of the throat and suggests new possibilities in the treatment of enlarged tonsils."

Now these exercises consist essentially of yawning, which has recently been recommended, independently, as a valuable exercise for the respiratory organs. According to Dr. Naegli of the University of Luettich, yawning brings all the respiratory muscles of the chest and throat into action and is therefore the best and most natural means of strengthening them. He advises everybody to yawn as deeply as possible, with arms outstretched, in order to change completely the air in the lungs and stimulate respiration. In many cases he has found the practice to relieve the difficulty in swallowing and disturbance of the sense of hearing that accompany catarrh of the throat. The patient is induced to yawn through suggestion, imitation or a preliminary exercise in deep breathing. Each treatment consists of from six to eight yawns, each followed by the operation of swallowing.

It should be added, however, that it is quite possible for deep breathing to be overdone, particularly by persons with weak hearts, and it is at least open to question whether the obstacles to free respiration which the yawning cure is alleged to remove are not useful in preventing the entrance of germs and other foreign bodies.

CLIMATE: PAST AND PRESENT.

In the Monthly Weather Review, F. M. Bail argues that the popular belief that the climate is changing is not supported by an examination of some of the oldest records available, such as Angot's dates of vintage days since the fourteenth century, and temperature averages at St. Petersburg (since 1743), Philadelphia (since 1758), and St. Paul, Minn. (since 1822). Geology, on the other hand, teaches us that the climates must have changed many times. Mr. Bail discusses the general factors which determine climate, with special reference to the changes in the distribution of land and sea, changes of elevation, to Croll's theory, to T. C. Chamberlin's hypothesis that refrigeration and glacial sparks might be due to a depletion of the atmosphere of carbon dioxide, water vapor, and dust particles, and to the changes in the winds that would result from change in the configurations of the continents.

THE CURRENT SUPPLEMENT.

The great Union Station at Washington is nearing completion. Few pieces of work under way in America excite more interest and curiosity than the construction of this vast Roman palace of shining granite. Mr. Frank N. Bauskett writes instructively and eloquently on the subject in the opening article of the current SUPPLEMENT, No. 1620. Mr. E. J. Bolton contributes a well-considered and illuminating explanation of the manufacture of brass wire. Last year Prof. Berthelot published some results of experiments which tend to rehabilitate theories long since abandoned and to furnish a fresh proof that science moves in circles. In an article entitled "Radium and Geological Changes," the results of Berthelot's investigations are imparted. The ability of the modern gas engine to take the place of the steam engine in general power work has been questioned, as well as the ability of the gas engine and producer to work harmoniously together under widely varying load demands. Mr. J. R. Bibbins throws much light on the subject in his article on "A Producer Gas Power Test." Load diagrams, fuel consumption curves, efficiency test charts, and indicator cards accompany the text. Gas engine types are discussed by Jonas E. King. William McDonald writes on reinforced concrete in greenhouse construction. One of the most interesting papers read before the recent meeting of the British Institution of Civil Engineers was that of the president, Sir Alexander B. W. Kennedy, on the "Work of the Engineer." The paper is published in the current SUPPLEMENT The development of battleship protection is simply set forth. E. Walter Maunder, the well-known English astronomer, reviews the progress of astronomy in 1906.