HSR:MPC
VIII-O

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON

Letter
Circular
LC487

January 8, 1937

NOMENCLATURE OF COPPER ALLOYS - BRASS AND BRONZE
(Replaces Letter Circular LC268)

Many inquiries are received by the National Bureau of Standards concerning the proper use of the names "brass" and"bronze" as well as requests for advice concerning proper compositions for certain specific uses. This Letter Circular has been prepared as an aid in replying to such inquiries.

Brass and bronze have been companion materials since time immemorial. The first bronze was essentially an alloy of copper with tin, whereas brass was an alloy of copper with zinc, but it was soon found that the addition of other metals to the simple binary copper-tin alloy often resulted in a material with improved properties, such as strength and corrosion-resistance or more pleasing appearance. Consequently, many of our nominal copper-tin alloys contain both tin and zinc and sometimes other metals. In such alloys it is often difficult to determine whether the zinc or the tin has a predominating effect; the decision cannot be based on the numerical percentages of the two since a given amount of tin usually has more effect than an equal percentage of zinc. With increasing complexity in the composition of the alloys, it becomes increasingly difficult to determine whether a given alloy should be called a brass or a bronze. In those cases where a distinction between brass and bronze could be made, there has been no great misuse of the term "brass", save that in railroad engineering parlance any kind of a bearing is often called a "brass", referring to the bearing rather than to the alloy of which it is made. On the other hand, misapplications of the term "bronze" are frequently encountered. Bronze has long been generally accepted as being superior in a number of ways to brass and advantage of this fact was taken in applying the term "bronze" to newly developed alloys. The term "bronze" has been applied to so many copper alloys that the simple alloys of copper with tin are now often referred to as "tin bronze".

Some of the commercially important alloys are discussed briefly in the following paragraphs:-

Brass:- An alloy consisting essentially of copper (50 to 95 percent) and zinc (50 to 5 percent). If the zinc content is greater than 30 percent the alloy is a "high brass" or a "yellow brass", whereas if the zinc content is less than 20 percent the alloy is a "low brass". Brass containing an intentional admixture of lead for improving its machining characteristics is known as "leaded brass" or "lead brass". Alloys that contain more than 50 percent zinc are usually designated as "zinc-base" alloys.

Brass of the general composition 60 percent copper, 40 percent zinc is widely known as "Muntz Metal", but such names for specific compositions are less commonly applied to brasses than to bronzes. However, some specific terms may be very misleading. For example, the name "German Silver" or "Nickel Silver" refers to the white color of the alloys, not to their composition. They are alloys of copper, nickel, and zinc; they do not contain silver. Such compositions are more properly termed "nickel brasses", although their characteristic properties differ decidedly from those ordinarily associated with brass. According to a decision of the United States Federal Trade Commission (Docket 1479, February 6, 1928) the words "nickel silver" should not be used to advertise or describe alloys which do not actually contain both of these metals.

Examples of the improper application of the term "bronze" are found in the alloys known as "architectural bronze", "manganese bronze" and "bronze" screen wire cloth. "Manganese bronze" is basically a copper-zinc alloy with improved mechanical properties and corrosion-resistance because of the presence of small amounts of iron, tin, manganese, and aluminum. The name "high tensile brass" for such alloys, as used recently by the Copper Development Research Association (London), is highly commendable. "Architectural bronze" is essentially a simple leaded brass, used for decorative purposes. "Bronze" screen wire cloth is a simple brass containing 90 percent copper and 10 percent zinc. There is no metallurgical justification whatsoever for calling such material "bronze".

An illustration of confusion in nomenclature is encountered in the widely used alloy "85 and three 5's", 85 percent copper, 5 tin, 5 zinc, and 5 lead. This alloy is as frequently called "valve bronze" as it is "red brass"; it is also known as "ounce metal" because the constituents are in the ratio of 1 ounce of each to about 1 pound of copper. This alloy is a "brass"according to the Specifications of the American Society for Testing Materials; it is listed as "red brass" in Specification B30-36 and "composition brass" or "ounce metal" in Specification B62-36. On the basis of structure there is good reason for calling this alloy a bronze and it appears in the list of bronzes covered by Federal Specification, QQ-B-691, for Casting Bronzes. Another alloy on this same list of bronzes, however, contains 80 percent copper, 15 zinc and 4.5 tin. Numerous other examples of non-uniformity and inconsistency in naming alloys of this general type in specifications might easily be cited.

Bronze:- Alloys of copper and tin have been known since the dawn of history as "bronze". Except for a very few alloys, including bell metals, speculum metal, and certain special bronze files, the tin content is normally well below 20 percent.

The use of simple binary alloys of copper and tin is quite limited; it is customary to add zinc and often lead to make these alloys, particularly in cast form, better fitted for industrial use. Such alloys containing from 10 to about 30 percent lead, regardless of any zinc

present, are known as "leaded bronze" and are widely used in bearings. The name "zinc bronze" has been used to some extent for copper-tin alloys modified by the admixture of zinc but for brevity the word "zinc" is often omitted and the material referred to simply as "bronze". Two widely used alloys in this class are the "88-10-2" alloy (88 percent copper, 10 tin, and 2 zinc) and its modern counterpart, the "88-8-4" alloy.

"Phosphor-bronze":- This name indicates that phosphorus was used as a deoxidizer during melting. Such a treatment usually confers superior properties on the alloy although chemical analysis often fails to show more than a trace of phosphorus in the finished material.

"Government Bronze":- There is a widespread but erroneous belief that there is a definite composition officially accepted by the Federal Government as the "best" bronze. One of the alloys of longest commercial use is the "88-10-2" alloy, containing 88 percent copper, 10 tin, and 2 zinc. In the days when cannon were made of bronze this was known as "gun bronze", and for many years this alloy appeared as "Composition G" in the United States Navy Specifications. It also appeared in Specification B-10-18 of the American Society for Testing Materials, but this specification is now replaced by B-60-36 for the 88-8-4 alloy, which also appears in the list of bronzes for castings covered by Federal Specification QQ-A-691. Although this composition is, on the whole, a better all-around alloy for many purposes than the 88-10-2, it is not to be designated a "government bronze" any more than any of the others covered by Federal Specifications.

In the field of "statuary bronzes" or "art bronzes", there is a similar erroneous idea that there is a preferred "government bronze". It appears that in 1895, in a letter by an individual purchasing officer concerning the Hancock statue, it was specified that the "U. S. Standard bronze to be used should consist of 90 parts of copper, 7 parts of tin, 3 parts of New Jersey refined spelter". Some of the firms receiving the letter, assuming that this phraseology had legal effect, designated this composition as "U. S. Standard" and used this term in somewhat the same manner as the terms "Sterling silver" or "Eighteen carat gold" are used. Numerous cases can be cited to show that, even in its statuary purchases, the Federal Government has not adhered to this so-called "Standard". One illustration is the bronze group in front of the Library of Congress which is made of an alloy of 90 percent copper, 8 tin, 2 lead. Noted statues vary so in composition that it is clear that there are no fixed "ideal proportions" for art bronze, as well as no "U. S. Government Standard".

Other Bronzes:- Examples of the tendency to apply the name "bronze" to copper alloys other than those containing tin, are found in "aluminum bronze", "silicaon bronze" and "conductivity bronze".

Aluminum Bronze:- The alloy having the approximate composition, 90 to 93 percent copper, 7 to 10 percent aluminum, with perhaps a little iron,

is generally known as "aluminum bronze". It lacks the characteristic bronze color but has superior corrosion-resistance and high strength. Other than trade names, the use of which should be discouraged, no descriptive name appropriate from the metallurgical standpoint has been suggested. The name "aluminum bronze" appears in Federal Specifications and in those of the American Society for Testing Materials and other technical societies.

Silicon Bronze:- This name is often applied, for lack of a better one, to a class of high strength copper alloys which have recently received much attention. The name "copper-silicon alloy" is used in the Federal Specifications (QQ-C-591 and 593) and suggests silicon as the essential alloying constituent. However, other alloying elements, manganese, zinc, iron and tin are often present and the percentage of some of these may equal the silicon content. These alloys are outstanding in many respects and their commercial use, particularly in wrought forms, is rapidly increasing.

Conductivity Bronze:- This name is often used to designate alloyed copper for which a combination of high tensile strength and relatively high electrical conductivity is required. Cadmium and tin are the best alloying elements for the purpose, and are generally used in amounts somewhat below 2 percent. With respect to the degree to which the conductivity of copper is lowered by the admixture of another element, cadmium is decidedly superior to tin.

Other Uses for the Term "Bronze"

The term "bronze" is widely used as descriptive of the surface appearance of metals, especially with reference to the decorative effect. The designation of a leaded brass as "architectural bronze" is justified only on this basis. Certain decorative surface effects are described as "bronzed"; such a one is that given to steel by copper plating it and then treating it with a sulphide solution. Another use is in reference to the metallic pigments used in "bronzing paints". Finely divided metal in the form of flaky particles, whether copper, copper-zinc alloy or aluminum, is termed "bronze".

****

With such looseness of terminology, and such a wide range of alloys in use, it is obvious that statistics of production of "brass" and "bronze" may not be used with great certainty or exactness for such purposes as attempting to calculate the amount of tin or zinc entering into the products.