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## ALLOY

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This invention relates to alloys exhibiting unusual resistance to attack by corrosive agents and more particularly to nickel base alloys having a high percentage of molybdenum and which are highly resistant to attack by solutions containing hydrochloric acid.

It is known that alloys possessing good resistance to acids and corrosive agents generally can be produced by combining molybdenum and a predominating amount of nickel. Alloys of this type are disclosed in Patents 1,375,082 and 1,375,083 to Clements; 1,710,445 to Becket; and 1,836,317 to Franks. In addition to molybdenum and nickel, these compositions generally include one or more of the following: iron, chromium, and lesser amounts of copper, manganese, tungsten and vanadium, specifically added to impart desired physical characteristics. Silicon and carbon in small amounts are present in the raw materials used, and are thereby introduced into the alloys and in some instances are specified as constituents thereof. Thus in Clements, amounts of silicon ranging from 0.25 to 0.50% of the alloy are held to be useful in enhancing fluidity in the pour stage, while in Becket, up to 1.5%, but preferably below 0.5%, and in Franks up to 1%, but preferably between 0.25 and 1% of silicon is disclosed, presumably for the same purpose, i. e., of enhancing fluidity whereby ease of handling the alloy in the pour stage is increased. Carbon appears to be of more doubtful utility, although amounts up to 2% have been cited as permissible in previous practice. However, none of these added elements other than tungsten, contributes to the corrosion resistance of the alloys and I have found that when they are used in the amounts heretofore regarded as satisfactory, they in fact definitely lessen the resistance of the alloys to corrosion.

An object of my invention is to obtain alloys of improved corrosion resistance. Another object of my invention is to obtain alloys which are more resistant towards hot solutions containing hydrochloric acid than are the alloys now obtainable but which retain the desirable physical characteristics of said alloys now obtainable. These and other objects will more clearly appear hereinafter.

The objects of my invention are accomplished by carefully controlling the amount of impurities, especially carbon and silicon, introduced by intention or otherwise into alloys of the high-molybdenum nickel base type. For purposes of my invention, all constituents which do not enhance the corrosion resistant property are regarded as impurities. This includes iron, chromium, manganese, copper and vanadium which, as pointed out, are added for purposes other than corrosion resistance.

My alloys, like those of the prior art, consist principally of nickel and molybdenum with or without the addition of smaller amounts of iron, manganese, tungsten, copper and other known modifying agents. The essential and most important difference between my alloys and others previously described, is the specific limitation of impurities, especially carbon and silicon, which are normally present in appreciable amounts. The proportions in which the above elements may be combined will depend upon the particular corrosive to be handled and the physical properties, i. e., tensile strength, ductility, malleability, etc., required. For satisfactory resistance to hot hydrochloric acid solutions, I have found that the alloy should contain at least 28% by weight of molybdenum, the carbon content should be below 0.05%, and the silicon content below 0.10%. Preferably the amount of carbon and silicon should be reduced below these limits since further reduction is accompanied by further marked improvement in the corrosion resistance of the alloy. A preferred limit of carbon content within the critical limit above recited is below 0.02% carbon. I have also found that the detrimental effect of carbon and silicon is considerably increased when the two are present together. In no case should the total content of carbon and silicon exceed 0.15%.

Chromium and manganese alone in amounts up to 1% are without appreciable influence on the corrosion resistance of alloys of the high-molybdenum nickel base type. However, the simultaneous presence of chromium or manganese with appreciable amounts of carbon and silicon is definitely detrimental. For example, if the carbon content is above approximately 0.025% and/or silicon is present to the extent of 0.10% or more, the presence of chromium and manganese materially decreases the corrosion resistance of the alloy. Preferably my alloys will contain less than 0.05% carbon, less than 0.10% silicon and less than 0.25% total chromium and manganese, except where the carbon content is below 0.025% and silicon below 0.10%, in which case up to 1% chromium and/or manganese is permissible.

The preferred iron content is 0 to 5% but may be as high as 10%, and the preferred molybdenum content 30 to 40% but may be as low as 28%. Up to 10% tungsten and 5% copper may

be added, the balance of the alloy being nickel in each case.

While corrosion resistance to hot hydrochloric acid solutions has been mentioned as the most important property of the improved alloys, they are not limited in this particular. They are also very resistant to other acid solutions, such as sulfuric acid, phosphoric acid, and acetic acids, to solutions of non-oxidizing inorganic salts, to caustic soda and other alkaline solutions, and to many corrosive gases. The alloys may be easily cast and welded and the compositions below approximately 32% molybdenum are machinable.

The above is for purposes of illustration and it is understood that all modifications within the spirit of my invention are to be included within the scope of the said invention as defined in the following claims.

I claim:

1. Alloys resistant to corrosive agents which consist of from 28 to 40% of molybdenum, small but effective amounts of iron up to 5%, of copper up to 5%, of tungsten up to 10%, chromium and manganese each in small but effective amounts and totalling up to 0.25%, carbon up to 0.05%, silicon up to 0.10%, and the balance of the alloy being nickel.

2. Alloys resistant to corrosive agents which consist of from 28 to 40% of molybdenum, small but effective amounts of iron up to 5%, of copper up to 5%, of tungsten up to 10%, of chromium up to 1%, of manganese up to 1%, up to 0.025% of carbon, up to 0.10% silicon, and the balance of the alloy being nickel.

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