practicable, any mixture of water and spirit, which would tend to vitiate the experiments.

The heat from the gas-flame is first taken up by the water in the boiler, and is then passed on to the copper coil, and evaporates the spirit; the water only acting as a convenient means of transmitting the heat from the flame to the spirit. By these means it was possible to try steam and spirit vapor under precisely similar circumstances with regard to boiler efficiency.

The experiments consisted of several continuous trials, each of three hours duration, alternately with steam and with spirit vapor. The upshot of these experiments was, that although the amount of gas consumed during the three hours was practically the same, being at the rate of 82 and 83 cubic feet, the power obtained, as tested on the brakes, was, in the case of spirit, nearly twice that recorded in the case of water, the powers being as 4,722 to 2,524.

At equal intervals during these trials, diagrams were taken with an ordinary indicator. The working-out of these diagrams gives a power, in the case of spirit, of 11,975 foot-pounds per minute, and, in the case of water, of 5,199 foot-pounds per minute, which more than confirms the results obtained by the brake.

Touching the class of spirit used for the experiments, Mr. Yarrow mentioned that it was a hydrocarbon distilled from petroleum, having a specific gravity of about .680. The reason this spirit was adopted was because it is low in price, and can be easily procured; and also, being obtained from petroleum, it is of an oily nature. A spirit which is not oily in its character would be deficient in lubricating-power, and therefore not so suitable for working the machinery.

Touching the evaporation of spirit to produce power in actual practice, at present the only application which has been successfully developed is for the propulsion of launches. It is termed the "Zephyr" system. For small sizes, certainly there would seem to be no question, that, where the spirit is obtainable, this system is destined to take the place of steam, not so much on account of the probable increased efficiency, as the general convenience of the arrangement. A launch propelled on this plan, 36 feet long by 6 feet beam, and built of steel, has a total weight, including machinery, of only one ton; while, had it been propelled by steam, the weight would have been considerably greater.

Mr. Yarrow did not venture to assign any reason for the apparent gain in the use of spirit over water, but pointed out, that, in a condensing-engine, the two great losses of heat are due, first, to the waste gases which pass up the funnel, and simply go to raise the temperature of the surrounding air; and, second, to the loss arising through raising the temperature of the condensing-water, which goes to warm the sea.

As regards the first loss, it is self-evident, that, owing to the low temperature at which the spirit evaporates, the products of combustion are available to produce evaporation down to a much lower temperature than in the case of water. As an illustration of the low temperature at which the waste gases pass away in the "Zephyr" launches, when going at full speed, it is quite possible to hold one's hand immediately over the funnel.

The results of these experiments give reasonable ground for believing that this system, in some form, is capable of further and possibly extensive development.

WEST INDIAN HURRICANES.

JUNE is the first of the five months that constitute the hurricane season, and every navigator bound for the tropics should now be on his guard, and watch for the earliest indications of an approaching cyclone, lest it may be of hurricane violence. The "Pilot Chart" last month contained a small chart illustrating the general tracks along which these storms move, together with a diagram explaining the importance of the fact that the tracks recurve in a latitude dependent upon the month. In June, for instance, the point of recurvature is in about latitude 20° to 23° north, and here the entire storm moves in a northerly direction, while in lower latitudes it moves north-westerly, and in higher latitudes north-easterly. Each of the accompanying diagrams is therefore applicable to a slightly different belt of latitude, according to the month, as stated therewith. There may be an occasional exception, but a navigator can at first only be guided by the general rule.

A careful study of these diagrams will, it is thought, enable a navigator to form a clear idea as to the general character of West Indian hurricanes. It should, of course, be understood that no two hurricanes are exactly alike; and a master of a vessel can only be guided by what is known from the experience of others, his own experience, and the indications that he can obtain from the weather, wind, barometer, cloud-movements, etc. It is now generally recognized that the old 8-point rule is not always a safe guide for action; and, although the storm-card based upon it has been published on the "Pilot Chart" up to the present time, efforts have been made to explain the spirally inblowing character of the winds in a cyclone. The old storm-card and the 8-point rule can no longer be recommended, except, perhaps, as a rough-and-ready rule for those who will not take advantage of the progress that has been made since this old rule was established. By looking at any one of these diagrams, for instance, it will be seen that the bearing of the centre is hardly ever exactly eight points to the right of the wind, but is generally considerably more than that, especially in rear of the storm. It will be noticed, also, that the storm is never exactly circular, and that its shape changes as it moves along its track. The limited space on the chart forbids any detailed discussion of the subject; but the following brief *résumé*, prepared for the information and guidance of practical navigators during the present hurricane season, is taken from the June "Pilot Chart:"—

The hurricane regions embrace the tropics north of the 10th parallel, the Caribbean Sea, Gulf of Mexico, and a broad belt curving north-westward from about St. Thomas, and following the Gulf Stream toward the Grand Banks of Newfoundland.

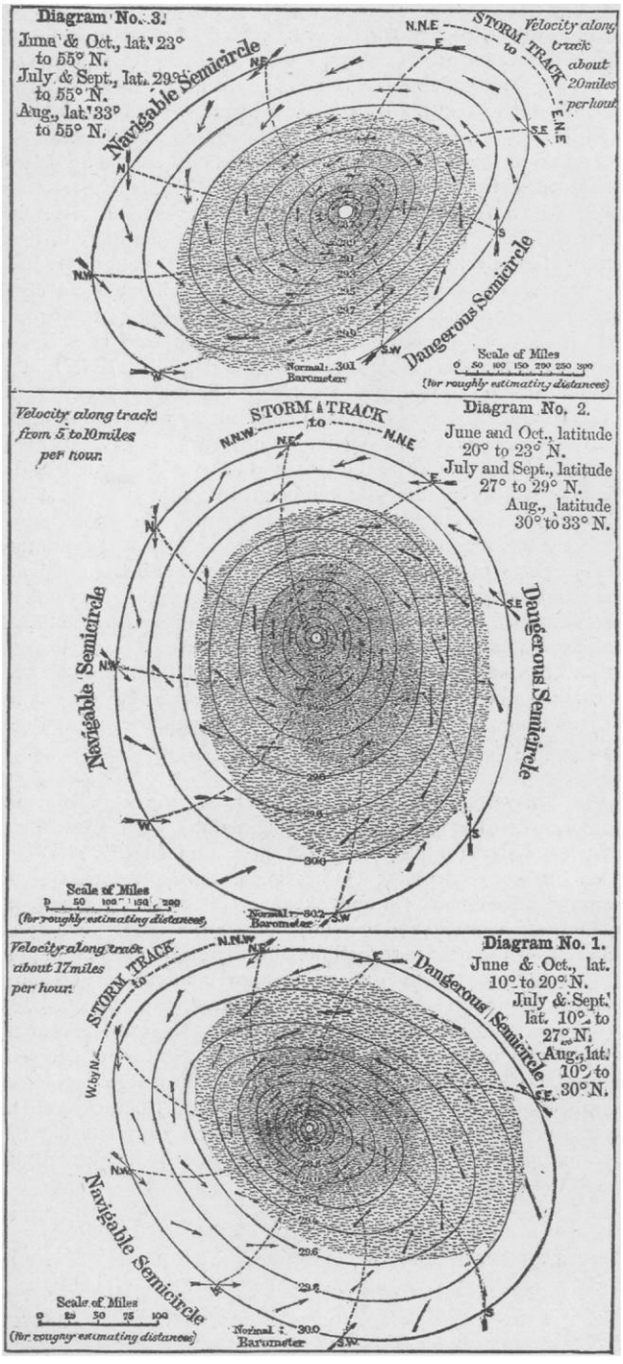
The earliest indications are, unusually high barometer, with cool, dry, fresh winds, and very transparent atmosphere; a long, low ocean-swell from the direction of the distant storm; light, feathery plumes of cirrus clouds, radiating from a point on the horizon where a whitish arc indicates the bearing of the centre.

Unmistakable signs of a hurricane are the following: As the cirrus veil spreads overhead, with halos about the sun and moon, the barometer begins to fall, slowly but steadily, and the ocean-swell increases; the air becomes heavy, hot, and moist; dark red and violet tints are seen at dawn and twilight; the heavy cloud-bank of the hurricane soon appears on the horizon, like a distant mountain range; the barometer falls more rapidly, and the wind freshens, with occasional squalls of fine, misty rain.

As to general size and velocity of progression, the storm area is smaller in the tropics than farther north, the cloud-ring averaging about 500 miles in diameter, and the region of stormy winds 300 miles or even less. In low latitudes the entire storm moves westward and north-westward about 17 miles an hour; in middle latitudes, north-westward and northward, moving more slowly as it recurves; and finally north-eastward, with a velocity of translation of 20 or even 30 miles an hour, its area increasing rapidly as it follows the Gulf Stream toward the Grand Banks, and sweeps across the Atlantic toward northern Europe.

One of the most important indications that an approaching storm is of hurricane violence is the marked cyclonic circulation of the wind, lower and upper clouds, etc. This may be easily appreciated by remembering that a cyclone of any great intensity is an ascending spiral whirl, with a rotary motion (in the northern hemisphere) against the hands of a watch, as shown on the diagrams. The surface wind, therefore, blows spirally inward (*not* circularly, except very near the centre); the next upper current (carrying the low scud and rain clouds), in almost an exact circle about the centre; the next higher current (the high cumulus), in an outward spiral; and so on, up to the highest cirrus clouds, which radiate directly outward. The angle of divergence between the successive currents is almost exactly two points of the compass. Ordinarily, with a surface wind from the north, for instance, the low clouds come from the north also; on the edge of a hurricane, however, they come from north-north-east invariably. In rear of a hurricane, the wind blows still more nearly inward. With a south-east wind, for instance, the centre will bear about west, the low clouds coming from south-south-east (two points to the right of the wind), etc. Great activity of movement of the upper clouds, while the storm is still distant, indicates that the hurricane is of great violence.

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



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.

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.

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