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MAGNETIC ALLOY

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This invention relates to quaternary alloys and their application to telegraphic and telephonic conductors.

The alloys in question comprise nickel and iron, a third element which is either silicon or aluminium, and a fourth element, preferably either chromium, tungsten, molybdenum or vanadium.

The objects of the invention are alloys of high electrical resistance and high magnetic permeabilities in fields of H from .001 gauss to 2 gauss.

Alloys are known which have high electrical resistance and initial permeability of the order of 1000 and in the known alloys nickel is the chief constituent. In the alloys described herein, iron is the major constituent and these possess initial permeabilities of a higher order, so that not only are they superior in magnetic properties to the known alloys, but they are also less costly to manufacture.

According to this invention an alloy comprises nickel 32–42%, the said third and fourth elements, each of which may vary between 1–4% of the whole, and the remainder iron, which is, however, preferably within the limits 55–65%.

Such alloys possess very high electrical resistance, and magnetic permeabilities which are practically constant within fields between .001 and .100 gauss and do not vary more than 10%.

Carbon should be substantially excluded, but to promote workability, a small content amounting to not more than a few tenths of 1% of manganese or other metal having deoxidizing properties may be added. Substances of this class will be hereinafter included in the term "a deoxidizer of the manganese type". A quantity as great as 1% is not desirable, and excellent results have been secured with the addition of only .3%.

As a result of many experiments we have found alloys which, when rolled into strip, or drawn into wire, etc., and suitably heat treated have properties which make them suitable for loading submarine telegraph conductors for duplex working.

Example 1

	Per cent
Iron	60.0
Nickel	36.5
Chromium	2.0
Silicon	1.3
Manganese	.2

after forging, drawing the wire and heat treating rapidly to 900° C. in nitrogen, maintaining at that temperature for two minutes, and cooling in air, had the following magnetic properties:—

H=.001	μ=1580
H=.05	μ=1650
H=.10	μ=1675

Its electrical resistance was 95 microhms per cm^3.

In order to secure the foregoing results the raw materials used in the manufacture of the alloy were of good quality. Swedish charcoal iron containing only .04% of carbon was used as a base. Mond nickel and chromium prepared by the thermit process were melted with the iron; the silicon addition which took the form of 95% ferro silicon, was added together with the manganese immediately prior to casting. The melting was carried out in an induction type of furnace, the subsequent operations for forging, rolling, etc., were carried out by the usual methods.

A signalling conductor loaded with wire of the foregoing composition, after heat treatment, when tested with an alternating current of between 1 and 100 milliamperes, had an inductance that only varied 8%.

Example 2.—An alloy containing:—

	Per cent
Iron	60.0
Nickel	36.5
Chromium	1.9
Silicon	1.3
Manganese	.3

after forging, drawing to wire and annealing at 900° C. for two minutes, has an electrical resistance of 95 microhms per cm³., and the following magnetic properties:—

H= .001	μ=1500
H= .01	μ=1600
H= .10	μ=1770
H=1.0	μ=4780

When aluminium is the third element, the magnetic permeability shows greater variation within the limits of a field between .001 and .100 gauss. For example, an alloy containing:—

	Per cent
Iron	58
Nickel	36
Chromium	3
Aluminium	3

after reducing to wire, and heat treating as previously described, gave the following magnetic results:—

H=.001	μ=1300
H=.05	μ=1360
H=.10	μ=1420

its electrical resistance was 104.5 microhms per cm³.

What we claim is:—

1. A magnetic material substantially free from carbon comprising nickel 32–42%, 1–4% of aluminum, 1–4% of an element for increasing the electrical resistance, and iron the remainder.

2. A magnetic material substantially free from carbon comprising nickel 32–42%, iron 55–65%, 1–4% of aluminum and 1–4% of an element for increasing the electrical resistance.

3. An alloy as claimed in claim 1, comprising not more than 1% of a deoxidizer such as manganese.

4. A magnetic material substantially free from carbon comprising nickel 32–42%, iron 55–65%, 1–4% of aluminum, 1–4% of an element for increasing the electrical resistance, and not more than 1% of a deoxidizer such as manganese.

5. A magnetic material substantially free from carbon comprising iron 58%, nickel 36%, chromium 3%, aluminium 3%.

6. A magnetic material substantially free from carbon comprising nickel 32–42%, 1–4% of aluminum, chromium 1–4% and iron the remainder.

7. A magnetic material substantially free from carbon comprising nickel 32–42%, iron 55–65%, 1–4% of aluminum, and 1–4% of chromium.

8. Quaternary alloys of iron and nickel, comprising nickel 32–42%, iron 55–65%, aluminium 1–4%, 1–4% of chromium, and not more than 1% of a deoxidizer such as manganese.

9. A magnetic material substantially free from carbon comprising about 32 to 42% of nickel, about 55 to 65% of iron, about 1 to 4% of a substance selected from the group consisting of silicon and aluminum, and about 1 to 4% of a substance selected from the group consisting of chromium, tungsten, molybdenum and vanadium, such alloy containing no more than a few tenths of a per cent of manganese.

10. A magnetic material substantially free from carbon comprising about 32 to 42% of nickel, about 55 to 65% of iron, about 1 to 4% of a substance selected from the group consisting of silicon and aluminum, and about 1 to 4% of a substance selected from the group consisting of chromium, tungsten, molybdenum and vanadium, and containing a few tenths of a per cent only of "a deoxidizer of the manganese type".

11. A magnetic material substantially free from carbon comprising about 32 to 42% of nickel, about 55 to 65% of iron, about 1 to 4% of a substance selected from the group consisting of silicon and aluminum, and about 1 to 4% of a substance selected from the group consisting of chromium, tungsten, molybdenum and vanadium, the said alloy being substantially free of carbon, such alloy containing no more than a few tenths of a per cent of manganese.

In testimony that we claim the foregoing as our invention, we have signed our names this twenty fourth day of October, 1927.

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