May 14, 1946. F. HUDSON 2,400,234

MARINE PROPELLER AND THE LIKE

Filed July 3, 1942 2 Sheets-Sheet 1

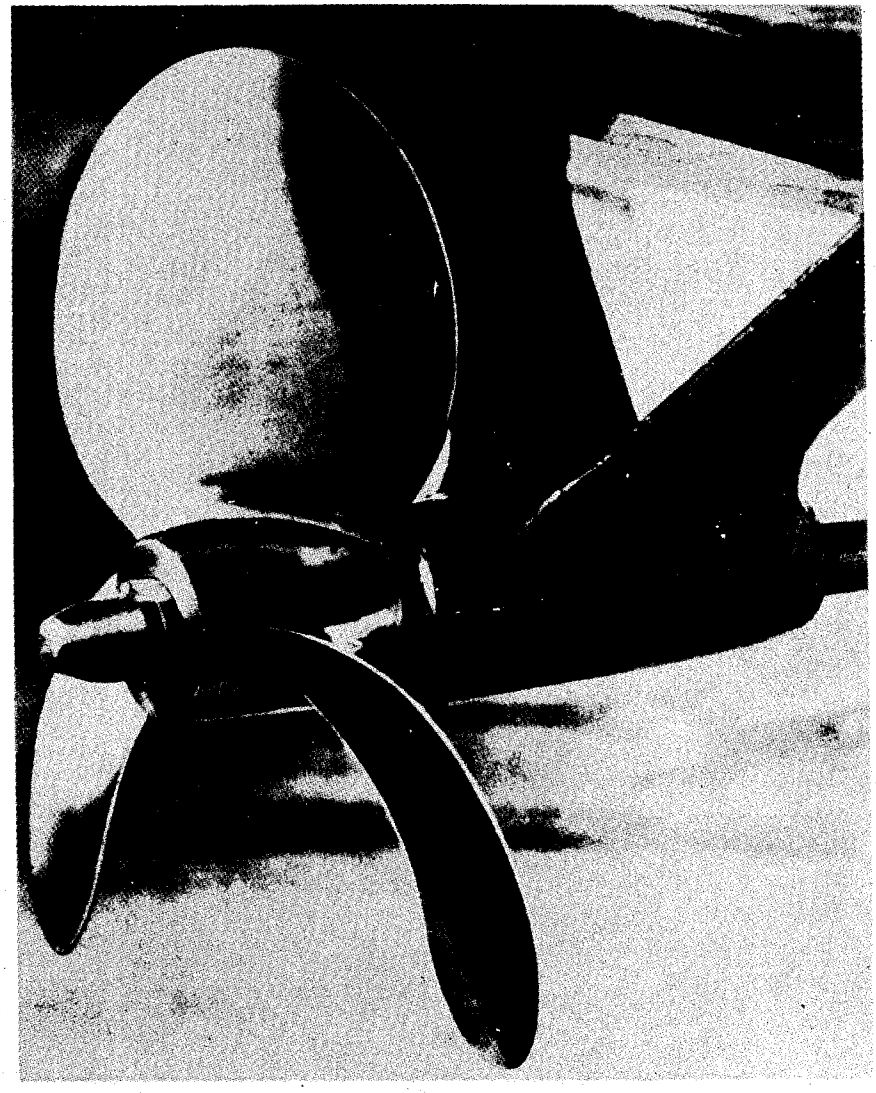


FIG. 1

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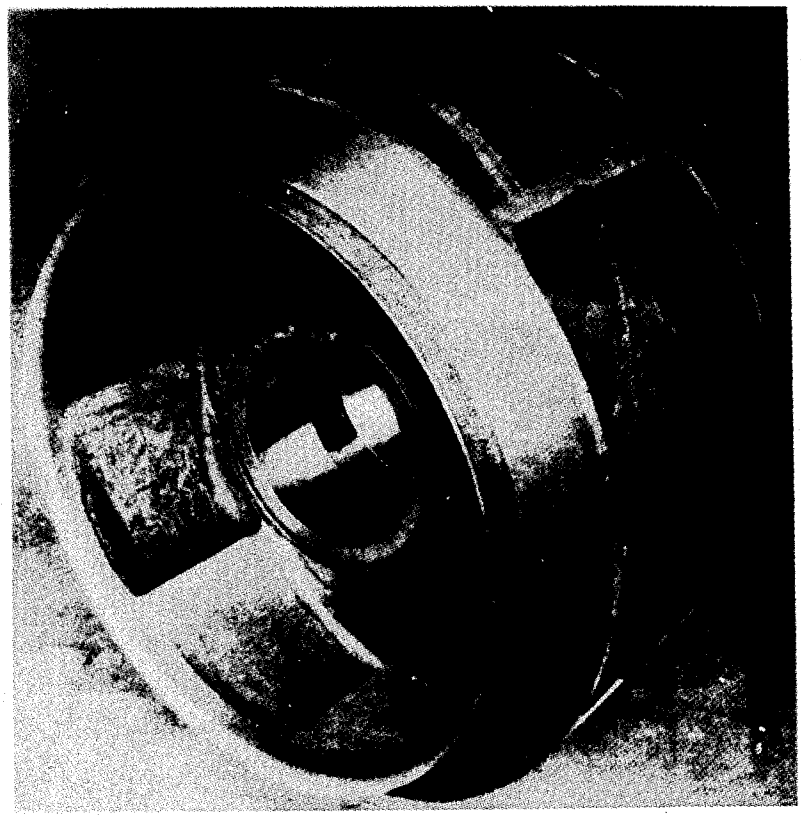


FIG. 3

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2,400,234

MARINE PROPELLER AND THE LIKE

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In Great Britain July 11, 1941

6 Claims. (Cl. 75—157.5)

The present invention relates to metal articles of manufacture which in normal use are subjected to contact with turbulent water and other liquids, and more particularly to alloys intended primarily for the manufacture of propellers and impellers, such as marine propellers, centrifugal pump impellers, and other similar metal articles which in normal use have to resist erosion, and particularly cavitation erosion.

Alloys suitable for use in the manufacture of propellers, impellers and like parts, have to possess not only good mechanical properties, resistance to corrosion and resistance to erosion, particularly cavitation erosion, but also, if they are to be wholly satisfactory, have to possess good casting properties and repairability by such processes as welding or "burning on." Various alloys are known which possess one or another of these properties but there is a demand for an alloy possessing all the properties in combination. Although many attempts were made to remedy the foregoing shortcomings, none as far as is known, was entirely successful when put into actual practice on an industrial scale in consistently producing satisfactory results.

It is an object of the present invention to provide improved metal articles which in normal use are subjected to erosive influences.

It is an other object of the present invention to provide improved metal articles adapted for use in contact with turbulent water and other liquids having an improved combination of properties.

It is a further object of the invention to provide improved bladed hydraulic rotors made of an improved copper-zinc-nickel-aluminum-manganese alloy and characterized by an improved combination of properties, including an improved combination of high mechanical properties and high resistance to cavitation erosion.

The invention also provides improved cavitation-resisting alloys particularly adapted for use in propellers and impellers, such as marine propellers, centrifugal pump impellers and like parts and containing special proportions of nickel, aluminum, manganese, zinc and copper.

Other objects and advantages of the invention will become apparent to those skilled in the art from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a reproduction of a photograph of a marine propeller contemplated by the present invention; and

Fig. 2 is a reproduction of a photograph of a pump impeller contemplated by the present invention.

According to the present invention, the articles of the class set forth hereinbefore are made of improved alloys containing from 3 to 6% nickel, 3 to 6% aluminum, 5 to 30% zinc, 0.5 to 2.5% manganese and the balance copper, the proportions being adjusted within these ranges to give a duplex structure, e. g., an alpha-beta structure. We have found that the alloys possess all the properties referred to hereinbefore to a sufficiently high degree to render them excellent for use in the manufacture of marine propellers and similar articles of the class described. The alloys may advantageously also contain 0 to 4% iron and/or 0 to 1% tin. While these metals may be absent, the alloys may be further benefited when they contain small amounts of iron and/or tin within the ranges specified and it is to be understood that when it is stated that the "balance" is copper or is substantially all copper, it is not intended to exclude the presence of iron in small amounts up to 4%, or of tin in small amounts up to 1%. Similarly, it is not intended to exclude minor constituents and impurities which may be present in such amounts as occur or are added for known purposes in commercial practice or in amounts not adversely affecting the desired properties of the product.

Alloys made in accordance with the present invention can be cast without undue difficulty so that large propellers or the like can be made from them. If parts made from the alloys are damaged they can be repaired by such processes as welding and "burning on," the success of these operations being determined by the fact that the alloy has an alpha-beta structure. Most of the high tensile manganese bronzes developed in the past possess a beta structure which gives rise to cracking when heated and consequently articles made from such material cannot be repaired by welding or "burning on."

On the other hand, the possession of an alpha-beta structure alone is not sufficient criterion for the purpose of the present invention, since if the nickel, aluminum, zinc or manganese is omitted, although high strength combined with an alpha-beta structure may be obtained, the resistance to cavitation erosion is lowered. By employing a composition in accordance with the present invention, the resistance to cavitation erosion and the mechanical properties of the alloys are good.

If the amounts of nickel and aluminum in the alloy are less than 3%, the general properties of

the alloys suffer. If the aluminum content exceeds 6%, the founding of large castings becomes more difficult, while if, in the presence of aluminum, the nickel content exceeds 6%, there is a danger of undue reduction of ductility. Within the range 0.5 to 2.5% manganese improves the castability and at the same time increases the tensile strength of the alloy without destroying its alpha-beta structure. The addition of manganese in amounts greater than 2.5% will, however, reduce the ductility of the alloy so that this amount should not be exceeded. Iron has a beneficial effect on the mechanical properties of the alloy and may be present up to a maximum of 4%, since if this amount is exceeded, the corrosion resistance of the alloy tends to be reduced. The amount of zinc present in the alloy should not exceed 30%, since greater amounts will result in a beta structure being present in the alloy, which is objectionable as it appreciably reduces the resistance to corrosion fatigue and causes cracking to arise when the alloy is being repaired or built up by welding or "burning on."

As an illustrative example, an alloy made in accordance with the present invention contained about 4.98% nickel, 4.73% aluminum, 1.86% manganese, 12.0% zinc and the balance copper. An alloy of the above composition in which was included 3.24% iron had a yield point of about 17.7 tons per square inch and a maximum stress of about 39.6 tons per square inch with an elongation of about 28%. When tested for resistance to cavitation erosion, the alloy was found to be superior to other alloys of equal castability; for example it was found to suffer less than half the weight loss suffered by a sample of Admiralty manganese-bronze.

The alloys provided by the present invention have been found to be particularly applicable for modern high speed medium and large sized propellers. The alloys have been found to be very satisfactory for use in the manufacture of large propellers having high rotation speeds and are characterized by an improved combination of high resistance to corrosion and erosion, e. g., cavitation erosion, good castability and very good repairability, e. g. by such processes as welding or "burning on," in comparison with alloys heretofore used for such purposes. Figs. 1 and 2 illustrate bladed hydraulic rotors such as contemplated by the present invention. Fig. 1 shows a marine propeller, and Fig. 2 shows a centrifugal pump impeller. The present invention includes such propellers and impellers made of an alloy containing about 3% to 6% nickel, 3% to 6% aluminum, 0.5% to 2.5% manganese, 5% to 30% zinc and the balance substantially all copper, said alloy being characterized by a microstructure comprising alpha and beta microconstituents.

Although the present invention has been described in conjunction with preferred embodiments, it is understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such variations and modifications are considered to be within the purview and scope of the following claims.

I claim:

1. As an article of manufacture, a bladed hydraulic rotor made of an alloy containing about 3% to 6% nickel, 3% to 6% aluminum, 0.5% to 2.5% manganese, 5% to 30% zinc and the balance substantially all copper, said alloy being characterized by a duplex microstructure comprising an alpha-beta structure and by an improved combination of properties.

2. A metal article which in its normal use is subjected to the erosive influences of liquids made of an alloy containing about 3% to 6% nickel, 3% to 6% aluminum, 0.5% to 2.5% manganese, 5% to 30% zinc and the balance substantially all copper, said alloy being characterized by a duplex microstructure comprising an alpha-beta structure.

3. An alloy containing about 3% to 6% nickel, 3% to 6% aluminum, 0.5% to 2.5% manganese, 5% to 30% zinc and the balance substantially all copper, said alloy being characterized by a duplex microstructure comprising an alpha-beta structure.

4. As a new article of manufacture, a casting adapted for use in contact with turbulent liquids made of an alloy containing about 3% to 6% nickel, 3% to 6% aluminum, 0.5% to 2.5% manganese, 5% to 30% zinc and the balance substantially all copper, said alloy being characterized by a duplex microstructure comprising an alpha-beta structure.

5. As an article of manufacture, a propeller made of an alloy containing about 3% to 6% nickel, 3% to 6% aluminum, 0.5% to 2.5% manganese, 5% to 30% zinc and the balance substantially all copper, said alloy being characterized by a microstructure comprising alpha and beta microconstituents.

6. As an article of manufacture, an impeller made of an alloy containing about 3% to 6% nickel, 3% to 6% aluminum, 0.5% to 2.5% manganese, 5% to 30% zinc and the balance substantially all copper, said alloy being characterized by a microstructure comprising alpha and beta microconstituents.

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