This invention relates to copper-tin alloys, and more particularly to a phosphor bronze, and has for an object to produce such an alloy which is hot workable and has greater strength and hardness.

This application is a continuation in part of my prior application Serial No. 108,816, filed October 31, 1936.

The so-called phosphor bronzes are alloys of copper and tin deoxidized with phosphorus before pouring or casting the molten metal into suitable molds. In order to make sure the metal is properly deoxidized there is usually sufficient of the deoxidizer used so that there is a small surplus and a small amount of the deoxidizer remains in the resulting alloy. In the present alloy, however, sufficient phosphorus is added not only to deoxidize the melt but to have some residual phosphorus remaining in the alloy and up to about 30 worked with a tin content up to 20 percent. Thus a bronze that could not be hot rolled at all can be easily hot rolled with additions of phosphorus and iron in the ratio of one to four.

This effect is secured in these copper tin alloys with a tin content of from 2 to 20 percent, and balance principally copper, the content of phosphorus being from 0.05 percent up to about 1 percent, and the content of iron from 0.25 percent to about 5 percent. The content of iron for best results should be at least sufficient so that the ratio of phosphorus to iron is about 1 to 4, or sufficient to form the compound Fe3P. Thus in this alloy sufficient phosphorus is added not only to deoxidize the melt, but to have some residual phosphorus alloyed with the metal for the purpose of securing definite physical properties, and sufficient iron is added to convert the phosphorus into iron phosphide.

It appears that the phosphorus in a phosphor bronze when iron is present in amount insufficient to form the compound Fe3P forms a phosphorus-tin compound which melts below a suitable hot rolling temperature and thereby further increases the hot shortness of the tin bronzes containing more than 2 percent tin, and making it even more difficult to hot work. However, it appears that with iron present in amount sufficient to convert all, or substantially all, of the phosphorus into iron phosphide Fe3P no objectionable phosphorus-tin compound is formed, but the compound of iron and phosphorus is formed instead, which compound melts considerably above the hot rolling temperature. Upon cooling this copper-tin-iron-phosphorus alloy the iron phosphide crystallizes first from the melt. Thus dispersed throughout the liquid metal, these particles appear to control the crystallization of the copper and tin producing a fine grain structure with little tin segregation. Therefore, it is seen that by having phosphorus and iron present in substantially the above mentioned ratio a phosphor bronze of higher tin content may be produced which can be hot rolled or hot forged, and which due to its superior structure possesses greater strength and hardness than the ordinary phosphor bronze.

It will be appreciated a large number of specific alloys may be made within the ranges of elements noted, but an example of an alloy that hot rolls very nicely has approximately the following proportions, tin 5 percent, iron 0.5 percent, phosphorus 0.1 percent, and balance copper.

An example of another desirable alloy has approximately 10 percent tin, 1 percent iron, 0.2 percent phosphorus, and balance copper.

Having thus set forth the nature of my invention, what I claim is:

1. An alloy composed of 2% to 20% tin, from 0.25% to 5% iron, phosphorus from 0.05% up to 1%, and balance copper, which is characterized by being hot workable.
2. An alloy composed of 2% to 20% tin, from 0.25% to 5% iron, phosphorus from 0.05% up to 1%, and balance copper, and in which the iron content is at least about four times the phosphorus content.
3. An alloy composed of approximately 5% tin, 0.5% iron, 0.1% phosphorus, and balance copper.
4. An alloy composed of approximately 10% tin, 1% iron, 0.2% phosphorus, and balance copper.

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