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CONTROLLING GRAIN GROWTH IN ALUMINUM-MANGANESE ALLOYS

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This invention relates to the control of grain characteristics in aluminum-base alloys containing aluminum in amounts of over about 50 per cent, and particularly to such of these alloys as contain manganese.

The aluminum-base alloys containing manganese have a distinct propensity to grain growth under certain conditions of working and thermal treatment, which requires that the fabrication of such alloys into the desired forms be carefully controlled lest the final product, because of its large grain size, be of little use. This tendency to grain growth (or to a large apparent crystalline structure) is an undesirable characteristic of these alloys with reference to any fabricating or forming operations which the alloy in a semi-fabricated condition must undergo. It is particularly undesirable, however, in drawing operations as, for instance, the drawing operation by which a utensil is formed by a single or double draw from a flat sheet metal blank. In such instances, the working of the metal produces selective strain effects on adjacent grains or crystals in the sheet, and when the original blank is of large grain, induced by the aforesaid grain growth, the surface of the resulting drawn product is rough, uneven and generally unsatisfactory.

Such phenomena as these have long been known to exist in connection with aluminum-manganese alloys, and in order to avoid their cause, viz. excessive grain growth, it has been thought necessary to exercise in the fabrication of the metal a most rigorous control of fabrication and thermal processes. This control has naturally resulted in increased cost of manufacture but has not been so efficient in action but what large quantities of fabricated metal made from such alloys are still rejected because of large grain size. The only other possible method of eliminating this propensity to grain growth in aluminum-manganese alloys has been recognized to be the adjustment of the alloy composition, but although many experiments in this direction have been carried out, they have hitherto resulted in either failure or only partial success.

One of the objects of this invention is the provision of a method of treatment by which the propensity of aluminum-manganese alloys to excessive grain size may be overcome. A further object of the invention is the provision of certain aluminum-manganese alloys having such controlled compositions that the propensity to large grain in the fabricated condition is substantially eliminated.

It is well recognized in the art of alloying metals that the addition of one or more alloying metals to a given alloy having certain advantageous characteristics usually modifies these characteristics in a marked degree, often to such an extent that the properties of the original alloy are seriously impaired or even no longer available. It is a problem of major importance, therefore, to modify the composition of a given alloy to the extent necessary to overcome a latent defect in such alloy without simultaneously producing a harmful effect upon the desirable properties of the original alloy. The aluminum-manganese alloys, and particularly those containing 1 to 1.5 per cent of manganese, have certain working properties and properties of strength and corrosion resistance which in combination have made such alloys especially useful for the fabrication of certain types of articles. In the present case, however, I have found that the disadvantageous grain growth from which aluminum-manganese alloys are so prone to suffer can be effectively controlled, without appreciably affecting the advantageous properties of the alloys, by adding to the alloy a small amount of copper.

The amount of copper which I have found it necessary to add to the aluminum-manganese alloys for the purpose of inhibiting grain growth is not large and in fact is surprisingly small. I have found that additions of 0.2 to 0.5 per cent are most efficient. Smaller amounts, while having some effect, do not entirely accomplish the desired purpose, and amounts of about 0.2 per cent are necessarily added before a satisfactory inhibition to grain growth is effected. On the other hand, amounts much greater than 0.5

per cent do not increase the effect to an extent which would justify larger additions and the larger amounts of copper would change, in part, the useful and desired properties obtained in the aluminum-manganese alloys. For these reasons, therefore, the amount of copper added should not vary greatly from about 0.2 to 0.5 per cent, and for usual purposes an addition of about 0.2 to 0.35 per cent of that metal is preferred as producing a maximum desired effect on grain size with a minimum change in the physical properties, the working properties, and the corrosion-resistance of the original aluminum-manganese alloy. The copper can be added to the molten alloy at any convenient stage before casting the ingot or other article which is to be worked.

The aluminum-manganese alloys to which the addition of copper is beneficial in reducing the grain size of the fabricated product are those containing from about 0.75 to 3 per cent of manganese. The invention is particularly advantageous, however, with alloys containing about 1.0 to 1.5 per cent of manganese.

As illustrative of the benefits of the invention, drawing tests were made upon aluminum-manganese alloys containing about 1.25 per cent of manganese and 0.25 per cent of copper. The tested pieces consisted of flat sheet circles having a thickness of 0.05 inch and a diameter of about 20 inches. These circles or disks were shaped by means of the usual drawing dies into utensils of a diameter of about 9.5 inches and a depth of 7 to 7.5 inches. Other test pieces of the same form and having a diameter of about 13 inches and a thickness of 0.04 inch were drawn to utensils having a diameter of about 6.5 inches and a depth of about 4.5 to 5 inches. Still other test pieces of the same form and having a diameter of about 11.5 inches and a thickness of 0.08 inch were drawn to utensils having a diameter of about 8.5 inches and a depth of 2 to 2.5 inches. In every case the finished drawn product was smooth in appearance and surface and exhibited none of the tendencies of aluminum-manganese alloys to develop the surface roughness and other well known defects incident to the working of metal of large grain size. I have also found that in the fabrication of these new aluminum-manganese-copper alloys from ingot to sheet or in other working operations, the necessity for nicety of control of working and thermal conditions is eliminated and the aluminum-manganese alloys containing this added element are analogous to the other common aluminum alloys as respects grain growth in their reaction to such conditions.

It is to be understood that the term "aluminum", as used throughout the description and claims, is intended to include aluminum of very high purity as well as metal of the usual commercial grades.

I claim—

1. An aluminum-manganese alloy consisting of aluminum, and about 0.75 to 3.0 per cent of manganese and 0.2 to 0.5 per cent of copper.

2. An aluminum-manganese alloy consisting of aluminum, and about 1 to 1.5 per cent of manganese and 0.2 to 0.5 per cent of copper.

3. An aluminum-manganese alloy consisting of aluminum, about 1 to 1.5 per cent of manganese, and about 0.25 per cent of copper.

In testimony whereof I hereto affix my signature.

THEODORE W. BOSSERT.