PAPER NO: 22

NICKEL IN NON-FERROUS GENERAL ENGINEERING ALLOYS(*)

B.A. Weldon, Development Officer,
International Nickel Limited, London S.W.1.

Dr. S.N. Anant Narayan, Managing Director,
International Nickel (India) Pvt.Ltd.,
Bombay-1 BR.

Some recent developments in the nickel-containing copper and aluminium alloys and in nickel alloys of general engineering interest, i.e. excluding the high-temperature alloys, are described in details in the paper.

Alloy 625

This nickel-chromium-molybdenum alloy has recently been developed in the U.S.A. as a high-temperature material. It is now finding application in this field, but other uses which depend on the wet corrosion-resistance are under active investigation.

Alloy 625 has excellent resistance to many aqueous environments, including chloride mixtures, but of particular interest is its extremely high resistance to sea-water corrosion. The general corrosion rate of the alloy under all conditions of exposure is for all practical purposes zero; even in crevice conditions it is extremely resistant to the pitting attack in sea-water which occurs in many high-chromium alloys. It has shown high resistance to stress corrosion in all tests carried out to date. This corrosion-resistance, coupled with excellent strength, makes the alloy of considerable interest for marine engineering applications.

Nickel-Silicon Alloys

Recent work on ternary nickel-silicon-titanium alloys

(*) Paper for presentation at the Symposium on "Recent Developments in Non-Ferrous Metals' Technology" - 4th to 7th December, 1968, Jamshedpur.

has led to the possibility of developing an alloy which will combine good resistance to boiling sulphuric acid over the whole concentration range with a useful degree of ductility. This work has established that the beta phase of the binary nickel-silicon system is more ductile than previously supposed, and that titanium additions stabilize this beta phase. The corrosion-resistance of the nickel-silicon-titanium alloys having essentially a beta structure can be improved by small additions of molybdenum and copper. Alloys of this type have already been patented.

High-strength copper-nickel alloys

Alloys already being produced commercially include "Hiduron"* 191 in the U.K., Alloy 717C in the U.S.A. and Nickel Bronze NB_1 in Germany; all are essentially precipitation-hardening alloys, although separate heat-treatments are carried out only if the maximum level of strength is required.

Another cupro-nickel of enhanced strength - IN-732-X - has recently been invented, and is in the process of being developed commercially. This alloy contains 2.8% chromium and is unusual in that the strengthening mechanism is a spinodal decomposition.

Nickel Silvers

The other class of copper alloy in which nickel is a major alloying element is the nickel silvers. These are, of course, very old-established materials but they have been employed mainly for decorative applications, such as spoons and forks, holloware and architectural trim. The only major use in general engineering has been in the telecommunications industry, which employs the copper-18% nickel-27% zinc alloy, in particular, for relay springs and contacts.

The engineering properties of the nickel silvers have been the subject of renewed interest recently, and the alloys are being incresingly used for springs and connectors in the electrical and electronics industries. In one example of this, recently described by Worth, the alloy containing 12%

* Trade Mark

nickel and 29% zinc has been used for a new design of connector.

Aluminium-Silicon-Nickel piston alloys

Nickel is not normally considered to be a major alloying element in the aluminium-base alloys, but it is present in many of the cast aluminium-silicon alloys used for pistons of internal-combustion engines. These alloys are divided into two broad classes: the hypoeutectic alloys containing up to 12 or 13 per cent silicon, and the hypereutectic alloys with over 13 per cent silicon. Both types usually contain small additions of copper and magnesium - about one per cent of each is common. The nickel content normally ranges from about 0.7 to 2 per cent, although for certain of the high-duty hypereutectic alloys it may be as high as 3.5 per cent.

The main function of nickel in these alloys is to improve their elevated-temperature properties, particularly strength and dimensional stability, without the loss in machinability which would occur if the silicon content were raised to effect the same improvements.

Aluminium-nickel-manganese pressure-
die-casting alloys

An alloy containing 2.5 per cent each of nickel and manganese has been recently developed in Italy, for use primarily in the burners of gas stoves. The alloy is suitable for pressure die-casting, and this process is particularly useful for making burners with the close dimensional tolerances which are desirable when using natural gas. The flame characteristics of natural gas are such that the burner itself tends to become much hotter than is the case with coal gas; temperatures up to 560°C have been found in normal operation.

An aluminium-4% manganese alloy has also been used for die-cast gas burners. It also has higher strength than the aluminium-silicon type, but is somewhat susceptible to hot tearing during the die-casting process.

The aluminium-nickel-manganese alloy is already in commercial production in Italy, where it was first developed, and it is being considered for use in other countries, particularly in Northern Europe, where natural gas is becoming more widely available. Consideration is also being given to its use in applications other than gas burners, since, in addition to its attractive mechanical properties, it has the ability to take and retain a good surface finish.

- - - -