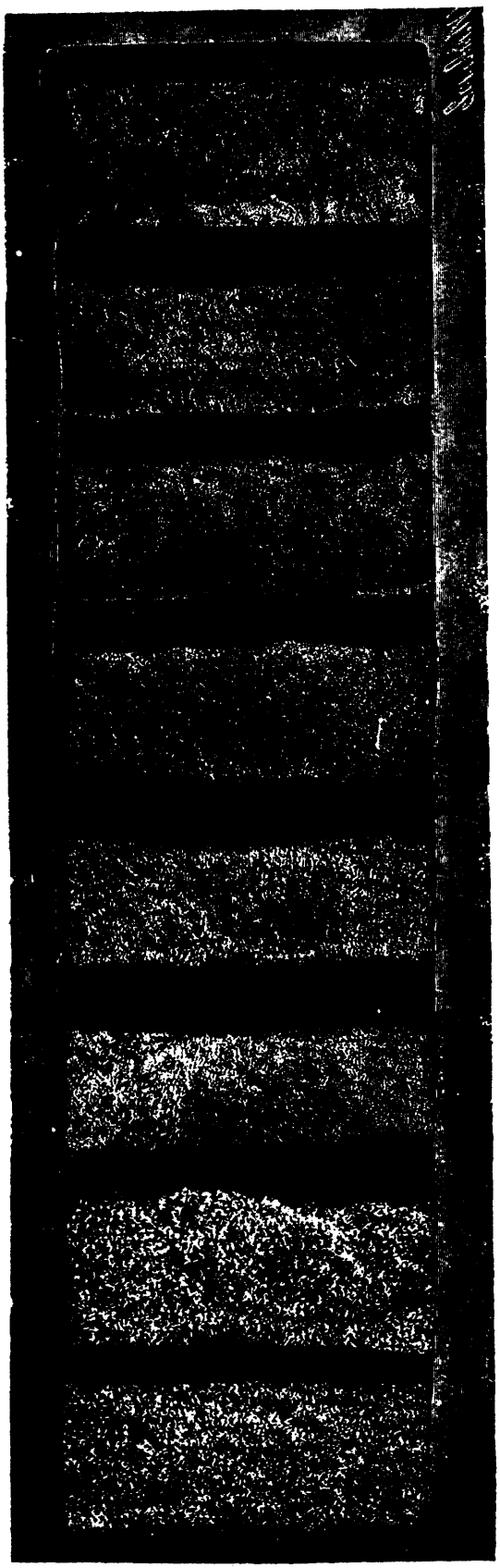

THE EFFECTS OF HEAT UPON STEEL.

As soon as heated, let the bar be quenched in cold water and kept there until quite cold. After cooling, the bar should be carefully wiped dry, especially in the notches. An examination by the file will reveal the following, if high steel has been used :

No. 1 will scratch glass; Nos. 2, 3 and 4, excessively hard; Nos 5 and 6 well hardened; No. 7 about hard enough for tap steel; No. 8 not hardened. In breaking off the pieces over the corner of the anvil they should be caught in a clean keg or box, to keep the fractures clean and bright.

No. 1 will be as brittle as glass; No. 2 will be nearly as brittle as glass; Nos. 3, 4, and 5 will break off easily, each a little stronger than the other; Nos. 6 and 7 will be very strong, and much stronger that No. 8, or the bar unhardened.

Place the pieces in the order of their numbers fitting the fractures, then upend each one, beginning with No. 1, and following with each in the order in which they lie, and the result will be fractures as shown so beautifully in our illustration, each differing from the other.

No. 1 will be coarse, yellowish cast, and very lustrous; No. 2 will be coarse and not quite so yellow as No. 1; No. 3 will be finer than 1 or 2, and coaser than No. 8, and will have fiery lustre; No. 4, like No. 3, not quite so coarse, yet coarser than No. 8; No. 5 will be about the same size grain as No. 8, but will have fiery lustre; No. 6 will be much finer than No. 8, will have no fiery lustre, will be hard through and very strong. This is what is called REFINING by hardening. No. 7 will be refined and hard on the corners and edges, and rather coarser, and not quite so hard in the middle. This is about the right heat for hardening taps, nailling tools, etc., the teeth of which will be amply hard, while there will be no danger of cracking the tool. No. 8 illustrates the original grain of the bar.

In nine cases out of ten the bar will crack along the middle to the refined piece. In the illustration the crack shows very plainly in No. 4, but we have never known this crack to extend into the refined piece, although we have repeated the experiment many times. We learn from this experiment the following :

FIRST, "*a*" Any difference in temperature sufficiently great to be seen by the color will cause a corresponding difference in the grain. "*b*" This variation in grain will produce internal strains and cracks.

SECOND, Any temperature so high as to open the grain so that the hardened piece will be coarser than the original bar will cause the hardened piece to be brittle, liable to crack, and to crumble on the edges in use.

THIRD, A temperature high enough to cause a piece to harden through, but not high enough to open the grain, will cause the piece to REFINE, to be stronger than the untempered bar, and to carry a tough, keen cutting edge.

FOURTH, A temperature which will harden and refine the corners and edges of a bar, which will not harden the bar through, is just the right heat at which to harden taps, rosebits and complicated cutters of any shape, as it will harden the teeth sufficiently without risk of cracking, and will leave the mass of the tool soft and tough, so that it can yield a little to pressure to prevent the teeth tearing out. These four rules are general, and apply equally well to any quality of steel or to any temper of steel.

Steel which is so mild that it will not harden in the ordinary acceptance of the term will show differences of grain corresponding to variations in temperature.

To restore any of the first seven pieces shown in No. 8 it is only necessary to heat it through to a good red heat, not to a high red, allow it to stay at this temperature for ten minutes to thirty minutes, according to the size of the piece, and then to cool slowly. If upon the first trial the restoration should be found incomplete, and the piece upon being fractured should still show some fiery grains, a second heating continued a little longer than the first would cause a restoration of the fracture. This property of restoration is not peculiar to any steel, and its performance requires no mysterious agencies beyond those given above.

It should be distinctly borne in mind that a piece restored from overheating is never *quite* as good as it would have remained if it had never been abused, and we strongly advise that no occasion should ever be given for the use of this process of restoration except as an interesting experiment. The original and proper strength of fine steel can never be FULLY RESTORED after it has once been destroyed by overheating.—*Treatment of Steel.*