THE INFLUENCE OF INTENSE COLD ON STEEL AND IRON.

[Condensed from Nature.]

There has recently been a most interesting discussion at the Literary and Philosophical Society, Manchester, on the above subject.

The paper which gave rise to the discussion was by Mr. Brockbank, who detailed many experiments, and ended by stating his opinion that iron does become much weaker, both in its cast and wrought states, under the influence of low temperature; but Mr. Brockbank's paper was immediately followed by others by Sir W. Fairbairn, Dr. Joule, and Mr. Spence, which at once put an entirely new complexion on the matter.

Dr. Joule says:

"As is usual in a severe frost, we have recently heard of many severe accidents consequent upon the fracture of the tires of the wheels of railway carriages. The common-sense explanation of these accidents is, that the ground being harder than usual, the metal with which it is brought into contact is more severely tried than in ordinary circumstances. In order apparently to excuse certain railway companies, a pretence has been set up that iron and steel become brittle at a low temperature. This pretence, although put forth in defiance, not only of all we know, of the properties of materials, but also of the experience of everyday life, has yet obtained the credence of so many people that I thought it would be useful to make the following simple experiments:

"1st. A freezing mixture of salt and snow was placed on a table. Wires of steel and of iron were stretched, so that a part of them was in contact with the freezing mixture and another part out of it. In every case I tried the wire broke outside of the mixture, showing that it was weaker at 50° F., than at about 12° F.

"2d. I took twelve darning needles of good quality, 3 in. long, $\frac{1}{24}$ in. thick. The ends of these were placed against steel props, $2\frac{1}{8}$ in. asunder. In making an experiment, a wire was fastened to the middle of a needle, the other end being attached to a spring weighing-machine. This was then pulled until the needle gave way. Six of the needles, taken at random, were tried at a temperature of 55° F., and the remaining six in a freezing mixture which brought down their temperature to 12° F. The results were as follow:—

Warm Needles.			Cold Needles.		
64	ounces	broke	55	ounces	broke
65	"	"	64	"	"
55	"	"	72	"	"
62	"	"	60		bent
44	"	"	68	"	broke
60	"	bent	40	"	"
Average, $58\frac{1}{3}$			Average, $59\frac{5}{6}$		

"I did not notice any perceptible difference in the perfection of elasticity in the two sets of needles. The result, as far as it goes, is in favor of the cold metal.

"3d. The above are doubtless decisive of the question at issue. But as it might be alleged that the violence to which a railway wheel is subjected is more akin to a blow than a steady pull; and as, moreover, the pretended brittleness is attributed more to cast iron than any other description of the metal, I have made yet another kind of experiment. I got a quantity of cast iron garden nails, an inch and a quarter long and $\frac{1}{8}$ in. thick in the middle. These I weighed, and selected such as were nearly of the same weight. I then arranged matters so that by removing a prop I could cause the blunt edge of a steel chisel weighted to 4lb. 2oz., to fall from a given height upon the middle of the nail as it was supported from each end, $1\frac{1}{16}$ in asunder. In order to secure the absolute fairness of the trials, the nails were taken at random, and an experiment with a cold nail was always alternated with one at the ordinary temperature. The nails to be cooled were placed in a mixture of salt and snow, from which they were removed and struck with the hammer in less than 5″"

The collective result of the experiments, the details of which need not be given, was that 21 cold nails broke and 20 warm ones.

Dr. Joule adds, "The experiments of Lavoisier and Laplace, of Smeaton, of Dulong and Petit, and of Troughton, conspire in giving a less expansion by heat to steel than iron, especially if the former be in an untempered state; but this, would in certain limits have the effect of strengthening rather than of weakening an iron wheel with a tire of steel.

"The general conclusion is this: Frost does *not* make either iron (cast or wrought), or steel, brittle.

Mr. Spence, in his experiments, decided on having some lengths of cast iron made of a uniform thickness of $\frac{1}{2}$ in. square, from the same metal and the same mould.

He writes:—"Two of the four castings I got seemed to be good ones, and I got the surface taken off, and made them as regular a thickness as was practicable.

"I then fixed two knife-edged wedges upon the surface of a plank, at exactly nine inches distance from each other, with an opening in the plank in the intervening space, the bar being laid across the wedges, a knife-edged hook was hung in the middle of the suspended piece of the bar, and to the hook was hung a large scale on which to place weights.

"The bar was tried first at a temperature of 60° F.; to find the breaking weight I placed 56lb. weights one after another on the scale, and when the ninth was put on the bar snapped. This was the only unsatisfactory experiment, as 14 or 28lb. might have done it, but I include it among others. I now adopted another precaution, by placing the one end of the plank on a fixed point and the other end on to a screw-jack. by raising which I could, without any vibration, bring the weight to bear upon the bar. By this means, small weights up to 7lb. could be put on while hanging, but when these had to be taken off and a large weight put on, the scale was lowered to the rest, and again raised after the change was made. I may here state that a curious circumstance occurred twice, which seems to indicate that mere raising of the weight, without the slightest apparent vibration, was equal in effect to an additional weight. $3\frac{3}{4}$ cwts. were on the scale, a 14lb. weight was added, then 7lb., then 4lb., 2lb., 1lb., and 1lb., making 4cwts. and 1lb. This was allowed to act for from one to two minutes, and then lowered to take off the small weights, which were replaced by a 56lb. with the intention of adding small weights when suspended; the whole was then raised so imperceptibly by the screw, that the only way of ascertaining that it was suspended, was by looking under the scale to see that it was clear of the rest. As soon as it was half-an-inch clear it snapped, thus breaking at once with one pound less than it resisted for nearly two minutes.

"Six experiments were carefully conducted at 60° F., the parts of the bars being selected so as to give to each set of experiments similar portions of both bars; the results are marked on the pieces. My assistant now prepared a refrigerating mixture which stood at zero, the bars were immersed for some time in this, and we prepared for the breaking trials to be made as quickly as could be, consistently with accuracy; and to secure the low temperature, each bar, on being placed in the machine, had its surface at top covered with the freezing mixture. The bars at zero broke with more regularity than at 60°, but instead of the results confirming the general impression as to cold rendering iron more brittle, they are calculated to substantiate an exactly opposite idea, namely, that reduction of temperature, *cæteris paribus*, increases, the strength of cast iron. The only doubtful experiment of the whole twelve is the first, and as it stands much the highest, the probability is that it should be lower; yet, even taking it as it stands, the average of the six experiments at 60° F., gives 4cwt. 4lb. as the breaking weight of the bar at that temperature, while the average of the six experiments at zero gives 4cwt 20lb. as the breaking weight of the bar at zero, being an increase of strength, from the reduction of temperature, equal to 3.5 per cent."

Sir W. Fairbairn states: "It has been asserted, in evidence given at the coroner's inquest, in a recent railway accident, that the breaking of the steel tire was occasioned by the intensity of the frost, which is supposed to have rendered the metal, of which this particular tire was composed, brittle. This is the opinion of most persons, but judging from my own experience such is not the fact. Some years since I endeavored to settle this question by a long and careful series of experiments on wrought iron, from which it was proved that the resistance to a tensile chain was as great at the temperature of zero as it was at 60° or upwards, until it attained a scarcely visible red heat."

The immense number of purposes to which both iron and steel are applied, and the changes of temperature to which they are exposed, renders the inquiry not only interesting in a scientific point of view, but absolutely necessary to a knowledge of their security under the various influences of those changes. It was for these reasons that the experiments in question were undertaken, and the summary of results is sufficiently conclusive to show that changes of temperature are not always the cause of failure. Sir W. Fairbairn adds: "The danger arising from broken tires does not, according to my opinion, arise so much from changes of temperature as from the practice of heating them to a dull red heat, and shrinking them on to the rim of the wheels. This, I believe, is the general practice, and the unequal, and in some cases, the severe strains to which they are subject, has a direct tendency to break the tires."

OAK GRAINING IN OIL COLORS.

Condensed from the Building News.

There is a charm and feeling about work executed by the hand, which gives it a value no mere machine work can possess. Machine work, from its very nature, necessitates a repetition of pattern, which cannot be avoided. Hand-work, on the contrary, can imitate every variety, and follow nature so closely that no two pieces need be alike. There is also in hand-work a wide scope for the inventive faculty and the exercise of good taste (both in form and color) and skillful workmanship. As a rule, strong contrasts between the ground and the graining color should be avoided. The figure and grain should of course be seen clearly, but only so clearly as to be distinct, without interfering with the general and uniform quietness of tone necessary to fulfil the conditions required by the laws of harmony and good taste. Violent contrasts and gaudy coloring are always vulgar, brilliancy and richness of color are not necessarily vulgar; it is the absence of the guiding power of knowledge and pure taste in their arrangement which degrades them to the rank of vulgarity. We have before spoken of the importance of good combing, and of the various kinds of combs used; we now proceed to describe how the work is done. The graining color is brushed over the work, in the ordinary manner, with a pound-brush, care being taken not to put too much color on, or else it is very liable to be dirty. A dry duster is now used to stipple with, which, if properly done, will distribute the color evenly; it is now ready for combing. In the real oak it will be found, as a rule, that the grain is invariably coarser on one side of the panel than on the other; this arises from the very nature of the growth of the tree; it is, therefore, well to imitate this pattern, and in order to do so we take first a medium or coarse cut gutta-percha comb, and draw it down one side of the panel; then use a finer one to complete it. This comb will leave the marks of the grain in clear unbroken lines from top to bottom of the panel. We now take a fine steel comb and go over the whole of the previous combing, moving it in a slanting or diagonal direction across the previous grain, or with a quick and short wavy motion or curl; both the former and the latter motion will break up the long lines, left by the gutta-percha comb, into short bits, which of course represent the pores or grains of the real wood. There are several other motions of the comb having the same end in view; and by using the gutta-percha or cork combs, in conjunction with the fine steel, an infinite variety of grain may be produced. Steel combs, with one or more folds of thin rag placed over the ends of the teeth are a style of comb which has nothing to recommend it. A natural variation in the grain may be produced by one comb alone, according to the manner in which it is held. For instance, if we take a coarse or broad-toothed gutta-percha comb, and commence at the top of a panel, with the comb, placed at its full width: if drawn down in this position it will leave a grain of the same width as the width of the teeth: but if we start with the full width, and gradually turn the comb or slightly incline it to one side—that is to say, on its edge, we thereby graduate the grain from coarse to fine at pleasure, and by holding the comb at a certain inclination we may actually make very fine the coarse comb. A very important point is the formation of the joints in the wood, as much of the effect of otherwise good work is lost in consequence of neglect in this respect. In looking at a real oak door, the joints of the stiles and rails are clearly and sharply defined, not by any defect of workmanship, but by the difference in the run of the grain, the stiles being perpendicular, and the rails horizontal. The rails being cut sharp off by the stiles, show a perfectly straight line. The light also acts differently upon the two, simply because the grain or fibre of the wood is exposed to its influence under different aspects. This also tends to produce a difference in the depth of the color of rails and stiles, and panels also. It will be evident that no imitations can be considered really good except they include these seemingly unimportant points.

It is a common practice for grainers to imitate a broad piece of heart or sap of oak, upon the back rail of almost every door they do, and many of them are not even content with that, but daub the stiles over from top to bottom with it also. There is nothing so vulgar or in such bad taste. It should only be done upon those parts of the work on which it would appear on a real oak door, namely, on the edges of the doors and on mouldings. There is a vulgar pretentiousness about what we may call the sappy style of work which is very undesirable. The figures cross the grain more or less abruptly and of course are of different shapes, sizes, and forms, a knowledge of which can only be acquired by study of the real wood. The figure may be wiped out with a piece of soft rag, held tight over the thumb nail. This should have two or three folds over the nail, the superfluous rag being held by the other hand to prevent it hanging down and smearing the grain; and every time a figure is wiped, the rag should be moved slightly, so that the same part of the rag will not be used twice, thus insuring clean work. It will often happen that the thumb-nail will get broken, or is too weak to stand the work; in these cases, or, in fact, in any case, a good substitute or artificial thumb-nail may be made of gutta-percha, thus: A piece of thin sheet gutta-percha is put into warm water, and, while soft, is wrapped around the end of the thumb up to the first joint. It is then pressed with the hand, so as to fit and take the shape of the thumb and nail. This cannot be done at one heating, but will have to be put into the hot water again, and the end pinched and squeezed into form to the shape of the nail, and to fit easily upon the thumb. When this gets hard, it may be trimmed into perfect form with a penknife. This artificial nail will answer the purpose admirably if properly made; and even when the natural nail is good, the gutta-percha will serve to save it from injury. Good figuring may also be done by using the blank end of the steel comb with a rag folded over its edge. We have also used a piece of gutta-percha to take out the lights. This should be square-ended, about one inch wide, and three or four inches long, and will do successful work of a certain class, but not of the best. Many grainers use a piece of thin horn, in shape something like a spatula, about three or four inches long and three quarters of an inch wide, with rounded ends, and quite flexible. With this tool the figure is cut or scooped out—a sort of quick, side-long motion, very difficult to describe, and requiring a very considerable amount of practice before it can be worked with any success. There is, however, the same objection to this tool as may be urged against the gutta-percha for figuring, namely, that neither of them take the color clean away, but leave an accumulation of color on the edge of the figure, which is fatal to good work; and therefore we cannot honestly recommend the use of any method but the wiping out with the thumb-nail or its substitute. When the figure is wiped out it will require to be softened. By softening, we mean the imitation of those half shades seen upon and about the figures in the real wood. Between and around the lights or figure in oak, there is always a lighter tint of color; this is imitated by doubling a piece of rag into a small roll, and with the side of this the grain is partially wiped away, but not to the extent of taking off the whole of the grain. A recent but most admirable system of graining oak, by means of over-combing, is worked exactly the reverse of any of the foregoing methods; that is to say, the figure is first wiped out, and the combing or grain is done afterwards, when the graining color is dry, in this wise: The graining color is mixed somewhat thinner than for ordinary graining, and is brushed over the work sparingly, leaving it just sufficiently strong to show a clear distinction between the ground