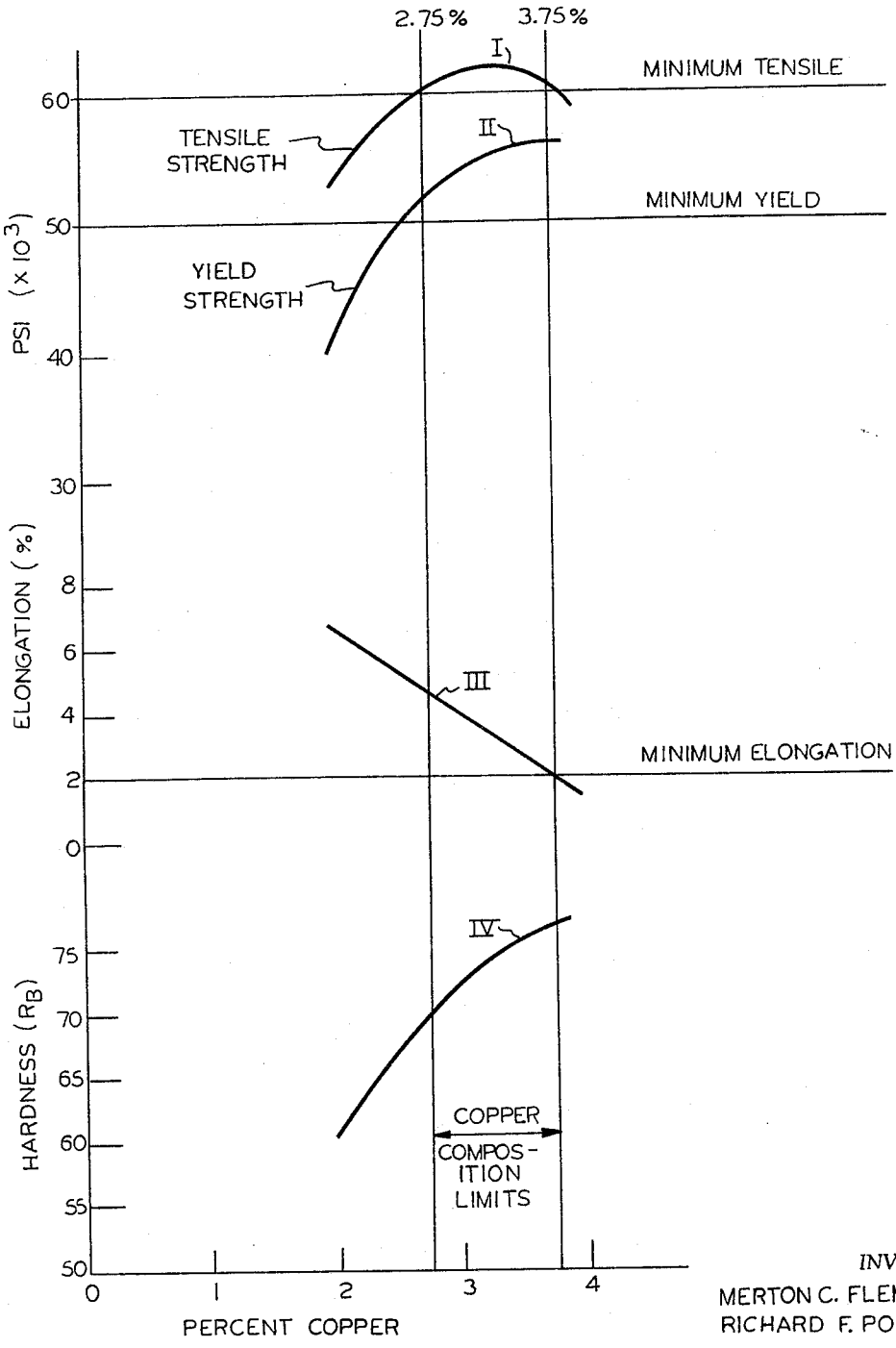
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HIGH-STRENGTH ALUMINUM CASTING ALLOY CONTAINING COPPER-MAGNESIUM-SILICON-SILVER

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HIGH-STRENGTH ALUMINUM CASTING ALLOY CONTAINING COPPER-MAGNESIUM-SILICON-SILVER

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2 Claims. (Cl. 75—142)

This is a continuation of application Ser. No. 286,630, filed June 10, 1963, now abandoned.

The present invention relates to aluminum casting alloys.

The nominal mechanical properties of many aluminum casting alloys are in the range 15,000–20,000 p.s.i. tensile strength for as-cast or annealed alloys, and 30,000–40,000 p.s.i. tensile strength for alloys in the so-called "T_6" (solution plus age) condition. Recently, this limit has been raised to 50,000 p.s.i. in castings made with special techniques which require heavy chilling, as described in the paper of applicant Merton C. Flemings, entitled "Premium-Quality Light Alloy Castings," appearing at pages 10–15 of Aerospace Engineering, July 1962.

It is to the problem of further increasing the tensile and yield strengths of such alloys consistent with minimum elongation, that the present invention is primarily directed. The difficulties which present themselves in the development of a new casting alloy, however, are not simply those of selecting compositions which have inherently high mechanical properties; for example, nearly all wrought alloys are stronger than any casting alloy and several wrought alloys are stronger than that disclosed herein.

The problem is, rather, to attain these high properties in cast materials where the mechanism by which alloys solidify plays a controlling part. When an alloy solidifies, the initial solid has a composition with solute lower than the average composition. As solidification proceeds, the composition of both liquid and solid increase in solute until finally the liquid reaches eutectic composition and solidifies isothermally. The result is microsegregation, or an uneven distribution of solute. In wrought alloy, redistribution of solute is greatly expedited by mechanical working, wherein large areas of eutectic are broken up and areas of high and low solute concentration are squeezed together. In cast alloys, however, since the part is already in the desired shape, the only mechanism for redistribution of solute is thermally, by diffusion. Thus, for a casting alloy to be commercially feasible, the alloy content must be such that at least most of the microsegregation can be eliminated by heat treatment, and within some reasonable length of time. In addition, the alloy must be reasonably "castable"; e.g., it must not be excessively susceptible to such foundry defects as microporosity, hot tearing, etc.

An object of the present invention, accordingly, is to provide a new and improved aluminum casting alloy that is of significantly higher strength than prior-art alloys of this character.

A further object is to provide a novel alloy of more general utility, also.

Other and further objects will be explained hereinafter and will be more particularly pointed out in the appended claims.

The invention will now be described in connection with the accompanying drawing the single figure of which is a composite experimentally obtained graph illustrating the mechanical properties of the novel alloy of the invention. Underlying the invention is the discovery that several highly desirable and optimal mechanical properties can be attained simultaneously by rather critical percentages of additive elements in the aluminum alloy. Referring to the drawing, the percentage of copper is plotted along the abscissa and pounds per square inch (tensile and yield strength—curves I and II, respectively), elongation (percent—curve III), and hardness (curve IV) are plotted at successively lower regions along the ordinate.

It will be observed from curve I that only in a critical region of from substantially 2.75 to 3.75 percent copper, can high tensile strengths of at least 60,000 p.s.i. be attained, with an optimum for substantially 3.25 percent copper. This highly desirable result has been found to be accompanied by yield strength well in excess of 50,000 p.s.i., curve II. Below substantially 2.75 percent copper, the tensile strength falls below 60,000 p.s.i. and the yield strength falls below 50,000 p.s.i. Above substantially 3.75 percent copper, the ultimate strength again falls below 60,000 p.s.i.; but, even more dangerous from the viewpoint of the designer is the drop in ductility. A minimum elongation of about 2 percent, moreover, as shown in curve III, can be simultaneously guaranteed in all areas of the sand casting, with highly desirable hardness properties, curve IV.

The composition of the novel aluminum casting alloy of the invention that attains these results is presented in the following Table I:

TABLE I

Composition of new alloy

	Cu	Mg	Si	Ag	Ti	Al
Optimum (percent)	3.25	0.5	0.8	0.4	0.20 max.	Balance.
Limits (percent)	2.75–3.75	0.4–0.6	0.7–1.2	0.35–0.45	0.20 max.	Balance.

Table II shows mechanical properties obtainable from the novel composition of the invention.

TABLE II

Mechanical properties of the new alloy [1]

Ultimate Tensile Strength (p.s.i.)	Yield Strength (p.s.i.)	Elongation	
64,000	56,000	12%	Chill Cast Test Bar.
64,900	55,000	16%	
64,250	55,000	12%	Sand Cast Test Bars.
63,500	54,000	4%	
61,500	55,000	3%	

[1] Heat Treatment:
1. Solution Treatment, 16 hrs. at 930° F.
2. Water Quench.
3. Age Treatment, 12 hrs. at 345° F.

Of special importance in Table II are the sand cast test bar properties. While the chill bar properties are important in showing what optimum properties may be

obtained from the alloy, the sand test bar properties are indicative of properties obtained in those parts of the casting which may be less rapidly cooled. The available elongation even for sand-cast bars is of real significance.

Further modifications will occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. High-strength aluminum casting alloy having the properties of minimum tensile strength of essentially 60,000 pounds per square inch and minimum yield strength of essentially 50,000 pounds per square inch and having high ductility, said alloy consisting essentially of

2.75 to 3.75% copper, 0.4 to 0.6% magnesium, 0.7 to 1.2% silicon, and 0.35 to 0.45 silver with the balance aluminum.

2. High-strength aluminum casting alloy as claimed in claim 1, and in which up to a maximum of 0.2% titanium is included in the alloy.

References Cited by the Examiner

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