let it get cold again before using it; for when quite cold water is used, there is always a risk of the steel cracking.

"By applying aquafortis to the surface of steel previously brightened, it immediately produces a black spot; if applied to iron the metal remains clean, but looks a little dull where the acid touched it. By this test iron may be known from steel, as the smallest vein of either will be distinguished by its peculiar sign. There are many large things broken by taking them out of the water before they are thoroughly cold ; and some people are of the opinion that it is the action of the air on the steel which causes it to break. But be this as it may, it is a real fact that if a large body of steel be taken out of the water before it is thoroughly cold, in nine cases out of ten it is sure to break. If a large piece of iron is heated and put in the water, and kept under the water a considerable time, after the outside of the iron is black, and then drawn out of the water, the heat from the middle of the iron will in a few seconds turn the outside to a red heat again. Water acts on steel in a similar manner. When first the article is put into the water, the water begins to act on the outside of the steel, cooling it gradually towards the middle; and if taken from the water before it is quite cold, the heat in the middle begins to act on the outside of the steel in a contrary way to the water, by straining the outside of the steel more than it can bear; and in most instances I have noticed, when I have been trying experiments, that as soon as the water dries on the steel, it cracks, and the larger the steel the greater the risk, so it is important that it should be quite cold before it is taken out of the water, if the article be any way large.

"It is not requisite that the article should lie in the water till the water is dead cold, for in some instances the article is wanted for use as soon as possibly it can be had; in such cases, if the article is not too large to go into a handbowl, put the bowl under the water in the tank, and place the article in the bowl, lift the bowl and the article out together, with the water covering the article in the bowl, and then sink the bowl with the article still in it into another tank of dead cold water, or under a tap, with cold water running on it, and it will in a short time be ready to lift out. But if the article is too large to go into a bowl, put it in a bucket and act as I have stated, and it will then come out safe without a crack, and not crack after it is out. Hundreds of things break, by lifting them out before they are cold.

"In many things where the heat that is on the article is wanted to temper the part that is dipped in the water, such as chisels, drills, and the like articles; these things, when they are dipped to the depth required to harden them, should always be moved quickly about in the water, and it will prevent many a drill screwing off in that particular spot, and prevent many a chisel breaking. I have no doubt that many readers of this little book have noticed when they have been chipping, that their chisels have broken clean off, about an inch from the edge, with a very light blow from the hammer, and the cause of that arises in a great number of instance from the chisel having been held still in the water when hardening it;

for the water cooling it across in a straight line causes the hardened part to tear from the other, yet not sufficient to show till it is struck with the hammer, and then it drops off, and if the break be examined it can be seen that the water did it. But these kind of articles having the skin on the steel when they are dipped in the water, it prevents the water from having just the same effect on them as it does on articles previously brightened. I recollect once having a quantity of small drifts to harden, and I was requested to keep the heads soft, so I put a certain number of them in a box, with charcoal dust to heat them, and when sufficiently hot, I shot them into the water with the intention of softening the heads after; but I found upon examining them that I had a number of them very crooked, owing to their being very slight, and going from the box so suddenly into the water; so I adopted another plan. I heated a certain number together, and taking them out separately, dipped them straight and gently into the water, which answered the purpose so far. But it took a little longer to dip them separately; so thinking to save this extra time, I thought I would only dip them in as far as I required them hard, and that would save me the trouble of softening the part that was not required hard. But not caring about going ahead with any quantity of things till I make myself sure that all is going on well, after I had done about two dozen I examined them, and I did not find one of them but what was cracked at the part that was level with the top of the water, so I dipped the remainder all over, and not a crack appeared in one I then made some lead red hot and dipped after. the parts that were required soft into it, and accomplished them very nicely. If the hardener should meet with articles that he considers have too large a centre in them, and that there is a risk of having a crack in them, if he stop the centre up with a piece of loom to keep the water out of it, there is little or no danger of its cracking.

In hardening a number of articles at one time. it is best to put them all into a box together with some charcoal dust, let them lie till they have acquired the low red heat called cherry-red, and then empty the contents of the box into the water; they will then be very clean, without scales, and beautifully hard. It is a very good plan for all small taps; and as it is usual to temper these things to a colour after they are hardened, it is necessary to know that they are all hard before beginning to temper them, for it will sometimes happen that there will be some among them that are scarcely hard. If the box has been taken from the fire before it has been properly heated through, then the middle articles in the box will prove not hot enough; so, to make sure of good work, always try them with a smooth file to prove them, for in some instances one bad article would get all the others condemned, even if all the others were right. But the use of the file can be dispensed with if they are brightened on a buff or a stone, which are the proper things for the purpose; for the persons that brighten them will find, if they are properly hard, plenty of brisk lively sparks will fly from them when they are held on the buff; and if they are not hard enough there will be very little fire in them; therefore, with a very little atten-

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