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(54) **Fabricating metal objects**

(57) In a method of fabricating a substantially rigid, three-dimensional, apparently solid metal-covered object, individual metal components are welded or fused together around a non-metallic template by a laser weld-

ing operation, the metal components contacting the template over substantially the whole area thereof, and the template forming part of the finished object.

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DescriptionField of the Invention

[0001] The invention relates to fabricating apparently solid three-dimensional objects by welding or fusion. In particular but not exclusively, the invention relates to jewellery produced by this method.

Background to the Invention

[0002] A combination of light weight and strength is desirable in many if not most apparently solid metal structures. In cases where the weight should be minimised it is possible to use a core, usually metal or composite, sheathed in metal. However, there are situations in which it is desirable to minimise the metal content and in which only one type of metal can be used. A so-called organic core would fulfill this purpose but cannot be sheathed with metal using conventional gas or arc based welding, fusing or soldering methods because the flammable core would be excessively burned during the process.

[0003] A comparative advantage of laser welding is that the spread of heat from the point of fusion is extremely limited, both directionally and laterally. Laser welding machines are currently used within the jewellery industry where their principal deployment is for repairs because the low heat-spread allows welding very close to heat sensitive components such as precious stones. This means that, for example, settings for stones can be re-built without the necessity of removing other stones on the piece, thus significantly reducing labour time.

[0004] Laser welding technology is also used to a limited extent in jewellery production, rather than just repairs. Such work primarily features wire-based constructions and precious stone settings. One technique is the use of a three-dimensional Medium Density Fibre-board (MDF) template core over which to form welded constructions of platinum, gold or stainless steel wire. Once the wire construction has been welded the MDF core is burnt out or otherwise removed.

[0005] The result of this is a light, strong and quickly assembled structure suitable for jewellery purposes. However, the convention of the removal of the MDF or other organic material core does not allow for apparently solid objects constructed from sheet metal.

[0006] The problem therefore is that:

- Fabricated metal objects that appear to be solid conventionally require construction methods that result in significant weight due to the structural contribution of the metal. This is particularly the case where softer metals such as gold are being used. Reduction in material quantity normally reduces strength and rigidity and the building of internal frames is time consuming. Thus the economic cre-

ation of light but strong apparently solid objects is challenging.

- Conventional flame soldering, and electric and gas welding techniques cause thermal damage to any flammable material lying close to or under the metal being welded. They also cause distortion when sheets of thin metal are being welded together;
- Laser welding techniques exist which can overcome these problems but have been used hitherto only in the localised repair of solid objects and/or the delicate open work construction of non-solid-appearance objects in the jewellery field.
- The current jewellery fabrication method of welding around a sacrificial solid template does not address the problem of creating lightweight solid objects;
- The welding of thin metal skins over fabricated internal frames, for example metal honeycomb, is now conventional in other industries but requires significant additional preparatory engineering and may not always address the need to minimise metal content and avoid mixing types of metals;
- In a precious metal jewellery context, the creation of an internal structure that can be sheathed would be time consuming and comparatively heavy because of the softness of the metal. However, under the UK hall-marking regulations a more suitable metal of lesser preciousness cannot be used for this hidden internal structure.

Summary of the Invention

[0007] In accordance with the invention in its broadest aspect, these problems are solved by a method of fabricating a substantially rigid, three-dimensional, apparently solid metal-covered object in which individual metal components are welded or fused together around a non-metallic template by a laser welding operation; in which the metal components contact the template over substantially the whole area thereof; and in which the template forms part of the finished object.

[0008] This enables the use of thin metal sheets, lower quantity and lower cost of material used whilst delivering potentially significant gains in strength and rigidity.

[0009] Laser welding techniques provide a highly localised form of heat and thus in manufacturing terms, minimal thermal distortion or damage to heat sensitive materials. Minimal heat spread arises from a laser spot weld or a series of spot welds forming a seam weld. Burn penetration to an organic or other non-metal template core is minimal and distortion of the sheet metal during assembly due to build up of heat is almost non-existent. This permits the total enclosure of the template core without significant damage or combustion to that core,

and thus the creation of a very light but rigid solid object.

[0010] Finally, objects produced by such a method can be hallmarked because the Assay Office permits the combined use of precious metals only with non metallic material.

[0011] Preferably the template is substantially solid but may, for specific purposes, be constructed. Solidity increases the integrity of the finished object.

[0012] Such a process generally enables designs that would have been too difficult and costly to realise using conventional soldering or welding, or simply would have been too heavy or weak. In jewellery terms the method will permit the construction of objects significantly larger than those that have previously been physically or economically viable.

[0013] Whilst the jewellery industry is one beneficiary of this invention it is envisioned that the significant torsional rigidity and very light weight of what is externally a solid three-dimensional object may make it appropriate for applications within the aerospace, defence, motor racing or other high-tech sport contexts using metals including gold, platinum, stainless steel, mild steel and titanium.

Detailed Description of Examples of the Invention

[0014] A solid object can be constructed by this method in several ways according to variables including the form desired, the metals being used and the purpose for which the object is intended.

[0015] In essence a three dimensional template is prepared from a non-metallic material, usually with distinctly separate surfaces. Whilst it is possible to generate compound curves, generally it is more straightforward to create an object each of whose sides involves curves only in one axis, if any at all. If desired, the sheets thickness can vary between surfaces, according to the form that must be achieved and the function of any particular surface.

[0016] Once the 3D template is prepared, a thin metal sheet is cut precisely to size to fit each surface. Each sheet is then bonded to its respective surface. The consequent fit between each sheet of metal should be precise. The maximum tolerance for the fit is 10% of the thickness of the metal. If the gap along the seam is greater than this the weld will require filling with additional weld which will significantly increase the difficulty and the time required while impairing the physical and visual quality of the weld.

[0017] Where the template that becomes the core is prepared by hand it can, for example, be made of a substance as light as balsa wood. Where mechanical preparation is involved a more resistant and precise, though heavier, material may be preferred. (The use of oil based materials is not recommended since fumes may be released and ignition may occur through even slight contact with the laser beam.)

[0018] The 3D object now appears to be constructed

of metal. The seams are welded with the laser welder machine, with filling where necessary. Because the metal sheets are held firmly in place by the bonding, the welding should not be challenging or unduly slow, providing the fit is good. When the welding is completed there should be no buckling of the metal sheath and the object should appear to be made of solid metal, there remaining essentially no indication of the existence of the non-metal core.

[0019] According to aesthetic and functional requirements, the weld seams can either be left as welded or cleaned up. If they are cleaned up there is a risk that the abrasive process may either break through or excessively reduce the thickness of the metal sheet. If a pit caused by the weld is revealed it will need to be filled, after which it must be re-welded and cleaned up again. This repeated process increases the risk of damaging the metal sheath. It is therefore preferable and more economic to leave the weld fillets in evidence wherever this is appropriate. Where the weld fillet is to be cleaned up it is advisable to use slightly thicker metal than would otherwise be the case, for example 0.3mm thickness rather than 0.2mm.

[0020] Conventional flame- or arc- based joining of a hollow 3D form constructed of sheet metal runs the risk of heating the interior atmosphere, creating a partial vacuum as the atmosphere cools within the now sealed interior space. This vacuum generates forces that are likely to distort the form or even collapse it.

[0021] To avoid this a small hole is generally drilled somewhere on the form to allow the interior and exterior pressures to equalise, but this challenges the integrity of the 3D object. Because the heating caused by the laser welder in the present method of the invention is so brief and localised it causes negligible heating of the interior atmosphere so there is no pressure inequality and thus no distorting forces. With laser welded objects constructed according to this method there is consequently no compromise of the integrity of the object.

[0022] For one-off objects that do not require engineering precision, hand preparation is sufficient. Where significant precision or replication is necessary the template core may be designed in CAD, the data set thus generated then being used to direct a milling machine or the layer manufacturing process. Where the design has been carried out with CAD the same data set that is used to construct the 3D template can also be used to define and control the cutting of the 2D surface panels that are required to cover it. In this way the only hand-work required will be any bending and the laser welding of the metal sheets.

[0023] Though this method works well for jewellery, where manufacture involves soft metals and must result in strong and light pieces that will be assayed, it has a potential for significantly wider deployment within engineering applications where strength, rigidity and light weight are required. In this context a further virtue is that, for example, mechanisms can be contained and

fixed within the template core, being welded to the metal sheath only in the places at which they emerge through it. In this way the 3D template serves both as structure and internal armature.

[0024] The method also lends itself to a variety of post-assembly processes, for example the subsequent pressure forming of the metal sheath as controlled by concavities included in the surface of the template core. However, all such processes are made possible by the fundamental claimed method by which the 3D object is created.

Claims

1. A method of fabricating a substantially rigid, three-dimensional, apparently solid metal-covered object in which individual metal components are welded or fused together around a non-metallic template by a laser welding operation; in which the metal components contact the template over substantially the whole area thereof; and in which the template forms part of the finished object.
2. A method of fabricating a substantially rigid, three-dimensional, apparently solid metal-covered object according to the preceding claim **characterised by** the feature that the non-metallic template is substantially solid.
3. A method of fabricating a substantially rigid, three-dimensional, apparently solid metal-covered object substantially described with reference to and as illustrated in the accompanying text.
4. A substantially rigid, three-dimensional, apparently solid metal-covered object in which individual metal components are welded or fused together around a non-metallic template by a laser welding operation; in which the metal components contact the template over substantially the whole area thereof; and in which the template forms part of the finished object.
5. A substantially rigid, three-dimensional, apparently solid metal-covered object according to claim 4, in which the non-metallic template is substantially solid.
6. A substantially rigid, three-dimensional, apparently solid metal-covered object substantially described with reference to and as illustrated in the accompanying text.



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EUROPEAN SEARCH REPORT

Application Number
EP 04 25 6233

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 01/18341 A2 (AMWELD BUILDING PRODUCTS; AMWELD BUILDING PRODUCTS, LLC) 15 March 2001 (2001-03-15) * page 5, line 20 - page 6, line 2 * * page 7, line 28 - line 30 * * page 9, line 14 - line 26; figures 1-5 * -----	1-6	A44C27/00
X	EP 1 347 521 A1 (SANYO ELECTRIC CO., LTD) 24 September 2003 (2003-09-24) * paragraphs [0014] - [0016]; figures 1,2 * -----	1-6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 January 2005	Examiner Horubala, T
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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