rapidly in Europe, and has fast superseded iron for structural purposes.

The paper was discussed by members present. During the discussion Mr. Theodore Cooper referred to the conservative stand taken by him in a paper presented to the Society some four years since and expressed the opinion that at the present time he would feel still more conservative in regard to the use of iron instead of steel for structural purposes, particularly for bridges or other similar constructions.

For boilers for ships, etc., steel has answered very well, but for structures he would be inclined as yet to advise the use of wrought iron. In compression, in his opinion, steel has not been proved to be as strong as wrought iron, and the necessity for most careful inspection is greater for steel than for wrought iron.

Mr. M. N. Forney referred to the increasing use of steel for rails, for wheel tires, and for various parts of locomotive machinery. He referred to the record of accidents which showed that some 66 per cent of accidents in this country are due to derailment, and only 8 per cent due to the same cause in England. In this country the number of broken wheels is very great and the tendency towards the use of steel for tires is decided.

Vice-President Paine gave details of the methods of tests of steel in use during the construction of the Brooklyn Bridge, and expressed an opinion favorable to the use of steel.

The paper was also discussed by Messrs. Collingwood, Frith and North.

SOLID AND GASEOUS FUEL.

In view of the large amount of attention that is just now being directed to the comparative value of solid and gaseous fuel, the following, from *Le Gaz Belge*, will be read with interest:

When solid fuel is employed, it is not only necessary to provide the supply of oxygen required for combustion, but also to convey into the furnace sufficient air to drive off the products of that combustion, by ensuring the contact of the oxygen with the whole surface of the combustible material. In practice it is found that nearly twice the quantity of air theoretically required has to be provided, and this, of course, doubles the volume of the gases that have to be heated. It may thus be assumed that half of the air admitted into a furnace does not serve for combustion; and this excess of air naturally carries off a considerable quantity of heat. The loss, however, is a necessity, for if less air were supplied there would be a possibility of combustion being incomplete, and the evil would become greater. In fact, the carbon passing into the condition of carbonic acid (the result of the most complete combustion) develops 7,200 heat units, while with a less perfect transformation it furnishes carbonic oxide, giving only 1,400 units. When gaseous combustibles are utilized, these losses may be prevented, since very nearly the determined quantity of oxygen may be supplied, and this be caused to mix more closely with the combustible elements, without necessitating the expenditure, on the part of the mixture, of an amount of energy comparable with that required by the solid combustibles.

The commercial value of the two kinds of combustibles may be approximately stated as follows: Coals have, according to their quantity, a standard of from 4,500 to 7,500—say an average of 6,000 heat units. From this number must be deducted 500 heat units lost in effecting combustion. There remain, therefore, 5,500 heat units. Now the absolute available heat of furnaces employed for industrial purposes does not exceed 40 per cent of their theoretic-heating capacity, and, therefore, effective caloric power is reduced to about 2,000 calories. The cost of furnace coal of average quality ranges from 6 to 8 francs per 1,000 kilos—say 0.8c per killogramme (2.2 pounds). The 2,000 calories heating power therefor cost 0.8c. If coal gas is taken as the element of comparison, its yield in heat being 12,000 units of the net cost of 7 cents, the ratio becomes 1.4 for coal gas respectively. This, however, is exclusive of the cost of labor, maintainance of appliances, transport of fuel, etc., all of which would double the net cost of the solid combustible material, so that the proportion really become 2 for coal and 1.4 for gas. But the solid combustible furnishes only 2,000 calories, while if it is transformed into lighting gas it would furnish 3,000 calories. The final ratio of the net cost, therefore, become 3 for coal against 1.4 for gas. In other words, the employment of illuminating gas as a combustible is attended with about twice the economy that results from the use of ordinary coal.

TORPEDO BOATS.

In Figs. 10 to 17, on page 37, is illustrated a second-class torpedo boat built by Messrs. Yarrow and Co. for the English Government. The hull is of galvanized steel. The engines are of the usual compound condensing type. Separate engines are sometimes provided in these boats for working the air, circulating, and feed pumps. The advantages claimed for this arrangement are, that it allows a vacuum to be always maintained in the condenser, and the main engines are consequently more under control. It also enables the high-pressure steam to be blown into the condenser in the event of a sudden stoppage, so that the firing may be continued and a too sudden change of temperature in the firebox be avoided. In boats of this class it is undesirable to allow any escape of steam into the open air which might in action betray the presence of the boat to an enemy. In the case of the main engines racing in rough weather, there is less risk of a breakdown to the pumps if they are worked separately. In these boats the main engines are provided with piston valves, which, in Messrs. Yarrow and Co.'s opinion, are more suitable than the ordinary slide valves in engines running at as high a speed as 500 revolutions a minute.

The following are the principal dimensions of the boat and engines:

		ft.	in.
Hull:			
Length over all		63	0
Breadth		7	9
Draught of water amidships when loaded		2	3
Displacement		12.5 tons.	
Engines:		ft.	in.
Diameter of cylinders	H.P.	0	8
	L.P.	0	13
Stroke		0	10
Cooling surfsce in condenser		230 sq. ft.	
		ft.	in.
Diameter of cylinders of air-pump enfines	H.P.	0	3¼
	L.P.	0	6¼
Length of strokes of cylinders of air-pump engines		0	4¼
Diameter of ram of feed pumps		0	2¼
Length of stroke		0	2¼
Boiler:			
Diameter of barrel		3	4
Length over all		7	6
Number of tubes	135		
Diameter of tubes		0	1¼
Total heating surface		225 sq. ft.	

The condenser is of copper with brass tubes. A small engine 3½ in. in diameter by 3 in. stroke which runs at 1200 to 1500 revolutions a minute, is provided for working the fan, the diameter of the latter being 31 in. The speed of the boat when loaded in accordance with Admiralty requirements, is 17.27 knots on a two hours' run.

It will be seen from the illustrations that the torpedoes are placed in two troughs at the bow, these troughs being inclined downwards, the angle of inclination when the boat is at rest being 6 deg. The torpedoes are projected by means of steam impulse gear, and this system is now adopted in all second-class torpedo boats built for the English Government. The impulse cylinders have a diameter of 6 in. and a stroke of 7 ft. The steam presses against the pistons through 5½ ft. of the stroke, after which the pistons are cushioned by air, whilts at the same time a valve shuts up the steam and opens a connection to the condenser, by which means the pistons are drawn back into their original position, and are ready to eject another torpedo immediately it is lowered into its trough. This impulse gear is arranged so that it can be started by the officer in charge in the conning tower, who is able from thence to fire the torpedo, and also to steer the boat. In the former operation, only one valve has to be opened, and as it is of the equilibrium type very little power is required to work it.

This arrangement was introduced by Messrs. Yarrow and Co. and was tested by the Admiralty officials at Portsmouth in March last, giving very satisfactory results. The impulse cylinders, as will be seen by the illustrations, are completely covered by the deck of the boat, and, being to the boiler, they are kept warm, and thus always ready for use. Were the cylinders exposed it would be necessary to warm them before they could be put in action, and the delay caused by this process would render the system entirely impracticable.

The steam trials of the last boat Messrs. Yarrow built for the English Government took place on Thames on the 26th of February, 1883, when the following results were obtained:

Pressure of steam	116 lbs.
Vacuum	24 in.
Revolutions per minute	554
Speed	17.27 knots.

We believe that this is the highest result that has hitherto been obtained by a boat of this size tested under the Admiralty conditions.—*Engineering.*