NEW APPLICATIONS OF ELECTROMETALLURGICAL ALLOYS.

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Among the alloys prepared by means of the electric furnace the most important are those containing iron, and particularly the ferro-silicons.

Substances prepared in this way have a percentage of silicon varying from 20 to 75 per cent., the most usual being 20 to 25, 50 to 55, and 70 to 75 per cent.

Their uses are well known to all metallurgists, while the analytical methods for determining them are very numerous, accurate, and wholly without complication, being all based on the solutions of the substance in alkalis in the presence of an oxidising agent such as peroxide of sodium, sodium oxide, or free oxygen.

It is a fact well known to analysts that no methods of analysis are based on the effect of acid, except in the case of hydrofluoric acid, for the reason that ferro-silicons with percentages above 20 per cent. are insoluble in acids.

It is this peculiar property, due to silicon alone, which has been employed in an altogether unusual way; *i.e.*, instead of placing ferro-silicons in acids to dissolve them, acids during their preparation may be contained in ferro-silicon apparatus.

Thus, by using high percentage ferro-silicons, apparatus practically unaffected by acids are obtained.

Ferro-silicons are not, however, the only substances which possess this property. For, as this unalterability is due to the silicon, any alloy of a metal with this metalloid will behave in the same way to a greater or less degree according to the nature of the metal. It is evident, for instance, that calcium silicide will be unaffected by acid; the same phenomenon, in fact, occurs, for it is evidently much less affected than metallic calcium would be.

In answer to the question whether the problem of constructing apparatus for the preservation of acids is solved by making use of metallic silicides, it may be said that (1) these substances are very fragile; (2) they contract considerably on cooling, often breaking in the mould when scarcely solid and still at a bright red heat; (3) their melting-point is low compared with the temperatures occurring in ordinary foundry practice—*e.g.*, the second melting in a coke or furnace gas-heated cupola; and (4) certain of these compounds are powerful reducing agents, so that an effect similar to that produced by aluminium may occur. In consequence, fusion in the presence of the air necessary for combustion of the coke or furnace gas is impossible without

considerably lowering the percentage of silicon (especially in rich ferro-silicons—*i.e.*, about 35 per cent.) to such a point that sometimes it will become as low as 15 per cent., and thus give alloys which are attacked by moderately strong acids.

Manufacture of Apparatus.—It is not proposed to enter here into complete details of the foundry methods employed, which belong rather to technical metallurgy, and it will simply be shown that by quite special and perfect arrangements, as well as by the correction of the mechanical properties with alloys of different natures, it has been possible to obtain, after six years' research, apparatus of all kinds and descriptions.

The first part of the process consists in obtaining melted metal suitable for pouring into moulds.

The simplest and most used of these methods consists in pouring alloys, melted in that apparatus, directly from the electric furnace into a mould lined with some refractory material. The mixture is then made. In a second method, the alloys obtained from the electric furnace are remelted in an oil, or in certain cases in a crucible, and then cast into ingots.

Once the liquid metal is obtained, metals for corrective purposes are added. The number and nature of these is practically infinite for any particular case. They are added directly to the metal in the casting ladle, usually with aluminium, which raises the temperature of the bath and increases the fluidity.

When the ladle is ready it is used mechanically, by a travelling crane, and carried quickly, to prevent cooling, to the mould. The pouring is effected by ordinary means without any special precautions.

The casting is removed as soon as it solidifies, is turned out into the warm casting sand, and thus annealed at a bright red heat. It is then ready for use.

Resistance to Acids.—The resistance of the metallic alloys of silicon, which have been called "*Métillures*," to acids is quite interesting, as the following examples will show. Nitric acid, even as a vapour, such as is obtained at the exit of a bisulphate retort or when mixed with nitrous acid, does not affect them at all. A striking example of this is given by a pipe which has been submitted for nearly five years to the daily passage of 660 lbs. of nitric acid vapour at temperatures varying from 150° to 200° without its loss in weight exceeding a few decigrammes in a total weight of a score of kilogrammes. This loss occurred quite at the beginning of the period, and was probably due to a few impurities remaining on the inner surface of the pipe after fusion.

Sulphuric acid has still less effect, and acids of strength from 20 to 25, known as *petites eaux*, may be concentrated in vessels of this kind by direct heating and continuous evaporation.

Hydrochloric acid is analogous in its action, and use has been made of pipes of the above material for carrying and condensing its gases.

Acetic acid and the mixture produced by treating calcium acetate with sulphuric acid are without effect on "*Métillures*," even in the presence of air.

Resistance to other Reagents.—An important English firm has obtained the following figures relating to the resistance of "*Métillures*" to the action of cyanides, sulpho-cyanides, and prussic acid. The results are very remarkable, for they show both that the unattackability increases with the percentage of silicon, while for a suitable percentage it is practically negligible.

"MÉTILLURES"—20 PER CENT. NITRIC ACID.

No.	Weight in grms.	Change in Weight.	Reaction with Sulpho-Cyanide.
		After 24 hours.	
1	6'4410	— 0'0392	Violent.
2	5'1669	— 0'0047	Slight.
3	8'1524	— 0'0037	Moderate.
4	14'5013	+ 0'0012	Moderate.
5	1'7060	— 0'0716	Very violent.
6	1'4941	— 0'0034	Very slight.
		After 48 hours.	
1	6'4018	— 0'0207	Violent.
2	5'1622	— 0'0006	Very slight.
3	8'1487	— 0'0032	Moderate.
4	14'5025	+ 0'0045	Slight.
5	1'6344	— 0'0323	Violent.
6	1'4907	— 0'0007	None.

MÉTILLURES—13 PER CENT. SULPHO-CYANIDE OF ANILINE.

No.	Weight in grms.	Change in Weight.	Reaction with Potassium Ferri-cyanide.
		After 24 hours.	
1	6'3811	— 0'0387	Very violent.
2	5'1616	— 0'0065	Moderate.
3	8'1455	— 0'0455	Violent.
4	14'5070	+ 0'0055	Slight.
5	1'6021	— 0'0186	Violent.
6	1'4900	— 0'0160	Very slight.
		After 48 hours.	
1	6'3430	— 0'0675	Very violent.
2	5'1551	— 0'0219	Moderate.
3	8'1000	— 0'0433	Violent.
4	14'5125	— 0'0063	Slight.
5	1'5835	— 0'0216	Violent.
6	1'4740	— 0'0011	Very slight.

Under the same conditions, iron or any other metal in commercial use would be rapidly attacked, thus preventing its employment. The apparatus constructed up to the present time is extremely varied both in form and dimensions, ranging from evaporating dishes, troughs, right-angled bends, elbows, worms, ventilators, &c., and in the other from those weighing about 20 lbs. and having a diameter of 1 ft. to those weighing over 1 ton and measuring 7 ft. across, as well as pipes with a diameter of 8 ft. and weighing about $\frac{3}{4}$ of a ton.

To sum up, it may be said that the production of a material capable of resisting acids is an accomplished industrial fact, and the principal desiderata are realised. It remains, however, to remedy the unmalleability of these substances. This question is actually being studied, and a solution seems probable in the near future.

As electrometallurgists we may congratulate ourselves that without the electric furnace, which alone permits sufficiently high temperatures for the

reduction of silicon or silicates by carbon to be obtained, the high percentage alloys of metals with silicon could not have been manufactured.

Further, without the electric furnace the fusion of high-percentage silicides would not have been possible. For when the percentage exceeds 50 the temperature of a coke or gas furnace is not sufficient to permit these alloys to be cast, not because they will not run, but because their specific heat is too low for the metal to be poured. In fact, it will not leave the crucible, but forms a pasty mass.

This latest conquest of the electric furnace has come at a most suitable time. For platinum, the most stable industrial metal, is becoming more and more rare, while its price is increasing by leaps and bounds, making its employment a matter of greater and greater difficulty.