

UNITED STATES PATENT OFFICE.

ROBERT S. ARCHER AND ZAY JEFFRIES, OF CLEVELAND, OHIO, ASSIGNORS TO ALUMINUM COMPANY OF AMERICA, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

ALUMINUM-BASE ALLOY.

No Drawing.

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To all whom it may concern:

Be it known that we, ROBERT S. ARCHER and ZAY JEFFRIES, citizens of the United States, and residents of Cleveland, in the county of Cuyahoga and State of Ohio, have invented a new and useful Improvement in Aluminum-Base Alloys, of which the following is a specification.

The object of the invention is to provide an aluminum base alloy with low specific gravity, which can be easily worked either hot or cold, and which can be made hard and strong by heat treatment.

Aluminum base alloys containing various constituents in different percentages are known and in common use. Also it is old in the art to quench some of these alloys from certain temperatures and to subsequently age them either naturally or artificially for the purpose of increasing their physical properties. Such alloys often contain copper purposely added as an alloying element, and include as an impurity various amounts of silicon, usually not more than about 0.4%, the silicon being derived both from the materials entering into the manufacture of the alloys and from the receptacles in which they are produced.

Our invention is predicated upon our discovery that an aluminum base alloy free from copper except as an impurity and containing magnesium and not less than about 0.5% silicon, when quenched and artificially aged has an unexpectedly increased hardness and tensile strength.

In the practice of the invention the alloy may contain various percentages of both magnesium and silicon, and other elements may be added to it, such as nickel, manganese and chromium. The selection of the proper amounts of magnesium and silicon is determined by the treatment to which the alloy is subjected and the use to which it is to be put. The magnesium may exceed the silicon content, and when the magnesium is high the silicon may be quite low, and vice versa. However, the silicon content in all cases should not be less than about 0.5%. Generally the maximum physical properties can be obtained with about

1.0% magnesium and 1.0% silicon, although as much as 4.0% of each may be used. The larger the amounts of magnesium and silicon present, the harder the alloys are to work.

The quenching temperature of the alloy and the time it is maintained at such temperature depend to some extent upon the composition and the use to which the alloy is to be put, and so also with respect to the aging of the alloy. The quenching temperature is usually above about 500° C. and may be as high as 580° C., and the time the alloy may be held at the quenching temperature may be from a fraction of an hour to fifteen or more hours. When the alloys are in the form of castings excellent results have been obtained by maintaining the castings at a quenching temperature of 550° C. or slightly higher for fifteen hours.

The alloy may either be quenched to normal or room temperature and subsequently heated and artificially aged, or it may be quenched to the desired artificial aging temperature and maintained at the latter for the required time. Aging may be effected at temperatures varying from about 100 to 200° C.

The invention may be further explained with reference to a few examples of the alloys we have produced and tested.

A forged alloy containing 0.75% silicon and 0.5% magnesium after being heated to a temperature of about 500° C. and cooled slowly in a furnace had a Brinell hardness number of 29, a tensile strength of 15,000 lbs. per square inch and an elongation of about 35% in two inches. In this condition its ductility or plasticity approached that of commercially pure aluminum so that articles of complicated shapes could be made of it by deforming processes. After being forged and then quenched from a temperature of 560° C. it had a Brinell hardness number of 38, a tensile strength of 21,000 lbs. per square inch and an elongation of 37.5% in two inches. After aging for 17 hours at 150° C. the Brinell hardness number had increased to 110, the tensile strength to 44,500 lbs. per square inch, and the elongation was reduced to 13.5% in two inches.

That these improved physical properties are incident to artificial aging, is shown by the fact that the same alloy when aged naturally at normal or room temperature for seven days had a tensile strength of 31,000 lbs. per square inch and an elongation of 30% in two inches.

The same alloy (0.75% silicon and 0.5% magnesium) was quenched from 550° C. and the metal stretched 15% in a tensile machine. It was then artificially aged for sixty hours at 145° C. after which it had a tensile strength of 42,300 lbs. per square inch, an elongation of 12.5% in two inches, and a Brinell hardness number of 99. Similar final physical properties were produced by allowing the quenched bar to age naturally, that is to say, at normal or room temperature for one week, then stretching it 15% and artificially aging it for sixty hours at 145° C.

An alloy containing 1% magnesium and 1.75% silicon after being forged was quenched from a temperature of 550° C. and artificially aged for fifteen hours at a temperature of 150° C. When thus quenched and aged it had a tensile strength of 53,400 lbs. per square inch, an elongation of 12.5% in two inches, and a Brinell hardness number of 123.

An alloy containing 4% magnesium and 2% silicon after being forged was quenched from a temperature of 550° C. and artificially aged for forty hours at 100° C. It then had a tensile strength of 48,350 lbs. per square inch, an elongation of 16% in two inches, and a Brinell hardness number of 106. The same alloy aged an additional eighteen hours at 150° C. had a tensile strength of 53,300 lbs. per square inch, an elongation of 13% in two inches, and a Brinell hardness number of 125.

The foregoing are all examples of mechanically worked aluminum base alloys containing magnesium and silicon. As indicating that these alloys in the form of castings have greatly improved strength and hardness, the following example is given.

An alloy containing 1.75% silicon and 1.0% magnesium had, after casting in a permanent mold, a tensile strength of 20,000 lbs. per square inch, an elongation of 5% in two inches and a Brinell hardness number of 60. After quenching from a temperature of 550° C. maintained for slightly over fifteen hours, the tensile strength was increased to 36,000 lbs. per square inch, the elongation to 16% in two inches and Brinell hardness of 67. After being artificially aged for fifteen hours at 150° C. the tensile strength was further increased to 50,000 lbs. per square inch, the Brinell hardness number to 123, while the elongation was decreased to 5.5%. To secure the best results, castings formed of the improved alloy should, as previously

stated, be maintained for a considerable period of time at the quenching temperature. This time may be fifteen hours or more and the temperature may be 550° C. or slightly higher.

The addition of other alloying metals such as nickel, manganese, and chromium does not destroy the effect of the magnesium and silicon, but in certain cases results in improved properties, especially in ductility. For example an alloy containing 1% magnesium, 0.5% silicon and 2% nickel had a tensile strength of 16,000 lbs. per square inch, an elongation of 5% in two inches and a Brinell hardness number of 55, as cast in a permanent mold. After being quenched from 550° C., at which temperature it was maintained for fifteen hours, its tensile strength was increased to 27,700 lbs. per square inch, its elongation to 13% in two inches, and its Brinell hardness number to 59. When aged at a temperature of 150° C. its tensile strength was 43,400 lbs. per square inch, its elongation 3.5% in two inches and its Brinell hardness number 114. The same alloy when forged and then quenched and aged in the same manner had a tensile strength of 47,600 lbs. per square inch, an elongation of 19% in two inches and a Brinell hardness number of 106.

From the foregoing examples it is clear that the alloy we provide, whether worked or cast, has surprisingly improved physical properties when artificially aged.

We claim as our invention:

1. A quenched and artificially aged aluminum base alloy free from copper except as an impurity, and containing magnesium and not less than about 0.5% silicon, the alloy being hard and having high tensile strength.
2. A quenched and artificially aged aluminum base alloy free from copper except as an impurity, and containing about 1.0% magnesium and about 1% silicon, the alloy being hard and having high tensile strength and low specific gravity.
3. An aluminum base alloy free from copper except as an impurity, and containing magnesium and not less than about 0.5% silicon, the alloy having been quenched from a temperature above about 500° C. and artificially aged.
4. An aluminum base alloy free from copper except as an impurity, and containing about 1.0% magnesium and about 1.0% silicon, the alloy having been quenched from a temperature above about 500° C. and artificially aged.
5. An aluminum base alloy free from copper except as an impurity, and containing magnesium and not less than about 0.5% silicon, the alloy having been quenched from a temperature above about 500° C. and artificially aged at a temperature above about 100° C.

6. An aluminum base alloy free from copper except as an impurity, and containing about 1.0% magnesium and about 1.0% silicon, the alloy having been quenched from a temperature above about 500° C. and artificially aged at a temperature above about 100° C.

In testimony whereof, we hereunto sign our names.

ROBERT S. ARCHER.
ZAY JEFFRIES.

Witnesses:

MERLE B. PRICE,
THOMAS J. DORAN.