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# UNITED STATES PATENT OFFICE

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## METAL ALLOY

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The object of the invention is to provide a relatively inexpensive metal alloy which is highly resistant to dilute mineral acids.

A metal alloy embodying our invention may be classified as a chromium-copper-nickel steel. Steel containing the alloying metals specified is known, but the production of an alloy steel that will accomplish the object of our invention requires that the percentages of the alloying metals shall be fixed within well defined limits.

It is well known that high nickel will impart to steel excellent resistance to sulphuric acid; but nickel is a comparatively expensive metal and for that reason high nickel steel is not saleable to any substantial extent for acid resistance purposes. It is known that copper can displace nickel to a limited extent, but not sufficiently to enable the nickel content to be reduced to the degree required to make its use economical. It is also known that chromium, while increasing resistance to solution by nitric acid, is devoid of capacity to impart to steel any special resistance to sulphuric acid, although its use in various proportions with nickel, or with nickel and copper, is known to be practicable, provided the nickel content remains sufficiently high.

We have discovered that if we add a proportion of chromium which is unusually high, but which is within comparatively narrow limits, it is possible to displace by copper a much larger proportion of the nickel than has heretofore been deemed possible, so that the percentage of nickel may be reduced to as low as four percent, and to even as low as one percent, the copper then functioning, provided it be added in sufficiently high proportion, to displace most of the nickel. Since the cost of copper is small in comparison with the cost of nickel, the combined cost of nickel and copper is low; and since ferro-chromium is comparatively inexpensive, it is possible to produce an acid resistance alloy steel at a cost heretofore considered impossible, while at the same time imparting to the alloy steel a high resistance to dilute sulphuric and hydrochloric acids and a fair resistance to nitric acid.

An alloy embodying our invention contains chromium 20 to 25%, copper 7 to 15%, preferably not less than 10%, nickel 1 to less than 4%, silicon 2 to 8% and carbon .1 to 2%; the remainder of the composition, which may comprise from about one-half to two-thirds of the composition, being principally iron. The percentage of chromium must exceed that of the copper and the percentage of copper must exceed that of the nickel. The percentage of chromium should exceed that of the copper and nickel combined.

A preferred composition comprises chromium 22%, copper 12%, nickel 3%, silicon 5% and iron 57%. If the material is to be forged it appears necessary that the silicon be below 6%.

Compositions containing the alloys specified within the ranges specified show not only good resistance to cold nitric and sulphuric acid but they are fairly resistant to hydrochloric acid, as is shown by the following examples, wherein the last three columns show the loss, in milligrams per square centimeter per hour, of metal at the acid concentration specified and at the temperature specified:

| C | Mn | Si | Ni | Cr | Cu | | 3% | 20% | 40% |
|---|---|---|---|---|---|---|---|---|---|
| .23 | .45 | 2.64 | 4.25 | 21.80 | 11.75 | 80° F. $H_2SO_4$ | .019 | .005 | .005 |
| | | | | | | 80° F. HCl | .055 | .226 | .496 |
| | | | | | | 80° F. $HNO_3$ | .011 | .130 | .740 |
| .16 | .46 | 3.85 | 3.38 | 21.50 | 7.38 | 80° F. $H_2SO_4$ | .000 | .005 | .009 |
| | | | | | | 180° F. $H_2SO_4$ | .038 | ----- | ----- |

What we claim is:

1. A metal alloy comprising chromium 20 to 25%, copper 10 to 15%, nickel 1 to less than 4%, silicon 2 to 8%, the balance of the composition being principally iron; the alloy being characterized by high resistance to sulphuric acid and fair resistance to hydrochloric acid.

2. A metal alloy comprising chromium 20 to 25%, silicon 2 to 8%, copper and nickel combined over 10% to less than 19%, the copper being not less than 7% and not over 15% and the nickel being over 1% and less than 4%, the balance of the composition being principally iron; the alloy being characterized by high resistance to sulphuric acid and fair resistance to hydrochloric acid.

In testimony of which invention, we have hereunto set our hands, at Philadelphia, Pa., on this first day of October, 1931.

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