whatever can be derived from using a screw of two blades, instead of four, when sailing; because, when screws are uncoupled and revolving freely, those of four blades oppose no greater resistance to the vessel than those of two. When fixed and held stationary, in a vertical position behind the stern post, the loss of speed due to the resistance of the screw, expressed in percentage of speed, has been shown by careful experiment to be 18·29 per cent; while the four or two bladed screw, revolving freely by the pressure of the water, gives a resistance of only 9·96 per cent, being nearly two to one in favor of the revolving screw. The four bladed screw also produces less vibration in a ship than one of three, and the latter less than one of two blades. The propelling efficiency of a screw is entirely independent of the number of its blades, but is wholly dependent upon the area, the pitch, the fraction of the pitch used, and the area of the circle described by the blades.

To diminish the shocks and vibration, more or less incidental to the use of the screw propeller, the largest amount of clearance admissible for the screw between the stern and rudder post should be given. It is obvious, then, says the report before us, that a post, intended for a screw, the area of which is contained in four blades having the same surface, pitch, and fraction of pitch, for that screw must be just double the length of the former in the line of its axis. Consequently, the two bladed screws, which were substituted for those of four blades, were necessarily constructed of less propelling area, as the post openings of the vessels could not be enlarged: hence the inefficiency of the screws as reported.

THE MANUFACTURE OF EARTHENWARE.

The potter's art has long furnished Great Britain and other European countries with most important branches of commerce. It was first introduced into England by two foreigners, at a place called Bradawoods, which is now Longport, situated about two miles from Burslem, Staffordshire. These two men commenced in a small way and kept themselves very secluded. The ware which they made was of quality very inferior to that of the present day; the business was only in its infancy, and the only mode of glazing the ware was by simply throwing salt into the saggars or vessels in which the crockery was baked. It was reserved for the famous and ever noted Josiah Wedgewood to be the pioneer in introducing new glazes and bodies, and to improve and bring to perfection the manufacture of earthenware. This was during the commencement of the eighteenth century. He it was who laid the foundation of the famous Staffordshire potteries, which now extend some ten or twelve miles in length and two or three miles in width. The district contains the towns of Tunstall, Burslem, Longport, Dalehall, Hanley, Stoke upon Trent, Fenton, and Longton. The potteries are right amidst the clays that are used in the manufacture. The same clays are also found in abundance in Derbyshire, which is the next county, but the most important and valuable clay is found in Cornwall. It is called china clay, and is purely white. This clay is not found anywhere else in the United Kingdom. Another valuable acquisition to the potteries is the valuable coal beds which abound in North Staffordshire, and furnish very important material in the manufature of earthenware.

The clay is generally weathered for one or two years before being used, that is, it is exposed to the effects of the atmosphere, to make it of a better color and more pliable. After which, certain quantities of each kind are weighed out, put in large vats, and worked together until they are thoroughly mixed, and become of the consistency of thick milk. Other ingredients are then mixed with these clays. They are china clay, felspar, and a few other materials to give body and consistence to the ware. After the whole has been ground and mixed up together, it is put in a large press (a new invention which has been patented); and by means of heat, the materials become more solid, are pressed into largo blocks, and are ready to be used. An earthenware manufactory is arranged in such a manner that each branch is kept separate to itself.

In making a water pitcher, for instance, the body of the pitcher is made in two equal parts, and the handle is made separately. The presser, as he is called, takes sufficient clay for the molds he is going to use; the mold is made of plaster of Paris. When both halves of the mold are filled, he puts them together, and straps them tightly; he then finishes the inside of the pitcher, by smoothing it by means of a wet sponge, to fill up the seams. He then takes off the strap, and places the mold with its contents in a small room which is kept at a high temperature. This is done to harden the clay, and evaporate the water. After being in a few hours, the clay appears white; and the mold is taken out and opened. The pitcher is then finished off and the handle is put on. This being done, it is ready for what is called the biscuit oven, where it undergoes its first baking. A similar process is gone through in making dishes, plates, cups and saucers, and other articles, except that the molds are of different shape. The ovens, or kilns as they are called, are built of brick and are of a conical shape, something like a sugar loaf.

After the ware is finished, it is placed in what are called saggars, vessels made of clay and baked before using; sand is sprinkled in these saggars and round the ware to prevent the whole from sticking together. When placed in the oven, it is exposed to a very severe heat for forty-eight hours; the fires are then allowed to go down and the ware to cool gradually. The oven and the ware are still very warm; and the men employed to take the pottery from the oven have to wear flannel over their hands and bodies to protect themselves from being scorched. They cannot remain many minutes at a time in the oven. The ware is then carried to what is called the biscuit warehouse, where it is sorted over by women and girls. In this state, it is called biscuit and is of a porous nature. The position of fireman of the biscuit oven is a very important post, and it requires a man of great experience and skill. If the ware be not fired or baked up to a certain point, it is very apt to craze, a phrase used amongst manufacturers to imply that it is liable to have those small cracks upon it which are sometimes seen upon earthenware or crockery. After being sorted over, it is prepared to go through a second firing.

The printing is done upon the biscuit ware before it receives the glaze. But figured earthenware has been largely superseded in this country by what is called white granite or white ironstone china, which is clear white. It looks much cleaner than the printed goods, and is much more easily matched. The ware, having been examined in the biscuit warehouse, is then taken to the dipping house. The dipping is a noxious process, owing to the white lead that is used in the glaze, in which the articles are dipped. The glaze is composed of borax, lead, flint, soda and other materials, which are ground together in a liquid state and put in large tubs, into which the ware is plunged and afterwards put on racks to dry. After this process, the ware is ready for the gloss oven, to give it the finishing touch. It is placed in saggars, the same as in the biscuit oven, some round and some oval, according to the size and description of the ware; but instead of sand being put in, the flat pieces, such as dishes, plates, saucers, etc., are kept separate by what are called cockspurs, small three pointed articles, made of clay and put between the wares. One may often see the marks of these cockspurs on the back of the ware. The time of firing the ware in the gloss oven is twenty-four hours, just half the time used in the biscuit oven. When the ware is drawn out of the gloss oven, it is taken to the gloss warehouse, where it is sorted over, and all the chipped, cracked, or damaged ware is put on one side. The good ware is packed in crates or casks by experienced packers, and shipped to its destination.

The importation of earthenware to the United States has been gradually increasing for many years. There were a few manufactories, established in this country, previous to the late war; and since its close many more have been started, and are doing a large business.

The duty upon earthenware is 40 per cent *ad valorem*; the freights are also high; and during the past year, the price of earthenware has been raised some 25 per cent in Staffordshire, owing to the high price of coal, labor, and materials, which have increased very much during the past two years. From these causes the importation has been much less in former years; and thus has been the means of giving more employment to the manufacturers on this side. There is no doubt but that all the materials used in the manufacture of both earthenware and china can be found in the United States; although many of our manufacturers are importing the china clay they use from Cornwall, at a great expense. This clay can be superseded by one which is found in large quantities in Alabama, and is being introduced generally. Missouri abounds with all the materials that are used in the manufacture of earthenware, and also is well supplied with extensive coal beds. There are also large earthenware manufactories at Trenton, N. J., East Liverpool and Cincinnati, Ohio, Geddes, N. Y., and St. Louis, Mo.

Considerable improvements have been made in the bodies and glazes of the ware during the past two years, and there are indications that this valuable business is firmly established in this country. Many gentlemen once connected with the manufacture of this class of ware in the Staffordshire potteries are now superintending works on this side, and there are several manufactories to be erected at different points during the coming year.

NOTE RELATIVE TO THE ESTIMATION OF THE COMMERCIAL VALUE OF COALS CONTAINING LARGE QUANTITIES OF ASH.

BY PROFESSOR R. H. THURSTON.

A question has lately been presented, involving the determination of the effects of an excessive amount of ash in modifying the commercial value of anthracite coal. The method of determination adopted will probably be of interest, since there is at present no generally accepted and standard method in use among engineers.

The value of a coal depends upon many circumstances. The proportions of uncombined carbon and hydrogen, the form in which hydrocarbons are contained in the fuel, the physical characteristics of the coal, and the chemical constitution and the percentage of the ash, all affect its market value. In individual cases, also, the form of heating or other apparatus in which the coal is burned influences the relative value of fuels equally good in other respects, one steam boiler, for example, being well adapted for anthracite, and another for bituminous coal.

Where the difference between two coals lies principally in their relative percentages of ash, the comparison is easily made.

The anthracites contain so little other combustible matter that, as shown by Professor Johnson,* their calorific value is proportional to the percentage of contained carbon, very nearly. Their commercial value is somewhat different.

The depreciation produced by presence of non-combustible matter occurs in the following ways:

First. A certain amount of carbon is required to heat the whole mass to the temperature of the furnace, of which a large part is lost. It follows, therefore, that a coal containing a certain small quantity of combustible would have no calorific value, and, consequently, would be worthless in the market.

Second. The presence of a high percentage of ash in a fuel checks combustion by its mechanical mixture with the combustible portion of the coal. A coal will, hence, have no commercial value when the proportion of refuse reaches a limit at which combustion becomes impossible in consequence of this action.

Third. The cost of transportation of ash being as great as that of transporting the combustible, the consumer paying for ash at the same rate as for the carbon, and also being compelled to go to additional expense for the removal of ash, these facts would also determine a limit beyond which an increased proportion of ash would render the fuel valueless.

Fourth. The determination of the financial losses due to increased wear and tear of furnaces and boilers, of incidental losses due to inequality or insufficiency of heat supply, and to the many other direct and indirect charges to be made against a poor fuel, will also indicate a limit which will have a different value for each case; but which will, in most cases, be difficult of even approximate determination.

The determination of the minimum proportion of combustible, under the first case, is thus made, assuming this heat to be entirely wasted.

The specific heat of ash is usually nearly 0·20. Let X represent the percentage of ash which is sufficient to render the coal valueless. Then, since each pound of carbon has a heating power of 14,500 thermal units: $14{,}500(100-X)=A$, represents the available heat of a unit in weight of the fuel.

$100\times0{\cdot}20\times3{,}000^{\circ}=B$: represents the heat required to raise this same amount of coal to a temperature equal to that of the furnace, which is here assumed at 3,000° above the surrounding atmosphere.

Since these quantities, A and B, are equal: $14{,}500\ (100-X)=100\times0{\cdot}2\times3{,}000^{\circ}$, and $X=96$ per cent.

The minimum quantity of fuel permissible is, therefore, four per cent, where the first consideration only is taken into the account.

The influence of the second is at present indeterminable in the absence of experiment.

The cost of transportation of ash to the consumer, as a part of the fuel, has no bearing in the determination of its value to him. The removal of ash is a tax upon the consumer which may be considered as the equivalent of the loss of a certain weight of combustible received. Since this cost fluctuates with the market value of coal, and since its amount is determined by the same causes, it is easy to make the statement in that form.

This cost is about ten per cent of the value of coal, weight for weight, and is therefore assumed at ten per cent of the proportion of ash found in the coal.

The losses, direct and indirect, coming under the fourth head, vary greatly and are sometimes very serious. An approximate estimate for an average example is taken, and is considered to be equal, at least, to a percentage of the total value of coal, in utilizable carbon, which equals one half the percentage of ash.

Comparing two anthracites, which we will suppose to contain, respectively, fifteen and twenty-five per cent ash, eighty-five and seventy-five per cent carbon, the first being a well known standard coal, selling in the market at six dollars per tun, we may, using this system of charging losses against equivalent values in combustible carbon, determine the proper commercial value of the second kind.

FIRST EXAMPLE.—From the 85 per cent carbon.

Deduct for heating to furnace temperature	0·040
" " transportation of refuse, 10 per cent of 15.	0·015
" " other losses, 50 per cent of 15	0·075
Total	0·130

Leaving available and valuable carbon 85 —13 = 72 per cent.

SECOND EXAMPLE.—From the 75 per cent carbon:

Deduct for heating to furnace temperature	0·040
" " removal of ash, 10 per cent of 25	0·025
" " sundry losses, 50 per cent of 25	0·125
Total	0·190

Leaving valuable available carbon 75 —19 = 56 per cent.

Finally, if $6.00 is paid for 72 per cent available combustible, for 56 per cent we should pay $\frac{56\times6}{72}=\$4.66\frac{2}{3}$.

Taking a third example, in which the fuel contains the unexceptionally large proportion of 30 per cent ash, we should, by similar method, proceed as follows, deducting from the seventy per cent carbon, as before, the estimated charges against it.

THIRD EXAMPLE:

Deduct for heating	0·040
" " removal of ash, 10 per cent of 30	0·030
" " sundry expenses, 50 per cent of 30	0·150
Total	0·220

Leaving available carbon, 70 —22 = 48 per cent, which would be worth $\frac{48\times6}{72}=\$4.00$.

Had the first coal had a market value of seven dollars per tun, the second and third would have been worth, respectively, $5.44½ and $4.66⅔.

This method is evidently largely empirical, and its results are but approximate. It is, however, simple and easily applied, and will often be found of use in the absence of more precise means of determination. Those whose experience may differ from that of the writer can readily modify the values for themselves.

Stevens' Institute of Technology, Hoboken, N. J.
December, 1873.

*Report to the Navy Department on American coals.