Other experiments indicate that with the latter treatment the bulk of the gases other than hydrogen, and about 0·05 c.c./100 gm. of the hydrogen itself, is associated with the oxide film which is inevitably present on the metal. The correction to obtain the true value of dissolved hydrogen is probably greater than this for the unturned specimen. We thus find that the hydrogen content of the corroded metal is rather less than 0·4 c.c./100 gm., with no evidence of a high concentration in the surface layers. A gas content of this order is quite normal for cast aluminium, and we therefore conclude that no appreciable absorption of hydrogen takes place under our conditions. We have certainly been unable to detect any effect of the magnitude described by Moreau and Chaudron.

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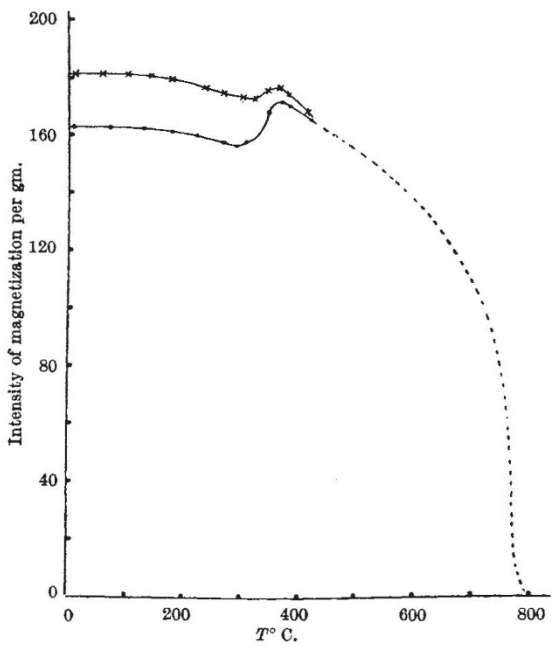
'Spoiling' of Tungsten Steel

It is known that the coercive force of tungsten magnet steel is reduced if the steel is maintained for a period at a temperature of 950–1,000° C. prior to hardening. The steel is then said to be 'spoiled'. In some such samples of tungsten steel the compound WC has been detected, and it has been suggested that the tungsten and carbon remaining in solution are insufficient to promote good hardening[1,2]. Experiments have been made on an unspoiled steel with the following analysis: W, 5·65; C, 0·72; Cr, 0·27; Si, 0·24; Mn, 0·3 per cent.



●—●—, quenched from 850° C.
×——×, annealed at 950° C. for 64 hr. and quenched from 850° C.

Small samples of this steel were heated for various times in an enclosed quartz tube at 950° C. Later, while still in the tube, they were quenched from 850° C. in water. The intensities of magnetization of these samples were measured by means of a Sucksmith balance[3] at various temperatures. The field of 11,300 Oersted was sufficient to produce saturation. The figure shows curves of specific magnetization against temperature for two specimens treated in this way, the periods for which the specimens were kept at 950° C. being zero and 64 hours respectively. The specific magnetization of these specimens at room temperature after annealing in a region between 400° C. and 700° C. is always about 189.

The curves can be explained by assuming that the quenched specimens contain some austenite which is non-magnetic. On heating to 300° C., the austenite is transformed into a magnetic martensite or ferrite. (The change actually occurs slowly between 250° and 300° C., but the curves shown were taken with the temperature rising fairly rapidly, and consequently the transition appears at a slightly higher temperature.) The percentage of austenite can be estimated either (*a*) by assuming that it is proportional to the amount by which the specific magnetization at room temperature is less than that for a completely ferritic specimen, or (*b*) from the increase in the specific magnetization at 300° C. shown in the figure. Results using the two methods of estimation are shown in the table.

	Time at 950° C. (hr.)	σ	% of austenite	
			Method *a*	Method *b*
1	0	161·2	15	12
2	0	162·9	14	12
3	1	170·0	10·5	10
4	4	173·5	7	7
5	64	178·5	5	5

The percentage of retained austenite can be seen to decrease progressively as the time of annealing at 950° C. increases. To explain this result it may be assumed that at 950° C. tungsten and carbon combine to form a separate carbide phase, the reaction proceeding rather slowly and approaching equilibrium exponentially according to the law of mass action. The remaining solid solution becomes less rich in these elements, and since it is the presence of tungsten and carbon that enables austenite to be retained on quenching, the percentage of austenite retained will decrease as the amount of tungsten carbide increases.

The specimens were also examined microscopically, but it was not found possible to estimate the quantity of austenite by this method; but an increase in the patterns usually attributed to WC was observed as the time of annealing at 950° C. increased.

These experiments strengthen the theory that the 'spoiling' of tungsten magnet steel is caused by the formation of a separate carbide phase which reduces the amount of tungsten and carbon available to promote hardening.

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