

derable sum to the project; which money, of course, would all have been lost, and perhaps some families ruined; but a nobleman who understands the nature of engines very well, knowing the impossibility of what was proposed, threw out the bill.

“Our legislators may make laws to govern us, repeal some, and enact others, and we must obey them; but they cannot alter the laws of nature, nor add, or take away, one iota from the gravity of bodies.”

---

*Remarks on KUGLER's Planing Machine.*

We noticed this planing machine in the last volume of our Journal, p. 394, and in our notice expressed a fear that the resistance opposed to the motion of the board, by the simultaneous action of the great number of plane irons employed in it, would, especially on cross grained stuff, be so great as to interfere with its utility. Although we have not yet had an opportunity of seeing the machine in action, we have conversed with gentlemen of intelligence who were interested in the discovery of any objections to which it was liable, and whose account of it is such as to show that our apprehensions were altogether unfounded.

We have made the following memorandum of the information communicated, of the absolute and entire truth of which we cannot entertain the slightest doubt. Its ordinary rate of working is the planing, tonguing, and grooving, of six flooring boards, twenty-four feet long, in a minute, or of a corresponding number of those which are shorter. It appears to meet with no difficulty from such as are knotty, or cross grained, the angular direction of the irons causing them to cut without the slightest tearing. The machine, it appears, will take off twenty-three shavings from the top, and an equal number from each side, at one operation.

The inquiries of the gentlemen to whom we alluded in the commencement of this article, were directed solely to the ascertaining of the originality of the invention, in those particulars which constitute the claim; a point upon which we did not entertain any doubt whatever, and it is to us a source of unmixed pleasure, to find that we were incorrect in the only doubt which we did entertain, namely, that respecting the practical operation of the machine.

EDITOR.

---

*On the principles which determine the Hardness of Iron Castings, and the mode of selecting the different varieties required by the mechanist.* By RUFUS TYLER, *Mechanist.*

TO THE COMMITTEE ON PUBLICATIONS.

GENTLEMEN,—Estimating highly the importance to the practical mechanic and to science, of a mutual interchange of ideas and observations, through the medium of this Journal, I beg leave to offer for

your disposal, the following remarks, drawn from many years experience, relative to cast iron, and its application in the construction of machinery.

Formerly, mechanists experienced much difficulty in procuring iron castings of sufficient softness to admit of being worked with any facility, and even at the present day, the art of producing castings of any desired quality, is involved in some degree of obscurity. I shall endeavour, in my communication, to remove this obscurity, and thus to enable the founder to economise metal, and to assist mechanists in determining with readiness and accuracy, the fitness of any casting which may be offered to them.

It is usual to distinguish the hardest and softest kinds of cast iron, by the terms white and black, and all intermediate degrees by the term grey. The darker shades indicate the greater proportions of carbon which the material contains, and are most highly valued for melting, as a portion of this substance is unavoidably lost in that operation.

These indications, so far as the different shades of grey actually appear, may generally be relied upon for determining the quality of any article under examination; but circumstances incident to the casting, may cause each and all of them to assume the appearance and properties of the white variety, from which they cannot afterwards be distinguished, except by annealing, by remelting, or by chemical analysis. It is a mistake, therefore, to attribute to a deficiency of carbon, as is almost universally done, properties common to castings of every degree of carbonization; properties which will be found upon investigation, to depend upon *the particular arrangement of the particles*, assumed in passing from the fluid to the solid state, *determined by the length of time occupied in cooling, and by the proportion of carbon, conjointly.*

It is a fact, with which every workman in this material is familiarly acquainted, that opposite qualities are frequently exhibited in different parts of the same piece of casting. This is generally supposed to arise from an unequal distribution of the carbon, caused by the more rapid cooling of the thinner parts, which are always the first to assume the crystalline form. Hence it is the universal practice among founders, in making selections for melting, to break off and reject the hard parts, and to retain those which are soft for producing soft castings, and vice versa, for hard. In reality, every piece of cast iron, appearances to the contrary notwithstanding, is of the same composition throughout; and, further, it is only from such pieces as present both the hard and soft form, that an accurate knowledge can be obtained of the qualities of the material by inspection.

A knowledge of this fact, is of the utmost importance to founders, since under their present mistaken views, they are liable not only to undervalue much of their best material, because of its close resemblance to that which is inferior, but whenever this same supposed hard metal is employed for casting articles in which extreme hardness is a principal requisite, a disappointment necessarily results, except in

castings which happen to be as thin as those from which the selection for the furnace has been made. As it frequently happens that a charge is made up of both *real* and *supposed* hard iron, the result is seldom so totally at variance with what is expected, as in the case which I have just supposed. It is, however, in general sufficiently so to call forth the usual explanation, namely, that the metal has been improved, that is, has received an accession of carbon, in the furnace, although the reverse is known to take place generally, and to such an extent, that after metal of the softest quality has been remelted half a dozen times, it is no longer fit for any but the hardest castings; indeed, an allowance for this must always be made, particularly in the common air furnace, which hardens metal more than the cupola or blast furnace.

In attempting to produce extreme hardness, in thick masses, there is a difficulty in addition to that of the improper selection of metal. The high melting point of the metal, suitable for such purposes, produces this difficulty, which is further increased by the necessity of choosing from masses, as large, at least, as those which it is intended to produce. This, however, will not be regarded as an inconvenience, by those who are not aware that *hard* metal, in the form of thin scraps, may, or may not, produce hard castings, of larger, or rather of thicker, masses, at least by those who not having very powerful furnaces, reject large masses altogether. It is probably owing to this circumstance, together with the want of correct theory, that recourse is generally had to the artificial "chill," for hardening anvil faces, and many similar articles, thereby causing the metal to consolidate within the *hardening limit of time*.

By the employment of metal found to be truly hard, in pieces as large as can be conveniently managed, there will be no need of chilling any castings, smaller than those from which such selections have been made.

Some years ago, a notice went the rounds of the journals, of the discovery that hard cast iron, might be rendered quite soft by annealing in sugar.

I have before stated, that castings having different proportions of carbon, but resembling each other in being very hard, may be distinguished from each other by annealing; the fact is, that iron, highly carbonized, but hard from being chilled, or from being cast in very thin plates, may be softened by a simple annealing, and this may account for its working so *sweetly*, as your worthy Editor would say, after sugaring, as I did not find that experiment to succeed in a trial to which I subjected a piece of my own selecting.

Those who suppose that there is an unequal distribution of the carbon, in pieces which are soft and hard in spots, are answered by asking, what becomes of the carbon when a piece which would otherwise be grey and soft, is chilled in such a manner as to be rendered white and hard throughout, under circumstances which do not well admit the supposition, that the carbon has escaped? For instance, let a hole, half an inch in diameter, be drilled six or more inches deep, in a large block of brass, we must avoid cast iron, for that might

be said to absorb the carbon, and filled with melted iron. Now no one can doubt, that, in this case, the casting would be hardened through. It is necessary, therefore, to seek for some other theory than the one just mentioned, to account for this phenomenon. The one which I have adopted, as before stated, supposes, that whenever such a result takes place, it is due to circumstances in the *time of cooling*; in other words, that every piece of casting, whether white or grey, being remelted without changing the proportions of carbon and iron, will reproduce the same quality, if the time occupied in congealing be the same as before.

According to this theory, every different quality of cast iron, has *its own rate of cooling*, which determines the character it will assume. To illustrate this point, after I had long known the fact, I had a pattern made, consisting of two wedges, as nearly alike as possible; being about two inches wide, by three in length, and tapering from half an inch thick at the back to as thin an edge as could well be cast in the usual moulds of sand. These wedges were then connected at their backs by a piece as wide as one of the wedges, and about half an inch in thickness, in such a manner as to insure equality in moulding and casting in all respects: the edges being downward in the mould, caused them to fill, by pressure, very perfectly. From this pattern, or double wedge, I procured castings of various qualities of metal, from very soft, and highly carbonized, to that which was of a medium quality, (degree of carbonization,) and when broken diagonally across, one of the wedges of each pair from the edge towards the back, exhibited in the same fracture both the white and grey iron. In each, the white always commenced at the edge, and extended towards the back, where it met the grey, the transition being sudden, and tolerably well defined, but varying in *distance* from the edge, with the *shade* of grey, and thus furnishing a relative scale of measurement of the different qualities of the material.

This line of transition was found to follow very accurately the line of equal thickness, or, which is the same thing, of equal distance from the edge, across the wedge from side to side. The same appearance was exhibited by the other wedge of the pair, as was anticipated; and any number of similar wedges, cast under the same circumstances, of the same metal, whether connected or not, would exactly coincide, the time of cooling being the same in each.

From these facts, it is manifest that nothing more is necessary to enable one to determine the precise hardness of any casting, without defacing it, than to search out some thin wedge shaped part which may be broken off without injury; a wedge may be previously attached to the pattern, for the purpose, from any one of the castings made at the same time, of the same metal; and by noting the thickness at which the white form, passes into grey, having previous knowledge of the quality due to that thickness.

An exception to this rule, will be found in the last running of a heat, which is always harder than the first, the reason of which is, that the metal goes into the mould, at a temperature considerably

lower than at first, and consequently does not heat it to the same degree, and therefore the time of cooling of the metal, will be less for a given thickness.

Subsequently to the experiment before mentioned, I procured some pieces of different kinds of iron, cast from a pattern in the form of a cup, the rim of which was wedge shaped, instead of the double wedge, as being free from an objection which ought to have been mentioned in its proper place, to wit, that the edges being more exposed than the middle of the wedge, would cool sooner, and consequently remove the hardening point a little further up, making a slight variation in the line of transition, at those points.

It is probable, likewise, that these results would be slightly modified by another principle, which was indicated by the cast wedge; that in such forms as terminate every where by edges thicker than the hardening point, while portions are just inferior in thickness to that point, no hardening would take place; as the hard form, which is probably the result of crystallization, seems in this, as in other substances, to require some arrangement by which it may be commenced, and from which it will extend. Indeed, I have reason to believe, that where, from the nature of the furnace, or the metal employed, or from the acuteness of the angles in the pieces to be cast, danger is apprehended that the edges most exposed, will become hard for a small distance, that this result may be prevented entirely, by removing from the pattern these edges to a *less distance*. Such small portions may well be spared, even if recourse should afterwards be had to the file, or chisel, for restoring to the casting its proper form.

In the examination of a lot of castings at the foundry, care should be taken to avoid selecting such pieces, or parts, for breaking, as are likely to have had the rate of cooling affected by peculiar circumstances, such as the *gates*, (parts of which are either exposed to the atmosphere, or to sand immediately heated by the metal running over it,) or finny parts immediately in contact with large masses, which would cause them to remain longer in a fluid state. In this, there is seldom any difficulty, as there are generally to be found, for some days after any particular castings have been made, imperfect or damaged pieces, known to have been cast at the same time, upon which the examination can be made. Although wedge formed pieces, for reasons which must now be sufficiently obvious, are to be preferred, yet is often sufficient to examine the fracture of a piece of almost any shape, provided its time of cooling would be within that allowed to the thinnest portion of those to be determined; for the question, generally, is not, what is the precise quality, but whether castings are *soft enough* to admit of being worked.