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WATER DISINTEGRABLE LEAD SHOT

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ABSTRACT OF THE DISCLOSURE

A lead-base alloy contains, by weight, from 2 to 6 percent magnesium, from 0.2 to 3 percent rare earth metal and up to 6 percent mercury. Preferably the alloy contains 2.5 to 3.5 percent magnesium, from 0.5 to 2 percent rare earth metal, and more preferably, mercury is also present in the range of 0.5 to 1.5 percent. Substantially spherical lead shot consists of lead-base alloy containing from 2 to 6 percent magnesium, and at least one of from 0.2 to 6 percent mercury and from 0.2 to 3 percent rare earth metal, and is characterized by ready disintegration on immersion in water.

The invention relates to a novel lead alloy and more particularly relates to a lead alloy suitable for the preparation of bird shot.

The problem of poisoning ducks and other bottom feeding water fowl with lead shot has been recognized for a long time and has become more serious because the increasing number of nimrods has increased the concentration of residual lead shot in popular hunting areas. The problem arises wherein shot does not find its target and falls into relatively shallow water where it is mistaken for gravel by water fowl and ingested.

It has been proposed heretofore to employ lead alloy containing magnesium. However, lead shot made from lead alloy containing magnesium as the sole alloying additament and shotted in a shooting tower has not disintegrated rapidly, if at all, on immersion in water, but has tended to merely crack slightly without opening.

It is therefore a principal object of the present invention to provide an improved lead alloy for the preparation of lead shot which will crack open or disintegrate rapidly during immersion in water at ambient room temperature.

Another object of the invention is to provide a water-disintegrable lead alloy from which there can be prepared lead shot having sufficient density for accurate shooting.

These and other objects and advantages of the present invention will be more clearly understood upon becoming familiar with the following description and the illustrative examples.

It is now been found that upon preparing a lead-base alloy comprising from about 2 to about 6 percent by weight of magnesium, up to about 6 percent by weight of mercury, up to about 3 percent rare earth metal and the balance substantially lead and at least one of the alloying components of mercury and rare earth metal being present in the alloy at a concentration of at least 0.2 percent by weight and the said alloy being prepared as substantially spherical lead shot, the so-provided shot is characterized by ready cracking open or disintegration upon immersion in water at ambient room temperature for about 24 hours. Preferably the alloy contains from 2.5 to 3.5 percent by weight of magnesium and from 0.5 to 1.5 percent by weight of mercury. In another preferred embodiment, the alloy contains from 0.5 to 2 percent by weight of rare earth metal, desirably in combination with both of magnesium and mercury. Even though the magnesium content of the present alloy is relatively high, the alloy has a density such that good reproducible carry is

realized and a high order of accuracy is attainable on shooting shot made of the alloy.

The lead alloy is readily prepared in a conventional manner by heating lead and the alloying constituents together to a temperature of about 650 to 700° F. or higher. Generally, higher temperatures are employed in connection with the alloy containing rare earth metal. Melting temperatures of about 1000° F. are used in order to dissolve rare earth metal in the molten lead. Melt temperatures above about 700° F. are typically used to keep the rare earth metal dissolved in the melt. Rare earth metal is more easily added after the addition of magnesium which increases the solubility of the rare earth metal in the molten lead. Rare earth metal can best be added to the lead as a master alloy of magnesium-rare earth metal. Lanthanum, being about the most soluble of the rare earth metals commercially available, is a preferred rare earth metal.

It is preferred to add mercury to the alloy after all other alloying additions and at as low a temperature as possible, e.g., about 500 to 600° F. if rare earth metal is not present in the alloy, to avoid volatilization of the mercury. Lower temperatures also favor the retention of the megnesium content of the melt. The lead used in making the alloy is preferably substantially free of antimony, bismuth, tin, or other elements which tends to form solid-insoluble phases or intermetallic compounds with magnesium, as well understood in the art. The lead can be made sufficiently free of such elements, if necessary, by adding magnesium to the molten lead and skimming off the insoluble phases. The Pb-Mg alloy is then analyzed and additional magnesium is added, if needed, to make the intended composition.

Generally the alloy is allowed to settle briefly, any insolubles present are skimmed off, and the molten metal is then cast into molds or shotted in a shot tower while the melt is at a temperature in the range of 500 to 700° F., or higher if necessary to retain the rare earth metal content. Where molds are used, the molds are generally brought to a temperature in the range of about 200 to 450° F. just prior to casting the metal.

If desired, the present alloy may be cast as a billet. The billet is then reduced to shot mechanically, for example, by extruding the metal into wire or rod which is cut into short pieces and worked into substantially spherical form.

The cast billets may also be transformed into shot upon machining the billets into chips and squeezing or compressing the chips into substantially spherical shape in a die, using a concave punch and die, or by mechanical agglomerating methods.

For the purposes of this description and the appended claims, the expressions water disintegrable shot and shot subject to ready disintegration are understood to refer to shot which does more than exhibit surface cracks or split into two or three major pieces, but cracks into a number of pieces or becomes friable or both while otherwise retaining integrity of structure, or further, falls completely apart without mechanical agitation.

The following examples serve to illustrate the invention and are not to be considered as limiting the scope thereof.

In a series of runs according to the invention, lead melts containing various amounts of magnesium with or without mercury and/or rare earth metal were prepared by melting the metals together in a conventional manner, the magnesium being added first in each case. The rare earth metal employed was misch metal, a commercially available mixture of rare earth metals. Samples of each alloy while at a temperature of about 600 to 700° F. were cast into 3/16 inch diameter pellets in molds maintained at

250 and 450°F., respectively. Two pellets of each alloy, respectively, from each mold were placed in respective bottles containing tap water and observed periodically until bubbling, i.e., gas generation, stopped. Generally, bubbling did not continue more than two days. Each pellet was then examined visually and its final condition rated. The nominal compositions employed and the ratings on visual examination are summarized in the following table. The actual compositions are generally somewhat lower than nominal values. In general, reactivity increased with increasing proportion of mercury in the lead alloy. The alloys containing 5 percent by weight of mercury stopped reacting in less than 22 hours.

In additional runs made by way of comparison, lead melts were prepared containing magnesium but no mercury or rare earth metal. The comparison alloys were similarly cast into pellets and immersed in water. The compositions of the comparison alloys and the condition of the pellets on visual examination are also listed in the table.

TABLE I.—FINAL CONDITION OF PELLETS TESTED

Run No.	Composition, by weight* Percent Mg	Percent Hg	Percent MM	Mold temp., 450° F.	Mold temp., 250° F.
Comparison 1	2.5	0		Cracked, 2 pieces broke off	Few small cracks.
Comparison 2	4	0		Little disintegration at surface	Cracked.
1	2.5	1		Broke into few large pieces	Broke into many pieces.
2	2.5	5		Cracked wide open	Cracked open, 1 piece broke off.
3	4	1		Approx. ⅓ disintegrated, rest friable	Disintegrated.
4	4	5		Disintegrated	Broke into large pieces.
5	3	1		Cracked into pieces	Cracked into pieces.
6	3.5	1		Cracked wide open	Cracked wide open.
7	4	.5		Cracked wide open, some disintegration.	Cracked wide open, some disintegration.
8	4	.25		Cracked slightly open	Cracked slightly open.
9	4		1	do	Do.
10	4		2	Considerable flaking off surface	Considerable flaking off surface.
11	3.5	1	1	Broke apart, some disintegration	Broke apart, some disintegration.
12	4	1		Disintegrated	Disintegrated.

*Balance lead.
MM=misch metal, a commercially available mixture of rare earth metals.

In two additional runs which illustrate the invention, lead melts were made up in the same manner as described in the foregoing runs and cast into 3/16 inch diameter pellets in a similar manner using a mold which was at a temperature of about 400°F. at the time of casting. Several pellets of each alloy, respectively, were placed in respective bottles containing tap water and observations were made periodically until bubbling stopped in about 24 hours. Pellets of each alloy were also analyzed to determine actual composition. The nominal and actual compositions of each alloy and the results of the water immersion test on final visual examination of the pellets are listed in Table II.

TABLE II

Run No.	Composition, Percent by Weight* Mg	Hg	Results of visual examination
13	3(1.92)	1(0.68)	Cracked and was readily crushed.
14	3.5(3.34)	1.5(0.93)	Disintegrated readily.

*Balance lead.
Actual composition values are shown in parenthesis.

The lead alloy and lead shot of the invention having been thus fully disclosed, various modifications thereof will at once be apparent to those skilled in the art and the scope of the invention is to be considered limited only by the breadth of the claims hereafter appended.

I Claim:

1. A lead-base alloy consisting essentially of from about 2 to about 6 percent by weight of magnesium, from about 0.2 to about 3 percent by weight of rare earth metal, up to about 6 percent by weight of mercury, and the balance lead.

2. The alloy as in claim 1 which contains from about 0.2 to about 6 percent by weight of mercury.

3. The alloy as in claim 1 which contains from about 2.5 to 3.5 percent by weight of magnesium.

4. The alloy as in claim 1 which contains from about 0.5 to 1.5 percent by weight of mercury.

5. The alloy as in claim 1 which contains from about 0.5 to 2 percent by weight of rare earth metal.

6. Substantially spherical lead shot formed from lead-base alloy consisting essentially of from about 2 to about 6 percent by weight of magnesium, about 0.2 to 3 percent by weight of rare earth metal, up to about 6 percent by weight of mercury and the balance lead, the lead shot being characterized by ready disintegration upon immersion in water at ambient room temperature for about 24 hours.

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