makes of lamps were used in the tests, their candle-power and efficiency being determined at intervals during a working period of 850 hours. There were fifteen commercial lamps of each make at first, but afterwards some additional lamps were sent from the factories. The methods of tests used were calculated to give accurate results, and much care was taken in the measurements, there being frequent comparisons of both current and potential measuring-instruments with standards; while the Methuen burner used in determining the candle-power was compared with standard candles, and found to be practically correct.

The results of the measurements can hardly be regarded as flattering to incandescent-lamp manufactures. The initial efficiency of the lamps varied from about 3 watts to the candle-power (about fifteen 16-candle-power lamps to the electrical horse-power) to 5 watts to the candle-power (nine lamps to the horse-power). As time went on, however, the lamps, from the blackening of the globes and the increased resistance of the filaments, grew dimmer, until the candle-power had gone down in some cases to six or eight candles; while the efficiency had decreased, until in some cases lamps which gave a candle-light with an expenditure of 3 watts, finally required 7 watts to give the same light. The highest average efficiency for any make of lamps, for 800 hours, was 4.58 watts, the lowest 5.8 watts, per candle-power. Probably the most satisfactory of the lamps experimented on had an average efficiency of about 4.8 watts; the final candle-power, after 900 hours' service, being about 14, the initial being 16 candles.

An important point brought out in these tests is the marked decrease in the candle-power of commercial lamps, even after a moderate service. It is not at all satisfactory to consumers to have the lamp gradually decrease in brightness until it finally does not give enough light to read by, and to this cause may doubtless be attributed the comparatively slow introduction of the light. If the users are to replace the lamps, it is hardly in human nature to do so until they are broken, and a life of 2,000 or 3,000 hours is not uncommon. At the end of that time, a 16-candle lamp is giving about six candles, and that at a very low efficiency. There are many electric-light companies that guarantee twelve 16-candle lamps to the mechanical horse-power (equivalent to an efficiency of the lamp of about 3 watts to the candle). It is possible that a plant might give such results for a few hours; but, if these tests are to be trusted, none of the lamps in extended commercial use can do better than a candle-power for 4.8 watts, with the light at the end of 900 hours having 85 per cent of its initial brilliancy. The practical life of the lamp, then, is limited by two things, — the breaking of the filament, and the decrease of candle-power. This latter has not been recognized as it should have been, and Mr. Peirce's paper is of value in calling attention to it.

INHERENT DEFECTS OF LEAD SECONDARY BATTERIES. — A paper under this title was read at the meeting of the Institute of Electrical Engineers by Dr. Louis Duncan. It consisted mainly of a description of and deductions from a series of experiments which had been carried on by himself and Mr. Henry Wiegand during the past year; the principal points investigated being the loss of energy in charging and discharging such cells, with the causes of their deterioration. The cells experimented on were of the "grid" type, in which the active materials — peroxide of lead and spongy lead — are pasted into hourglass-shaped cavities in a cast-lead "grid." This type is the one almost universally used in commercial work, and it has so far been the most successful. The defects of these batteries lie (1) in the limited storage capacity, it being but one-eighth of the calculated value; (2) in the loss of energy in charge and discharge; (3) in the deterioration; (4) in the low discharge rate allowed by considerations of efficiency and length of life. The loss of energy exhibits itself by two effects, — a lower potential difference on discharge than on charge, and a loss in ampère hours between charge and discharge. The loss of energy must be traced to two things, — the production of heat or the formation of irreversible chemical products. It is known that the electro-motive force of a secondary battery is greater as the strength of the acid increases. When the strength is greatly diminished, there is a formation of irreversible sulphates of lead and a rapid corrosion of the plates. It is also known that discharge of the cell consists in a sulphating of both plates, causing a weakening of the acid; charge results in desulphating, strengthening the acid. In the plugs of active material, where diffusion is slow, there must be considerable differences of density in the acid between charge and discharge, this being especially the case when the current rate is considerable. We can consider, then, that the charge is in strong acid; the discharge, in weak. To these considerations correspond the facts that the electro-motive force is higher on charge than discharge; that a rapid discharge lowers the electro-motive force, which, however, rises again after a period of repose; and that a rapid discharge causes a deterioration of the plates. To see if there were any ground for these suppositions, experiments were made on the rate of diffusion of acid from the plates, and it was found to be slow, especially with partly run-down plates, this corresponding to the fact that fully charged plates can be discharged more rapidly than partly discharged ones. To fix the losses of energy which result in heat effects, a cell was discharged in a calorimeter, and the rise of temperature and other data observed under various circumstances. The first thing that appeared was, that there was a much greater heating during charge than during discharge, there being sometimes an absolute fall of temperature in the latter case, when the C^2R effect was allowed for. This is partly due to the weakening and strengthening of the acid in the solution, there being of course a corresponding absorption or production of heat. Every one who has mixed acid and water is aware of the latter fact. Again, on charging or discharging for short periods, allowing the cell to stand idle for the same length of time, it was observed that the temperature continued to rise after the current had stopped. This was accounted for by supposing, that, the distribution of current in the plugs not being uniform, different parts of the same plug would be in different chemical states, and local currents would be produced, tending to make the plug uniform. These local currents cause losses, which exhibit themselves finally as heat. The principal cause of loss, however, seems to be due to the electrolysis of the solution, the loss from this cause appearing as heat, and in the liberation of oxygen and hydrogen from the two plates. The other losses are mainly due to the formation of irreversible products in the form of lead salts. In one discharge and charge cited, the total loss was 98 watt hours. Of these, 51 watts were accounted for in heat; the remainder must have been due to irreversible chemical actions. The heat losses may be classed as (1) the Joule effect, measured by C^2R; (2) heating due to eddy-currents; (3) heating due to electrolysis of the solution into free hydrogen and oxygen. It should be noted that the alternate heating and cooling due to the strengthening and weakening of the acid is reversible, and therefore does not appear as a loss. Of the losses due to chemical actions during charge, which are not reversed on discharge, the most important, as far as loss of energy goes, is the electrolysis of the solution into free hydrogen and oxygen. The most important, so far as deterioration goes, is the formation of salts of lead on discharge in the weak acid in the plug, from the material of the support-plate. This last effect is exaggerated by rapid discharge, or by discharging until the formation of the more bulky sulphate of lead has greatly decreased the diffusion.

HEALTH MATTERS.

WOMEN'S BREATHING. — Our readers will doubtless remember the claim made by Dr. Thomas J. Mays of Philadelphia, that he had succeeded in demonstrating that the statement made in almost every text-book on physiology, that it was natural for women to breathe from the chest, was wrong; that the abdominal type of respiration, as ordinarily observed in men, was the natural type of women as well, and the costal type as seen in women is the result of modern dress. This claim he supported by the result of an examination of eighty-two American Indian girls. Dr. J. H. Kellogg, from an examination of Chinese and other women untrammelled by tight-fitting dress, finds the abdominal type present in them. Other observers, notably Hutchinson, in twenty-four girls whose waists had never been constricted by corsets or other appliances, found the costal type present. The question of what is the natural type of respiration may therefore still be regarded as *sub judice*, unless, which perhaps may be the truth, both types are natural under varying conditions, independent of dress.

FILTERS. — Dr. Currier of New York has recently been engaged in examining into the efficacy of filters and other means employed to purify drinking-water. His paper on the subject is published in the *Medical News*. He summarizes the result of the investigation as follows: Boiling sterilizes water, and within thirty minutes will have killed harmful bacteria. Drugs and other agents acting chemically, if used in amounts which are commonly safe, do not sterilize water. The prolonged heat which water undergoes in the usual process of distillation destroys all germs which may be in the water undergoing the process. Ordinary filters, even if satisfactory as strainers, fail to remove all bacteria from drinking-water. So far from lessening the number in the original water, the filtering substance may allow a more rapid multiplication than these micro-organisms would ordinarily undergo in the unfiltered water on standing; and the germs of disease, even if held back by the filtering substance, may be harbored in all filters. The finer the substance through which the water passes, and the lower the pressure, the more perfect is the action of the filter in holding back the bacteria. Of all substances thus far furnished for domestic filters, porous rebaked porcelain, carefully selected, has been found to be the best. If thick and strong enough to allow the use of a large surface, and the substance remain perfect (without flaw or break), this may yield a fair flow of clear water, free from all bacteria; yet, under our ordinary Croton pressure of one atmosphere or less, this yield is only in rapid drops, unless the apparatus be complex. To insure the permanency of this action, the filter should be occasionally sterilized throughout, by steaming or by other means; for, under prolonged pressure, various kinds of bacteria can go through, and in the copious organic matter collected on the filter some harmful micro-organisms can retain a high degree of vitality for weeks longer than they have ever been found to live in pure water. Where filtering is really necessary, it is in general best for the community that it be done carefully on a large scale through sand-beds upon which a fine layer of organic and inorganic matter is expressly produced by sedimentation, because of its valuable action in holding back the great majority of the bacteria. A bad water filtered is less desirable than a pure water in its natural state. When, therefore, filtration is employed because of real danger of infection, the filtered water should, as a rule, be furthermore boiled, as the entire absence of sediment and cloudiness does not insure that the bacteria of disease may not have made their way through the filter.

ASPHYXIATION BY ILLUMINATING-GAS. — At a recent meeting of the American Gaslight Association of Toronto, the following rules were given, to be followed when men are overcome by gas: 1. Take the man at once into fresh air. Don't crowd around him. 2. Keep him on his back. Don't raise his head nor turn him on his side. 3. Loosen his clothing at his neck and waist. 4. Give a little brandy and water, — not more than four tablespoonfuls of brandy in all. Give the ammonia mixture (one part aromatic ammonia to sixteen parts water) in small quantities, at short intervals, — a teaspoonful every two or three minutes. 5. Slap the face and chest with the wet end of a towel. 6. Apply warmth and friction if the body and limbs are cold. 7. If the breathing is feeble or irregular, artificial respiration should be used, and kept up until there is no doubt that it can no longer be of use. 8. Administer oxygen.

CANCER CONTAGION. — The contagiousness of cancer is still a mooted question. Dr. Arnaudet, in *La Normandie Médicale*, maintains the affirmative of the question, and gives the following facts to support his views: At Saint-Sylvestre-de-Cormeilles, which has a population of about four hundred persons, there were seventy-four deaths in eight years. Of these, eleven were from cancer. In the neighboring villages of Normandy, although exact figures are wanting, the death-rate from cancer is said to be nearly the same. Of these eleven cases, six occurred within a limited area, and the order of their occurrence was such as to suggest a possible connection between them. The first case was that of a man living in an elevated portion of the hamlet; the next case was a man living on the side of the hill below the first; then three cases occurred almost simultaneously in persons living close together in the valley at the foot of this hill; and the sixth patient was a near neighbor of the first, on the plateau above the valley. In none of these cases could any history of heredity be obtained, and they were all free from the reproach of alcoholic addiction. In five of the cases the cancer was seated in the stomach, and in the sixth the location of the disease was in the neck. Dr. Arnaudet believed that the germ of the disease, microbial in its nature, was carried in the water. None of the patients drank water, but they were all moderate consumers of cider, and that was the beverage that the author accused of being the carrier of the contagion. In making cider, the inhabitants of that region added water taken from the swampy ground; and the darker the color of the water, consequently the more impure, the higher it was esteemed as a diluent of the apple-juice.

NOTES AND NEWS.

THE invention and development of electric welding of solid bodies by Professor Elihu Thomson has been followed by a method of making endless pipes by the adaptation of the discovery to that purpose. This has apparently been done by Mr. Elias E. Ries of Baltimore. The smooth interior of the pipe is secured by the use of a removable refractory core, made of some insulating material, or the same object is attained by subjecting the interior of the pipe while being welded to compressed air or fluid pressure.

— In a description of the Calais harbor works in *Engineering*, occurs the following reference to the use of the water-jet for sinking the piles of the protecting dike or dam of the sluicing-basin: "The engineer in charge of this portion of the work sunk all the piles with the help of water-jets, — a system which has, of course, been in use for many years for sinking cylinders and iron piles, but which, we believe, had never been previously employed in this particular manner. The first trials were made in 1877, and the results obtained were so remarkable that the method was followed throughout nearly the whole of the work. Before this means was tried, the operation of driving a panel of sheet piling 9 feet high and 6 feet wide required 900 blows from a 1,300-pound weight, and the average time occupied was 8½ hours. The sand offered so much resistance, that the thickness of the piling had to be increased from 3-inch to 5-inch, and even then the wood was frequently broken. All these difficulties disappeared with the introduction of the water-jet, which was forced into the sand by hand-pumps through a 1-inch nozzle connected to rubber tubes. Much wider panels could be lowered in this manner, and the time of sinking was reduced to about one hour, while in many cases the operation was completed in 15 minutes. The number of blows from the falling weight never exceeded 50, and were only necessary to overcome the friction between the adjoining panels, which were tongued and grooved so as to make a tight joint. As a rule, the weight of the 1,300-pound tup resting on the head of a 10-foot pile sufficed to drive it almost instantly into its place."

— An international congress of agriculture and forestry will be held in Vienna during the summer of 1890.

— We learn from the *American Lancet* that since its establishment the Minnesota Board of Medical Examiners have had eighty-six applications for examination for a license to practise medicine. Of these, six were refused admission because they had not taken three full courses of lectures of six months each. Of the eighty entering the examination, fifty-one were found able to pass the same, and twenty-nine were rejected as not possessing the knowledge of medicine required by the board. Of those passing, forty-nine are regular, and two are homœopathic. Of those rejected, eighteen were regulars, eight homœopaths, and three eclectics. Students from two-term medical colleges cannot even get a chance to be examined in Minnesota.

— An improved method of producing phosphorus has lately been patented in Paris. It consists, as described in *The Engineering and Mining Journal*, in treating bones or powdered mineral with nitric acid. A large proportion of the calcium is then removed from the solution — on the addition of potassium sulphate to liquid — in the form of calcium sulphate. The liquid then contains phosphoric acid and potassium and calcium nitrates. After removing the precipitated calcium sulphate by means of filtration, sufficient mercurious nitrate is added to precipitate the phosphoric acid as mercury phosphate. The phosphate of mercury so ob-