

position is contained. The absence of weldability given by the sulphur, must necessarily produce a fibrous structure. The fibers are black and short because of the diffusion of slag throughout the mass. These irons offer in the cold, great resistance to flexure because of the possible approximation of the molecules before the point of rupture is reached. All these characters belong to irons which are not thoroughly welded.

Phosphorus.

In speaking of the influence of phosphorus upon the structure of iron, I omit from consideration those compounds of phosphorus and iron in which the metalloid is present in sufficient quantity to form true phosphides, since these compounds do not affect the question which I am discussing in this memoir. I shall speak here only of irons containing very small quantities of phosphorus, into which this metalloid enters only in amounts of a few thousandths. Phosphorus under these conditions plays a part diametrically opposite to that of sulphur. Phosphoretted irons weld with facility. Karsten* and all practical metallurgists also tell us of the very considerable weldability of irons which contain phosphorus. Now, since these irons have always a granular structure, we see here additional proof that these granular irons are our thoroughly welded irons.

RÉSUMÉ.

Although it would be possible for me to bring forward still other proofs in support of my position, I will stop here, believing that I have sufficiently elucidated the question and have demonstrated that iron possesses only a single texture, and that the granular one; and that this texture depends on one of the most essential properties of iron, its weldability. Every other kind of structure in iron is only a change in the granular texture, resulting from imperfect welding during the process of working the mass.

NOTE UPON THE MEMOIR OF M. JANOYER.

By M. L. GRUNER.

It is by no means easy to observe the real texture of a more or less malleable metal. In breaking it, certain portions of the bar in which especially it is necessary to study the internal structure, are always

* *Manual of Metallurgy*, i, § 196.

deformed. Moreover, it is now certain that many of the metals if not all, take on a crystalline structure when subjected to prolonged cooling. The crystals too are larger and coarser, the larger the metallic mass in which they are formed. Hence the cavities with crystalline sides which are observed in large wrought iron forged shafts, when by accident, these are ruptured.

It follows from these facts, that the rupture of a bar of more or less malleable iron, enables us to judge of the appearance of the fracture may be, but not of the texture properly so called. What M. Janoyer says above of granular and of fibrous irons, therefore, applies in reality only to fracture, not to texture.

Fracture may be produced either by a sudden, sharp and violent blow, or by a gradual and slow bending. According to the mode of rupture, the appearance of the fractured surface will be very different. When the break is effected by a slow flexure, the fibers of the iron may stretch and elongate themselves before rupturing; a fibrous fracture would then be produced. While the same iron, suddenly broken, may present a more or less granular fracture. In order to compare fractures, it is very necessary to operate in precisely the same way in all cases and upon bars of the same dimensions. A gradual bending produces precisely the same tearing effect upon the iron as too cold rolling; the molecules slide over each other, on the convex side of the bend; there is tearing and consequently, a fibrous fracture.

These facts excepted, it is entirely certain that the observations presented by M. Janoyer, are, in great part, correct. It is undoubtedly to interposed slag, very often, that it is necessary to attribute the imperfect welding of certain irons, and their tendency then, to present a fibrous fracture. But it is necessary also to recall the fact that when a partially carbonized iron is submitted to a welding heat, the carbon, by reducing the basic slags, may entirely disappear; while an iron not carbonized, is not, under the same circumstances, modified in any way whatever. Hence it happens that highly carbonized irons are actually more ready to assume or to maintain a granular fracture, than irons feebly carbonized.

M. Janoyer also seems to me to criticise wrongly the assertion of Karsten "that an iron composed of fibers and grains mixed, is a badly refined iron." It is quite certain that a badly refined iron, containing silicon or even slag in some parts of it, will show precisely this faulty welding at those places and will show a fracture varying in character at its different points.