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FERRONICKEL-CHROMIUM ALLOY.

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To all whom it may concern:

Be it known that I, PIERRE GIRIN, a citizen of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in Ferronickel-Chromium Alloys, of which the following is a specification.

One of the first applications of steels with a high content of nickel has been their use in the manufacture of blades of steam turbines. This choice was justified by the remarkable mechanical properties of the ferro-nickels, especially their high mechanical resistance associated with the complete absence of brittleness, their resistance to wear and to rust, and, finally, by the possibility of avoiding, by a judicious choice of the coefficient of expansion, which varies between 0 and 18 x 10^{-6} per degree according to the content in nickel, displacement and leakage, inevitable when we associate in a thermal machine materials having different coefficients of expansion. But experience has shown a considerable drawback in the use of ferro-nickels in contact with steam or hot and moist gases, a drawback which has entirely proscribed its use for members exposed to the atmospheres above mentioned; light pittings due to rust appear and ultimately produce fissures. These fissures extend from point to point, are opened by the play due to vibration, and rapidly become larger, finally compromising the solidity of the member attacked.

After a minute study of the conditions and the processes of the attack, it has been possible to discover the remedy.

The present invention concerns an alloy of iron, nickel and chromium, including, perhaps, tungsten, molybdenum, cobalt, vanadium and titanium, presenting mechanical qualities superior to those of the ferro-nickels and absolutely refractory to any local attack, or to corrosion in saturated or superheated steam or moist or hot gases.

Alloys according to the present invention contain besides iron:

Nickel	25	to 40	per	cent.
Chromium	10	to 15	"	"
Manganese	0.5	to 1	"	"
Carbon	0.3	to 1	"	"

and may contain in addition any one or more of the following:

Cobalt	0	to 10	per	cent.
Tungsten	2	to 5	"	"
Molybdenum	1	to 3	"	"
Vanadium	0.2	to 1	"	"
Titanium	0.1	to 0.2	"	"

Such additions of cobalt, tungsten, molybdenum, vanadium and (or) titanium in the proportions above stated may be made in order to improve the mechanical properties of the alloy, but they are not essential. Such additions are made at the expense of the proportion of iron remaining.

We can modify the composition between wide limits without changing the essential quality of the steel which is a resistance to alteration under the conditions mentioned. An addition of tungsten, molybdenum, or cobalt, permits the mechanical resistance to be increased from 70 kgs. up to 90 or 100 kgs. and improves the resistance to wear without increasing brittleness. The working can be facilitated and also the quality improved by an addition of vanadium or titanium.

According to the content in nickel adopted the coefficient of expansion will vary from 8 to 17 x 10^{-6}. It is consequently possible to obtain a predetermined expansibility, for example, that of steel, 11 x 10^{-6}, or bronze 17 x 10^{-6}.

Chromium in large quantities has not only the effect of rendering the metal more resistant and inoxidizable, but completely prevents the physico-chemical phenomena to which are due the pittings and local changes peculiar to ferro-nickels.

Having thus described the nature of the said invention and the best means I know of carrying the same into practical effect, I claim:—

1. An alloy of iron, nickel, chromium and manganese, containing nickel, 25 to 40 per cent, chromium, 10 to 15 per cent, manganese, 0.5 to 1 per cent, and carbon, 0.3 to 1 per cent, such alloy being inoxidizable and unalterable in superheated steam and in moist and hot gases, having high mechanical resistance without brittleness and great resistance to wear, and having any required

coefficient of expansion between 8 and 17 x 10^{-6}, notably those of steel, bronze or glass.

2. The alloy of claim 1, containing also from 1 to 5 per cent of a metal in the nature of tungsten, and from 0.1 to 1 per cent of a metal in the nature of vanadium.

3. The alloy of claim 1, containing also from 1 to 5 per cent of a metal in the nature of tungsten.

4. The alloy of claim 1, containing also from 1 to 5 per cent of molybdenum.

In witness whereof, I have hereunto signed my name.

PIERRE GIRIN.