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(54) **Title**: A METAL ALLOY

(57) **Abstract**: The present invention discloses a zinc alloy wherein the composition comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel and the balance being zinc preferably at purity of 99.995 % or any combination thereof. The said zinc alloy may also contain, by weight, 0.1-1 % of tin and/or 0.03-0.5% of silver. The said zinc alloy may also contain, by weight, 0.05-2.5 % of bismuth with or without 0.45-3 % of copper. For sheet rolling process, tin of 13-30% by weight may be added for producing a zinc alloy which can be rolled. The present invention further discloses a zinc alloy wherein the composition comprising of, by weight, 0.15-0.40 % of magnesium, 0.03- 0.5 % of silver and the balance being zinc preferably at purity of 99.995 % or any combination thereof. This said zinc alloy may also contain, by weight, 0.05-2.5% of bismuth and/or 0.1-1% of tin. The present invention also discloses a zinc alloy wherein the composition comprising of, by weight, 0.15-0.40 % of magnesium, 0.03- 0.5 % of silver, 0.30-8.00 % of tin, 0.30-6.00 % of nickel and the balance being zinc preferably at purity of 99.995 % or any combination thereof.

A METAL ALLOY

Field of the Invention

The present invention relates to a metal alloy which can be cast, rolled and soldered and has good tarnish and corrosion resistance.

Background of the Invention and Prior Art

Zinc alloys are the easiest to cast into moulds as compared with steel and aluminum alloys. Presently available alloys are generally not suitable for use for the manufacture of functional and ornamental products as they are not easily soldered, rolled and/or cast. Soldering of one or more parts of the alloy together with common tin/bismuth solder is important as many products are made from a combination of different parts. The colour of the alloy is also an important consideration for most products.

Various zinc alloys have been disclosed in the prior art described below but they do not have all the desirable qualities or properties for the manufacture of small metal products.

United Kingdom patent No. 378,645 discloses zinc base die-casting alloys containing an appropriate amount of aluminium for die-casting purposes, say 2 to 10% (preferably about 4%), from 0.01 to 0.3% magnesium (preferably about 0.1%), from 0.05 to 2% copper (preferably about 1%), and the balance being high grade zinc metal (preferably containing at least 99.94% zinc).

United Kingdom patent No. 427,238 discloses zinc base die-casting alloys containing 1-15% aluminum, preferably 2-5% with optimum of about 4%, 0-0.4% copper, 0.005 to 0.45% magnesium, preferably 0.01-0.1%, with an optimum of about 0.04%, 0.005-0.5% nickel, preferably 0.005-0.1%, with an optimum of about 0.02%, and the balance being zinc at least 99.98% pure and preferably 99.99% pure, not containing more than 0.003% lead, more than 0.003% cadmium or more than 0.001% tin.

United States patent No. 4,863,686 discloses a high-strength, easily-castable zinc alloy comprising substantially of, by weight, from 1 to 30% aluminum, from 1 to 20% copper, from 0.01 to 1% titanium, from 0.01 to 1% zirconium, and the balance zinc, and also is provided a high-strength, easily-castable zinc alloy further including from 0.01 to 0.1% magnesium. These alloys are useful in the manufacture of molds for injection molding of plastics or as die casting products.

Japanese patent publication No. 10-168533 discloses a zinc alloy excellent in tensile strength and creep resistance at high temperature comprising of, by weight, 0.1-4.5% magnesium and the balance zinc with inevitable impurities and additionally containing, if necessary, 7 or less %, in total, of at least one element among copper, nickel, and manganese, and/or 10 or less % aluminum, and/or 2 or less %, in total, of at least one element selected from the group comprising of titanium, zirconium, chromium, cobalt, lithium, berylium, silicon and lanthanoide series elements.

It is an object of this invention to have a zinc based alloy having an improved quality in terms of strength and is easy to cast and solder. Further, it is also malleable and has high tarnish resistance with finer grain and a desirable color.

Summary of the Invention

The present invention discloses an alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel or any combination thereof and the balance being zinc wherein the zinc is preferably at purity of 99.995 %. The said alloy may further contain, by weight, 0.1-1 % of tin and/or 0.03-0.5 % of silver. The said alloy may further contain, by weight, 0.05-2.5 % of bismuth with or without 0.45-3 % copper.

With the addition of by weight, 13-30 % of tin, the said alloy becomes easier to roll. Alternatively, the alloy may contain, by weight, 13-30 % of tin and 0.03-0.5 % of silver.

The present invention further discloses an alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5 % of silver or any combination thereof and the balance

being zinc wherein the zinc is preferably at a purity of 99.995 %. The said alloy may further contain, by weight, 0.05-2.5 % of bismuth and /or 0.1-1 % of tin.

The present invention also discloses an alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5 % of silver, 0.3-8.0 % of tin, 0.3-6.0 % of nickel or any combination thereof and the balance being zinc wherein the zinc is preferably at a purity of 99.995 %. The said alloy may further contain, by weight, 0.05-2.5 % of bismuth.

The present invention discloses alloys which can be used to manufacture products by casting including a wide range of hardware, accessories or giftware. It can also be used as an alternative to and substitute for tin alloys.

Detailed Description of the Invention

The present invention discloses a zinc alloy that can be cast, rolled and soldered to produce a wide range of metal products.

The present invention discloses a zinc alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel or any combination thereof and the balance being zinc at purity of 99.995 %.

The present invention also discloses a zinc alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel, 0.1-1 % of tin or any combination thereof and the balance being zinc at a purity of 99.995 %.

In addition, the present invention discloses a zinc alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel, 0.1-1 % of tin, 0.03-0.5 % of silver or any combination thereof and the balance being zinc at purity of 99.995 %.

In addition, the present invention discloses a zinc alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5

% of nickel, 0.05-2.5 % of bismuth or any combination thereof and the balance being zinc at purity of 99.995 %.

In addition, the present invention discloses a zinc alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel, 0.05-2.5 % of bismuth or any combination thereof and the balance being zinc at purity of 99.995 %.

For use in a sheet rolling process, the present invention discloses a zinc alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel, 13-30 % of tin, 0.03-0.5 % of silver or any combination thereof and the balance being zinc at preferably a purity of 99.995 %.

In addition, the present invention discloses a zinc alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5 % of silver or any combination thereof and the balance being zinc at purity of 99.995 %. For this range, aluminum, copper and nickel are not included into the alloy to avoid high viscosity for molten alloy due to higher content of magnesium.

In addition, the present invention discloses a zinc alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5 % of silver, 0.05-2.5 % of bismuth and/or 0.1-1 % of tin or any combination thereof and the balance being zinc at purity of 99.995 %. For this range, aluminum, copper and nickel are not included into the alloy to avoid high viscosity for molten alloy due to higher content of magnesium.

In addition, the present invention discloses a zinc alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5 % of silver, 0.3-8.0 % of tin, 0.3-6.0 % of nickel or any combination thereof and the balance being zinc at purity of 99.995 %. For this range, aluminum and copper are not included into the alloy to avoid high viscosity for molten alloy. Nickel blends well together with tin.

In addition, the present invention discloses a zinc alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5% of silver, 0.3-8.0 % of tin, 0.3-6.0 % of nickel and/or 0.05-2.5 % of bismuth or any combination thereof and the balance being zinc at purity of 99.995 %. For this range, aluminum and copper are not included into the alloy to avoid high viscosity for molten alloy. Nickel blends well together with tin.

Aluminum

Aluminum increases the tarnish resistance of the zinc alloy by passivation protection as zinc tarnishes easily. The present invention discloses the use of aluminum in combination with zinc wherein the total amount of aluminum exceeds 0.75 % by weight to achieve passivation protection. However, the amount of aluminum should not exceed 4.75 % by weight, as it would be difficult to cast due to the high viscosity of the molten alloy. Hence, the present invention discloses the use of aluminum in the preferable range of 0.75-4.75 % by weight. An alloy with aluminum within this range can be cast using various casting methods. However, the grains of this alloy are rough and the thinner portions of the cast parts break easily. Further, the color of the cast part is dull grey to whitish dull grey with increasing aluminum content. Also, a higher percentage of aluminum with higher passivation protection would make soldering with tin/bismuth alloy difficult. The solderability values of the alloy are shown in Table 1.

Copper

The inclusion of copper will improve the malleability of the alloy. Without copper, cast parts tend to crack or break off during removal from the mould. The present invention discloses the use of copper in combination with zinc wherein the total amount of copper exceeds 0.45 % by weight. However, if the amount of copper exceeds 3 % by weight, the alloy becomes hard to remove from the moulds. Moreover, finishing processes for the alloy become difficult if the hardness is high. Hence, the present invention discloses the use of copper in the preferable range of 0.45-3 % by weight. The alloy within this range can be cast using various casting methods but the grains will be rough. With the addition of copper, the cast parts do not crack or break off easily. The color of this alloy becomes darker dull grey with

increasing copper content. The solderability values of this alloy are shown in Table 1.

Magnesium

Magnesium produces finer grain for cast parts from the alloy. The present invention discloses the use of magnesium in combination with zinc wherein the total amount of magnesium exceeds 0.07 % by weight. However, the amount of magnesium used should not exceed 0.09 % by weight as the viscosity of the alloy will be adversely affected. When the molten alloy becomes too viscose, the alloy becomes difficult to cast. Moreover, a higher content of magnesium in the alloy will cause excessive dross formation. Hence, the present invention discloses the use of magnesium in the preferable range of 0.07-0.09 % by weight. An alloy within this range can be cast using various casting methods without rough grains. The color of this alloy becomes a brighter grey with increasing magnesium content.

Alternatively, the content of magnesium can be increased to a preferable range of 0.15–0.40 % by weight. For this range, aluminum and copper are not included into the alloy to avoid high viscosity for molten alloy. Instead silver is added at range of 0.03–0.5 % by weight to provide malleability to the alloy. The color of the alloy is brighter gray white. In addition, 0.05-2.5 % by weight of bismuth and/or 0.1-8 % by weight of tin and/or 0.3-6 % by weight of nickel may be added to the alloy in various combinations. The solderability values of this alloy are shown in Table 1.

Nickel

Nickel will increase the corrosion resistance of the alloy, improve the color of the alloy and improve solderability. The present invention discloses the use of nickel in combination with zinc wherein the total amount of nickel exceeds 0.05 % by weight. However, the amount of nickel should not exceed 1.5 % by weight, as the molten alloy will become too viscose. It is difficult to cast with high viscosity and the alloy will also become brittle. Hence, the present invention discloses the use of nickel in the preferable range of 0.05-1.5 % by weight. An alloy within this range can be cast

using various casting methods. The color of this alloy becomes bright grey with increasing nickel content.

The total amount of nickel can be increased to a level not exceeding 6 % by weight when mixed with tin. The combination with tin at ratio of roughly 3:4 would allow the viscosity to be maintained. The solderability values of this alloy are shown in Table 1.

Tin

Tin will improve the solderability and increase the ductility of the alloy. The present invention discloses the use of tin in combination with zinc wherein the total amount of tin exceeds 0.1 % by weight. However, the amount of tin should not exceed 1 % by weight. Higher level of tin will contribute towards increasing the internal corrosion of the alloy. Hence, the present invention discloses the inclusion of tin in the preferable range of 0.1-1 % by weight. The color of this alloy becomes bright grey with additional tin. The level of tin can be increased to 8 % when mixed together with nickel. The solderability values of this alloy are shown in Table 1.

Silver

Silver may be used to give a shinier color to the alloy. It will also increase the malleability of the alloy. The present invention discloses the use of silver in combination with zinc wherein the total amount of silver exceeds 0.03 % by weight. However, the amount of silver should not exceed 0.5 % by weight as the viscosity of molten alloy increases with increasing silver content. It becomes difficult to cast with higher viscosity. Hence, the present invention discloses the inclusion of silver in the preferable range of 0.03-0.5 % by weight. The solderability values of this alloy are shown in Table 1.

Bismuth

Bismuth will reduce the porosity of cast part. The present invention discloses the use of bismuth in combination with zinc wherein the total amount of bismuth exceeds 0.05 % by weight. However, the amount of bismuth should not exceed 2.5 % by

weight as the color will turn whitish with increasing bismuth content. Tarnish resistance is reduced with increasing amount of bismuth. Hence, the present invention discloses the inclusion of bismuth in the preferable range of 0.05-2.5 % by weight. Alternatively, by adding bismuth to the alloy, copper element may be replaced from the composition. The solderability values of this alloy are shown in Table 1.

Rolling Process

The present invention further discloses a zinc alloy with a high percentage of tin developed for the rolling process. Tin is needed to improve ductility thus enabling the alloy to be rolled. For the rolling process, the present invention discloses the use of tin in combination with zinc wherein the total amount of tin exceeds 13 % by weight to be effective as an alloy as tin content below that percentage cracks easily during rolling operation. However, the amount of tin need not exceed 30 % by weight. Hence, the present invention discloses the use of tin for rolling process in the preferable range of 13-30 %. The solderability values of this alloy are shown in Table 1.

Table 1. Solderability of the alloy at different compositions.

Composition zn: Zinc al: Aluminum cu: Copper mg: Magnesium ni: Nickel sn: Stannum (Tin) ag: Argentum (Silver) bi: Bismuth	**Soldering Grade** 1: Zero solderability 2: Poor solderability 3:Average solderability 4: Good solderability 5:Excellent solderability Based on 60 Tin/ 40 Bismuth rod
al 0.75 zn bal	3
al 2 zn bal	2
al 4.75 zn bal	1.5
al 0.75 cu 0.45 zn bal	3
al 0.75 cu 1.5 zn bal	3.5
al 0.75 cu 3 zn bal	3.5
al 2 cu 0.45 zn bal	2
al 2 cu 1.5 zn bal	2
al 2 cu 3 zn bal	2.5

al 4.75 cu 0.45 zn bal	1.5
al 4.75 cu 1.5 zn bal	1.5
al 4.75 cu 3 zn bal	2
al 0.75 cu 0.45 mg 0.08 zn bal	3
al 0.75 cu 3 mg 0.08 zn bal	3.5
al 4.75 cu 0.45 mg 0.08 zn bal	1.5
al 4.75 cu 3 mg 0.08 zn bal	2
al 0.75 cu 0.45 mg 0.08 ni 0.05 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 1 zn bal	4.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 zn bal	4.5
al 0.75 cu 3 mg 0.08 ni 0.05 zn bal	4
al 0.75 cu 3 mg 0.08 ni 1 zn bal	4.5
al 0.75 cu 3 mg 0.08 ni 1.5 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 0.05 zn bal	2
al 4.75 cu 0.45 mg 0.08 ni 1 zn bal	3
al 4.75 cu 0.45 mg 0.08 ni 1.5 zn bal	3
al 4.75 cu 3 mg 0.08 ni 0.05 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 1 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 1.5 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 0.05 sn 0.1 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 0.05 sn 0.5 zn bal	4
al 0.75 cu 0.45 mg 0.08 ni 0.05 sn 1 zn bal	4.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 sn 0.1 zn bal	4.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 sn 0.5 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 1.5 sn 1 zn bal	5
al 0.75 cu 3 mg 0.08 ni 0.05 sn 0.1 zn bal	4
al 0.75 cu 3 mg 0.08 ni 0.05 sn 0.5 zn bal	4.5
al 0.75 cu 3 mg 0.08 ni 0.05 sn 1 zn bal	4.5
al 0.75 cu 3 mg 0.08 ni 1.5 sn 0.1 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 sn 0.5 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 sn 1 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 0.05 sn 0.1 zn bal	2
al 4.75 cu 0.45 mg 0.08 ni 0.05 sn 0.5 zn bal	2.5
al 4.75 cu 0.45 mg 0.08 ni 0.05 sn 1 zn bal	2.5
al 4.75 cu 0.45 mg 0.08 ni 1.5 sn 0.1 zn bal	3
al 4.75 cu 0.45 mg 0.08 ni 1.5 sn 0.5 zn bal	3.5
al 4.75 cu 0.45 mg 0.08 ni 1.5 sn 1 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 0.05 sn 0.1 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 0.05 sn 0.5 zn bal	3
al 4.75 cu 3 mg 0.08 ni 0.05 sn 1 zn bal	3
al 4.75 cu 3 mg 0.08 ni 1.5 sn 0.1 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 1.5 sn 0.5 zn bal	4
al 4.75 cu 3 mg 0.08 ni 1.5 sn 1 zn bal	4
al 0.75 cu 0.45 mg 0.08 ni 0.05 sn 0.1 ag 0.03 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 0.05 sn 0.1 ag 0.5 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 0.05 sn 1 ag 0.03 zn bal	4

al 0.75 cu 0.45 mg 0.08 ni 0.05 sn 1 ag 0.5 zn bal	4
al 0.75 cu 0.45 mg 0.08 ni 1.5 sn 0.1 ag 0.03 zn bal	4.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 sn 0.1 ag 0.5 zn bal	4.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 sn 1 ag 0.03 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 1.5 sn 1 ag 0.5 zn bal	5
al 0.75 cu 3 mg 0.08 ni 0.05 sn 0.1 ag 0.03 zn bal	4
al 0.75 cu 3 mg 0.08 ni 0.05 sn 0.1 ag 0.5 zn bal	4
al 0.75 cu 3 mg 0.08 ni 0.05 sn 1 ag 0.03 zn bal	4.5
al 0.75 cu 3 mg 0.08 ni 0.05 sn 1 ag 0.5 zn bal	4.5
al 0.75 cu 3 mg 0.08 ni 1.5 sn 0.1 ag 0.03 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 sn 0.1 ag 0.5 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 sn 1 ag 0.03 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 sn 1 ag 0.5 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 0.05 sn 0.1 ag 0.03 zn bal	2
al 4.75 cu 0.45 mg 0.08 ni 0.05 sn 0.1 ag 0.5 zn bal	2
al 4.75 cu 0.45 mg 0.08 ni 0.05 sn 1 ag 0.03 zn bal	2.5
al 4.75 cu 0.45 mg 0.08 ni 0.05 sn 1 ag 0.5 zn bal	2.5
al 4.75 cu 0.45 mg 0.08 ni 1.5 sn 0.1 ag 0.03 zn bal	3
al 4.75 cu 0.45 mg 0.08 ni 1.5 sn 0.1 ag 0.5 zn bal	3
al 4.75 cu 0.45 mg 0.08 ni 1.5 sn 1 ag 0.03 zn bal	3.5
al 4.75 cu 0.45 mg 0.08 ni 1.5 sn 1 ag 0.5 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 0.05 sn 0.1 ag 0.03 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 0.05 sn 0.1 ag 0.5 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 0.05 sn 1 ag 0.03 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 0.05 sn 1 ag 0.5 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 1.5 sn 0.1 ag 0.03 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 1.5 sn 0.1 ag 0.5 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 1.5 sn 1 ag 0.03 zn bal	4
al 4.75 cu 3 mg 0.08 ni 1.5 sn 1 ag 0.5 zn bal	4
al 0.75 cu 0.45 mg 0.08 ni 0.05 bi 0.05 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 0.05 bi 1 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 0.05 bi 2.5 zn bal	3.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 bi 0.05 zn bal	4.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 bi 1 zn bal	4.5
al 0.75 cu 0.45 mg 0.08 ni 1.5 bi 2.5 zn bal	4.5
al 0.75 cu 3 mg 0.08 ni 0.05 bi 0.05 zn bal	4
al 0.75 cu 3 mg 0.08 ni 0.05 bi 1 zn bal	4
al 0.75 cu 3 mg 0.08 ni 0.05 bi 2.5 zn bal	4
al 0.75 cu 3 mg 0.08 ni 1.5 bi 0.05 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 bi 1 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 bi 2.5 zn bal	4
al 4.75 cu 0.45 mg 0.08 ni 0.05 bi 0.05 zn bal	2
al 4.75 cu 0.45 mg 0.08 ni 0.05 bi 1 zn bal	2
al 4.75 cu 0.45 mg 0.08 ni 0.05 bi 2.5 zn bal	2
al 4.75 cu 0.45 mg 0.08 ni 1.5 bi 0.05 zn bal	3
al 4.75 cu 0.45 mg 0.08 ni 1.5 bi 1 zn bal	3

al 4.75 cu 0.45 mg 0.08 ni 1.5 bi 2.5 zn bal	3
al 4.75 cu 3 mg 0.08 ni 0.05 bi 0.05 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 0.05 bi 1 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 0.05 bi 2.5 zn bal	2.5
al 4.75 cu 3 mg 0.08 ni 1.5 bi 0.05 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 1.5 bi 1 zn bal	3.5
al 4.75 cu 3 mg 0.08 ni 1.5 bi 2.5 zn bal	3.5
al 0.75 mg 0.08 ni 0.05 bi 0.05 zn bal	3.5
al 0.75 mg 0.08 ni 0.05 bi 1 zn bal	3.5
al 0.75 mg 0.08 ni 0.05 bi 2.5 zn bal	3.5
al 0.75 mg 0.08 ni 1.5 bi 0.05 zn bal	4.5
al 0.75 mg 0.08 ni 1.5 bi 1 zn bal	4.5
al 0.75 mg 0.08 ni 1.5 bi 2.5 zn bal	4.5
al 4.75 mg 0.08 ni 0.05 bi 0.05 zn bal	2
al 4.75 mg 0.08 ni 0.05 bi 1 zn bal	2
al 4.75 mg 0.08 ni 0.05 bi 2.5 zn bal	2
al 4.75 mg 0.08 ni 1.5 bi 0.05 zn bal	3
al 4.75 mg 0.08 ni 1.5 bi 1 zn bal	3
al 4.75 mg 0.08 ni 1.5 bi 2.5 zn bal	3
al 0.75 cu 0.45 mg 0.08 ni 0.05 ag 0.03 sn 13 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 0.05 ag 0.03 sn 30 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 0.05 ag 0.5 sn 13 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 0.05 ag 0.5 sn 30 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 1.5 ag 0.03 sn 13 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 1.5 ag 0.03 sn 30 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 1.5 ag 0.5 sn 13 zn bal	5
al 0.75 cu 0.45 mg 0.08 ni 1.5 ag 0.5 sn 30 zn bal	5
al 0.75 cu 3 mg 0.08 ni 0.05 ag 0.03 sn 13 zn bal	5
al 0.75 cu 3 mg 0.08 ni 0.05 ag 0.03 sn 30 zn bal	5
al 0.75 cu 3 mg 0.08 ni 0.05 ag 0.5 sn 13 zn bal	5
al 0.75 cu 3 mg 0.08 ni 0.05 ag 0.5 sn 20 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 ag 0.03 sn 13 zn bal	5
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al 0.75 cu 3 mg 0.08 ni 1.5 ag 0.5 sn 13 zn bal	5
al 0.75 cu 3 mg 0.08 ni 1.5 ag 0.5 sn 30 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 0.05 ag 0.03 sn 13 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 0.05 ag 0.03 sn 30 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 0.05 ag 0.5 sn 13 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 0.05 ag 0.5 sn 30 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 1.5 ag 0.03 sn 13 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 1.5 ag 0.03 sn 30 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 1.5 ag 0.5 sn 13 zn bal	5
al 4.75 cu 0.45 mg 0.08 ni 1.5 ag 0.5 sn 30 zn bal	5
al 4.75 cu 3 mg 0.08 ni 0.05 ag 0.03 sn 13 zn bal	5
al 4.75 cu 3 mg 0.08 ni 0.05 ag 0.03 sn 30 zn bal	5
al 4.75 cu 3 mg 0.08 ni 0.05 ag 0.5 sn 13 zn bal	5

al 4.75 cu 3 mg 0.08 ni 0.05 ag 0.5 sn 30 zn bal	5
al 4.75 cu 3 mg 0.08 ni 1.5 ag 0.03 sn 13 zn bal	5
al 4.75 cu 3 mg 0.08 ni 1.5 ag 0.03 sn 30 zn bal	5
al 4.75 cu 3 mg 0.08 ni 1.5 ag 0.5 sn 13 zn bal	5
al 4.75 cu 3 mg 0.08 ni 1.5 ag 0.5 sn 30 zn bal	5
mg 0.15 ag 0.03 zn bal	5
mg 0.15 ag 0.5 zn bal	5
mg 0.40 ag 0.03 zn bal	5
mg 0.40 ag 0.5 zn bal	5
mg 0.15 ag 0.03 bi .05 zn bal	5
mg 0.15 ag 0.03 bi 2.5 zn bal	5
mg 0.15 ag 0.5 bi 0.05 zn bal	5
mg 0.15 ag 0.5 bi 2.5 zn bal	5
mg 0.40 ag 0.03 bi 0.05 zn bal	5
mg 0.40 ag 0.03 bi 2.5 zn bal	5
mg 0.40 ag 0.5 bi 0.05 zn bal	5
mg 0.40 ag 0.5 bi 2.5 zn bal	5
mg 0.15 ag 0.03 sn 0.1 zn bal	5
mg 0.15 ag 0.03 sn 1.0 zn bal	5
mg 0.15 ag 0.5 sn 0.1 zn bal	5
mg 0.15 ag 0.5 sn 1.0 zn bal	5
mg 0.40 ag 0.03 sn 0.1 zn bal	5
mg 0.40 ag 0.03 sn 1.0 zn bal	5
mg 0.40 ag 0.5 sn 0.1 zn bal	5
mg 0.40 ag 0.5 sn 1.0 zn bal	5
mg 0.15 ag 0.03 sn 0.3 ni 0.3 zn bal	5
mg 0.15 ag 0.03 sn 0.3 ni 6.0 zn bal	5
mg 0.15 ag 0.03 sn 8.0 ni 0.3 zn bal	5
mg 0.15 ag 0.03 sn 8.0 ni 6.0 zn bal	5
mg 0.15 ag 0.5 sn 0.3 ni 0.3 zn bal	5
mg 0.15 ag 0.5 sn 0.3 ni 6.0 zn bal	5
mg 0.15 ag 0.5 sn 8.0 ni 0.3 zn bal	5
mg 0.15 ag 0.5 sn 8.0 ni 6.0 zn bal	5
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mg 0.4 ag 0.03 sn 0.3 ni 6.0 zn bal	5
mg 0.4 ag 0.03 sn 8.0 ni 0.3 zn bal	5
mg 0.4 ag 0.03 sn 8.0 ni 6.0 zn bal	5
mg 0.4 ag 0.5 sn 0.3 ni 0.3 zn bal	5
mg 0.4 ag 0.5 sn 0.3 ni 6.0 zn bal	5
mg 0.4 ag 0.5 sn 8.0 ni 0.3 zn bal	5
mg 0.4 ag 0.5 sn 8.0 ni 6.0 zn bal	5

Sheet Rolling Operations

Sheet rolling operations have been conducted using 17.78 x 12.70 x 1.27 cm (7 x 5 x ½ inches) sheet made from the disclosed alloy. Final sheet thickness is around 2 mm. Reasonably good rolled sheets were obtained.

The present invention discloses a zinc alloy that has a wide application and can be used in the design and production of a varied range of functional and ornamental products. Example of the products include range of hardware, such as furniture, household articles, counter-tops, architectural hardware, interior and exterior decorative accessories, gardening goods and components for lightings and fixtures. The disclosed zinc alloy is also suitable for producing a wide range of giftware. It may also be used as an alternative to and substitute for tin alloys.

CLAIMS

1. An alloy comprising of, by weight, 0.75-4.75 % of aluminum, 0.45-3 % of copper, 0.07-0.09 % of magnesium, 0.05-1.5 % of nickel or any combination thereof and the balance being zinc.

2. The alloy according to claim 1 wherein said zinc is preferably at a purity of 99.995 %.

3. The alloy according to claim 1 further comprising of, by weight, 0.1-1 % of tin.

4. The alloy according to claim 1 further comprising of, by weight, 0.03-0.5 % of silver.

5. The alloy according to claim 1 further comprising of, by weight, 0.1-1 % of tin and 0.03-0.5 % of silver.

6. The alloy according to claim 1 further comprising of, by weight, 0.05-2.5 % of bismuth.

7. The alloy according to claim 1 further comprising of, by weight, 0.05-2.5 % of bismuth without 0.45-3 % of copper.

8. The alloy according to claim 1 further comprising of, by weight, 13-30 % of tin.

9. The alloy according to claim 1 further comprising of, by weight, 13-30 % of tin and 0.03-0.5 % of silver.

10. The alloy according to claims 8 and 9 wherein the said alloy can be rolled.

11. An alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5 % of silver or any combination thereof and the balance being zinc.

12. The alloy according to claim 11 further comprising of, by weight, 0.05-2.5 % of bismuth.

13. The alloy according to claim 11 further comprising of, by weight, 0.1-1 % of tin.

14. The alloy according to claim 11 further comprising of, by weight, 0.05-2.5 % of bismuth and 0.1-1 % of tin.

15. An alloy comprising of, by weight, 0.15-0.40 % of magnesium, 0.03-0.5 % of silver, 0.3-8.0 % of tin, 0.3-6.0 % of nickel or any combination thereof and the balance being zinc.

16. The alloy according to claim 15 further comprising of, by weight, 0.05-2.5 % of bismuth.

17. The alloy according to any of the preceding claims wherein the alloy is used for the production of articles by casting.

18. The alloy according to any of the preceding claims wherein the alloy is used for the production of a wide range of hardware, functional and decorative accessories or giftware.

19. The alloy according to any of the preceding claims wherein the alloy is used for the production of a wide range of furniture, household articles, architectural hardware, interior and exterior decorative articles, gardening goods or lightings and parts and fittings thereof.

20. The alloy according to any of the preceding claims wherein the alloy is suitable for the substitution of tin alloys.

AMENDED CLAIMS
received by the International Bureau on 06 July 2010 (06.07.10)

1. An alloy comprising of, by weight, 0.15-0.40% of magnesium, 0.03-0.5% of silver, 0.05-2.5% of bismuth, 0.1-1% of tin and the balance being zinc.

2. The alloy comprising of, by weight, 0.15-0.40% of magnesium, 0.03-0.5% of silver, 0.3-8.0% of tin, 0.3-6.0% of nickel, 0.05-2.5% of bismuth and the balance being zinc.

3. An alloy comprising of, by weight, 0.75-4.75% of aluminium, 0.45-3.0% of copper, 0.07-0.09% of magnesium, 0.05-1.5% of nickel, 13-30% of tin and 0.03-0.5% of silver and the balance being zinc, wherein the said alloy can be rolled.

4. The alloy according to claims 1-3 wherein the alloy is used for the production of articles by casting.

5. The alloy according to claims 1-3 wherein the alloy is used for the production of a wide range of hardware, functional and decorative accessories or giftware.

6. The alloy according to claims 1-3 wherein the alloy is used for the production of furniture, household articles, architectural hardware, interior and exterior decorative articles, gardening goods or lightings and parts and fittings thereof

7. The alloy according to claims 1-3 wherein the alloy is suitable for the substitution of tin alloys.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2010/000011

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

C22C 18/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI: /IC/EC C22C18/00, keywords: ALUMINIUM, COPPER, MAGNESIUM, NICKEL, ZINC (with like key words)
Espacenet, Google.Patent, USPTO: ALUMINIUM, COPPER, MAGNESIUM, NICKEL, ZINC (with like key words)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3733687 A (TANAKA ET AL) 22 May, 1973 See Abstract, examples, col 1 line 5-10, 47-67, col 2 line 35-65, col 4 line 7-22,	part of claims 1, 2, 17, 18, 19, 20
A	EP 0197680 A2 (THE STANDARD OIL COMPANY) 15 October, 1986 Abstract, Table 1	part of claims 1, 2, 17, 18, 19, 20
A	US 5945066 A (GRIFFIN ET AL) 31 August, 1999 Abstract	part of claims 1, 2, 17, 18, 19, 20

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 April 2010	11 MAY 2010

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2010/000011

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: **part of claims 1, 2, 17, 18, 19, 20 and claims 3-16 (in full)**
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
The description does not meet the requirements of Article 5 of the PCT with regards to it being sufficiently clear and complete for the invention to be carried out by a person skilled in the art. Here, part of claims 1, 2, 17, 18, 19, 20 [the invention related to Al alloy where Al is: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%)Ni (0.05-1.5%)Zn (bal)] is searched as proposed by the ISA and accepted by the applicant without any comment (refer to PCT form 224 and email communication). See supplementary box for detailed explanation.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See **Supplemental Box 1**

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: **part of claims 1, 2, 17, 18, 19, 20**

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2010/000011

Supplemental Box 1
(To be used when the space in any of Boxes I to IV is not sufficient)

Continuation of Box No: III

Claims 1-20 relate to multitudinous inventions.

The independent claims define different alloys by introducing different elements. For example A1, A5 and A6 are considered as different alloys where
A1: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%)Ni (0.05-1.5%) Zn (bal)).....one of the alloys interpreted from claim 1*
A5: Mg (0.15-0.4%) Ag (0.03-0.5%) Zn (bal)).....one of the alloys interpreted from claim 11*
A6: Mg (0.15-0.4%) Ag (0.03-0.5%) Sn (0.3-8%) Ni (0.3-6%) Zn (bal))..... one of the alloys interpreted from claim 15*

Further, the dependent claims appended to each of the independent claims define different alloys by introducing different elements where each independent claim defines a large number of alloys. For example A1, A7 and A8 are considered as different alloys where
A1: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%) Ni (0.05-1.5%) Zn (bal).....one of the alloys interpreted from claim 1*
A7: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%) Ni (0.05-1.5%) Sn (0.1-1%) Zn (bal).....alloy defined by claim 3 (appended to claim 1) when claim 1 is interpreted as alloy A1*
A8: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%) Ni (0.05-1.5%) Ag (0.03-0.5%) Zn (bal)... alloy defined by claim 4 (appended to claim 1) when claim 1 is interpreted as alloy A1*

Also, the dependent claims appended to each of the independent claims define different alloys by introducing the same elements in different composition ranges where each independent claim defines a large number of alloys. For example A1, A7 and A9 are considered as different alloys where
A1: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%) Ni (0.05-1.5%) Zn (bal)..... one of the alloys interpreted from claim 1*
A7: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%) Ni (0.05-1.5%) Sn (0.1-1%) Zn (bal)..... alloy defined by claim 3 (appended to claim 1) when claim 1 is interpreted as alloy A1*
A9: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%) Ni (0.05-1.5%) Sn (13-30%) Zn (bal)... alloy defined by claim 8 (appended to claim 1) when claim 1 is interpreted as alloy A1*

*It is noted here that the phrase "or any combination thereof" in independent claims 1, 11 and 15 renders the claims with indeterminate scope. For example the independent claim 1 defines a large number of alloys, a selection of which is listed below

A1: Al (0.75-4.75%) Cu (0.45-3%) Mg (0.07-0.09%)Ni (0.05-1.5%)Zn (bal)
A2: Al(0.75-4.75%) Zn (bal)
A3: Al(0.75-4.75%) Cu (0.45-3%) Zn (bal)
A4: Cu (0.45-3%) Zn (bal)

Thus, each of the independent claims 1, 11 and 15 relates to multitudinous alloys.

Therefore, claims 1-20 relate to multitudinous alloys.

In the above groups of claims, there is no common feature because each group relates to a different alloy. Therefore there is no special technical feature present in the claims and the requirements for unity of invention are consequently not satisfied *a priori*.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/MY2010/000011

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	3733687	CA	936388	DE	2126639	FR	2093821
		GB	1315263				
EP	0197680	AU	54881/86	AU	54882/86	AU	54883/86
		BR	8601380	BR	8601382	BR	8601446
		CA	1273825	CA	1273827	CA	1273828
		CN	86102056	CN	86102078	CN	86102099
		EP	0196190	EP	0197675	ES	8800367
		ES	8802106	ES	8802189	HK	64189
		IL	78107	IN	167302	JP	61269854
		JP	61277162	JP	61291938	NO	861193
		NO	861194	NO	861195	PH	22867
		PH	23655	PH	24448	PT	82288
		PT	82289	PT	82290	US	4923770
		ZA	8602082	ZA	8602085	ZA	8602270
US	5945066	NONE					

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX