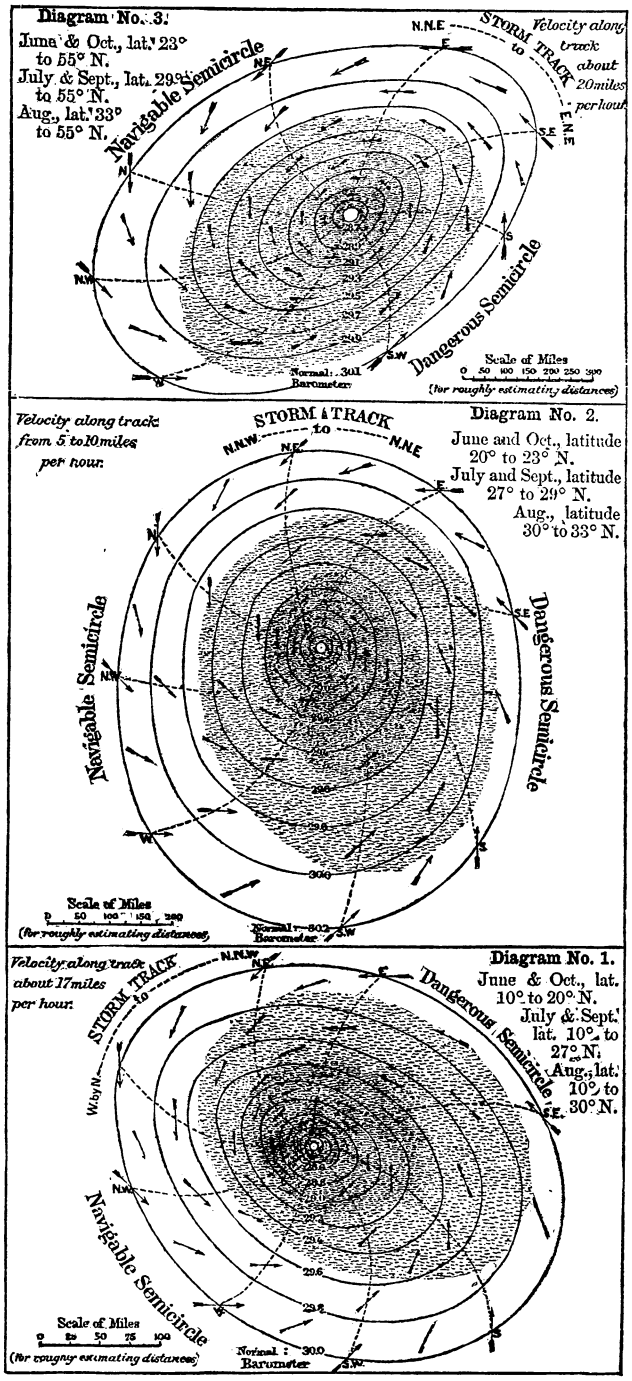
Another very important fact (established by Meldrum at Mauritius) may be stated thus: When a hurricane is moving along the equatorial limits of a trade-wind region, there is a belt of intensified trades to windward of its track. Not until the barometer has fallen about six-tenths of an inch is it safe to assume, that, because the trade-wind increases in force and remains steady in direction, you are on the track of the storm. By attempting too early to cross its track, running free as soon as the wind begins to freshen, you are liable to plunge directly into the vortex of the hurricane.



The small arrows fly with the wind, and the dotted lines (radiating from the centre) join points having same wind-direction (stated at outer arrow). The ovals are isobars, the barometer falling .20 of an inch from one curve to the next inner one. The shaded area is the region where it is most dangerous for a vessel. The average size of one of these storms in different latitudes can be estimated by means of the scale of miles accompanying each diagram.

Brief rules for action are the following: Watch carefully for the earliest indications, recording observations of barometer, thermometers, wind and weather, for future reference. When there is good reason to suspect that a hurricane is approaching, consider the latitude you are in, and the month, with a view to decide the probable direction in which the storm is moving, and when its track is likely to recurve. Early action may thus be taken to avoid its path. When the decided fall of the barometer, freshening rain-squalls, and other unmistakable signs, indicate that the cyclone is close upon you, observe the shifts of wind very carefully, in order to determine whether you are to the right or left of the storm-track. Remember that it is sometimes best to lie to when thus observing the shifts of wind. A fast steamer, for instance, may run into the dangerous semicircle of a slow-moving cyclone, and yet get shifts of wind characteristic of the navigable semicircle. If the freshening gale remain steady in direction, you are on the track of the advancing storm: square away, at all hazards, and run with the wind on the starboard quarter, keeping your compass course as the wind shifts; if obliged to lie to, do so on the port tack. If the wind shift to the right, you are to the right of the storm-track: put the ship on the starboard tack, and make as much headway as possible; if obliged to lie to, do so on the starboard tack. If the wind shift to the left, you are to the left of the storm-track: bring the wind on the starboard quarter, and keep your compass course, if possible; if obliged to lie to, do so on the port tack. Any attempt to cross the storm-track is dangerous; but, if you decide that it must be attempted, crowd sail and keep the wind well on the starboard quarter. In scudding, always keep the wind well on the starboard quarter, in order to run out of the storm. If obliged to lie to, always do so on the coming-up tack, so that the wind will shift aft, and not take you aback. Should you get into the central calm of a tropical cyclone, look out for a terrific squall from a point of the compass almost exactly opposite to that from which the wind was blowing when it fell calm.

So long as the barometer continues to fall, the centre is getting nearer. When it steadies and begins to rise, this marks the nearest point; and here the shifts of wind will be most sudden and violent, and the sea highest and most confused. If, when lying to, the wind begins to shift in the opposite direction to what it did at first, it is evidence that the storm-track is recurving, and your semicircle is changed: immediate action must be taken to suit the new conditions. But if your vessel is making any great headway, it may give you a shift of wind contrary to what you would have if lying to: this must be always borne in mind. Cool weather is characteristic, in extra-tropical regions, of the navigable semicircle, owing to the indraught from the north-westward; warm weather, on the contrary, indicates the dangerous semicircle, where the air is drawn in from the south-eastward.

After encountering a hurricane in the tropics, a northward-bound vessel is very liable to encounter the same storm again in higher latitudes, after it has recurved. The navigator should therefore remember that there is a hurricane off to the westward, and look out for it as he goes north.

There are two cyclone currents to be considered, — a current moving in a circular direction around the centre, caused by the wind; and a current which follows the storm along its track. These vary considerably with different storms, but should always be taken into account when near the coast.

The testimony as to the great value of the use of oil in heavy seas is so conclusive that it is now recognized by every commercial nation. No ship can afford to neglect its use in an emergency, when heavy broken seas threaten to come on board. Once tried, its value will never be disputed. Fifty-four reports have already been received this year from masters of vessels who have used oil with great success: thirteen of these refer to a single storm, the hurricane off Hatteras, April 6–9, and new reports are received almost every day.

ELECTRICAL NEWS.

The Average Efficiency of Incandescent Lamps.

AT the meeting of the Institute of Electrical Engineers, held on May 22, Mr. W. H. Peirce read a paper under the title "Relation between the Initial and Average Efficiency of Incandescent Electric Lamps," which gave the results of experiments made by him for the Chicago, Burlington, and Quincy Railroad. Four 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.