LIGHTHOUSES, LIGHTSHIPS, AND BUOYS.

In a recent issue of the SCIENTIFIC AMERICAN, we described the system of oil lamps used by the lighthouse establishment of the United States. The last developments in that department involve the universal employment of refined kerosene, the use of the particular types of oil lamps there illustrated, and of the Fresnel dioptric apparatus, sometimes for range lights supplemented by reflecting apparatus.

The structures built for the display of the lights, including lighthouses and beacons, and the additional safeguards to navigators afforded by buoys of different classes, including electric and gas lighted buoys, form an equally interesting subject. The diversity of position and surroundings and the need of absolutely distinctive characteristics for each lighthouse have given rise to much thought and ingenuity.

For small lights which are only required to be seen a few miles, the stake light or beacon is coming more into use than formerly. Our cut of a beacon shows a stake light upon the Hudson River, at Livingston Creek. Upon a crib a pole with arm is erected, and to the arm a lantern is suspended. In this type improvements have been recently inaugurated that tend to place such service on a much higher level than it has hitherto occupied. The well known tubular lamps have been used for this service. Ordinarily daily attention is required, but this can be dispensed with by the use of a supplemental oil reservoir, worked on the principle of a student's lamp. Such reservoirs holding a gallon of oil have been applied, enabling the lamp to burn for eight days without attention or extinguishment. There is also a move to substitute Fresnel lens lanterns in more important places, which would act to a degree as small lighthouses in the intensity of their light.

For shoal water stations where stake lights would be too small, trestle work is erected on the sands and on this a lighthouse station is erected. One illustration shows the Thimble Shoal Station, familiar to many visitors to Old Point Comfort. It is seen from the ships as they approach Hampton Roads. The general plan of all these stations is a platform supported by piles. Screw piles are often used. On the platform, a one-story building contains the keeper's dwelling, above whose center the light rises. They are structures favored mostly for southern waters, as they are particularly exposed to damage from floating ice. A ring of rip-rap stone work is sometimes placed around them to protect them from this danger.

In the same order comes the skeleton lighthouse proper, exemplified in Sombrero Key Lighthouse, Florida. This is a first order light, with lantern 142 feet above the surface of the water, and is rated as visible at eighteen nautical miles. There are several of this type in Florida waters resting on iron piles driven into coral rock. The details of the construction and of the care requisite in driving the piles vertically, when they were plumbed after every blow of the pile driver, indicate the difficulties of the work. It is on record that in the case of the American Shoals Lighthouse the iron work was completed at the north, was shipped, erected and the lamp was lighted at its summit in one year.

Masonry lighthouses are a more familiar and more ancient order of structure. The Minot's Ledge Lighthouse, which we illustrate, presents at high water a circular shaft rising directly out of the water, without any surrounding area. In it the keepers live, and go through the wildest storms which rage in Boston Bay. In 1847 and 1848, a lighthouse was built in this place upon wrought iron piles. Additional bracing was placed in position. In April, 1851, the whole was carried away in a storm. The last seen of it was on the night of April 16; the bell was heard a day later. This is the last known of its fate. It disappeared, leaving a few bent piles behind it. The work on the present structure began on July 1, 1855, and the difficulty of the work is shown by the fact that, in that year, but one hundred and thirty hours' work could be done on the rock. In 1860 the tower was completed. The sections illustrate the binding and interlocking of the courses of stone.

By using colored lights and flashing lights of different frequency, distinguishing characteristics are given at night. For the day, it is sometimes found useful to paint the lighthouses of distinguishing colors, so as to make them unmistakable landmarks. Cape Henry Lighthouse illustrates the use of vertical sections of color, and Morris Island Light, near Charleston, S. C., shows a lighthouse painted in broad rings or horizontal bands of color.

In connection with lighthouse stations, a view of Falkner's Island light is given, illustrating the establishment of a complete station for fog-signaling as well as for light-signaling. The building in the foreground not only serves as boiler house, but its roof is the water collector, and the rain supply is utilized for the boilers.

The floating structures include lightships and buoys. The lightships are strongly built schooners, which are anchored near dangerous shoals. In the daytime they are distinguished by disks at their mastheads. At night a powerful circle of lamps is hoisted up to a place immediately below the disk. They also carry a fog bell or whistle, for use as a fog signal. There are some twenty-three of these vessels on the Atlantic coast and one on Lake St. Clair. There are none on the Pacific coast. Relief lightships are kept in readiness to replace any ship which may be driven from her place. The low-placed hawse pipes leading out of the hull near the water line are characteristic. The name of the station is generally painted in large letters on the side.

The gas-lighted buoy with its reservoir of compressed gas, with high pressure regulator, burner, and lenticular apparatus, illustrates a method of warning to navigators which has recently been given a formidable rival in the electric-lighted buoy. The gas-lighted buoy will burn for three months without attention. It is designed for use both as a shoal water buoy and for designating channels.

Two other types of buoys are the whistling and ringing or bell buoys. The former depend on the fact that at a sufficient depth below the surface there is no wave motion. The whistling buoy has a long tube projecting far below it so as to reach or nearly reach this depth. This causes the water within the tube to occupy approximately the same level in storm or calm. When the buoy is lifted on a wave air is drawn into it, to be expelled as it sinks again. An inlet for air connects with the top of the tube and an outlet tube surmounted by a whistle also connects thereto. Otherwise it is tightly closed. When a sea is running a constant series of low-pitched whistling signals is thus produced.

The bell buoy of the type illustrated carries a fixed bell, with three nearly horizontal tubes arranged radially around its perimeter. Each contains a ball. With the least inclination one or the other ball rolls down its tube and strikes the bell. In very slight waves a constant ringing is thus kept up.

In our cut of the whistling buoy is shown the use of a fixed rudder plate to avoid danger of entanglement or fouling with the chain. This plate, acted on by the tide, keeps the buoy constantly facing toward its moorings. Without it there would be danger of the chain winding around the long tube. For the bell buoy the use of a bridle or double attachment of the chain is shown. The weight hung at its bottom for ballast is also shown.

The electric-lighted buoy now in use in the harbor of New York is also shown in the cut. It is used to define Gedney's Channel, so that ships can now enter by day or night. The buoys are fifty-foot juniper logs, each surmounted by the lamp shown in the cut, contained in a protecting iron cage. The lamp, of incandescent type, is rated at 100 candle power, with three loops in its filament to give even distribution. The lantern can be lifted out bodily from the frame or the lamp alone can be removed if desired. There are three buoys on each side of the channel, about 2,000 feet part. The station is situated at Sandy Hook. The plant is of the Edison type. The dynamo gives a direct current of 25·5 amperes and maintains a potential difference at its terminals of 160 volts. We show the construction of the heavy cable which it has been found advisable to use. The whole installation is cited as the only one of the kind in the world. By its use a channel 1,000 feet wide and 4,000 feet long is defined as clearly at night as by day.

We also illustrate the statue of Liberty in New York Harbor. The statue now carries in the torch a powerful system of electric lights. It has been proposed to so modify the distribution of light that the direct view of the light will be had from a distance only, while vessels near it will be protected from its glare. By reflectors the body of the statue proper will be lighted.

Our thanks are due for courtesies received to Commander C. H. West and Major D. P. Heap, of the United States Lighthouse establishment.

Electrical Terms.

At the present time electricity depends upon steam engineering for its generation. Therefore it behooves every live engineer to acquire all the knowledge regarding its generation and application that he possibly can. At the present time nearly all our ocean, river, and lake steamers are equipped with dynamos for electric lighting, and the engineer who does not acquire knowledge necessary to care for the dynamos and its appliances will find hard work to procure a position. Engineers will find herein the electrical terms so clearly defined that any person can easily understand them: Volt, unit of pressure, called electric motor force, same as pounds of steam; ampere, unit of quantity, called current, same as gallons of water; ohm, unit of resistance, similar to friction; watt, unit of energy consumed, similar to foot pounds, and thus 746 watts equal one horse power, same as 33,000 foot pounds.

The whole question of electrical distribution may be popularly illustrated by its analogy to hydraulics. The dynamo is essentially a rotary pump, but pumping electricity instead of water. If the discharge pipe of a rotary pump be carried around through a given circuit and connected with a suction, both pump and pipes being full of water, the movement of the pump will obviously cause the water to flow in one direction, producing a continuous current of water. Substitute dynamo for pump, wire for pipe, and electricity for water, and conception of electrical transmission by the continuous current is at once clear as to its elementary phenomena. We will bracket the analogous electrical terms; then we may say that a certain number of pounds (volts) of pressure are required to overcome the friction (resistance) of the pipe (wire) in order that the water (current) may flow at the rate of so many gallons (amperes) per minute. The larger the pipe (wire) the more water (current) can be carried and the less will be the friction (resistance); or per contra, the smaller the pipe (wire) the less the quantity (amperes) per minute and the greater the friction (resistance). Manifestly the pipe (wire) might be so small that the friction (resistance) would absorb a very large proportion of the power of the pump (dynamo), leaving but little remaining for useful effect, therefore the two horns of the dilemna are: If the pipe (wire) be too large, it will cost too much; if too small, the loss will be too great.

The electrical appliances are also analogous to engineering appliances. The switches are valves, the fusible strips are the safety valves, the contacts are the pipe fittings. If the contact is insufficient to carry the current, there will be a leak (drop) in the current. The voltmeter is the pressure gauge; the ammeter is the same as the water or gas meter, the recorder of quantity consumed.—*R. G. Davis, in Marine Review.*

The Sahara.

The Sahara is an immense zone of desert which commences on the shores of the Atlantic Ocean, between the Canaries and Cape de Verde, and traverses the whole of North Africa, Arabia, and Persia, as far as Central Asia. The Mediterranean portion of it may be said roughly to extend between the 15th and 30th degrees of north latitude.

This was popularly supposed to have been a vast inland sea in very recent times, but the theory was supported by geographical facts wrongly interpreted. It has been abundantly proved by the researches of travelers and geologists that such a sea was neither the cause nor the origin of the Libyan Desert.

Rainless and sterile regions of this nature are not peculiar to North Africa, but occur in two belts which go round the world in either hemisphere, at about similar distances north and south of the equator. These correspond in locality to the great inland drainage areas from which no water can be discharged into the ocean, and which occupy about one-fifth of the total land surface of the globe.

The African Sahara is by no means a uniform plain, but forms several distinct basins containing a considerable extent of what may almost be called mountain land. The Hoggar Mountains, in the center of the Sahara, are 7,000 feet high, and are covered during three months with snow. The general average may be taken at 1,500. The physical character of the region is very varied. In some places, such as Tiout, Touat, and other oases in or bordering on Morocco, there are well-watered valleys, with fine scenery and almost European vegetation, where the fruits of the North flourish side by side with the palm tree. In others there are rivers like the Uied Guir, an affluent of the Niger, which the French soldiers, who saw it in 1870, compared to the Loire. Again, as in the bed of the Uied Rir, there is a subterranean river which gives a sufficient supply of water to make a chain of rich and well peopled oases equal in fertility to some of the finest portions of Algeria. The greater part of Sahara, however, is hard and undulating, cut up by dry water courses, such as the Igharghar, which descends to the Chott Melghigh, and almost entirely without animal or vegetable life.

About one-sixth of its extent consists of dunes of moving sand, a vast accumulation of detritus washed down from more northern and southern regions—perhaps during the glacial epoch—but with no indication of marine formation. These are difficult and even dangerous to traverse, but they are not entirely destitute of vegetation. Water is found at rare but well known intervals, and there is an abundance of salsolaceous plants which serve as food for the camel. This sand is largely produced by wind action on the underlying rocks, and is not sterile in itself—it is only the want of water which makes it so. Wherever water does exist, or artesian wells are sunk, oases of great fertility never fail to follow.

Some parts of the Sahara are below the level of the sea, and here are formed what are called chotts or sebkhas, open depressions without any outlets, inundated by torrents from the southern slopes of the Atlas in winter and covered with a saline efflorescence in summer. This salt by no means proves the former existence of an inland sea. It is produced by the concentration of the natural salts, which exist in every variety of soil, washed down by winter rains, with which the unevaporated residue of water becomes saturated.—*Medit. Naturalist.*

The Garrison of the Human Body.

Among the topics discussed by Prince Krapotkin in an article on recent science contributed to the *Nineteenth Century*, there is one of extraordinary interest, namely, the incessant conflict going on between the micro-organisms that invade and those which defend the living body. Of all the discoveries made of late years by biologists, none is more striking than the demonstration that almost all infectious diseases may be traced to foreign bacilli, whose intrusion is resisted by a militia of resident micro-organisms known under the general name of leucocytes, the function of which is to attack, swallow, digest, neutralize, or expel the alien and noxious microbes. The outcome of this ceaseless struggle within the body is on the one hand health and life, and on the other disease and dissolution.

So far, we know more about our assailants than our defenders. Bacteriology, the branch of science which deals with the germ theory of disease, may be said to have been founded about the end of the fifties by Pasteur's researches into the fermentation of beer and wine and Virchow's investigations into cellular pathology. Since then, although some alleged discoveries have been confuted, many have been verified, and we indisputably know a great number of micro-organisms which are capable, under certain circumstances, of producing certain specific maladies. For example, cholera, typhoid fever, and gastric affections generally; malaria and influenza; tuberculosis, leprosy, and cancer; diphtheria, measles, and scarlet fever; rheumatism, smallpox, rabies, and tetanus have been traced to separate microscopical beings. The photograph of each separate bacillus may be found in the text books; its modes of life, and very often its methods of reproduction, have been carefully studied, both in the animal body and in artificial cultures; subjected also to minute scrutiny have been the morbid effects which it produces when introduced into the bodies of various animals. In a word, the germ origin of infectious diseases can no longer be described as a theory; it is a fact.

Relatively backward is our knowledge of the means of combating infectious micro-organisms. Most of the specifics which once awakened hope have proved, in the long run, as ineffective against the bacilli themselves as the specifics proposed by physicians have proved against the resultant maladies. The more the study of bacteria advances the stronger is the tendency to recognize that, as sanitary measures are the most effective precautions against the risks of infection, so a healthy body which is itself capable of checking the development of morbid micro-organisms is the best means of combating them. But what is it that permits a healthy body to resist invasion by morbid microbes? We know the invaders; but what is it that renders them highly noxious in some cases and quite inoffensive in some others? To this question cannot yet be given an answer which commands the universal assent of biologists. The broadest and most ingenious explanation of immunity thus far put forth is the theory elaborated in 1883 by Elie Menchikoff, which represents an extension of the leading principles of the struggle for life to the microscopic constituents of the animal body. There exist in the body of man, and of all vertebrates, besides the cells which constitute the animal tissues, a number of free cells, the white corpuscles of blood and lymph, and the so-called wandering cells of the tissues. Four different varieties of these free cells, collectively known as *leucocytes*, have been described, the distinctions between them being chiefly based upon the shape and the numbers of their nuclei. It appears that the leucocytes of both the higher and the lower animals have all the distinctive features of simple amœbæ. They protrude pseudopodia or feelers, and they move about, and, like amœbæ, they are endowed to a high degree with the capacity of ingesting all kinds of small granules which they find in their way, including various smaller micro-organisms. In some cases the bacilli thus ingested are *digested*, that is, transformed into a soluble matter, which is assimilated by the protoplasm of the leucocytes.

In other cases the bacteria are for some time kept alive within the leucocytes, and if the latter are placed in conditions unfavorable for themselves but favorable for the invading microbes, the invaders develop and are set free. In still other cases the leucocytes contribute to the defense of the body by driving the hostile bacteria out of the organism through the skin. Transpiration is a familiar instance of the last-named process. Investigation has also demonstrated that the efficiency of the leucocytes varies greatly in different members of the same species of animal, their vigor being proportionate to the general health of the body. If the leucocytes are vigorous, they prevent the germination of the spores which they had ingested; but they maintain this power at a maximum only so long as they are healthy. If an animal has been submitted to cold, or has been narcotized, it loses its immunity from infectious maladies.

Such are the facts, and it seems reasonable to explain them, as does Menchikoff, on the theory that the leucocytes are the defensive agencies against infectious disease with which animal bodies have been endowed by nature. The necessities of the struggle for existence have evolved in living organisms the capacity of self-protection by dispatching armies of leucocytes to the spots attacked by noxious microbes. The struggle, as we have said, may end in either the rout of the leucocytes, in which case disease ensues, or in the repulse of the microbes, which is followed by recovery. Or, again, the outcome may be a drawn battle, which represents the state of things in various chronic diseases.—*N. Y. Sun.*

Electric vs. Steam Roads.

In an article in a recent number of the *Railroad Gazette* on electric and steam traction for suburban and through lines, not car line traffic, the writer reaches the following conclusions:

1. There is no prospect of electricity replacing steam for long distance freight traffic.

2. There is a possibility of electricity becoming an economical substitute for steam locomotives for high speed service, wherever the traffic is sufficiently heavy and constant to warrant the construction of lines of track independent of those used for moderate speeds.

3. There are very few localities in the United States in which the conditions are such as to make such a substitution commercially possible, with the efficiencies at present obtained with electrical machinery.

4. If the electrical equipment could be purchased at reasonable prices, there are a few short lines of steam railroad on which the passenger traffic is such as to make electricity a possible form of motive power at present speeds.

5. It is probable the electric locomotives will be used in tunnels and for switching in cities where freedom from smoke is important.

6. No electric motor capable of doing the work of a medium weight steam locomotive has yet been constructed.

The first conclusion is evident from the fact that the cost of the conductors for the electric current and the loss on the long lines due to leakage and resistance would more than offset what might be gained in the fuel saving. The second conclusion is also evident, except that part calling for independent tracks and for high speed traffic. Why the traffic must be independent is not clear, as all that is needed is a clear track, and that can be had with slow or high speed trains. Perhaps a constant speed may be an essential condition, but it may be high or low and yet be constant. So far, the above quoted journal says, electric construction companies have been simply talking, and in that they contrast strongly with makers of other mechanical innovations, who do, as a rule, make a try at a job at least before they talk of the wonderful possibilities of their devices. But to do them justice, we should say they are working in good faith, only they prefer that some one else should pay the cost of making expensive experiments. The Baltimore and Ohio tunnel job will give them a chance to show what they can do, as the horse power required to haul the proposed trains at the proper speeds up the given grades, viz., 1,200 tons at fifteen miles an hour and 500 tons at thirty miles an hour up a 42 foot grade, is about 950. This is certainly enough to commence on.

A WRITER in *The Clay Worker* well says: "The capable man in any walk of life is rare. The capable boy is rare. It is a very difficult matter to get a good office boy or a steady, capable fellow to run an elevator in an office building. Really good laborers are scarce. We sometimes think about over-crowded professions, or an over-supply of help in many directions. The supply of really capable help of any kind is limited. A first-class superintendent of a works of any kind is very difficult to get hold of. He is rarely out of a job. A man who is out of a job is open to suspicion. The best and most capable help comes out of the workshop—the steady, quiet fellows. There are not many of them in any establishment. Generally one of good judgment can pick a leader from a gang of men. He will need a little coaching, some help and some patience. But he is nearly always to be found. When such a one is discovered, the great work has been done. A man has been lifted up from a lower plane to a higher one; his horizon has been enlarged; the world has grown bigger for him. Nevertheless, the really capable man is rare, and in this prosperous period he is seldom if ever out of a job.

Underground Telephone Wires.

In speaking of the future of the telephone, Professor A. Graham Bell says:

"The telephone, as at present constructed, needs the open air to obtain the best results. To use wires placed underground, a metallic circuit will be necessary, similar to the one used now on long distance lines. To place the wires under ground and to make a metallic circuit, which means to use two wires where one is used at present, will materially increase the expenses of the company, and the public must pay for the luxury. As the number of wires is increasing rapidly, it is evident that they must ere long be buried."

The Vanderbilt Palace in North Carolina.

Two miles out from Asheville, N. C., is a little station, Biltmore. It is the headquarters of a water tank and the gate of Kenilworth Inn. It is something more. The Salisbury and Spartanburg divisions of the Western North Carolina Railroad come together here, while a little branch road deflects to the right and is lost among the hills. If you happen to see one of the little cars on this road you will notice the letters "G. W. N. V. C." on it. The car is loaded with stone or coal, maybe iron, and you may be sure it is bound for Vanderbilt's famous building two miles away. "Biltmore" is called for Vanderbilt and a resident of the name of Moore, who has a pretty cottage on the road, just above the station. It is a smooth combination, and likely to become famous.

Following the branch road, which runs up and down hill with equal facility, and winds around the mountains, you reach, in the course of half an hour, the summit of the Long Pine. This is the busiest spot in North Carolina. You pass Vanderbilt's stone quarry, where much of the material for rougher work has been secured; you view his brick yards, where millions of tubes are pressing and baking; you stop at his blacksmith shop, where the tools are mended and some castings made; you ride near the shady home which he has purchased for his chief engineer, always following up his rails and telegraph lines, which lead to the spot where lies the site of the house of Vanderbilt.

Several years ago Vanderbilt wandered down to Buncombe County, N. C., and was attracted by the beauty of the place. He rode over the mountains, and while at the summit of Long Pine, two miles from Asheville, concluded he would buy a tract and put up a shooting lodge. This led to the purchase of a large lot of land up and down the mountain and along the French Broad, with the idea of controlling everything in sight and preventing settlers from obstructing the view or coming too close. Visions of deer park, quail covers, sheep farms, and other schemes enlarged his demesne until his acres began to be numbered by thousands. White and black settlers surrendered their lodgings at good prices, and now there are only two or three black dwellers within the Vanderbilt limits, who have refused to sell out, and hold their places at $1,000 per acre. Vanderbilt may buy them out or he may freeze them out.

When Vanderbilt had finished his purchase of 5,000 acres his ideas broadened. Instead of a shooting lodge he decided to put up a residence, and such a residence as would make Chauncey Depew's eyes glisten at Peekskill. So he set about him and leveled off the cone of the mountain thirty feet. Some time over a year ago he began to lay his foundations, and his stone masonry now begins to rise sheer over the side of the mountain, like a walled precipice. This is just what Vanderbilt wanted, for he determined that his castle would have the view and command the heights unobstructed. He concluded to spend from his income about $1,000,000 a year for ten years, and he is pretty well assured, at the end of that time, of having the finest private residence in America, possibly in the world. The architects are very clever, but will not show the designs of the house. Perhaps they fear somebody will duplicate them before the dwelling is completed. The building will be 400 feet long and 300 feet wide. It has a tennis court in the left which is a marvel of masonry and filling, and which alone cost $10,000. The banquet hall of the mansion is to be 70 feet long, and will have a pitch of 30 feet. Under the main entrance of the hall will be a swimming pool, while a fine gymnasium, wine cellar, and art gallery are to be connected with the establishment.

Three miles back of the dwelling is a cold spring on the top of Busby Mountain. He has purchased this spring and carries the water in six iron pipes all the way to the Long Pine. This will give him volume and pressure enough for every part of his premises, and enable him to throw a stream 100 feet high from any point on his place. It will insure a dozen or more fountains in his parks and drives; 500 hands are at work on the grounds and buildings. Superb carriage ways are graded and macadamized up the mountain, commanding an approach to the house, and these will be continued beyond the residence and down the valley to the French Broad, where Vanderbilt will throw an iron bridge over this picturesque stream.

Mr. Vanderbilt is thirty-eight and unmarried. He has selected a rare spot for his home. His front garden steps right off into space and secures a view for miles of rich valleys and high-walled mountains in the distance. Pisgah and the trains of hills seem to grow opaline in the sunset and to be transparent. At the base is the French Broad, and two miles away are the spires and smoke of Asheville. To the right are the red gables of Kenilworth Inn, while directly in front, a mile or more away, are the chimneys of Oakland Sanitarium and Connell's residence. There is nothing in Virginia, nothing in England, and, I am told, nothing finer than this view in western North Carolina. This palace of marble and iron is built for all time, and the picture will be kept perfect, so far as nature and art can make it so.—*Chattanooga Times.*