## MUSHET ON CAST IRON.

We find the following letter in the London *Engineer:*—

SIR :—In your article last week on cast-iron ordnance are some remarks on the nature of cast iron, and the means of improving that substance for purposes where tenacity and great strength are essential, and you suggest that such an improvement may be effected by partially decarbonizing pig iron in a Bessemer converter.

In the years 1846-1847 I made a series of experiments on this subject with a Bessemer converter, operating upon various brands of pig iron. The irons I employed were of the following kinds of gray, No. 1 quality:—Cleator hematite, Workington hematite, Barrow hematite, Tow Law gray pig, Cinderford, and Parkend. Victoria, Nos. 1, 2, 3 and 4 pig irons:—Blanavon, Pontypool. Russell's Hall and Westphalian gray pig.

The melted pig iron was blown in the converter until it had thrown off the frothy silicious slag which is eliminated during the first stage of the pneumatic process.

The gray iron thus deprived of its silicium, and some of its carbon, was cast into ingots of about 4 in. square. The fracture of these showed a very uniform grain of gray cast iron, the grains being small, and the texture very compact, but in no instance was the strength of the iron found to be nearly so great as that of the original pig iron from which it was prepared. These results I was prepared to anticipate from my previous knowledge of the nature of pig iron and of the cause to which its strength is due. There is no difficulty in thus treating cast iron, for the sides of the converter are not attacked by the silicious slag, and the operation can be carried on in converters of small size, which can be charged twice in an hour, and kept going night and day if required.

The iron thus operated upon is exceedingly fluid and lively, and can be run into the finest moldings; but the castings thus made are weak and brittle. Nothing in the way of improving the strength of cast iron can be expected from thus operating upon it. The reasons are, to me, quite obvious; but so long as the public are shackled by the empirical dogmas of chemists respecting the nature of cast iron, the matter must be more or less obscure to those who rely upon these dogmas.

Cast iron is not what chemists would have us to believe it to be, namely, a carburet or carbide of iron. Gray cast iron is an alloy of carburet of iron, steel, and malleable iron, with a mechanical mixture of graphite; white cast iron is an alloy of carburet of iron, steel and malleable iron, in which the first two substances largely predominate.

In the blast furnace the ores of iron descend into the zone of fusion in various conditions. These conditions are the following:—

1st. Iron ore partially deoxydized, but not yet metallized. When this comes into the zone of fusion it is reduced to a black slag, and none of it is metallized; when an excess of ore comes down in this state the blast furnace cinder is black, the iron white, and the furnace scours.

2ndly. Iron ore fully, deoxydized, but only in the nascent state of metallic iron.

3rdly. Iron ore completely deoxydized but not carbonized. This is in the state of malleable iron.

4thly. Iron ore deoxydized, metallized and carbonized so as to be in the state of crude steel.

5thly. Iron ore deoxydized and carbonized, so as to constitute carburet of iron.

6thly. Iron ore deoxydized and carbonized, so as to contain graphite mechanically mixed with it. When the bulk of the ore coming down into the zone of fusion is of this class the pig iron produced is very rich in carbon. Such is the Scotch pig iron, in which, from the nature of the black band ironstones, the iron and carbon of which are intimately mixed, and from the hight and size of the blast furnaces, the ore is almost wholly brought into the gray carbonized condition before it reaches the melting zone.

Iron ores, therefore, when passing through the blast furnace, are deoxydized and carbonized so as to form six distinct classes of material, when they descend into the melting zone of the blast furnace. The proportionate quantities of each class will depend upon the nature of the fuel, the nature of the blast (whether hot or cold), the weight and capacity of the furnace, and the nature and composition of the ores themselves, and the fluxes with which they are smelted.

The strength of cast iron depends almost wholly upon the quantity of malleable iron it contains; and therefore, when in any blast furnace a large portion of the ore, class No. 3 comes down to the melting zone, the pig iron produced will be proportionately strong. On the other hand, when classes No. 4 and 5 predominate, the pig iron is white and brittle, for crude steel and carburet of iron are brittle, as is also any mixture of these substances. When class No. 6 predominates the iron is gray, such as Scotch pig iron; but it is brittle, containing but little malleable iron. It is not, however, so brittle as white pig iron, because its texture is granular and not crystalline.

The effect of silica in the blast furnace is to retard or prevent the carbonization of the iron ore. Therefore, pure silicious iron ores, such as hematites and magnetic ores, when they come down to the zone of fusion, are more or less largely in the condition of class No. 3, and in small cold blast furnaces almost wholly so. Therefore rich silicious hematites and magnetic iron ores, smelted in small cold blast furnaces, have a strong tendency to fill the hearth with malleable iron, unless an excessive quantity of fuel is used to guard against this; but in any case a large portion of the ore of class No. 3 always comes down to the melting zone, and hence hematite and magnetic ore pig irons, when gray, are exceedingly strong, their strength being due to the large alloy of malleable iron which they contain. Gray pig iron is often rendered stronger by re-melting, and the cause of this is that the loss of carbon which takes place in melting increases the proportion of the malleable iron present in the alloy.

By partially decarbonizing cast iron in the Bessemer converter its strength is diminished for the following reason :—The malleable iron present being highly combustible is at once attacked by the oxygen of the blast, before the less combustible carburet of iron, steel, or gray carbonized iron is at all acted upon; so that the quantity of malleable iron which imparts strength to the cast iron is reduced, and the strength of the cast iron is, therefore, proportionately reduced also.

I am not aware that Mr. Morries Stirling was acquainted with the true composition of cast iron as I have here described it; but it is certain he was aware that cast iron could be strengthened by alloying it with malleable iron, and hence his patents for effecting that improvement.

On September 3d, 1863, I took out a patent for increasing the strength of cast iron by alloying it with Bessemer metal, decarbonized so as to be in the condition of malleable iron. Like most other great improvements, no notice has as yet been taken of this process, by which in all probability the strength of cast iron may be quadrupled. Inventions relating to iron and steel appear to require a probation of a series of years before the public are able to recognize their efficiency and importance. Thus the hot blast patent was scarcely named for the first ten years of its term. My own spiegeleisen patent, on which hangs the very existence of the Bessemer process in this country, was put aside for six years. The rotary puddling furnace is only now beginning to attract proper attention, after remaining for years in abeyance.

Of my process for strengthening cast iron, which has been now nearly two years before the public, I have heard nothing, except the opinion of a leading ironmaster, to the effect that my process was not worth a trial. Opinions such as these, confidently given by men who have never devoted a moment's thought to the subject they speak of, tend more than anything else to retard the progress of improvements in iron metallurgy. When my spiegeleisen patent was taken out, eight years ago, it was pronounced to be of no value, and a mere theoretical bagatelle. Yet this bagatelle is yielding Mr. Bessemer over £100,000, and his present licenses probably one million sterling, per annum, and a few years will see these returns increased probably tenfold. R. MUSHET.

Belgrave House, Cheltenham, April 18, 1865.

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MACHINES for seeding currants and stoning raisins are in common use in England.

## POLYTECHNIC ASSOCIATION OF THE AMERICAN INSTITUTE.

The Association held its regular weekly meeting at its room at the Cooper Institute, on Thursday evening April 27, 1865, the President, S. D. Tillman, Esq., in the chair.

### METALS—SOLID AND MELTED.

Dr. Rowell gave an account of some experiments which he had made to test the relative specific gravity of solid and molten lead. He took a hydrometer tube, which is a glass tube with two bulbs blown in it, a small one at the bottom and a larger one above, and introducing a small quantity of lead he melted the metal with an alchohol lamp. The quantity of lead was sufficient to fill the lower bulb and half the upper bulb. Dr. Rowell supposed that if the metal shrank in hardening it would draw the two bulbs together and break the glass at the neck, while if it expanded it would burst the lower bulb. The glass was not broken; he, therefore, concluded that lead in hardening neither expands nor contracts, at all events not more than glass.

Another experiment resulted in the same conclusion. Having a kettle with a hemispherical bottom he filled it with molten lead and allowed it to cool. He then melted it all except a little lump at the center of the surface, and observed that the upper part of this lump was precisely at the level of the surface of the molten mass. But if the temperature of the molten lead be raised a few degrees above the melting point, the solid lump sinks; lead, whether molten or solid, being subject to the law of expansion like other bodies.

The case is different with iron. Visiting an iron foundery a few days before, he took the opportunity to drop a small ball of nearly red hot cast-iron into a ladle of the molten metal, and the ball floated with about one-tenth of its mass above the surface. One of the workmen dropped a leaden bullet into the ladle, when it went to the bottom instantly.

Mr. Blanchard said that he had tried the experiment of throwing solid cast-iron into molten cast-iron a thousand times, and it will always float.

Mr. Norman Wiard observed that there was some deception practiced in relation to the lead bullet; as every foundery man knows that if lead be mixed with molten cast-iron an explosion follows. The iron may all be thrown out of a ladle at any time by placing a little lead in the bottom of the ladle before the iron is drawn in.

Mr. Bird said that in melting lead he had tried the experiment many times of pushing with a stick a solid lump of lead to the bottom of a molten mass, and it would invariably rise again to the surface.

The Chairman explained that he was present at the experiments made by Professor Everett, an account of which was given at the time, and it was found that a pig of solid lead would sink in a kettle of molten lead, but whether the temperature of the molten lead was not considerably above the melting point, was not carefully observed. Had the solid and the molten lead been of about the same temperature perhaps the result would have been different.

Mr. Garvey remarked that the fact of the solid floating upon the molten metal was not conclusive proof of a lower specific gravity, as there were mysteries connected with the behavior of the substances under these conditions that had not yet been unraveled.

Dr. Parmelee observed that water, sulphur and some other substances when they change from the solid to the liquid state crystalize, and the crystals arrange themselves in such way as to have interstices between them, in this way diminishing the specific gravity of the substances. But substances which have not this property, increase their specific gravity in passing from the solid to the liquid state. If the experiment be properly and fairly tried it will be found that solid lead or iron will always sink in the same metal melted.

### THE VANDERBILT MEDAL.

Mr. Norman Wiard presented the designs and plaster casts of the gold medal voted by Congress to Commodore Vanderbilt in recognition of his munificent gift of his superb steamship, the *Vanderbilt,* to the nation in her hour of need. The design was by Leutze and the medal is being executed by Mr. Salathiel Ellis. On one side is a likeness of the Commo-