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ALUMINUM ALLOY

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6 Claims. (Cl. 75—142)

This invention relates to alloys, and particularly to aluminum base alloys suitable for casting and working, and having high strength at ordinary and elevated temperatures.

This application is a division of my copending application Serial No. 389,020, filed April 17, 1941, for Aluminum alloys, and of my copending application Serial No. 398,315, filed June 16, 1941, for Aluminum alloys.

It is an object of this invention to produce alloys having relatively high elongation and relatively high tensile strength.

It is a further object of this invention to provide a relatively light alloy which may be easily cast and machined, which may be used at elevated temperatures without a rapid deterioration of desirable properties, and which may be readily treated with anodic treatment to give excellent lustre and finish.

It is a still further object of this invention to provide an alloy having a relatively high proportional limit and relatively high fatigue strength, and in which these properties may be obtained without heat treatment.

It has been found that an aluminum alloy containing iron, and having zinc and magnesium present in proper proportions, will produce an alloy that may be readily cast and have improved physical properties for use both at ordinary and elevated temperatures, and which may have these properties improved by heat treatment.

When magnesium and zinc are added to aluminum in the proper proportions, a ternary compound of aluminum, magnesium and zinc is formed, which compound is soluble in solid solution in the aluminum. The presence of this compound in relatively small amounts greatly improves the characteristics of aluminum and produces an alloy having high strength combined with high ductility, good casting and forging properties, good color, and excellent corrosion resistance. In calculating the amount of magnesium and zinc that should be present in the aluminum alloy to form the desired percentage of ternary compound, only magnesium which is not combined with silicon is to be calculated, as it is only such magnesium that is available to combine with zinc and aluminum to form the ternary compound.

The ternary compound is said by some investigators to have a composition having substantially the formula $Al_3Mg_7Zn_6$, and other investigators have considered the formula for the ternary compound as being $Al_2Mg_3Zn_3$. It will be seen that the amounts of magnesium and zinc relative to each other are quite similar in both formulas and, for the purposes of the improved alloy, the magnesium and zinc should be present in about the proportion necessary to form the ternary compound of either formula.

An excess of zinc, over and above that which cooperates with magnesium and aluminum to form a ternary compound according to the above formula having the greatest proportion of zinc, increases the brittleness and decreases the ductility of the alloy. For this reason it is undesirable that zinc be present in quantities substantially greater than the amount to react to form such a ternary compound with magnesium and aluminum. The most desirable properties are obtained when the magnesium and the zinc are proportioned so that the ratio of magnesium (uncombined with any silicon) to zinc is about equal to the ratio represented by the formula $Al_2Mg_3Zn_3$, or somewhat larger as represented by the formula $Al_3Mg_7Zn_6$. A small amount of magnesium may be provided to replenish losses that may occur when the alloy metal is remelted.

Magnesium adds tothe hardness and machining qualities of the alloy and, as above stated, should be present in an amount sufficient to combine with the zinc and aluminum present. In greater quantities magnesium tends to make the alloy sluggish, decreasing castability.

Magnesium and zinc have heretofore been added to aluminum in the proportion represented by the formula $MgZn_2$. It has been found, however, that a given percentage of ternary compound is more effective in producing desirable properties and, because the zinc content of the ternary alloys is less, they have a lower density.

The improved aluminum alloys may have the ternary compound of aluminum, zinc and magnesium present in an amount ranging from about 2% to 20%, the preferred range being between about 3% and 15%. At room temperture the ternary compound goes into solid solution in aluminum alloys in an amount of about 2%. The percentage in solid solution increases at high temperatures and decreases upon cooling, the excess precipitating out. Aluminum alloys containing the ternary compound may, therefore, be advantageously heat treated to improve their properties.

A small amount of silicon is usually present in aluminum alloys and from .15% to about .7% is desirable in alloys of the present invention which are to be forged or drawn; more than .7% is frequently desirable in casting alloys. Silicon combines with magnesium in preference to most

elements, each part by weight of silicon combining with about 1.75%, by weight, of magnesium to form Mg_2Si. At least sufficient magnesium is therefore added to the alloy to combine with the silicon uncombined with any calcium to form Mg_2Si, and, in addition, to combine with all the zinc and form the ternary compound according to the formula $Al_2Mg_3Zn_3$. Mg_2Si is more stable than the ternary compound above mentioned and may be maintained in solid solution in aluminum alloys in an amount up to about 1.85%, which is the quantity of Mg_2Si present if the silicon is present in the alloy, and acts as a hardener, which is sometimes desirable in conjunction with the ternary compound. Mg_2Si does not, however, make an efficient use of the magnesium as does the above mentioned ternary compound. Therefore, it is desirable to have the magnesium present on the rich side to prevent the silicon from being present in excess and taking magnesium away from the ternary compound.

If the alloy is desired particularly for casting purposes, more silicon, such as up to about 1.5%, may be present. If, however, a somewhat larger amount of silicon is present in the alloy than is desirable for the purpose for which the alloy is intended, and such amount of silicon is not too excessive, then a small amount of calcium may be added. Calcium has an even stronger affinity for silicon than has magnesum and, therefore, it can be used to reduce the amount of silicon available for combination with magnesium. The amount of the relatively expensive magnesium available for the formation of the ternary compound may thus be increased. Although much more than 1.85% silicide acts as a supplemental hardener and more than about 3% or so makes the alloy more sluggish and adversely affects the castability of the alloy, up to 3% is desirable, and more than 3% may, in some cases, be desirable in the production when a large amount of the ternary compound is present in the alloy. Usually, however, the amount of silicon should be between .5% and 1.5%, especially in castings not heat treated. This is true even when calcium is present, although with the latter element more magnesium is available for formation of the ternary compound.

It has now been found that aluminum alloys containing magnesium (over that necessary to combine with silicon) and zinc in the proportions to form a ternary compound are greatly improved by the addition of one or more members of the group of hardening elements, consisting of .1% to 1.5% nickel, .1% to 1.5% manganese and .05% to 1% chromium, in a total amount of about .2% or .3% to 5%, with or without one or more of the grain refining elements selected from the group consisting of titanium, columbium, zirconium, boron, tungsten, molybdenum, tantalum and vanadium, in a total amout of .005% to .5%.

Although the metal manganese, chromium and nickel each increase the hardness of the alloy, a given percentage of each of these elements improves certain of the properties more than it does others. It is therefore preferred that more than one of these elements be present in the alloy. Nickel increases the tensile strength. proportional limit and yield strength of the alloy without decreasing its elongation to any appreciable degree. In fact, with certain amounts of nickel the elongation is increased, so that an alloy having exceedingly desirable and exceptional properties may be obtained.

Alloys containing nickel may be readily heat treated or age hardened to give somewhat superior properties, but very desirable properties which are almost equivalent to the heat treated alloys are also obtained when castings are simply aged at room temperature, with or without quenching from the mold.

Nickel is quite an effective element in the alloy and appreciable improvements in properties of the alloy are noted when it is present in an amount of about .1% or more. The preferred properties are obtained with about .3% to about .8% or 1% nickel, and in some cases it is desirable to have the nickel present in amounts as great as 1.5%.

Manganese, although it decreases the tensile strength and elongation to some degree, increases the yield strength, hardness and proportional limit of the alloy. It also makes the alloy more corrosion-resistant.

Alloys containing manganese may be readily heat treated or age hardened to give somewhat superior properties, but very desirable properties are obtainable when castings are simply aged at room temperature, or when quenched from the mold and aged.

Manganese is a very effective element in the alloy and desirable improvements are noted when about .1%, or even a little less, is present in the alloy. The preferred properties are obtained with about .2% to about .3% or .8% manganese, and in some cases it is desirable to have the manganese present in amounts as great as about 1%, or even 1.5%.

Chromium, although it does not appear to improve the proportional limit and yield strength of the alloy, increases its elongation. It is, therefore, particularly advantageous that both chromium and manganese be present. As little as .05% or .1% chromium, particularly with manganese, is effective in improving properties of the alloy, but .2% or .3% to about .8% or even 1% is desirable. When manganese is also present, the total of manganese and chromium should preferably be between about .3% and 1.5% of the alloy. When both manganese and chromium are present, they may be in about equal proportions, or preferably with a slightly greater amount of manganese than chromium.

The quantity of each of the hardening metals desired in a given alloy also depends somewhat upon the quantity of other hardening ingredients present and upon the amount of ternary compound, a given hardness and tensile strength often being obtainable, either with a relatively large amount of strength-improving hardening metal and a relatively small amount of ternary compound, or with a relatively small amount of such metal and a relatively large amount of magnesium and zinc in the proportions of a ternary compound.

As silicon decreases the ductility of the alloy to a substantial degree, it is best that when the alloy contains nickel present in the upper portion of the above mentioned range the silicon does not exceed .7% or .8%, as the presence of too much of the hardener Mg_2Si may decrease the ductility to such an extent that the alloy is undesirable for many purposes. Alloys containing nickel and free magnesium and zinc in the ratio of a ternary compound may contain as much as 1% or 1.5% silicon. While 2% or 3% of the ternary compound of aluminum, magne-

sium and zinc improves the properties of aluminum or aluminum alloys having low silicon content, alloys containing such low percentages of a ternary compound are relatively difficult to cast.

An alloy containing 2% of the ternary compound may be used for casting purposes. The castability, however, is improved with an increase in the amount of ternary compound, and it is, therefore, preferred to have a larger percentage of the ternary compound present, such as 4% to 8%, for casting purposes. When the casting is more or less intricately shaped, still greater percentages, such as 10% to 15% or 20%, of the ternary compound may be present. For alloys to be forged or shaped after casting, the ternary compound should be present in the lower ranges, such as 2% to 8% or so, as the metal is less hard with the lower percentages of the ternary compound.

A larger proportion of the ternary compound and metals of the above hardening group may be present in alloys which are to be given a so-called "solution treatment" than in alloys to be given only an aging treatment, or those to be quenched from the casting mold and aged at relatively low temperatures. Thus, the desirable properties of the solution heat treated alloys may be obtained when they contain the ternary compound in amounts up to 20% or so, whereas less of the ternary compound, such as 4% to 15%, is preferred in alloys which are quenched upon removal from the mold and heat treated at a low temperature, or aged at room temperature.

It has generally been considered that aluminum alloys of magnesium containing iron much above the impurity value in commercial aluminum are of little commercial value; but it has also now been found that an alloy containing the above described ternary compound, with or without one or more of the above mentioned group of hardening elements, and with or without one or more of the above group of grain refiners, is improved by the presence of iron in suitable proportion.

Iron in suitable amounts further increases the hardness and tensile strength of the alloy without decreasing its ductility a substantial amount. A small amount of iron thus permits one to obtain the properties desired with a smaller amount of magnesium and zinc. These alloys containing iron may be readily heat treated or age hardened to give somewhat superior properties, but the iron in combination with the ternary elements in the above proportion is also outstanding, in that almost as desirable properties are obtained when castings are aged at room temperature without a heat treatment or quenching.

Iron has generally been considered to crystallize in large platelike crystals, which weaken the alloy. Iron in the presence of the ternary compound appears to crystallize in finely dispersed form, and the ternary compound also seems to be dispersed, thus producing a highly desirable alloy.

Iron in the amount of .4% or more in the alloys of the present invention gives noticeable effects in improving the properties of the alloy, and as much as 2% has been found to be desirable for some purposes. For most castings it is desirable that the alloy have .6% or .7% to 1.5% of iron, although about 1% is usually preferred. The quantity of iron desired in the alloy depends also upon the quantity of other hardening ingredients and upon the amount of ternary present, a given hardness and tensile strength often being obtainable with a relatively larger amount of iron and a relatively smaller amount of ternary compound, or a relatively smaller amount of iron and a relatively larger amount of ternary.

The hardening elements and the grain refining elements are particularly desirable in an aluminum alloy containing both iron and the ternary compound. Although the iron itself improves the properties of the alloy, the hardening elements and the grain refining elements exert a still further improvement independently of iron.

The aluminum alloys of the present invention containing magnesium, uncombined with silicon, and zinc in the proportion of a ternary compound, when cast in molds of a design such that chilling takes place substantially simultaneously in the various portions of the casting, solidify without the use of grain refining agents and form good castings. However, it has been found that certain grain refining elements substantially improve the properties of the aluminum alloy containing the ternary compound, whether or not it contains one or more of the above hardening metals, with or without iron. This is especially true when the metal is cast in molds of more or less intricate shape, where the chilling may not be so uniform throughout the casting.

Grain refiners which improve the properties of the alloy are boron in the amount of .005% to 1%, zirconium in the amount of .01% to .5%, tungsten in the amount of .01% to .5%, molybdenum in the amount of .01% to .5%, vanadium in the amount of .01% to .5%, titanium in the amount of .05% to .5%, columbium in the amount of .01% to .5%, and tantalum in the amount of .05% to .5%. These grain refining elements should preferably be present in a total amount of from .005% to .5%, and it is frequently desirable to have more than one of these elements present in a given alloy.

While the grain refiners in the above group are desirable in the alloys of the present invention, not all of the grain refiners affect the properties in the same way. The particular refiner or group of refiners selected in any given instance depends upon the particular condition which must be satisfied. The grain refiners selected from the group consisting of titanium, tungsten, molybdenum, zirconium and vanadium, and especially tungsten and molybdenum, improve both the strength and the elongation of the castings. Of these, titanium, being less expensive, is usually used for ordinary castings, but in cases where the highest elongation, together with strength, is necessary, it is preferred to use tungsten or molybdenum. The grain refiners selected from the group consisting of boron, columbium and tantalum do not appear to appreciably increase the strength or elongation of the alloy, and are usually used where appearance, finish and corrosion resistance are most important, and where strength is of less consequence.

The above described hardening elements, manganese, chromium and nickel, substantially decrease the hot shortness, improve the properties of the alloy, and assist in maintaining the improved properties at high temperatures, such as are encountered in internal combustion engines. The above grain refining elements, particularly members of the group consisting of tungsten, molybdenum, vanadium and titanium, also have this property when present in substantial

amounts, such as .2% or .3%, or so. It is, therefore, especially desirable to have up to .5% or so of these latter elements present when other hardening ingredients are absent.

EXAMPLE 1

Test bars chill cast from an alloy containing 6% of the ternary compound, about .6% iron, about .25% chromium, and about .5% manganese, showed, after quenching and aging for seven days at room temperature, a tensile strength of 41,600 lbs./sq. in., a yield strength of 23,500 lbs./sq. in., a proportional limit of 17,600 lbs./sq. in., an elongation of 9.6%, and a hardness of 80 kg./mm^2.

When bars of the same alloy were simply air-cooled and aged for seven days at room temperature, the tensile strength was 41,600 lbs./sq. in., the yield strength was 23,500 lbs./sq. in., the proportional limit was 18,100 lbs./sq. in., the elongation was about 8%, and the hardness was 82 kg./mm^2.

When the quantity of manganese in the alloy of Example 1 was increased to about 1%, the tensile strength of air-cooled test bars, aged for seven days at room temperature, was 38,900 lbs./sq. in., the yield strength was 26,600 lbs./sq. in., the proportional limit was 20,100 lbs./sq. in., the elongation was about 5%, and the hardness was 82 kg./mm^2.

From the above examples it is seen that even a small proportion of manganese and chromium markedly increases the tensile strength, proportional limit, yield strength, hardness, and even the elongation of aluminum base alloys. Since most alloying elements which tend to improve the tensile strength of an alloy also usually decrease its elongation to a marked degree, it is seen that manganese and chromium in combination with each other and with a ternary compound have a remarkable effect, and that an alloy of outstanding characteristics is produced.

An aluminum base alloy containing .2% silicon and magnesium (uncombined with silicon) and zinc in the proportions represented by the formula $Al_3Mg_7Zn_6$, and in sufficient amounts to produce 6% of this ternary compound in the alloy, was prepared. From this base alloy three different alloys were prepared by incorporating the proportions of iron indicated in the following Table 1, and chill cast in standard test bar molds. Several bars of each alloy were given the indicated heat treatments, that is, some of the bars of each alloy were removed from the mold while hot and allowed to cool in air, and then aged seven days at room temperature; another set of bars was removed from the mold before the bars had cooled sufficiently to precipitate the hardening ingredients, then quenched in water and allowed to age at room temperature for seven days.

Table 1

Alloy	Fe	Elongation	Proportional limit	Yield strength	Tensile strength	Brinell hardness
	Percent	*Percent*	*Lbs./in.*^{2}	*Lbs./in.*^{2}	*Lbs./in.*^{2}	*Wkg./mm.*^{2}
1*	.81	6.2	16,100	23,300	36,900	79
2*	1.34	4.4	19,200	26,400	39,500	85
3*	1.87	5.4	18,500	25,300	39,600	84
1**	.81	7.9	16,400	23,100	39,400	79
2**	1.34	5.0	19,400	26,600	41,100	85
3**	1.87	5.8	17,400	25,000	40,400	83

*Alloy air-cooled; aged at room temperature seven days.
**Alloy quenched; aged at room temperature seven days.

It is seen from the test results of the above table that, although the tensile strength may be increased to some extent by a quenching treatment, almost equal results are obtained by simply air-cooling the casting and aging it at room temperature. Before the quenched casting is aged a tensile strength of over 30,000 lbs./sq. in. is obtained, while at the same time the casting has an elongation of 12%. In an aged casting a tensile strength of even greater than 40,000 lbs./sq. in., together with an elongation of almost 8% is obtained. In an aged casting maximum elongation and substantially maximum strength are obtained when the iron content is about 1% or so.

When the quantity of ternary compound is increased, these maximum values may be obtained with a somewhat lower iron content, or higher maximum strength is obtained with the same iron content; the castability of the alloy may be also somewhat increased. It will be seen that, since the iron permits one to obtain exceptionally high elongation, combined with high tensile strength, without the necessity of even as much heat treatment as quenching from the mold, the alloy is especially useful for many purposes, such as large castings or forgings, wherein it is difficult to heat treat or quench.

As shown above, iron and the ternary compound alone produce exceptional properties in an aluminum base alloy, with or without the usual impurities. Even more desirable properties, for some purposes, are obtained with iron and one or more hardening metals of the group consisting of about .1% to 1.5% chromium, about .05% to 1.5% manganese, and about .1% to 1.5% nickel. As little as a total of about .1% or .2% of these hardening metals is effective in improving the iron ternary aluminum alloy, but about .4% or .5% to about 1.5% of these hardening metals is preferred, and even 2% is desirable for many applications. The iron may be present in the amounts above set forth, but less than about 1.5% is preferred.

If it is desirable to make the alloy more responsive to heat treatment, from .2% to about 1%, or even up to about 1.5% copper may be present in the alloy. Copper is a precipitation hardening ingredient, and the benefits of this element are obtainable when the alloy is subjected to conditions of heat treatment which precipitate the element from the solid solution. The presence of from .5% to 1.5% copper permits a reduction in the amount of the ternary compound, which may be as low as 1%, and preferably should not exceed about 10% or 12%.

When copper is present in the above alloy containing magnesium in the proportion to combine with the silicon to form Mg_2Si, and with the zinc and aluminum to form a ternary compound as above described, iron, as above set forth, may or may not be present, although superior properties are obtained with .4% to 1.5% or 2% iron. The alloys containing copper and iron are substantially improved when at least one member of the above group of hardening elements and/or at least one member of the group of grain refining elements are also present.

EXAMPLE 2

An aluminum base alloy containing about 6% of the ternary compound, about .6% iron, about .3% manganese, about .5% copper, about .25% chromium, about .2% silicon, and about .2% titanium, was chill cast into test bars, quenched

and aged three hours at 125° C. When tested these bars had the following properties: tensile strength 43,500 lbs./sq. in.; yield strength 35,400 lbs./sq. in.; proportional limit of 23,500 lbs./sq. in.; elongation of 6.5%; and hardness of 86 Rockwell E.

EXAMPLE 3

The alloy of Example 2, but containing .75% copper in addition to the elements thereof, when chill cast into test bars, quenched and aged three hours at 125° C., had the following properties: tensile strength 43,000 lbs./sq. in.; yield strength 31,400 lbs./sq. in.; proportional limit of 19,500 lbs./sq. in.; elongation of 5.3%; and hardness of 86 Rockwell E.

EXAMPLE 4

The alloy of Example 2, but containing 1% copper in addition to the elements thereof, when chill cast into test bars, quenched and aged three hours at 125° C., had the following properties: tensile strength of 40,200 lbs./sq. in.; yield strength 33,100 lbs./sq. in.; proportional limit of 17,300 lbs./sq. in.; elongation of 3.2%; and hardness of 83 Rockwell E.

Since the molecular proportion of zinc is never more than the molecular proportion of the relatively light magnesium in the ternary compound, it is seen that, in addition to high strength, the alloys are light in weight and are, therefore, especially adapted to aircraft construction and the like. This is particularly true when the quantity of ternary compound is sufficiently low so that the alloy may be drawn or rolled into structural members.

If the alloy contains uncombined silicon, about 1.75% magnesium is required to combine with each percent of uncombined silicon to form magnesium silicide (Mg_2Si) before any ternary compound will be formed. For example, if 2% of the ternary compound on the basis of $Al_2Mg_3Zn_3$ be desired in an alloy having .3% silicon, the amount of magnesium to be added to form the ternary compound will be .45%, or about .5%, and the magnesium to combine with .3% silicon will be about .5%, making a total of about 1%.

The magnesium and zinc in an alloy containing .7% free silicon and 20% $Al_3Mg_7Zn_6$ would be about 7% and 12%, respectively. The alloys described herein include aluminum, magnesium and zinc, the zinc being present in the amounts of 1.2% to 12% of the alloy, and the magnesium, uncombined with silicon, being proportioned to the zinc in the ranges of the formulas given for the ternary compound. The proportions for the formation of the ternary compound in the alloy exist when the magnesium is about 35% to 45% of the zinc content plus 175% of the silicon content. Most desirable properties may be obtained when the magnesium (uncombined with silicon) is in the lower portion of this range, or about 35% to 40% of the zinc.

In the above examples of alloys of the present invention it is to be noted that excellent tensile strength and hardness are obtainable in a relatively short time by aging at room temperature. A very astounding fact has been discovered, however, in connection with these alloys, namely, that the tensile strength may increase up to approximately 50% of its initial value by aging at room temperature for relatively long periods of time, such as a few months. The same improvement in tensile strength can, of course, be obtained relatively quickly by aging at temperature above room temperature.

The improvement of properties is illustrated by the following table showing the improvement in an alloy containing a small percentage of silicon, about 6% ternary compound, about 1% iron, and about .2% titanium. The test bars were chill cast, quenched from the mold, and tested after aging at room temperature for the period indicated.

Table 2

Aging time	Elongation	Tensile strength	Hardness Rockwell E
	Per cent		
None	12	31,200	56
3 days	7.9	36,700	76
1 week	7.3	38,300	80
2 weeks	6.6	39,700	82
3 weeks	6.6	40,000	84
4 weeks	6.3	40,300	83
5 weeks	6.6	40,900	85
2 months	6.0	41,350	85.1
3 months	4.8	41,600	88.5
4 months	4.8	42,500	87.6
5 months	5.2	43,400	89.1
6 months	5.1	43,700	89.1

To obtain these exceptional properties in aluminum base alloys commonly in use one has to resort to a solution and aging heat treatment, whereas in alloys of the present invention it is not necesary to solution heat treat for improvement in properties.

The alloys of the present invention have good fatigue and tensile strength and a relatively high proportional limit, even at relatively high temperatures; they may be heat treated to improve and modify their properties; and they have sufficient ductility and hardness so that they can be used as sheets, rods, wire, structural shapes, castings, machine parts, etc. These alloys have a desirable color, high corrosion resistance, and may be anodically finished or highly polished with excellent results, and are suitable for many uses, among them being the production of castings which are shaped or formed to some extent after casting. The alloys having the lower percentages of ternary compound may even be forged at room temperature, and are thus useful for many special purposes.

It is to be understood that, in considering the amount of zinc and magnesium to add to aluminum alloys to form the ternary compound of aluminum, magnesium and zinc in the alloy, such magnesium as is necessary to combine with the uncombined silicon is not to be considered as part of the magnesium necessary to form the specified amount of ternary compound.

It is to be understood that the particular compounds disclosed and the procedure set forth are presented for purposes of explanation and illustration, and that various equivalents can be used and modifications of said procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. An aluminum alloy containing magnesium, zinc, about .4% to 2% iron, about .2% to 1.5% copper, silicon in an amount up to 1.5%, and one or more metals of the hardeners and grain refiners to increase strength, ductility or hardness of the alloy, with the balance substantially all aluminum and minor impurities, the amount of zinc in the alloy being about .6% to 12%, and the amount of magnesium in the alloy uncombined with the silicon being about 35% to 45% of the zinc content, the total magnesium being within the range of about .5% to 7%.

2. An aluminum alloy containing magnesium,

zinc, about .4% to 2% iron, about .2% to 1.5% copper, silicon in an amount up to 1.5%, and one or more metals of the hardeners and grain refiners to increase strength, ductility or hardness of the alloy, no one of such metals being present in amounts more than 1.5%, with the balance substantially all aluminum and minor impurities, the amount of zinc in the alloy being about 1.2% to 7.2%, and the amount of magnesium in the alloy uncombined with the silicon being about 35% to 45% of the zinc content, the total magnesium being within the range of about .5% to 7%.

3. An aluminum alloy containing magnesium, zinc, about .4% to 2% iron, about .2% to 1.5% copper, silicon in an amount up to 1.5%, and one or more metals of the hardeners and grain refiners to increast strength, ductility or hardness of the alloy, no one of such metals being present in amounts more than 1.5%, with the balance substantially all aluminum and minor impurities, the amount of zinc in the alloy being about .6% up to about 6%, and the amount of magnesium in the alloy uncombined with the silicon being about 35% to 45% of the zinc content, the total magnesium being within the range of about .5% to 6%.

4. The alloy set forth in claim 3 in which the zinc content is about .6% to 4.8% and the magnesium content is within the range of about .5% to 5%.

5. The alloy set forth in claim 3 in which manganese is present in the amount of about .1% to 1.5%.

6. The alloy set forth in claim 3 in which nickel is present in the amount of about .1% to 1.5%.

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