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THE EFFECT OF PHOSPHORUS ON THE HARDNESS OF IRON

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Pure Japanese Electrolytic Iron (0.01% P, 0.01% Si, 0.01% Mn, 0.01% S, 0.01% C and 0.005% Al) was melted down with various additions of Fe_3P (20-25% P, 2.5% Si, 2.5% Mn) to give a range of alloys containing 0.5 to 1.5% phosphorus..

Small billets were cast, allowed to cool, then annealed under vacuum at 800^{o}C for eight hours. Two methods of preparing test pieces were used on specimens cut from the billets. The first was the hot rolling of the specimen to form a flat bar, (specimens were heated to 800^{o}C in a muffle furnace under nitrogen atmosphere). The second set of specimens were surface ground to give flat test pieces. Both sets of test pieces were then cold worked.

The results for the hot rolled test pieces are given in Table I. The as-cast and annealed specimens show a rapid increase in hardness with increasing phosphorus content. The hot rolling to form the test pieces results show that there is a reduction in hardness, probably due to an homogenisation effect of the rolling. The cold working results show a rapid increase in hardness (except for 0.9% phosphorus which shown an initial decrease). The test pieces containing 1.2% and 1.5% phosphorus only just achieved 10% reduction, and no further working could be carried out.

Table I

HARDNESS OF COLD ROLLED ELECTROLYTIC IRON WITH PHOSPHORUS

(test pieces prepared by hot rolling)

% P	Hv			
	Cast & Annealed	After hot rolling	Cold reduced	
			10%	20%
0.6	250	216	295	320
0.9	316	250	230	330
1.2	333	287	325	-
1.5	437	270	310	-

Table II

HARDNESS OF COLD WORKED ELECTROLYTIC IRONS WITH PHOSPHORUS

(test pieces prepared by surface grinding)

% P	Hv	
	Cast & Annealed	Cold reduced 10%
0.6	250	300
0.9	316	305
1.2	333	364
1.5	437	340

The results for the surface ground test pieces are given in Table II. No significant reduction beyond 10% could be achieved. The results are not fully satisfactory, but they do suggest some segregation of the phosphorus (confirmed by Scanning Electron Microscopy). Billets containing 0.6 and 1.2% phosphorus show an increase in hardness due to the work hardening effect, whereas 0.9% and the 1.5% samples show a decrease due to the homogenisation effect.

Conclusions

The results obtained clearly show that hardnesses of the order of 300 Hv can be obtained by either hot working and subsequent cold working or solely cold working irons containing greater than 0.6% phosphorous.