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(54) **METAL SCRAP PACKAGES AND METHODS
AND APPARATUS CAPABLE OF BEING
USED THEREWITH**

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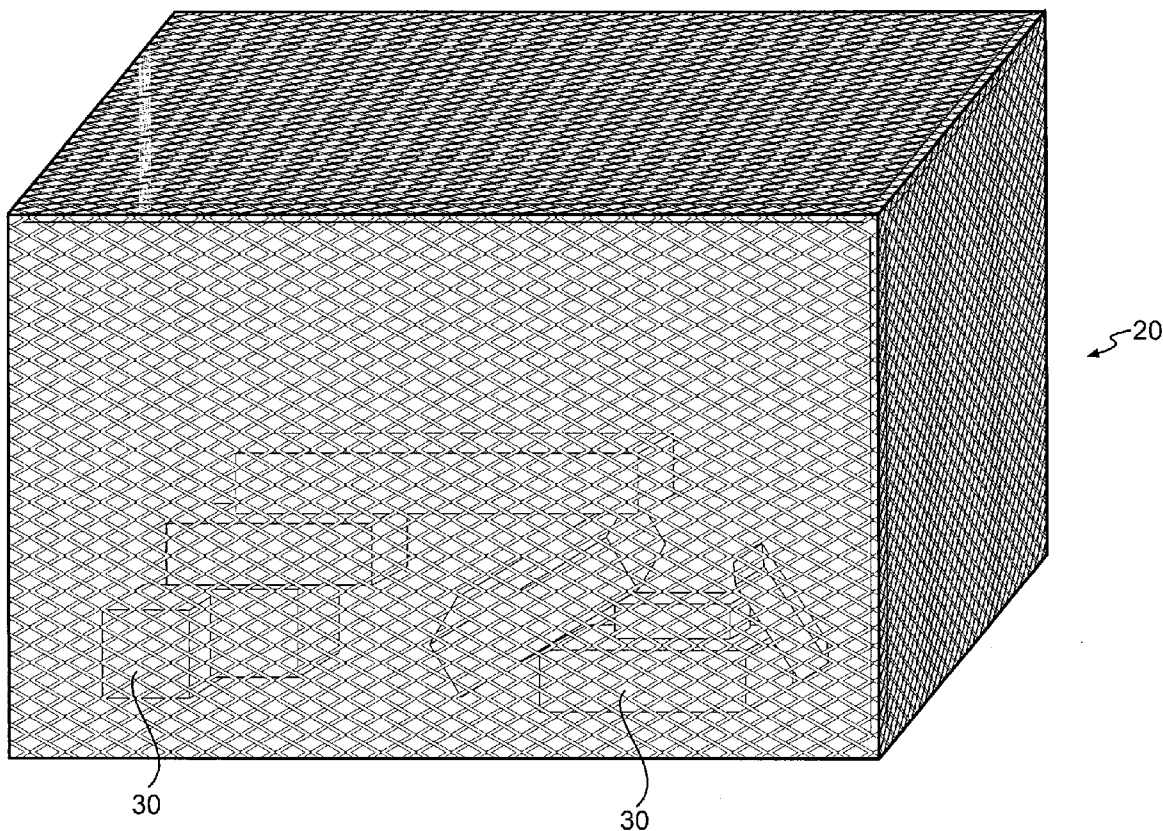
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(57) **ABSTRACT**

The present invention relates to a material package comprising a housing, at least one piece of scrap material contained in the housing, wherein the weight of the housing is from 1 to 5% of the weight of said scrap material, and the housing and the scrap material have melting points that are greater than about 300° F. The present invention further relates to associated methods and products employed with material packages as well as meltable housings, per se.

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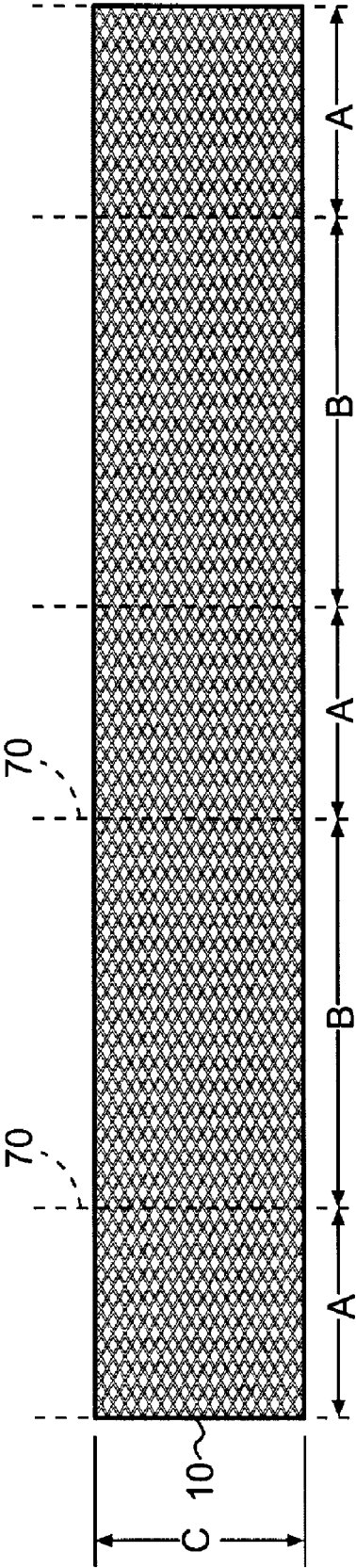


FIG. 1

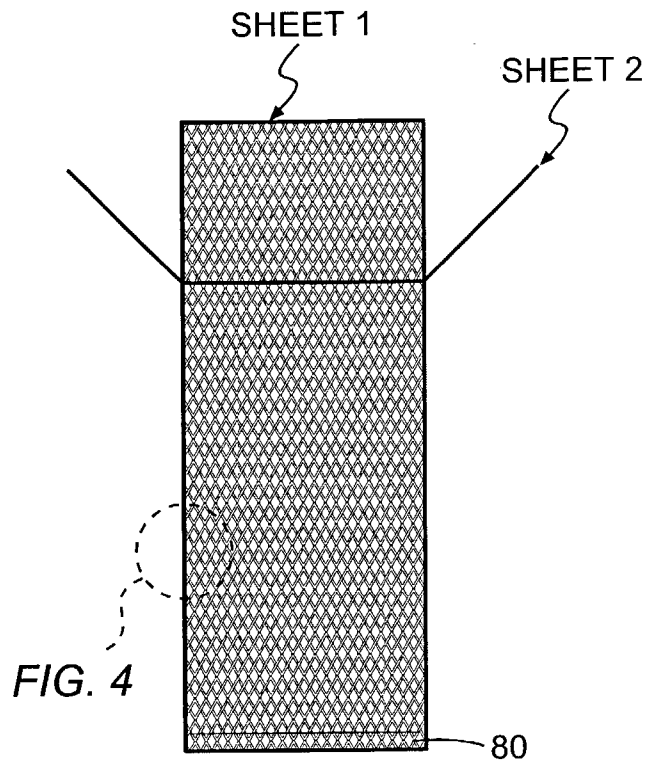


FIG. 2

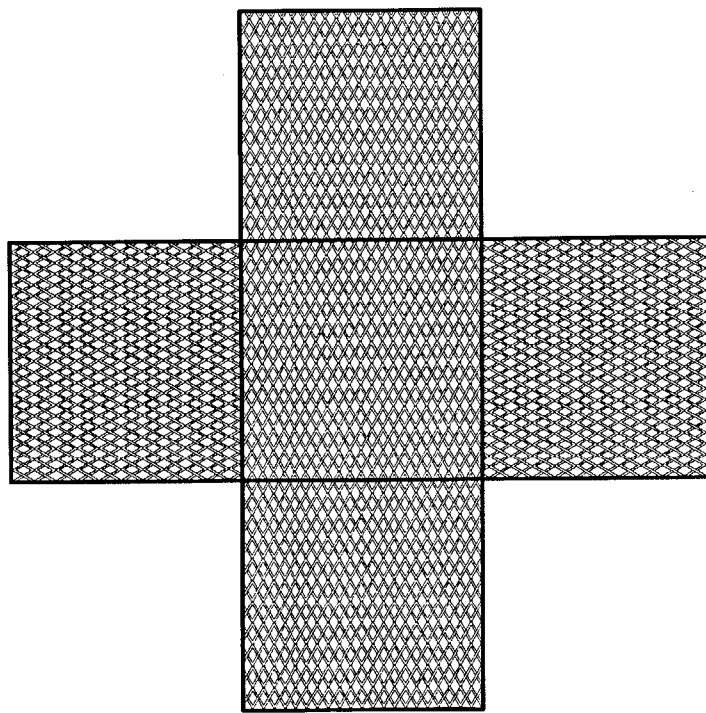


FIG. 3

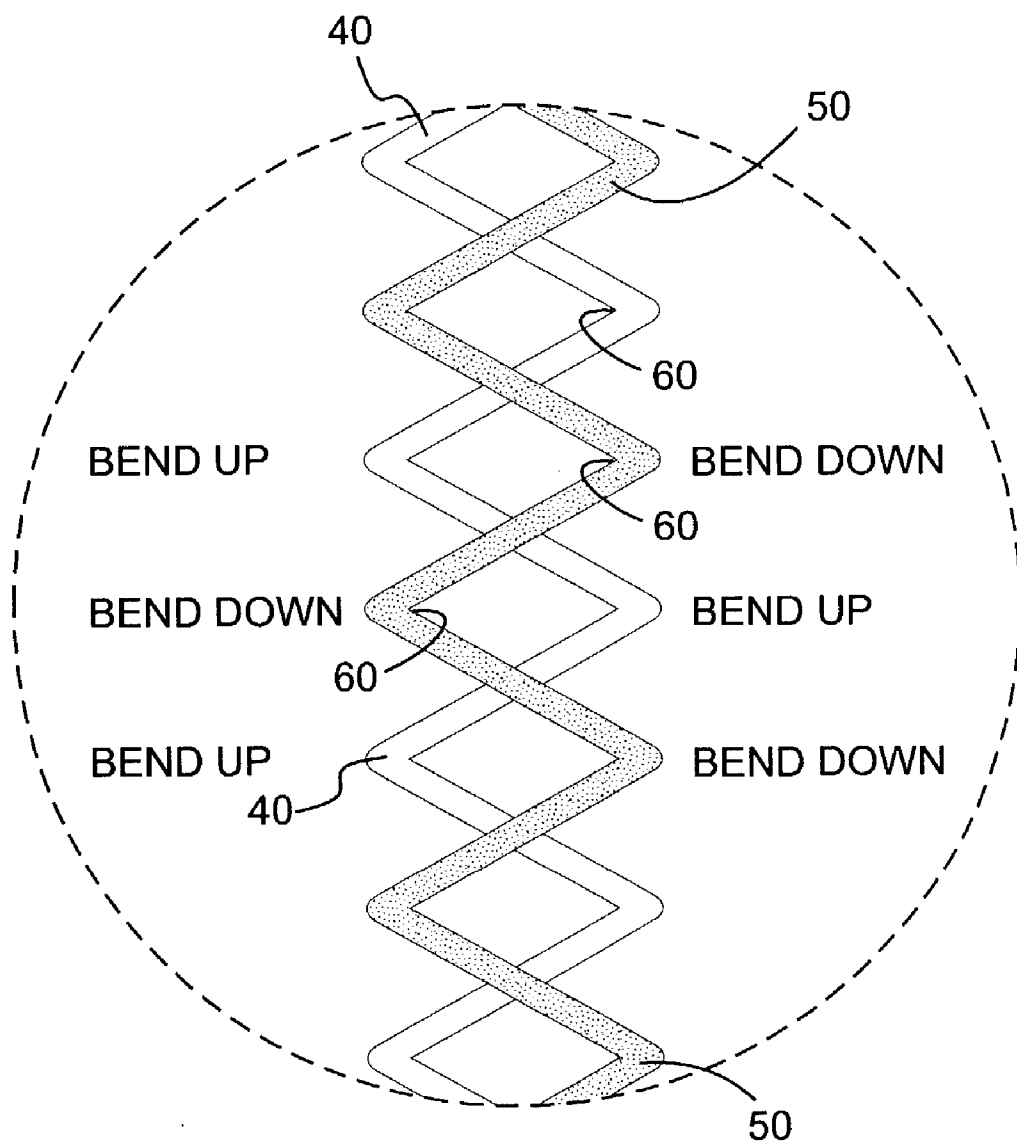
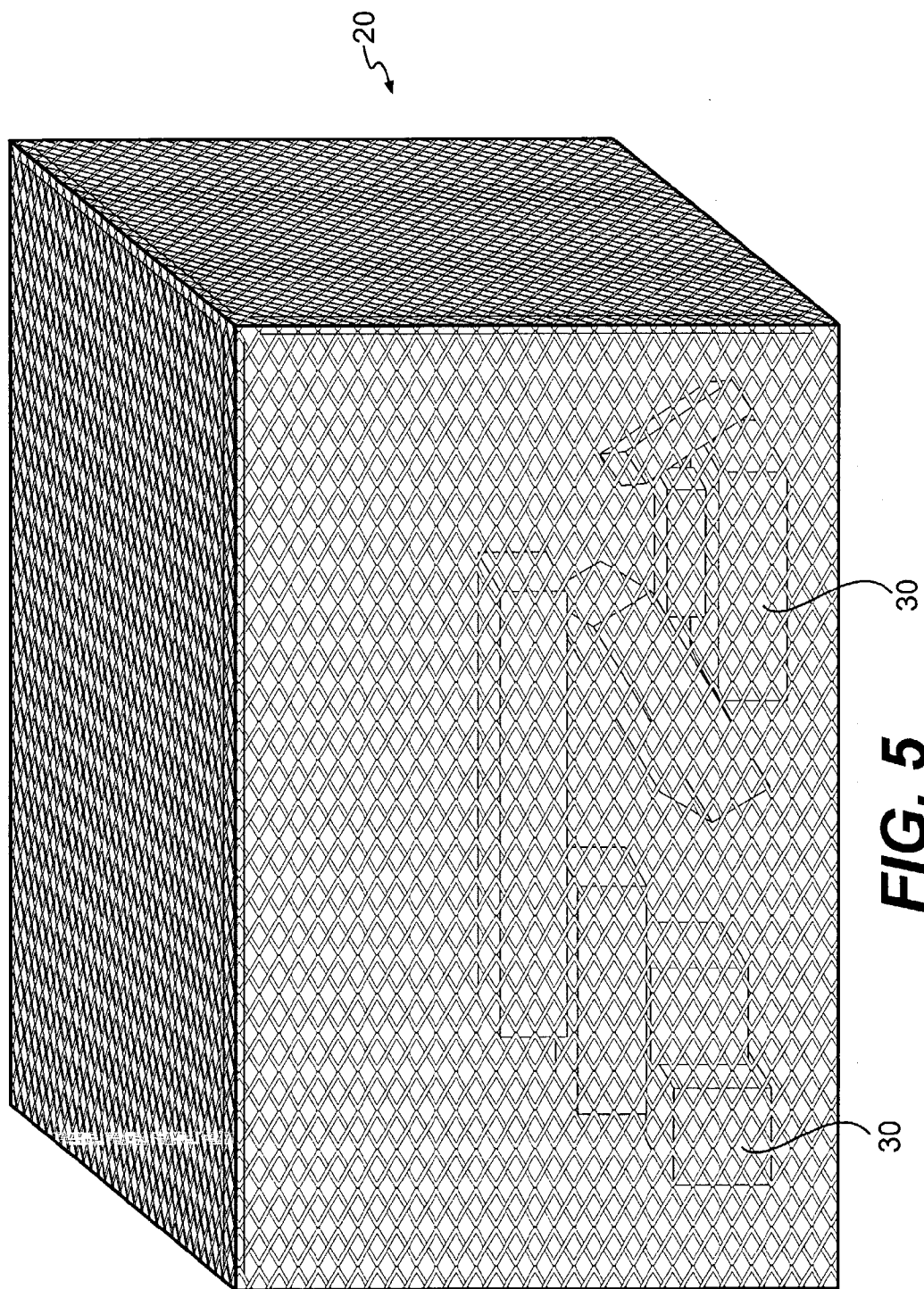


FIG. 4



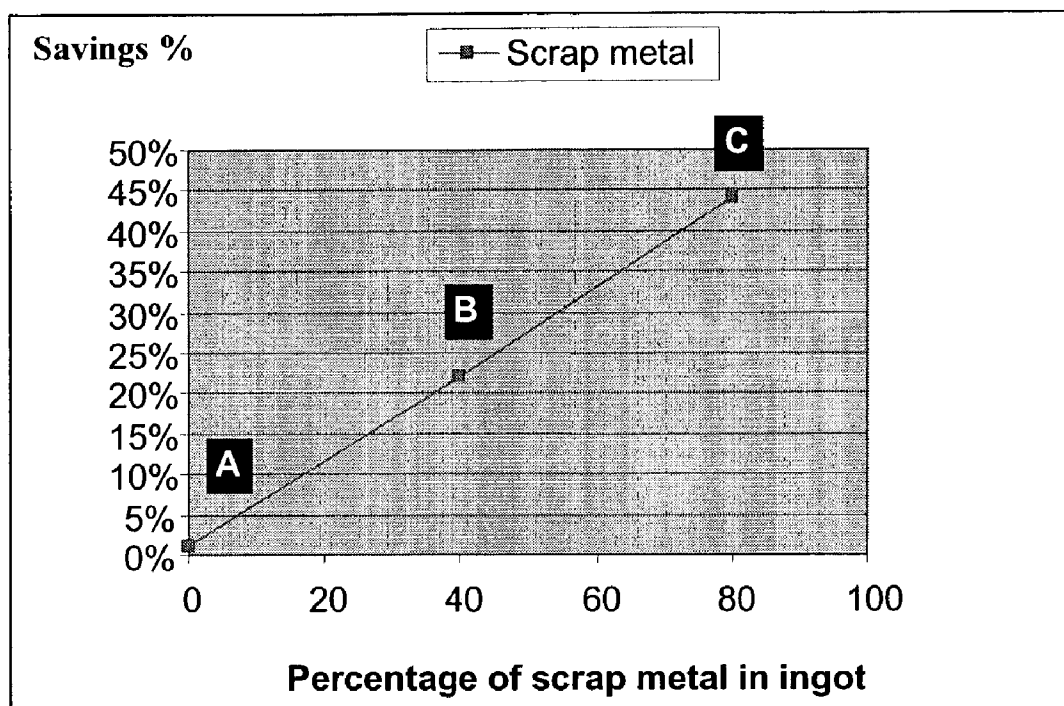


Figure 6

METAL SCRAP PACKAGES AND METHODS AND APPARATUS CAPABLE OF BEING USED THEREWITH

BACKGROUND OF THE INVENTION

[0001] 1. Technical Field of the Invention

[0002] The present invention relates generally to metal scrap and associated methods, and in particular, to methods suitable for use with Al—Li scrap as well as associated apparatus and products produced thereby.

[0003] 2.. Description of Related Art

[0004] With the large volume of products made of metal worldwide, there is inevitably an issue about what to do with the huge quantities of scrap metal that is left over after many manufacturing and machining operations. The scrap metal produced from these operations varies in size from small machined chips or swarf to various sized solid remnant. Moreover, since many metal alloys are constantly being reengineered and developed, large quantities of alloy scrap are often generated for every pound of usable metal produced. For example, a typical aircraft part machined from plate may have a “start-to-finish” ratio (the ratio of the starting raw stock weight to the finished part weight) of between 10 to 120 lbs of starting raw material weight for every pound of finished weight. This is particularly the case with respect to aluminum lithium metal alloys that are very lightweight and are still in many cases, in the experimental stage. Furthermore prior attempts recovering scrap Al—Li have been limited to large scrap that is produced during the manufacturing process at the mill, i.e., ingot heads and ingot butts. Solid Al—Li scrap material must be placed in the induction furnace quickly and carefully to avoid damaging the furnace linings. Thus, Al—Li of small sizes cannot be successfully recycled at all due to these problems, and hence, often goes to waste.

[0005] With respect to aluminum lithium and other alloys, it has been proposed in the past according, for example, to U.S. Pat. Nos. 4,882,017 and 4,973,390 to employ an electrolytic cell to extract lithium from the scrap, apparently in an effort to separate the alloying elements and reuse them individually. Further, with respect to other metals and alloys, other recycling methodologies have been suggested such as in U.S. Pat. Nos. 5,032,171, 6,074,455, 6,273,932 and 5,167,700. In these and related processes, various mechanisms for remelting and/or reincorporating scrap metal alloys are described. However, none of the methods proposed heretofore has provided a reliable and simple mechanism that can be used in any shop or facility that enables storage and separation of particular metal alloys.

SUMMARY OF THE INVENTION

[0006] It was therefore an object of the present invention to provide a method for recycling and/or incorporating metal alloys such as aluminum lithium alloys of virtually any size. Since most of the scrap material from machine shops is small, i.e., various shapes ranging from 1 pound to 200 pounds each, a method has been proposed capable of packaging scrap such that it could be loaded as a large quantity as quickly as possible.

[0007] In accordance with these and other objects, there is provided a meltable housing capable of receivingly accept-

ing at least one metal alloy therein. The meltable housing preferably has a melting point lower than the casting temperature of the metal alloy sought to be contained therein. That is, the meltable housing preferably has a melting point that is high enough to maintain sufficient structural integrity to hold the weight of metal alloy scrap during elevated temperature drying operations and during insertion into the casting furnace.

[0008] In one embodiment, the meltable housing forms a mesh “basket” with at least one entryway provided therein such that metal to be recycled can be placed therein. The mesh basket for melting aluminum lithium alloys can be made, for example, of 3003 or any suitable material that may be desired for a particular type of alloy.

[0009] The present invention is further directed to methods of recycling metal as well as to metal packages and products formed thereby.

[0010] Additional objects, features and advantages of the invention will be set forth in the description which follows, and in part, will be obvious from the description, or may be learned by practice of the invention. The objects, features and advantages of the invention may be realized and obtained by means of the instrumentalities and combination particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a layout of a mesh basket prior to assembly according to one embodiment of the present invention.

[0012] FIG. 2 is a side view of a mesh basket manufactured according to one embodiment of the present invention.

[0013] FIG. 3 is a top view of a basket of FIG. 2.

[0014] FIG. 4 is a close up view of a portion of FIG. 2 showing how mesh could be designed according to one embodiment of the present invention.

[0015] FIG. 5 is an assembled view of a mesh basket showing metal scrap loaded therein.

[0016] FIG. 6 is a graph representing percent savings capable being achieved compared with virgin material according to one embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0017] Since most scrap material from machine shops is small, i.e., various shapes ranging from 1 pound to 200 pounds each, a method was needed to package the scrap such that it could be loaded as a large quantity (i.e. quantities ranging from 1000 to 4000 pounds, preferably from 2500 to 3500 pounds) as quickly and easily as possible. In connection with the present invention, there is provided a meltable basket, preferably formed of metal such as aluminum alloy AA 3003 mesh material. However, the composition of the housing does not necessarily have to comprise aluminum, but actually can be fabricated in any desired composition or shape depending on the material sought to be packaged therein. In one embodiment, the metal basket is formed into a rectangular basket. See FIGS. 1-5. The meltable housing can be formed of any commercially available product and preferably has a melting point lower than the casting tem-

perature of the metal alloy contained therein that is sought to be recycled. For example, a meltable housing made of AA 3003 would have a solidus temperature of approximately 1190° F. and a liquidus temperature of approximately 1210° F. The meltable housing in such an embodiment would melt at a temperature below the casting temperature for aluminum lithium alloys. 3003 also has sufficient strength at temperatures between room temperature and the melting temperature of Al—Li to hold the weight of the metal alloy contained in the housing when subjected to elevated temperature drying operations and during insertion into the casting furnace.

[0018] In one embodiment as shown in **FIG. 1**, two pieces of mesh metal **10** that melts at a temperature below the casting temperature of the metal alloy contained therein, for example between 1190 and 1210° F. with respect to Al—Li, is formed into rectangular shape of any desired size $A \times B \times C$, whereby A is the width, B is the height, and C is the length. In one embodiment, the rectangular shape is 30" $\times$ 60" $\times$ 30" corresponding to a volume consistent with the furnace capabilities and loading methods. **FIG. 1** shows the forming locations **70** where the mesh metal is bent to form the rectangular shape. The formed parts are placed 90° with respect to each other as shown in **FIG. 2** and **FIG. 3** to form a rectangular basket **20** that has a double thick bottom **80** and top with dimensions of $A \times C$ " and sides of $B \times C$ ". The sides are interlocked together (see **FIG. 4**) and can be wired together by any desired means, such as with aluminum wire **40, 50**. The mesh in the basket is preferably of a size having openings ranging from 0.04" to 2", and more preferably has diamond shaped mesh opening sizes ranging from 0.7" to 1.5". By having mesh that is relatively small as described above, a machine shop is then able to load the baskets with small sized scrap metal **30**. As shown for example in **FIG. 4**, an exploded close up view of an advantageous design of mesh is shown. The sheets are secured using any desired mechanism. In a preferred embodiment, the edges of the sheets **10** are bent in a particular fashion as shown, for example in **FIG. 4**. The edges of the sheets **10** alternates in a "bend up"**40**"bend down"**50** orientation at angles **60** preferably ranging from 45° to 170°, more preferably from 80° to 110°. The edges shown in **FIG. 4** are shown prior to bending to interlock the edges together. Note that it is also possible to form a housing that is not mesh but designed to fully contain a quantity of metal sought to be recycled. The overlapping edges of the sheets **40, 50** are shown in **FIG. 4** is advantageous because the sheets **10** are able to be intermeshed to form a strong joint without necessarily requiring wires or other fasteners. In addition, the interlocking is preferably oriented in the depicted "bend up"**40**"bend down"**50** configuration because it minimizes the use of other alloy additions such as aluminum wire to the melt.

[0019] In one embodiment the gauge of the material forming the basket or housing is advantageously from 0.10" to 0.31" and when formed into a basket, can house about 3500 lbs of scrap. In one embodiment, the gauge is about 0.11." However, the gauge can be adjusted higher or lower depending on the requirements of the particular product being recycled and remelted.

[0020] A metal package housed as described above, is advantageous in that it can easily be lifted and moved with a common forklift and hoisted into a truck or other trailer or railway car for removal and transport to be remelted.

[0021] With respect to aluminum lithium alloys, the mesh design is particularly advantageous because the scrap material can be cleaned and/or dried after it is packaged. Once the housing or basket is full, the metal to be remelted can be dried at any suitable temperature, such as at a temperature from about 100° to 350° F. to remove water, oils and contaminants. The housing or basket can also be immersed or sprayed with a cleaning solution or suitable solvent to remove oils and contaminants prior to drying at elevated temperatures. The drying temperature should advantageously be lower than the melting temperature housing or the metal contained therein. The weight of the housing is preferably from 1% to 5% , more preferably from 2% to 3% of the weight of the material to be contained therein. These weight ratios are desirable because they minimize any undesirable alloy additions that may be present in the commercial metal basket materials. With respect to housing made of 3003, such an alloy has a higher iron level than many aluminum lithium alloys. The low weight ratio of the housing alloy to the weight of the aluminum lithium dilutes the iron levels close to the level of the aluminum lithium. The total material package generally has a weight that is preferably less than 3500 lbs. in order to ensure transportability thereof.

[0022] Once the housing **20** is loaded with a desired amount of scrap or other material to be housed, a "material package" is formed. In one embodiment, for example as shown in **FIG. 5**, the material package **20** comprises a mesh basket comprising at least one piece of metal **30** therein. When the material package **20** is sought to be melted, one or more material packages are delivered into a furnace (not shown) such as an Al—Li furnace to preferably provide for at least a 25% charge. In terms of Al—Li materials and other alloys where one or more of the alloying elements is relatively expensive, employing at least a 50% charge may reduce the need for Li and other expensive alloying elements and reduces the cost of the metal by up to 200% in some cases. The reduction in cost is possible without sacrificing any properties of the underlying material since the scrap being recycled is preferably of the identical composition as the materials being generated and formed into ingots.

[0023] Aluminum-Lithium solid remnant or compressed swarf/chips are particularly difficult to recycle from end-users such as machine shops because the remnant sizes are small (from 1 to 200 pounds) and difficult to load quickly and safely into the induction furnace. Methods to join the scrap together such as steel banding, welding, or other methods are not easily accomplished or introduce undesirable alloying elements into the furnace. The instant method and material package provides an affordable way for machine shops and other end-users to package the solid remnant or compressed swarf/chips into a container that is preferably capable of being melted along with the remnant material. This method is suitable for virtually any conventional aluminum alloys including Al—Li alloys as well as any other metal or product that needs to be recovered and returned to use with virgin material. Other materials capable of employing the instant material package and method include steel remnants, magnesium metals, copper alloys, titanium alloys, nickel alloys, thermoplastic materials, and polymers. The housing **10** to be used with materials other than aluminum will be formed of a material having a melting point that is similar to the melting point of the material(s) sought to be recycled. As such, the melting point of housings

for materials other than aluminum alloys may not have melting points from 1190° to 1210° F. as described above with respect to aluminum materials, but rather, will be chosen to optimize the melting and remelting of the material package being treated.

[0024] It is anticipated that end-users would be able to use the baskets as a normal part of their manufacturing process, thus reducing their overall scrap handling issues and providing an easy method of segregating solid scrap by alloy. In addition, in accordance with another embodiment of the present invention, such a meltable housing can be used to create new alloys by introducing two or more different materials therein and subjecting the filled housing to a temperature sufficient to melt the housing and the contents so as to form a final product. In some embodiments, the housing and the materials sought to be melted therein will have melting temperatures greater than 300° F.

[0025] Other types of baskets or packages could alternatively be employed such as wrapping the scrap in remeltable sheet or mesh containers. Automated processes or machines that would package the scrap in such a manner could also be utilized if desired for any reason.

EXAMPLES

Example 1

[0026] Container and Method Description:

[0027] An aluminum 3003 expanded mesh sheet was formed into a rectangular basket and wired together using 6063 aluminum wire. For an Al—Li furnace, a basket having dimensions of 30"×30"×60" was produced and filled with 3000 lbs. of remnant Al—Li material having size dimensions ranging from 1 to 2000 cubic inches. The package was secured using 6063 aluminum wire, and shipped to the cast house. The basket contained approximately 3000 lbs of solid remnant with a wire basket weight of about 46 lbs. In this example, the weight ratio between the 3003 basket and remnant material was 1.5% and this ratio allowed for dilution of any undesirable alloy elements such as Fe in the 3003 basket material. The filled basket was heated to a temperature of 250° F. that was suitable to off-gas any moisture or other contaminants prior to lowering into the induction furnace. A typical range for such heating could be between 100° F. and 500° F. After heating to remove contaminants, the scrap basket was lowered into a remelt furnace as typically done with large scrap pieces.

Example 2

[0028] According to Example 2, the following materials were prepared as set forth below:

[0029] 100% virgin aluminum standard ingot (no baskets)

[0030] 60% virgin aluminum ingot+40% scrap (Two 2500 lb baskets)

[0031] 20% virgin aluminum ingot+80% scrap (Four 2500 lb baskets)

[0032] The material employed was aluminum mesh—2 pieces 0.125" thick×30"×210" to produce a form. The form was broken at the locations 70 as shown in FIG. 2 and sheets 10 were combined together using the center section 80 as a

"double bottom" to provide additional strength. The basket was filled with solid scrap and compressed chips, segregated by alloy. The top of the basket 20 was closed and the edges were interwoven with the sides of the basket as shown in FIG. 4. The basket was shipped to a casting facility with the basket labeled with the name of the alloy. The basket was heated in an air furnace to above 250° F. to remove water and oils that may have been on the surface of scrap and this temperature was held for a time commensurate with the level of contamination to ensure removal of contaminants based on condition of scrap. The induction furnace was loaded with the scrap containing baskets and the remaining void was filled with virgin metal. The load was melted and cast according to known techniques. The baskets melted along with scrap and virgin material.

[0033] FIG. 6 illustrates certain cost reductions possible through the utilization of one or more scrap baskets in a casting operation according to one embodiment of the present invention as exemplified in Example 2. FIG. 6 compares the use of 100% virgin metals, alloying elements, and hardeners (A), 40% scrap/60% virgin metals (B), and 80% scrap/20% virgin metals (C) according to the results reported in Example 2. The use of one (B) or two (C) scrap containers has been demonstrated to reduce the metal cost associated with casting operations from 22 to 44% over the use of 100% virgin materials (A). The left hand side of FIG. 6 shows the potential cost savings versus 100% virgin metal.

[0034] Additional advantages, features and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, and representative devices, shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

[0035] All documents referred to herein are specifically incorporated herein by reference in their entireties.

[0036] As used herein and in the following claims, articles such as "the", "a" and "an" can connote the singular or plural.

What is claimed is:

1. A material package comprising:

a housing,

at least one piece of scrap material contained in said housing, wherein the weight of said housing is from 1 to 5% of the weight of said scrap material, and said housing and said scrap material have melting points that are greater than 300° F.

2. A material package according to claim 1, wherein said housing comprises a mesh basket.

3. A material package according to claim 2, wherein said mesh basket comprises aluminum.

4. A material package according to claim 2, wherein said scrap material comprises aluminum.

5. A material package according to claim 2, wherein both said scrap material and said mesh basket comprise aluminum.

6. A material package according to claim 5, wherein said scrap material comprises Al—Li.

7. A method for recycling scrap material comprising loading said scrap material in a housing, optionally drying

said scrap material and said housing to remove residual contaminants and/or moisture, optionally loading virgin material having a composition that is substantially the same as said scrap material into said housing, and subjecting said scrap material and said housing to a treatment sufficient to melt said scrap material and said housing.

8. A method according to claim 7, wherein said housing comprises a mesh basket.

9. A method according to claim 8, wherein said mesh basket comprises aluminum.

10. A method according to claim 8, wherein said scrap material comprises aluminum.

11. A method according to claim 8, wherein both said scrap material and said mesh basket comprise aluminum.

12. A method according to claim 11, wherein said scrap material comprises Al—Li.

13. An aluminum alloy wherein at least 5% thereof was prepared from a material package according to claim 1.

14. An aluminum alloy comprising recycled material, wherein said aluminum alloy was prepared according to a method of claim 7.

15. A housing capable of recycling metal comprising two sheets, optionally formed of mesh, said sheets being transposed with respect to each other to form a basket structure, wherein edges of said sheets are interwoven at an angle ranging from 80 to 110 degrees.

16. A material package comprising a housing according to claim 15 and scrap material therein.

17. A housing according to claim 15 comprising aluminum alloy AA 3003 mesh material.

18. A material package according to claim 16, wherein said scrap material comprises aluminum.

19. A material package according to claim 18, wherein said scrap material comprises aluminum lithium.

20. A material package according to claim 1, wherein the gauge of said housing is about 0.11.

21. A method for forming an alloy comprising placing at least two different materials in a meltable housing and subjecting the housing containing said materials to a temperature sufficient to melt said housing and said materials.

* * * * *