SCALING

Malleable iron.

Separation of parallel layers at the surface following annealing in an oxidizing temperature.

Possible Causes

Sulfide formation at the casting surface due to a heat treating atmosphere containing SO$_2$ or H$_2$S. (The SO$_2$ may arise from oxidation of sulfides in the iron during the initial stages of malleablizing.) The iron sulfide phase which may result from the reaction is liquid at ordinary annealing temperatures. With progressive decarburization it can penetrate at grain boundaries on the casting surface. Depending upon the silicon content, the sulfides may form as a more or less fine network structure.

At the exterior of the sulfide network (a strongly decarburized area), it forms oxides containing manganese and silicon, whose formation is accompanied by an increase in volume. The structure becomes loose and filled with porous cavities.

The exterior layer, extending to the porous zone, may flake off during cooling of the casting (Fig. 186). A second scale, in the region of the sulfide network, is formed only when the casting undergoes deformation (Figs. 187 and 188). The strength of the sulfide network is very low (very brittle, fine-grained, non-metallic intermediate layer).
Scaling of malleable iron.

It is likewise possible, due to a highly oxidizing atmosphere which forms FeO, that sulfide inclusions will be immediately oxidized to liberate SO. This results in a new network of sulfides. The silicon and manganese in the surface layers are also oxidized to form manganese silicate.

These conditions lead to the formation of a thick, loose surface layer, usually pitted with holes as shown above.

Remedies

— Reduce the silicon content of the alloy.
— Reduce sulfur content or increase manganese.
— Assure that packing material (ore) is low in sulfur; also reduce proportion of new packing material.
— Reduce sulfur content in furnace atmosphere.
— Be sure annealing pots are sealed.