of all, however, consequent on the presence of too many tubes, large or small, is found in the increase of the calorimeter, which is the real measure in all practical boilers—or, if not, it should be—of the quantity of air passing through the burning fuel. The great secret of success in boiler engineering is involved in the admission of just air enough, and no more, to complete the combustion of the fuel upon the grate. The temperature of a furnace is the measure of its economic evaporative efficiency, and this depends solely on the quantity of air which passes through it in a given time. For instance, with the best hard coke the temperature produced by just sufficient air to completely oxidize it will be about 4·347° Fah. If twice this quantity of air is admitted, the resulting temperature will be only 2·347°, and the evaporative value of the heat in the first case will be perhaps three times that produced in the second case, although the rate of combustion may be in both cases equal, or nearly so, and consequently the entire quantity of caloric expended precisely the same. A practical illustration of this fact is given every time a fire-door is opened to check the production of steam. A two-fold action ensues. The rapidity of combustion is moderately reduced at once, while the air rushing in absorbs so much heat from the fuel that very little remains to be imparted to the boiler. It is a mistake to imagine that the flues are absolutely cooled down. Their maximum temperature can only at most, be a very few degrees above that corresponding to the existing pressure within the boiler; and yet is certain that the heat of the entering air must, by the time it reaches the flues, be greatly in excess of this. The cooling action is indirect, not direct; and it implies a reduction in the quantity of caloric poured into the water, not a reabsorption of that already there. Indeed, it is possible that the temperature within the tubes is but moderately lower, in the few minutes after the door is opened, than it was before. But from what we have already said on the value of intensity, it will be easily understood that a very moderate reduction in this element will produce a very considerable reduction in the quantity of steam produced in a given time.

The most valuable experiments ever conducted on the relation of the calorimeter to the efficiency of a boiler were undertaken and carried out by Chief Engineer Isherwood, of the United States' Navy. We have before now taken exception to his views on expansion, and nothing has occurred since to lead us to form different opinions; but there can be no doubt that Mr. Isherwood is a careful experimenter, and all that he states is, therefore entitled to due consideration. In order, then, to settle this question, he selected a boiler of the ordinary return flue marine type, driving the machine shop of the New York navy yard. This boiler is 12 feet long, 7 feet 6 inches wide, and 12 feet high without a steam dome; the furnaces are two in number, 6 feet by 3 feet; the crowns 22 inches above the bars in front and 28 inches at the bridge. The lining plate of each furnace door is perforated with 100 3-8th-inch holes, on Williams's principle. The tubes are 144 in number, 3 inches diameter outside, and 8 feet 3 inches long. They are nine rows in hight, occupying a vertical space of 37 inches. The experiments were made by stopping up certain tubes with iron plugs; the fuel used was anthracite, and the results obtained were as follows:—

	Rate of combustion.	Area of heating surface.	Economic efficiency.
With all the tubes in use........	1·000	100·00	1·000
With the 2 upper horizontal rows stopped................	1·142	83·24	1·069
With the 3 upper rows stopped.	0.840	74'87	1·168
With the 4 upper rows stopped.	0·891	66·48	1·192
With the 2 lower rows stopped.	0·868	83·24	0·924
With the 3 lower rows stopped..	0·955	74·87	1·000
With the 4 lower rows stopped..	0·923	66·48	1·030
With the inner 2 vertical rows of each boiler stopped..........	0·874	81·15	0·930
With the inner 3 rows stopped..	0·990	71·72	0·965
With the inner 4 rows stopped..	0·951	62·29	0 990

Now two remarkable facts may be gleaned from this table. The first is, that, with the exception of the experiments with two rows of tubes suppressed, when the economic evaporation fell off 3 per cent, the economic evaporative efficiency increased a little with each diminution of tube surface and calorimeter, until, when four rows were stopped up, it had actually increased by 6¼ per cent over that obtained when all the tubes were in use. The second fact is that the tube area bore very little relation to the quantity of fuel burned. The extremes never varied more than 8 per cent. Here, then, we have a boiler the actual as well as the economic efficiency of which increased in a certain ratio as its heating surface was diminished. To what is this to be attributed? Simply to the fact that the calorimeter of all the tubes was so great that a much larger quantity of air than that indispensable for effecting combustion found its way into the fire-boxes, lowering the temperature, and consequently reducing the value of the fire-box surface. Closing an ash-pit damper would have had no effect; the rate of combustion would have been made less, but the proportion which the whole quantity of caloric produced would then bear to the number of cubic feet of air admitted would remain unaltered. In point of fact too much air through a grate is very nearly as fatal to the powers of a boiler as its admission through the fire door. The object had in view is the raising of water to a certain temperature, and its conversion into steam, and every cubic foot of air which enters a furnace above that necessary for complete combustion, carries away a portion of this heat to the chimney. There never was a more erroneous notion than the belief that advantage can be gained from filling a boiler and its tubes with a large volume of moderately heated air; one-half the quantity at a higher temperature would be more than twice as efficient.

We are not, however, to fall into an opposite error and reduce superficial tube area very much in order to keep down the calorimeter. A large tube with a contracted orifice is apparently, but only apparently, the proper thing. Thick ferrules, however, operate injuriously. They permit the existence of a languid current of air at the side of the tube, whether they are driven at the smoke-box or fire-box end. The best means of procuring a small calorimeter and a large tube surface will be found in the use of taper tubes, large at the fire-box end. At the present moment such tubes would be very expensive at first, though we feel no doubt that they would pay for themselves where coal is dear in a very short time. Improvements, however, are daily taking place in this branch of manufacture, and were there but a fair demand, there would soon be a full supply of tapered tubes in the market. It is more than probable that their use would be the greatest improvement of which the tubular boiler is now susceptible.—*London Mechanics' Magazine.*

[The term calorimeter would from its etymology manifestly mean a measurer of heat. It was applied by Lavoisier and Laplace to an instrument employed by them to determine the specific heat of different substances. We should suppose that the area of the orifices of the flue tubes would be a very uncertain indication of the heating capacity of a steam boiler, and therefore that the term "calorimeter" was not a happy selection of a name for this area.—Eds. Sci. Am.

The Iron Business of Lake Superior.

The amount of iron ore shipped from Lake Superior in 1855 was 1,447 tuns against 116,998 tuns in 1860, and 185,557 tuns in 1863. These amounts, especially those for the last two years, fall far below the demand, the difficulty having been in procuring transportation for the ore, and men to mine it. The quantity actually spoken for to supply the various furnaces using this ore, before the opening of navigation in 1862, was over 140,000 tuns, while in 1863, 250.000 tuns would not have supplied the demand.

Large investments have been made in timbered lands, along the lines of the Marquette and Ontonagon, and Peninsula Railroads, as well as on Big Bay de Noquet, with a view to erect blast furnaces for the manufacture of charcoal pig iron. The average value at Marquette of the ore shipped during the past year was $5 per tun, and that of the pig iron produced $45 per tun, giving the aggregate value of the iron product of the country for 1863, $1,327,245,-245.—*Marquette Journal.*

What Fifteen-inch Shot Do.

A correspondent of the New Orleans *Era* says:—

Troops continue to arrive, and the *Connecticut*, a few days ago brought down four hundred sailors from the North which has filled up all our deficiencies, and enables us to effectually man the *Tennessee* aud *Selma*, both of which vessels are doing very excellent service, the former at the fort and the latter about the bay in the shoal places. It must be very galling to the rebs to see the pride of their navy thus used against them. She went in at them last Saturday afternoon, and the fire from both was terrific. The fort struck her nine times but "failed beautifully" of producing any effect beyond the shooting away of a flagstaff, an anchor and a few fathoms of Chain. But the effect of our 15 and 11-inch shot is truly surprising. The after part of the monster's shield being all strained and shattered, and the angle on the port side aft completely opened apart. They are painting her new smoke-stack and touching her all around, slushing her down, &c.

DUST ON RAILROADS.

There is no necessity for having any dust in railroad traveling. In all parts of Europe, after a ride by rail the traveler does not need to have his coat brushed; the dust is effectually kept down by simply allowing grass to grow over the road. In this country men are employed to dig up every blade of grass and every weed that makes its appearance. The consequence is such a cloud of dust as to make railroad traveling a dreaded martyrdom, instead of a pleasant recreation as it is in other parts of the world.

The New York Central, and the New York and Erie roads are competing lines, and they both spend a good deal of money in advertisements and runners to draw business from each other. If the managers of one of these roads would cover the track with turf, or encourage the growth of grass they would most assuredly secure the monopoly of the through travel. Even roads where there is no competition, we have no doubt would find it to their advantage to adopt this effectual method for abolishing the one insufferable discomfort incident to this mode of locomotion.

The cheapest plan for covering a track with grass would doubtless be to spread manure over it, and sow hayseed. It would perhaps be well to sow rye also, or some other grain, together with the hayseed. This is the right time of year for the operation. Which one of the superintendents will win the blessings of the nation by taking the lead in this invaluable reform?

Cast Cast-steel Car Wheels.

In our list of Patents in the present number will be found that of Charles W. Stafford, Esq., of Saybrook, Conn., for process for *casting* a cast-steel car wheel.

This is a desideratum long sought for, and has heretofore failed of attainment. By the process just patented by Mr. Stafford the wheels are produced directly from molten cast-steel with great certainty and facility and in any of the ordinary forms which may be desirable. The hollow or cavity of the wheel is also susceptible of any variety of form which may be required, and has a smooth and perfect surface.

The great advantages of a cast-steel over a cast-iron car wheel are obvious to the most casual observer. The strength of cast-steel as compared with cast-iron is laid down as being from 5 or 6 to 1. The use of these wheels would afford almost an absolute insurance against all that class of accidents and the consequent damage resulting from broken wheels. Their value will be very great in all cases where a high rate of speed is sought, and also for burden trains on such roads as the Atlantic and Great Western, when it is desired to make long runs without change. The manufacture of cast-steel is in its infancy in this country, and we deem Mr. Stafford's invention a very important step in the right direction.

Cold Rolling Iron.—Interesting experiments have been made with the process of cold rolling as applied to iron. In one case, on testing specimens of cold rolled iron, a black bar from the rails broke with 26,-173 tuns per square inch, a similar turned bar with 27,119 tuns, and a cold rolled bar of the same iron sustained 39,388 tuns. The elongations, which may be considered as the measure of ductility, were 200 and 220 per unit of strength in the case of ordinary iron, and .079 in the case of the cold rolled iron. A plate of cold rolled iron sustained no less than 51.3 tuns per square inch. Endeavors are being made to apply this invention to railway bars.

Means of hardening Fragile or Friable Specimens.—Mr. Stahl gives solidity to friable specimens, even if of loose material like a mold in sand of a shell or bone, by running in a mixture of resin and spermaceti melted together.—*Les Mondes.*