

# UNITED STATES PATENT OFFICE.

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## ALLOY.

No Drawing.

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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 at 84 Rue de Lille, Paris, Seine, France, engineer, have invented new and useful Improvements in Alloys, which is fully set forth in the following specification.

In my U. S. Patent No. 1,422,096, dated July 11, 1922, is described the manufacture of an alloy which resists particularly well the corrosive action of chemical agents and has mechanical properties superior to those of steel.

This alloy was at first manufactured in small quantities and by small apparatus; the necessity for manufacturing on a large scale in a metallurgical apparatus like the Martin furnace has led the applicant, in order to satisfy the conditions peculiar to this mode of manufacture, to extend the limiting percentage of carbon and of manganese originally given and to increase in certain cases the percentage of nickel from 25 to 40 per cent.

The applicant has also selected among the possible constituents which may be added, those that present the most interest and has determined the practical limits in which they should be present to satisfy the above conditions of manufacture.

Referring to elements the functions of which have already been proved in metallurgical practice, namely cobalt as softener, vanadium and titanium in small doses as purifiers, tungsten and molybdenum as aiding chromium in improving the resistance to corrosion in general (temperature, superheated steam, acids); there are five constituents which are regarded as necessary for all contingencies, namely, iron, nickel, chromium, manganese and carbon.

The possible applications of these alloys are more extended than was originally supposed.

The alloy obtained according to the invention by increasing the content of carbon and manganese being practically unattacked by strong acids, is a fortiori unattacked by organic acids and other organic matters, and also resists alkalies in solution or even in igneous fusion.

The typical alloy comprises:—

|                 | Per cent |    |
|-----------------|----------|----|
| Nickel .....    | 20 to 40 |    |
| Chromium .....  | 10 to 15 | 55 |
| Manganese ..... | 1 to 5   |    |
| Carbon .....    | 0.2 to 1 |    |
| Iron, residue.  |          |    |

Accessories:—

|                  | Per cent |    |
|------------------|----------|----|
| Cobalt .....     | 0 to 10  | 60 |
| Vanadium .....   | 0.2 to 1 |    |
| Titanium .....   | 0.1 to 5 |    |
| Tungsten .....   | 0.5 to 5 |    |
| Molybdenum ..... | 0.2 to 3 | 65 |

The maximum content previously indicated for the carbon and manganese are carried to 1 per cent. and 5 per cent. respectively. Manganese is an indispensable constituent for ensuring satisfactory capacity for forging. An example of the composition is:

Ni: 22, Cr: 12, Mn: 2.5, C: 0.3, Fe: the rest.

The content of nickel may be carried to 40 per cent. to fulfill certain conditions in respect of elasticity and dilatation of the alloy; for example the composition of the alloy may be:—

Ni: 37, Cr: 10, Mn: 2, C: 0.5, Fe: the rest.

Such an alloy has the mean dilatation of glass ( $8 \times 10^{-6}$ ) and a modulus of elasticity in tension  $E = (10 \times 10^{-9}$  to  $20 \times 10^{-9})$  of which the temperature coefficient will be very small.

Additions of other metals as accessories, such as vanadium (from 0.2 to 1 per cent.), titanium (from 0.1 to 0.5 per cent.), may be made with advantage to facilitate the manufacture. Moreover, an addition of 0.5 to 5 per cent. of tungsten or of 0.2 to 3 per cent. of molybdenum, or a simultaneous addition of these two elements, improves the resistance to hydrochloric acid, and, in another order of ideas, the mechanical properties; in particular the temperature coefficient of the modulus of elasticity may be reduced practically to zero at ordinary temperatures.

Finally, an addition of 0 to 10 per cent. of cobalt also increases the mechanical strength.

The additions indicated are made at the cost of the content of iron.

Alloys made in accordance with either this invention or that described in the aforesaid patent are applicable for purposes in which non-oxidizability and resistance to chemical agents are required, for example:

1. Metallic gauze for making the safety sheath of miners' lamps as well as the sheets which, in the chemical laboratory, are introduced between glass vessels and burner flames. These articles were hitherto rapidly destroyed, because of the facility of oxidation of metal wire (iron, nickel, copper or their alloys) used hitherto in the construction of the gauze or sheets.

Metallic wires made from the alloys specially resisting corrosion described in the aforesaid patent and in the present specification, offer a chemical resistance infinitely superior to that of iron and of all metals. A wire of some tenths of a mm. made of one of these alloys, when heated to 900° C., does not show a sensible alteration for several hundred hours. At 1100° C. no change occurs for more than ten hours. The wire, flexible and very supple, lends itself well to the construction of gauze. Experiments made in the chemical laboratory have shown the perfect resistance and the unlimited durability of metallic gauze woven with these threads and used to protect glass flasks from the flame of the burner.

2. Certain parts of firearms, such as sporting guns. There has been sought for many years by manufacturers of sporting guns, notably guns de luxe, an alloy resisting sufficiently the oxidation provoked by the products from nitrated powders and having, moreover, the mechanical properties primarily necessary in a metal for such guns, that is to say:

High mechanical strength united with an absolute lack of brittleness (a strength insufficient to the shock produced by the deflagration of the powder being, in this application, particularly dangerous), and, moreover, capacity for being satisfactorily worked, notably drilled, at small diameter over a great length.

The alloys here in question respond to these various desiderata. They are not oxidizable and have, on the other hand, valuable mechanical properties, namely:

Tensile strength 70 to 90 kilos in the finished state, a figure variable with the degree

of hardening according to the mode of working (rolling or drawing finished at a more or less low temperature, drawing cold).

Elongation in the finished state, 15 to 20 per cent.

Resilience (by the Guillery test) 25 to 40 kilos.

Moreover, a very important quality, they can be worked very easily at a speed from 12-15 metres per minute with high speed steels of current manufacture.

These alloys have no need of being tempered and nevertheless offer a very satisfactory resistance to wear.

3. Cutlery de luxe, as in surgical cutting blades, flexible blades, instruments for use in surgical operations, where a metal is required which while possessing properties comparable with those of steel for retaining a cutting edge, elasticity and the absence of brittleness, resists the prolonged action of corrosive materials such as antiseptics; cutlery and instruments for the culinary art.

The alloys described in the aforesaid patent and in the present specification are useful in certain industries, such as the manufacture of vegetable extracts, dyestuffs, paper pulp, the preparation of textile materials of animal or vegetable origin, in which blades are used for the disintegration of various materials in the presence of various chemical agents.

The cutting edge which can be given to these alloys is not absolutely comparable with that which is obtainable in hard tempered steel, but it is very superior to that of bronze and other alloys having non-ferrous metals as basis which are used for the same purposes.

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

An alloy of the character described containing nickel appreciably in excess of 20% and not exceeding 40%, chromium 10% to 15%, manganese 1% to 5%, carbon 0.2% to 1%, and iron the remainder, said alloy being heat-resistant and non-corrodible and having ductility and malleability adapting it for wire drawing and forging.

In testimony whereof I have signed this specification.

PIERRE GIRIN.