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ALLOYS

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My invention relates to copper-base alloys.

Applicant has found that by compounding copper, nickel, iron and arsenic in proper proportions there can be produced an alloy which has excellent resistance to abrasion, excellent strength, a high degree of toughness, good machining and wearing properties, and a reasonably good resistance to corrosion through a wide range of temperatures, and at the same time the alloy may be readily hot or cold worked and hot extruded by common mill processes, and possesses the property of being capable of being hardened by heat treatment. These properties make the alloy particularly useful for many industrial applications as, for example, piston rings, valve stems, and other applications where the material is subjected to severe stresses and wear at relatively high temperatures.

Applicant has found, for example, that by substituting 2% nickel, 1.75% iron, and 0.75% arsenic for equal amounts of zinc in Muntz metal there is produced an alloy that can be very easily hot worked by forging, extruding, and hot rolling to produce shapes which can be hardened and strengthened by light cold working and be still further hardened by heat treatment. For example, it has been found that an extruded rod of the alloy having a hardness of B 65 Rockwell will have its hardness increased to B 79.5 upon 10% reduction by cold rolling. If it is then annealed for about 30 minutes at 700° F. the hardness is further increased to B 87 Rockwell.

The combination of nickel and iron it has been found imparts hardness, toughness, and resistance to abrasion and wear. The amount of iron ordinarily should not exceed 2% of the alloy because amounts in excess of this are not soluble within the range of zinc employed. Any iron in excess of about 2% of the alloy would be present as free iron, which would act to make articles fabricated of the alloy subject to fatigue failure and would form nuclei for the initiation of corrosion. Preferably, for these reasons, the iron should not exceed about 3% of the alloy. Appreciable results will be secured in respect to the iron when in amount as low as about 0.1% of the alloy.

Nickel will produce appreciable effects when present in amount as low as 0.1%. The maximum effects of the nickel are obtained at about 2.5%, and therefore, for reasons of economy, this amount ordinarily should not be exceeded. However, amounts of nickel up to 4% are not particularly objectionable in respect to deleteriously affecting the valuable properties of the alloy.

The arsenic, it has been found, in combination with the other elements acts to toughen the alloy, and is particularly valuable in that it hardens it without detracting from its cold working properties. Still further, arsenic is of value in case the alloy is exposed to high temperatures in that it will prevent dezincification which otherwise would occur in an alloy of this composition in the absence of arsenic. Appreciable results are secured with as little as 0.05% arsenic, and it may be employed in amounts up to 1% of the alloy.

The copper may range from about 54 to 69%, but preferably does not exceed 64% as with higher amounts of copper the alloy becomes increasingly difficult to work.

The balance of the alloy, in respect to copper, nickel, iron and arsenic and neglecting impurities, is zinc in the sense that such balance is all zinc or all zinc except for small amounts of other elements added for imparting special properties to the alloy without eliminating the characteristic properties of the basic copper-nickel-iron-arsenic-zinc alloy or for insuring the existence of or for modifying such characteristic properties. It will therefore be understood that in the appended claims by the words "balance zinc" is meant that the balance is zinc in the sense just defined. Among such other elements is manganese, small amounts of which may be added to the melt to insure against the deleterious effects of any sulphur that may be present in the alloy. The sulphur, if present, will unite with the manganese to form manganese-sulphide which in small amounts has little or no effect on the properties of the alloy, but in the absence of manganese the sulphur would unite with the nickel to form nickel-sulphide which, even in small amounts, has a deleterious effect on the cold working properties of the alloy. The manganese, which also will desulphurize any small amounts of nickel-sulphide commonly present in the nickel or nickel alloy added to the melt, preferably should not exceed 1% of the final alloy. As a large proportion of the manganese added to the melt commonly, but not necessarily, will burn off or will go off in the slag, it may be present in the final alloy from about 0.05 to 1%. Another of such elements is lead, which may be added in small amounts if the alloy is to be machined or if in use the alloy is to present a bearing surface. Lead from 0.1 to 2.5% will have appreciable effects in the respects mentioned without particularly modifying any of the properties of the basic alloy, except, for the reason that it constitutes a soft material entered into an otherwise hard alloy and is dispersed instead of dissolved in that alloy, it acts to improve its machining, wearing, and bearing properties. Still another of such elements which may be added is silicon, which may be present in amounts from 0.1 to 1%, silicon acting as a deoxidizer in the melt and also within this range acting materially to increase the tensile strength and markedly increase the corrosion resistant properties of the alloy.

It will be understood from the foregoing that the preferred alloy contains 54 to 64% copper, 0.25 to 2.5% nickel, 0.25 to 2% iron, and 0.05 to 1% arsenic. To insure against the deleterious effects of sulphur, it also, not necessarily but preferably, contains 0.05 to 1% manganese, and, if it is to be employed in situations where it is desired to machine it, 0.2 to 2.5% lead. Alloys containing the lesser amounts of copper and the gerater amounts of the other constituents within the ranges of elements specified have the best hot working properties and require only a minimum of cold working to develop maximums of strength, whereas alloys having the greater amounts of copper and the lesser amounts of the other constituents are not so easily hot worked. Nevertheless the alloys having the greater amounts of copper have sufficient plasticity within a temperature range of 1200° F. to 1500° F. to enable them to be fabricated into shapes by hot rolling, or hot forging, or hot extruding, but not with the same ease as the alloys containing the lesser amounts of copper.

I claim:

1. An alloy having a high degree of toughness and capable of being hot and cold worked, hot extruded and hardened by heat treatment containing 54 to 69% copper, 0.1 to 4% nickel, 0.1 to 3% iron, 0.05 to 1% arsenic, balance zinc.

2. Alloys according to claim 1 containing 0.25 to 2.5% nickel, and 0.25 to 2% iron.

3. Alloys according to claim 1 containing, approximately, 57% copper, 2.5% nickel, 1.75% iron, 0.75% arsenic, balance zinc.

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