

making steel, studying it, and working with it it becomes a subject of absorbing interest, if not of love; and steel when handled reasonably is so true that "true as steel" ceases to be a metaphor, it is then a fact which fills him with the most entire confidence.

Once more, steel highly charged with sulphur, phosphorus, arsenic, oxygen, and nitrogen is certainly highly charged with so many elements of disintegration; it takes more serious harm from ordinary deviations from good practice, such little irregularities as occur inevitably in daily working, than steel does which is more free from these elements.

Reasonably pure, sound, reliable steel can be had at moderate cost, and all consumers should insist upon having it.

Regular, uniform, reliable working can be had where it is required, and there should be no excuse for irregular grain, overheated work, uneven work, or any other bungling. Where skill is required and reasonable discipline is enforced, good work will not cost any more than bad work.

Many people still hold to the idea that there are many mysteries connected with steel, and that many unaccountable breaks occur which make it an unreliable material. It is hoped that what has been set down in these pages will go far to dissipate these supposed mysteries, and to give confidence to steel-users.

Many breaks are unaccounted for, but it is not within the author's experience that any fracture ever occurred that could not have been explained if it had been examined thoroughly in the light of what we know now. There is much to be learned, but there are no mysteries.

GLOSSARY.

THERE are many shop terms used in this book which may not be familiar to all steel-users.

They are in common use in steel-manufactories, and definitions of them will enable a steel-user to understand more clearly the common talk he will hear in the shops.

Blow-holes.—Blow-holes are the small cavities, usually spherical, which are formed in ingots as the steel congeals by bubbles of gas which cannot escape through the already frozen surface.

Burned.—Burned steel is steel that is reduced to oxide in part by excessive heating.

Check.—A check is a small rupture caused by water; it may run in any direction; it is usually not visible until steel is ruptured.

Chemical Numeration.—Chemical quantities are almost universally expressed in hundredths of one per cent, as explained in the body of the work. It is a very convenient numeration; any steel-worker, melter, hammerman, etc., will talk of 20, or 50, or 130 carbon; or 8 phosphorus; or 10, 15, or 25 silicon, etc.; and will talk intelligently, although he may not know the exact mathematical value of these points.

Dead-melting; synonym, killing.—Dead-melting—killing—means melting steel in the crucible or open hearth until it ceases to boil or evolve gases; it is then dead, it lies quiet in the furnace, and killed properly it will set in the moulds without rising or boiling.

Dry.—Steel is called *dry* when its fracture is sandy-looking, without lustre or sheen, and without a proper blue cast. There is more of a shade of yellowish sandstone. It is an evidence of impurity and weakness.

Fiery.—Fiery steel has a brilliant lustre; it is an evidence of high heat.

If the grain be fairly fine and of bluish cast, it is not necessarily bad in mild steel; in high steel or in tool-steel it should not be tolerated.

If the grain be large and of brassy cast, it is sure evidence of bad condition; the grain should be *restored* before the steel is used.

In hardened steel it is always bad, except in dies to be used under the impact of drop-hammers; in this case steel must be so hard as to be slightly fiery.

Grade.—Grade applies to quality, as crucible, Bessemer, or open-hearth grade. Or in the crucible, common, spring, machinery, tool, special tool, etc., etc. It does not indicate temper or relative hardness.

Honeycombed.—Unsound from many blow-holes. Usually applied to ingots. It is a bad condition.

Lap.—A lap is caused by careless hammering, or by badly proportioned grooves in rolls, or by careless rolling. A portion of the steel is folded over on itself, the walls are oxidized and cannot unite. A lap generally runs clear along a bar, practically parallel with its axis; it may be seen by a novice. Lapped steel should be rejected always.

Overblown.—Steel that has been blown in a Bessemer converter after the carbon is all burned; then there is nothing but steel to burn, and the result is bad.

Overheated.—Steel that has been heated too hot, and not quite burned; its fiery fracture exposes it. The grain of overheated steel may be restored, but restored steel is never as reliable as steel that has not been overheated. Overheating is a disintegrating operation.

Overmelted.—Steel that has been kept too long in fusion. The finest material may be ruined in a crucible by being kept in the furnace any considerable time after it has been killed. Open-hearth steel may be injured seriously in the same way. Prompt teeming after killing should be the rule.

Pipe.—A pipe is the cavity formed in an ingot when it cools; the walls chill first and nearly to the full size of the mould, then the shrinking mass separates in the middle, forming a pipe. A pipe should be at the top of the ingot; it may occur anywhere by bad teeming.

Point.—One hundredth of one per cent of any element. You have say 10 points of carbon, or 10 carbon; you want it raised a few points to 15 or 18 carbon.

Recalescence.—When a piece of steel is heated above medium orange color and cools slowly, at about medium orange—1100° to 1200° F.—the change of color ceases, then the color rises sometimes to bright orange, and afterwards the cooling goes on; this phenomenon is called recalescence. This is not yet a common shop term.

Restoring.—When a piece of overheated steel is re-heated to recalescence, kept there a few minutes, and then cooled slowly, its grain becomes fine and its fiery lustre disappears; this is called *restoring*. No nostrums are necessary.

Sappy.—Well-worked, good steel has a bluish cast, a fine grain, and a silky sheen. It is sappy; it is as good as it can be made.

Seam.—A seam is a longer or shorter defect, caused by a blow-hole which working has brought out to the surface and not eliminated. It usually, or always, runs in the direction of working. Seams are distinguished from laps by not being continuous; they are usually only an inch or two in length.

Short (Cold, Red, Hot).—*Cold-short* steel is weak and brittle when cold.

Red-short steel is brittle at dark orange or medium orange heat or at the common cherry-red heat. It may forge well at a lemon heat, and be reasonably tough when cold.

Hot-short steel is brittle and friable above a medium orange color; it may forge well from medium orange down to black heat.

Star.—A brilliant spot in mid-section showing that the pipe is not all cut away. It should be removed from tool-steel especially, as it may have considerable depth. It is of no use in any steel.

Temper.—Used by the steel-maker it means the quantity of carbon present. It is low temper, medium, or high; or number so and so by his shop numbers.

Used by the steel-user or the temperer it means the color to which hardened steel is drawn: straw, brown, pigeon-wing, blue, etc., etc.

Or, it is the steel-maker's measure of initial hardness; and it is the steel-user's measure of final hardness.

Water-crack.—A crack caused in hardening; it may run in any direction governed by lines of stress in the mass. It is distinguished from a *check* by being larger, and usually plainly visible.

Wild Steel.—Steel in fusion that boils violently, and acts in the moulds like lively soda-water or beer does when poured into a glass.



