CORROSION OF ALLOYS IN SEA WATER.

A series of exhaustive tests to determine the corrosion of certain alloys and metals have just been completed by the German Admiralty. The tests were carried on for a period of two years and were marked by the great care which characterizes all German expert investigations; hence the conclusions are of unusual value, particularly as experimental data on this subject is necessarily somewhat meager.

In the case of each alloy or metal a dozen strips were used, nine of them being placed in the sea water and three reserved for comparison as to quality and strength. At the end of every eight months three strips of each kind were removed and placed in the testing machine in comparison with the strips which had not been immersed. In this way it was possible to determine accurately the amount of deterioration due to stated periods of immersion. Other tests were made by exposing specimens of alloys that contained a large percentage of zinc to the free action of the atmosphere. The alloys represented in the tests were of the following character: Copper alloys rich in zinc, bronzes containing little zinc, pure tin bronzes, pure aluminum bronze, and iron-aluminum bronze.

The results were as follows: In the experiments on atmospheric deterioration it was proved that while iron-bronze alloys suffered practically no injury in two years' exposure, those alloys which contain much zinc are more subject to decay. Of the specimens immersed in sea water in contact with iron, the iron, tin and aluminum bronzes showed very little deterioration. After from two to two and half years' submersion, there was no marked difference in appearance, no loss of weight and no reduction of strength. Iron bronze in contact with tin bronze showed a serious loss, one specimen in two years' immersion losing two-thirds of its strength and four-fifths of its elongation, the material being partially destroyed by the dissolving out of the zinc. Similar effects were shown in the case of cast and wrought bronze. A wrought plate of iron bronze submerged in contact with a cast plate of the same material lost about sixty per cent of its strength in two years.

The conclusion deduced by the Admiralty from these tests is that the corrosive action between different metals depends upon their relative position in the electrical scale, the electrical relation of the metals in respect of corrosion being the same as in galvanic action. Thus pure aluminum bronze, which is practically proof against the corrosive action of sea water when in contact with metals which are electro-negative toward it, is quickly destroyed while in contact with electro-positive metals. Hence, it is best in the case of metals or alloys that are to be subjected to the action of sea water, to place only those in contact which are near to each other in the electrical scale.

GROWTH IN SPEED AND SIZE OF OCEAN LINERS.

It is an extremely rare occurrence for a new transatlantic liner to be thrown upon her builders' hands because of her failure to come up to contract requirements as to speed; indeed, in the past twenty-five years, there have been only two instances—one in the case of the "City of Rome," and the other in the case of that splendid ship, completed only last year, the "Kaiser Friedrich," which has now been rejected because of her slow speed. The "Kaiser Friedrich" is one of two vessels ordered by the North German Lloyd Company for their fast line. The first of these was the very successful "Kaiser Wilhelm der Grosse," built by the Vulcan Company at Stettin. She is 649 feet long, and her engines of 28,000 horse power have driven her across the Atlantic at an average speed of 22·3 knots an hour. The order for the "Kaiser Friedrich" was placed with Schichau, of Elbing, whose fast yachts and torpedo-boats have won for him a world-wide fame. She is 600 feet long, and her engines of 25,000 horse power were to have driven her at one-half a knot higher speed than the "Kaiser Wilhelm." As a matter of fact, the contractors have never been able to get a better average out of the boat than about 20 knots for the whole passage. The fault is attributed to the location of the engines amidships, and the unusual length of shafting which this necessitates. During our visit to the ship on her maiden trip we were struck with the fact that Schichau appeared to have simply reproduced the standard torpedo-boat design of engine on a very big scale. The valves of the ordinary slide pattern were very large and heavy, and cut badly on the maiden voyage.

Following closely upon the announcement of her rejection is another to the effect that the North German Lloyd people have ordered another vessel from the Vulcan works, which is to exceed the "Kaiser Wilhelm" in size and speed. The new ship is to be 700 feet long, 70 feet in beam, and is to make twenty-three and a half knots with engines of 36,000 horse power.

The new ship will thus be slightly larger and faster than the "Deutschland," building for the Hamburg-American line, illustrations of which appeared in the SCIENTIFIC AMERICAN of July 1, 1899. Although the new ship will be of practically the same length and of two feet more beam than the "Oceanic," of the White Star line, her displacement, on account of the fineness of her lines, will be less.

The American line, the total loss of whose fine vessel the "Paris" was announced in our last issue, evidently considers that smaller ships of a slower speed are more profitable investments, while seventeen knots an hour is fast enough for the average transatlantic passenger. This company has recently ordered from Clyde yards four 12,000-ton ships of seventeen knots speed and two somewhat smaller ships from the Cramps of Philadelphia. In respect of speed the company are following the lead of the White Star line, who were satisfied with 20 knots in the "Oceanic" and about 15 knots in the "Cymric." As to whether the high speed or moderate speed ship is to be the type of the future time will tell. With the Parsons turbine demonstrating its possibilities and speeds of 35 and 40 knots promised on half the weight of motive power per horse power, he is a bold prophet who will say that the era of the ocean "flier" is drawing to a close.

ELECTRIC HEATING.

BY ALTAN D. ADAMS.

The electric heater has an efficiency of 100 per cent; it transforms into heat all of the electric energy sent into it. No other device for heating returns anywhere near so large a share of the energy supplied. A first-class water-tube boiler supplies in steam from 70 to 80 per cent of the possible heat from fuel burned under it; ordinary cylindrical boilers furnish as steam but from 50 to 60 per cent of the heat contained in their fuels, and it is probable that the heat from steam and hot water house boilers seldom rises above 40 per cent, and from stoves above 30 per cent of that resulting from perfect combustion.

On the score of convenience the electric heater is easily first, as its maximum heat can usually be attained in one minute or less by simply turning a switch, and can be entirely discontinued instantly in the same manner.

Another point of convenience is that the electric heat, when used for some particular purpose, as for boiling, broiling, smoothing irons, soldering coppers, and many other purposes, is developed directly in the thing to be heated, as the stew pan or smoothing iron, so that a constant temperature in the article is maintained and no time lost while it is heating or in carrying it to and from a fire.

Electric heaters, being entirely free from the presence of combustion, produce none of its undesirable effects in the way of noxious gases, and a high degree of safety is assured by the complete absence of sparks and flame.

The care of an electric heater amounts to nothing, as there is neither fuel to supply nor products of combustion to remove. With the important qualities of efficiency, healthfulness, cleanliness, and convenience all in its favor, electric heat may seem about to displace all other forms, and opinions to this effect are sometimes heard; but quite the opposite is in fact the case, and must continue so until there is a complete change in the art of producing electric energy. At the present time the only practical source of electrical energy in any considerable quantity is the dynamo, and the dynamo requires energy in a mechanical form to operate it, and the main source of this mechanical power is the steam engine and boiler, so that ultimately the fuel burned under the boiler supplies the heat energy given off by the electric heater.

Now, although the electric heater has an efficiency of 100 per cent, there are losses in every other transforming and transmitting device between it and the steam boiler, and the sum total of these losses must be considered in order to show what part of the heat produced by combustion under the boiler is available at the electric heater. Taking the efficiency of the best boilers at 80 per cent, steam engines at 17·5 per cent, dynamos at 90 per cent, and transmission conductors at 95 per cent, the electric heater will furnish that fraction of the total heat of combustion represented by $0{\cdot}80 \times 0{\cdot}175 \times 0{\cdot}90 \times 0{\cdot}95 = 0{\cdot}1197$ or 11·97 per cent. If engines and boilers of only ordinary efficiency are used, say 70 per cent for boilers and 12 per cent for engines, the figures become $0{\cdot}70 \times 0{\cdot}12 \times 0{\cdot}90 \times 0{\cdot}95 = 0{\cdot}072$ or 7·2 per cent for relation between energy of the electric heater and the total energy of combustion.

To sum up the above, the per cents of total combustion energy which may be obtained from the several heating devices, when used in the same establishment, are about as follows:

Steam heat with good boilers	70 per cent.
Steam heat with ordinary house boilers	40 "
Hot water heat with ordinary house boilers	40 "
Heat from stoves	30 "
Heat from electric heaters	7 "

It may now be inferred, from the great losses between the combustion at the boiler and the electric heater, that electric heat can have no extended use; but this conclusion would be as incorrect as the one which supposed the electric heater about to occupy the entire field.

Where dynamos must depend for their power on the steam engine, the cost of electric energy above shown obviously puts it out of the question for the general heating of buildings in competition with coal and wood. There are many applications of heat to the arts, however, where the case may be different. The fact is that in many cases the cost of heat for cooking and mechanical operations is only a small part of the total cost, which is usually that for labor, and the saving in labor through constant readiness and instant control of the heating devices frequently amounts to more than the entire cost of electric heat. Another fact which reduces the comparative cost of electric heat for many purposes is that only so much heat need be expended as is necessary to maintain the thing to be heated at the desired temperature, as for instance a smoothing iron. When heat other than electric is used, it is commonly necessary to maintain combustion in some stove or heater, which wastes much more energy than is actually used in the device which is taken to the fire to be heated. In many cases of this sort the actual cost of fuel is greater than that of electric energy necessary to heat the required device, to say nothing of the saving in time.

Electrically heated tools and cooking dishes are already widely in use, and in many cases are doing their work at less cost than is possible in any other way. Thus far electric heat has been considered with reference to its actual cost of production; but this only applies to large users who have their own electric plants and secure energy in the electric form without profit added to its cost.

The majority of individual users of electric heating apparatus must purchase electric energy from the public supply, and the cost to them, also the relative cost of gas for the same work, is therefore of interest. Strange as it may seem, electric energy can be had at a lower rate for electric heating than for electric lighting in some, if not all, of the large cities; thus while for incandescent lighting a charge of from 10 cents to 15 cents per thousand watts per hour is commonly made, when the energy is to be used for heating it is sold at a rate of about 4½ cents per thousand watts per hour.

Now, one thousand watts during one hour delivers electric energy equivalent to 3,440 heat units, a heat unit being simply the amount of heat necessary to raise one pound of water 1° F. in temperature, when the water is at about 39° F. temperature.

The heat units per cubic foot of illuminating gas vary somewhat, but may be taken at seven hundred, this being about the value for New York gas. At $1 per thousand, or one mill per cubic foot, for gas, 4½ cents, the price of one thousand watts for one hour, electric energy, will pay for forty-five cubic feet of gas, containing, when perfectly burned, $700 \times 45 = 31{,}500$ heat units, or $31{,}500 \div 3{,}440 = 9{\cdot}1$ times the heat equivalent to electric energy of the same value. The facts that when gas is burned for heating purposes the combustion is not perfect, and further that a large per cent of the energy of combustion escapes with the hot air and gases up the chimney, probably operate to reduce above ratio about one-half; but even this leaves the gas much cheaper for purposes of general heat. In the matter of heating various tools used in the arts, the advantage for cost of heat alone seems to be with the electric method, as all of the electric heat is produced in the thing to be heated, while the heat from gas not only goes in part up the chimney with hot gases, but even a larger part goes into the gas stove and the air of the room, so that probably not one-tenth of the possible heat from the gas actually is absorbed by the device to be heated.

In construction the electric heater is cheap, simple, and inexpensive, consisting usually of iron wire of the proper size and quantity, closely coiled and insulated in its desired position on fireproof supports. For purposes of general heating, as in electric cars and other places, the iron heating coils are usually exposed to the air, which constantly rises from them as from steam radiator pipes.

When electric heat is applied to a tool or cooking dish, it is desirable to have the iron heating coil in very compact form and beyond the reach of accidental contact; so for these cases a coil of much finer wire than would be used if exposed to the air is commonly embedded in a thin layer of fireproof enamel fused at a high temperature on the surface, either inside or out of the thing to be heated. This insulating and supporting enamel conducts the heat from the fine wire much faster than the heat could escape were the wire exposed to the open air, and thus permits wires to be used in the enamel that if exposed to the air would be immediately fused by the heat resulting from their electric energy.

NUTTALL has determined that the smell of freshly turned earth is due to the growth of a bacterium, the Cladothrix odorifera, which multiplies in decomposing vegetable matter, and more rapidly in the presence of heat and moisture. Hence the odor is especially marked after a shower, or when moist earth is disturbed. In dry soil the development of the bacterium is arrested, but it is immediately resumed with vigor as soon as moisture is restored.