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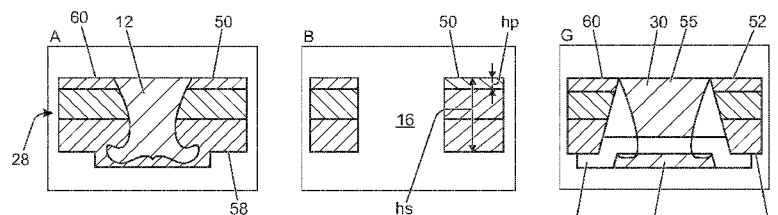


FIG. 7

(57) Abstract: A patch for use in replacement of a rivet, comprising: a protrusion for fitting into a hole created by removal of a rivet; and a flange area adjacent the protrusion.



A PATCH FOR USE IN REPLACEMENT OF A RIVET AND A METHOD FOR REPLACING A RIVET

5 TECHNICAL FIELD

The present disclosure relates to a patch for use in replacement of a rivet and a method for replacing a rivet. In particular, but not exclusively, it relates to a patch for use in replacement of a rivet and a method for replacing a rivet in a vehicle.

10

Aspects of the invention relate to a patch, a method, a vehicle part and a vehicle.

BACKGROUND

15 Rivets, such as self-piercing rivets (SPRs) are used to join layers of materials together, for example, in an automotive application to create a vehicle body structure. In particular, self-piercing rivets are particularly useful in manufacture of predominantly aluminium or aluminium alloy vehicle body structures, where the SPR is arranged to create its own aperture in the material of the body panels it is being used to secure together, thus negating
20 the need to pre-drill holes for each rivet.

Under certain circumstances a rivet, such as an SPR may need to be removed, for example to allow replacement of a damaged panel of material. In conventional methods a fitted rivet, such as an SPR, is drilled out leaving a hole at the original location of the fitted SPR.

25 Accordingly, if a new or replacement SPR is to be fitted, for example to attach a replacement panel, the original location for the SPR cannot be used and a new location for the replacement rivet must be found for use.

In some circumstances, such as if multiple repairs are required, there may be no suitable
30 locations for a new rivet, such as an SPR, to be fitted. This may render the object unrepairable and therefore out of use.

In addition, during vehicle production for example, the production process may change the properties of materials joined using a rivet, such as an SPR, such as adhesives in and

between a stack of materials. Accordingly, if a new rivet, such as an SPR, is fitted an unsatisfactory joint may be achieved due to the change in the material properties subsequent to the original fitting of the rivet.

- 5 It is an aim of the present invention to improve upon known techniques for the replacement of a rivet in the repair of a riveted structure.

SUMMARY OF THE INVENTION

- 10 Aspects and embodiments of the invention provide a patch, a method, a vehicle part and a vehicle as claimed in the appended claims.

According to an aspect of the invention, there is provided a patch for use in replacement of a self-piercing rivet, comprising:

- 15 a protrusion for fitting into a hole created by removal of a self-piercing rivet; and
a flange area adjacent the protrusion.

- According to a further aspect of the invention, there is provided a patch for use in replacement of a self-piercing rivet in a material stack comprising at least two material
20 sheets, by spanning a hole left by removal of a self-piercing rivet such that a replacement rivet can pierce the patch and thereby be retained in the hole, the patch comprising: a flange for abutment, in use, against a surface of a material stack to be joined, and a protrusion, extending from the flange, for extending, in use when the flange is in abutment with a surface of a material stack, into a hole created by removal of a self-piercing rivet from a
25 material stack.

The patch may be arranged to at least substantially close a hole left by removal of a self-piercing rivet.

- 30 The protrusion may be at least substantially continuous.

The flange may comprise a first portion extending from the protrusion in a first direction and a second portion extending from the protrusion in a second direction.

The second direction may be opposite to the first direction.

The protrusion may at least substantially extend continuously between the first flange portion and the second flange portion.

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The flange may surround the protrusion.

The flange may define an aperture, and the protrusion may extend from the edge of the aperture to at least substantially close the aperture.

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The protrusion may be circular.

The protrusion may be is chamfered such that it decreases in diameter away from the flange.

15

The protrusion may define a recess on the side opposite to the direction of extension of the protrusion from the flange.

The recess may be of a size and shape to aid location of a die for fixing of a self-piercing rivet.

20

The recess may be of a volume suitable for containing the die end of a self-piercing rivet, in use.

The self-piercing rivet may be for joining a material stack comprising at least two material sheets, the material stack including a replacement sheet, replacing at least a portion of a damaged sheet.

25

The patch may be comprised of metal.

30

The patch may be joined to at least one further patch along at least one edge. A plurality of patches may be joined together along at least one edge such they form a sheet or a strip.

The protrusion may be for fitting into a hole that has been modified following creation of the hole by removal of the self-piercing rivet.

5 The protrusion may be for fitting into a hole that has been modified by chamfering of the hole.

The protrusion may be for providing an interference fit with the hole.

10 The flange area may surround at least one edge of the protrusion.

The flange area may provide at least one surface for receiving adhesive to adhere the patch to a material stack that is to receive a replacement self-piercing rivet.

15 The flange area may comprise a first portion extending from the protrusion in a first direction and a second portion extending from the protrusion in a second direction.

The second direction may be opposite to the first direction.

20 The patch may comprise a recess for providing a location aid for application of a new self-piercing rivet.

25 According to a further aspect of the invention, there is provided the combination of a patch as claimed in any preceding claim and a material stack comprising at least two material sheets, the material stack including a replacement sheet replacing at least a portion of a damaged sheet, wherein the replacement sheet is positioned on a first side of the workpiece, and the patch is positioned on the opposing, second side of the workpiece.

30 The combination may further comprise a rivet, wherein the rivet extends through the replacement sheet and the patch, the punch-end of the rivet being located in the replacement sheet and the die-end of the rivet extending through the patch.

According to another aspect of the invention, there is provided a vehicle part comprising at least one patch according to an above aspect of the invention or the combination of a patch and a workpiece according to an above aspect of the invention.

According to a further aspect of the invention, there is provided a vehicle comprising at least one patch according to an above aspect of the inventions, or the combination of a patch and a workpiece according to an above aspect of the invention.

- 5 According to another aspect of the invention, there is provided a method for replacing a self-piercing rivet from a workpiece comprising at least two panels of material, the method comprising:

removing the self-piercing rivet to be replaced;

- 10 locating a patch as claimed in any of the preceding paragraphs so that the protrusion extends into a hole created by the removal of the self-piercing rivet; and

applying a new self-piercing rivet at the location of the patch so that it pierces the patch.

- 15 According to a still further aspect of the invention, there is provided a method for replacing a self-piercing rivet, comprising:

removing a fitted self-piercing rivet;

locating a patch as described in any of the preceding paragraphs in a hole created by removal of the self-piercing rivet; and

applying a new self-piercing rivet at the location of the patch.

20

The rivet may be applied through the hole in the workpiece to pierce the patch.

The method may comprise modifying the hole created by removal of the self-piercing rivet in order to accommodate the protrusion of the patch.

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Modifying the hole created by removal of the self-piercing rivet may comprise chamfering the hole.

- 30 Modifying the hole may comprise chamfering the hole so that the dimensions of the hole in the area in which the protrusion of the patch is located substantially correspond to those of the protrusion to aid location of the protrusion in the hole.

The self-piercing rivet to be replaced may be removed from a material stack, and the method may comprise removing at least a portion of at least one panel of material from the material stack after removal of the fitted self-piercing rivet.

- 5 The self-piercing rivet to be replaced may be removed from a material stack, and the method may comprise locating a new panel of material on the material stack to be fixed to the material stack by application of the new self-piercing rivet at the location of the patch. The new panel may be located on a first side of the material stack and the patch may be located on a second, opposing side of the material stack.

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The new panel of material may be located in the area from which the at least a portion of at least one panel of material was removed.

- 15 The replacement self-piercing rivet may be applied from the first side of the material stack towards the second side of the material stack.

The method may comprise applying adhesive to at least a portion of at least one surface of the flange area of the patch for adhering the patch to a material stack.

- 20 According to an aspect of the invention there is provided a patch comprising means for fitting into a hole created by removal of a self-piercing rivet to allow application of a new self-piercing rivet.

- 25 The means for fitting into a hole may comprise a protrusion.

The patch may comprise flange means adjacent the means for fitting into a hole.

According to yet another aspect of the invention, there is provided a patch for use in replacement of a rivet, comprising:

- 30 a protrusion for fitting into a hole created by removal of a rivet; and
 a flange area adjacent the protrusion.

The patch may comprise one or more apertures to allow insertion of the replacement rivet.

According to a further aspect of the invention there is provided a vehicle part comprising at least one patch as described in any of the preceding paragraphs.

5 According to a still further aspect of the invention there is provided a vehicle comprising at least one patch as described in any of the preceding paragraphs and/or at least one vehicle part as described in any of the preceding paragraphs.

According to another aspect of the invention, there is provided a method for replacing a rivet, comprising:

10 removing a fitted rivet;
locating a patch as described in any of the preceding paragraphs in a hole created by removal of the rivet; and
applying a new rivet at the location of the patch.

15 According to another aspect of the invention there is provided using a patch as described in any of the preceding paragraphs in replacement of a self-piercing rivet.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims
20 and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim
25 to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

30 One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig 1 illustrates an example of a patch for use in replacement of a self-piercing rivet according to an aspect of the invention;

Fig 2 illustrates an example of a vehicle part according to another aspect of the invention;

Figs 3A to 3C illustrate an example of a patch for use in replacement of a self-piercing rivet;

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Fig 4 illustrates an example of the patch of Figs 3A to 3C fitted to a body panel;

Fig 5 illustrates an example of a method according to a further aspect of the invention;

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Fig 6 illustrates another example of a method;

Fig 7 illustrates a further example of a method; and

Fig 8 illustrates an example of a vehicle according to still another aspect of the invention

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DETAILED DESCRIPTION

Examples and aspects of the present invention relate to replacement of a rivet such as a self-piercing rivet.

20

The following description and the examples shown in the Figures, are directed to the use of self-piercing rivets. However, the present disclosure is not intended to be limited to self-piercing rivets and the patch and associated methods described below for using the patch may be used for a variety of different types of rivets such as a pop-rivet (blind-rivet); a self-piercing rivet (SPR); a semi-tubular rivet; or a flush rivet. It will be appreciated that other types of rivet may be useful. Whilst the following description refers to a self-piercing rivet it is to be understood that the self-piercing rivet (SPR) is used by way of example only and that aspects of the present invention are not limited to the exclusive use with SPRs.

25

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In examples, a patch is located in a hole created by removal of a self-piercing rivet to allow a new self-piercing rivet to be fitted at the original location of the removed self-piercing rivet.

A technical effect of at least some examples of the disclosure is that the use of a patch in replacement of a rivet, such as a self-piercing rivet, allows a new self-piercing rivet to be

fitted at the original location meaning that, for example, unlimited repairs to a vehicle body can be made without exhausting locations for self-piercing rivet joints.

Furthermore, the use of patch in replacement of a self-piercing rivet also allows for control of the materials used in the new self-piercing rivet to provide for good quality consistent self-piercing rivet joints to be formed.

Additionally or alternatively the use of a patch in replacement of a self-piercing rivet provides that the button created by the new self-piercing rivet joint will be no thicker than the original self-piercing rivet joint. As a result, there will be no issues relating to, for example, fitting surrounding panels or seals over a new joint that can only tolerate certain overall thicknesses.

The use of a patch in replacement of rivets, such as self-piercing rivets, facilitates repair, permits component replacement and thus extends the service life of a riveted vehicle body in use.

Figs 1, 2, 3A to 3C, 4 and 7 illustrate a patch 10 for use in replacement of a self-piercing rivet 12, comprising; a protrusion 14 for fitting into a hole 16 created by removal of a self-piercing rivet 12; and a flange area 18 adjacent to the protrusion 14.

Figs 5 and 6 illustrate a method 500, 600 for replacing a self-piercing rivet 12, comprising; removing a fitted self-piercing rivet 12; locating a patch 10 as described herein in a hole 16 created by removal of the self-piercing rivet 12; and applying a new self-piercing rivet 30 at the location 48 of the patch 10.

Fig 1 schematically illustrates an example of a patch 10 for use in replacement of a self-piercing rivet 12. It is noted that some of the features referred to in relation to Figs 1 to 6 are illustrated in the example of Figs 7 and 8.

The patch 10 of Fig 1 may be comprised in a vehicle part 44 which may in turn be comprised in a vehicle 46. See, for example, the examples of Figs 2 and 8.

The patch 10 illustrated in the example of Fig 1 comprises a flange area or flange 18 and a protrusion 14 extending from the flange area 18.

The protrusion 14 is for fitting into a hole 16 created by removal of an SPR from a material stack comprising three sheets or panels or components. The skilled person will appreciate that the SPR could be used to join a material stack comprising two or more sheets, panel, or components. In some examples, the protrusion 14 is for fitting into a hole 16 that has been modified following creation of the hole 16 by removal of the SPR 12. In such examples, the modified hole 16 may still be considered to be the hole 16 created by removal of an SPR 12.

For example, the protrusion 14 may be for fitting into a hole 16 that has been modified by chamfering of the hole 16.

In examples, the protrusion 14 may be of any suitable size and/or shape. For example, the size and/or shape of the protrusion 14 may be selected in dependence upon the hole 16 created by removal of the SPR 12.

In some, but not necessarily all, examples the protrusion 14 may be circular in shape to match the hole 16 created by drilling out of a SPR 12.

Additionally or alternatively, the protrusion 14 may be tapered to match a modified hole 16 that has been chamfered (see, for example, the example of Fig 3C and Fig 7). The protrusion 14 may be tapered by any suitable amount.

The protrusion 14 may have any suitable height. The height of the protrusion 14 may be selected in dependence upon the usage of the patch 10. See, for example, Fig 3C.

In examples, the protrusion 14 may have a height h that is dependent on the height h_s of the workpiece or material stack 28. The protrusion height h may be substantially equal to the height of the material stack 28 after the removal of the damaged panel 50.

In examples, the protrusion height h may be less than the height of the material stack 28 minus the height h_p of the damaged panel 50.

In some examples, the protrusion 14 is for providing an interference fit 20 with the hole 16. For example, the size and/or shape and/or height of the protrusion may be selected to provide an interference fit with a hole 16 created by removal of an SPR 12.

5 In examples the patch 10 may comprise a plurality of protrusions 14.

In some examples the patch may comprise one or more apertures 19 (see Fig 3A) to allow insertion of a replacement rivet or rivets, such as a pop-rivet (blind-rivet), a semi-tubular rivet, or a flush rivet through the aperture(s).

10

In examples, such as the one illustrated in Fig 3A, the aperture 19 may be located on the protrusion 14.

The flange area 18 may be adjacent the protrusion 14. In some examples, the flange area
15 18 surrounds at least one edge 22 of the protrusion 14. See, for example, Figs 3A and 3B.

That is, in some examples, the flange area 18 may be located in every direction around an edge 22 of the protrusion 14.

20 The flange area 18 may have any suitable size and/or shape. In examples, the size and/or shape of the flange area 18 may be selected in dependence upon the intended use of the patch 10. For example, the size and/or shape of the flange area 18 may be selected to match the intended use location of the patch 10.

25 In examples, the flange area 18 comprises a first portion 32 extending from the protrusion 14 in a first direction 34 and a second portion 36 extending from the protrusion 14 in a second direction 38. The second direction 38 may be opposite to the first direction 34. See, for example, Figs 3A to 3C and Fig.4. The protrusion 14 extends substantially continuously between the first flange portion and the second flange portion.

30

In examples, the first portion 32 and second portion 36 may be of the same shape and/or size. In other examples, the first portion 32 and second portion 36 may be of different shapes and/or sizes.

The flange area 18 may be for abutting a surface of a material stack 28 through which the replacement SPR is to be fitted (see, for example, Fig 7).

5 Additionally or alternatively the flange area 18 may provide at least one surface 24 for receiving adhesive 26 to adhere the patch 10 to a material stack 28 that is to receive a replacement SPR 30. See, for example, Fig 7.

10 In some examples, the flange area 18 forms a plane to abut against the surface of a material stack 28 to support the protrusion 14 when it is located in a hole 16 created by removal of an SPR 12 and/or to provide at least one surface 24 for receiving adhesive.

For example, the surface of the flange area 18 that is to abut the material stack 28 may be provided with an adhesive 26 to adhere the patch 10 to the material stack 28. The use of the adhesive 26 may provide for a stronger SPR joint.

15

In examples any suitable adhesive 26 may be used. For example epoxies and/or single or two component adhesives and/or polyurethane structural adhesives and so on.

20 The patch 10 is considered for use in replacement of an SPR 12 as it allows for a new SPR 30 to be fitted in the hole 16 created by removal of an SPR 12. That is, the patch 10 allows for fitting of a new SPR 30 but does not itself replace an SPR 12.

25 The patch 10 may have any suitable size and/or shape. In examples, the size and/or shape of the patch 10 may be selected in dependence on the intended use of the patch 10. For example, the size and/or shape of the patch 10 may be selected in dependence upon the intended location of use of the patch 10 on a vehicle part 44 and/or on a vehicle 46.

The patch 10 may be made of/comprise any suitable material or materials.

30 The material of the patch 10 may be selected to have properties that ensure a satisfying strength and quality of SPR joint. For example the material or materials of the patch 10 may be selected to ensure a good SPR joint can be created using the patch 10.

In examples, the patch 10 may be made of/comprise any suitable metal or metal alloy.

In examples the material or materials of the patch 10 have a ductility percentage of approximately 20%. In some examples, an aluminium alloy that does not comprise silicon as an alloying element may be used.

5

In examples, suitable materials include, but are not limited to: steel, titanium magnesium alloys and any other metals/metal alloys with similar material properties.

Further examples of suitable materials are aluminium 5000 series, non-heat treatable aluminium, for example NG5754, and so on.

10

The patch 10 of Fig 1 may be made using any suitable method. For example, the patch 10 may be made using a forming process such as stamping or pressing and so on.

15 The patch 10 may comprise any number of additional elements not illustrated in the example of Fig 1.

For example, the patch 10 may comprise a recess 40. The recess 40 may correspond to the protrusion 14. For example, the recess 40 may be the reverse feature of the protrusion 14 on the patch 10. See, for example, Figs 3A to 3C. In some example, the recess 40 may not correspond to the protrusion 14.

20

In some examples, the recess 40 may include an aperture for receiving a non self-piercing type rivet, such as a pop-rivet (blind-rivet), a semi-tubular rivet; or a flush rivet as may be appropriate for a given riveted joint.

25

In examples, a recess 40 of the patch 10 is for providing a location aid 42 for application of a new SPR 30. For example, the recess 40 may provide an aid in locating a die 54 for fitting of a new SPR 30. See, for example, Fig 7.

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Throughout the description like numerals will be used to indicate like features.

Fig 2 schematically illustrates an example of a vehicle part 44. In the example of Fig 2 the vehicle part 44 is comprised in a vehicle 46 and comprises a patch 10 illustrated in Fig 1.

In the example of Fig 2, the patch 10 is comprised in the vehicle part 44 as part of replacement of one or more SPRs 12 to replace one or more panels of the vehicle part 44 in the vehicle 46. For example, the patch 10 may be comprised in a vehicle part 44 in the vehicle 46 as part of a repair of the vehicle part 44.

In examples, the vehicle part 44 may be any suitable vehicle part. For example, the vehicle part 44 may be an external part of a vehicle structure such as a vehicle body side, a rear quarter panel, an outer pillar panel and so on.

In some examples, the vehicle part 44 may comprise a plurality of patches 10.

The vehicle 46 may be any suitable vehicle 46 such as a car, van or truck and so on. In examples, the vehicle 46 may comprise a plurality of vehicle parts 44 comprising at least one patch 10.

An example of a vehicle 46 comprising a patch 10 is illustrated in Fig 8.

Figs 3A to 3C illustrate an example of a patch 10 for use in replacement of a self-piercing rivet 12. The patch 10 illustrated in the examples of Figs 3A to 3C is an example of a patch 10 illustrated in Figs 1 and/or 2.

In Fig 3A a top-down or plan view of the patch 10 is illustrated. In the example of Fig 3A, the protrusion 14 is circular and is pointing out of the page.

In Fig 3A, the protrusion 14 is tapered. This is illustrated in the figure by the diameter d_1 of the circle at the base of the protrusion 14 being larger than the diameter d_2 of the circle at the tip of the protrusion 14. The tapering of the protrusion 14 is illustrated more clearly in the example of Fig 3C.

Accordingly, in the example of Fig 3A the protrusion 14 is for fitting into a hole 16 that has been modified by chamfering of the hole 16. See, for example, Fig 7.

In examples, the diameters d1 and d2 may have any suitable size. For example, the diameter d1 may be dependent upon the diameter of the SPR 30 that is to be applied. For example, the diameter d1 may be chosen during manufacturing of the patch 10 in dependence upon the diameter of the SPR 30 that the patch 10 will be used with.

5

In some examples the diameter d1 is at least two times the diameter of the shaft of the SPR 30 that is to be applied to accommodate the SPR 30 that is to be applied. A typical value for d1 is approximately 10mm.

10

In examples, the difference between the d1 diameter and d2 diameter may be any suitable value. That is, in examples, the amount of tapering or chamfering of the protrusion 14 may be any suitable amount. For example, the amount of tapering of the protrusion 14 may match the amount of chamfering of the hole 16 into which the protrusion 14 is to be placed and/or may be selected to provide an interference fit 20.

15

In examples the patch 10 may comprise one or more apertures 19 to allow insertion of a replacement rivet. This is illustrated in Fig 3A by the dotted circular line on the protrusion 14.

20

In examples, the aperture 19 of the patch 10 may provide the aperture 19 into which a replacement pop-rivet (blind-rivet), a semi-tubular rivet, or a flush rivet may be fitted.

The aperture 19 may have any suitable size and shape to facilitate fitting of a replacement rivet such as a pop-rivet (blind-rivet), a semi-tubular rivet, or a flush rivet for example.

25

In the illustrated example the aperture 19 is located in the protrusion 14. However, in other examples the aperture 19 may be located at any suitable location on the patch 10.

In some examples the patch 10 may comprise a plurality of apertures 19 that may be of the same or different shapes and/or sizes to allow fitting of multiple replacement rivets.

30

In Fig 3A the flange area 18 surrounds an edge 22 of the protrusion 14. The edge 22 of the protrusion 14 is at the base of the protrusion 14. In this embodiment, the protrusion 14 is circular and the flange 18 surrounds the protrusion, although the skilled person would understand that other shapes of protrusion could be used.. In addition, the skilled man

would understand that the flange can be seen to define an aperture and the protrusion extends from the edge of the aperture to at least substantially close the aperture.

5 In Fig 3A, the flange area 18 comprises a first portion 32 extending from the protrusion 14 in a first direction 34 and a second portion 36 extending from the protrusion 14 in a second direction 38. The second direction 38 is opposite to the first direction 34.

In the example of Fig 3A, the flange area 18 forms a plane for abutting against a material stack 28 that is to receive a new SPR 30. See, for example, Fig 7.

10 The flange area 18, of the patch 10 in Fig 3A comprises a surface 24 for receiving adhesive 26 to adhere the patch 10 to a material stack 28 that is to receive a replacement SPR 30. In the example of Fig 3A, the adhesive 26 is indicated by a dotted box. However, in examples, the adhesive 26 may cover some or all of the flange area 18.

15 In some examples, the flange area 18 may comprise a plurality of surfaces for receiving an adhesive 26. In examples, the adhesive may be pre-applied to at least a portion of the flange area 18 which, depending on the type of adhesive used, may be covered by a removable protective film to protect the adhesive from contamination or exposure to air during storage
20 or transport prior to use. In examples, the protective film is removed by a user before the patch is fitted in place and the replacement rivet 30 applied.

In Fig 3A, the flange area 18 has a width W and a length L. In examples, the patch 10 may be considered to have a width W and a length L.

25 The flange area 18/patch 10 may have any suitable width W and/or length L. In examples the width W of the flange area 18/patch 10 may be dependent upon the size of the diameter d1. For example the width W may be chosen during manufacturing of the patch 10 in dependence upon the diameter d1. In examples the width W may be equal to or greater than
30 diameter d1 + 10mm.

In some examples the length L of the flange area 18/patch 10 may be dependent upon the size of the diameter d1. For example the length L may be chosen during manufacturing of

the patch 10 in dependence upon the diameter d_1 . In examples the length L may be equal to or greater than $d_1 + 10\text{mm}$.

In the example of Fig 3A, the patch 10 comprises a recess 40. The recess 40 corresponds to the protrusion 14 and is therefore on the underside of the patch 10 in the example of Fig 3A and not visible in the figure.

A plurality of patches may be provided joined together, for convenient transport and storage. A single patch can then be removed as needed. For example, patches may be joined along at least portions of opposing sides so that a roll of patches can be formed. Alternatively, patches may be joined along portions of multiple sides, to form a sheet.

Fig 3B illustrates an example of a patch 10 for use in replacement of a self-piercing rivet 12. The example of Fig 3B illustrates a perspective view of the patch 10 illustrated in Fig 3A.

In Fig 3B, the protrusion 14 is directed into the page. Accordingly, the recess 40 corresponding to the protrusion 14 illustrated in Fig 3A can be seen in the example of Fig 3B.

Fig 3C illustrates an example of a patch 10 for use in replacement of a self-piercing rivet 12. The example of Fig 3C illustrates a side view of the patch 10 illustrated in the examples of Figs 3A and 3B.

In the example of Fig 3C, the protrusion 14 can be seen extending upwards from the flange area 18. The tapering of the protrusion 14 is visible in the example of Fig 3C.

In the example of Fig 3C, the protrusion 14 has a height h and the flange area 18 has a thickness t .

In examples, the protrusion 14 may have any suitable height h and/or the flange area 18 may have any suitable thickness t .

In examples, the protrusion height h may be substantially equal to or less than the height h_s of the material stack with the removal of the damaged panel.

For example, the height h of the protrusion 14 may be greater than or equal to 1mm and less than or equal to 3mm. That is, in examples the height h of the protrusion 14 may be in the range $1\text{mm} \leq h \leq 3\text{mm}$. In examples the thickness t of the flange area 18 may be chosen in dependence upon the thickness of the vehicle part 44 that the patch 10 will be used with. In examples the thickness t may be less than or equal to 2.5mm.

Fig 4 illustrates an example of a patch 10 for use in replacement of a self-piercing rivet 12. In the example of Fig 4, the patch 10 is the patch illustrated in the examples of Figs 3A to 3C.

In the example of Fig 4, the patch 10 is comprised in a vehicle part 44 and is located in a hole 16 created by removal of a self-piercing rivet 12.

The recess 40 of the patch 10 is visible in Fig 4 and provides a location aid 42 for application of a new self-piercing rivet 30. In the example of Fig 4, the new self-piercing rivet 30 has not yet been applied.

It can be seen from the example of Fig 4 that the patch 10 provides for application of a new SPR 30 at the location 48 of the patch 10 at the recess 40. For example, the recess 40 may provide a location aid for locating a die 54 for use in fitting a new SPR 30. See, for example, Fig.7. In addition, as illustrated in Fig. 7, the recess 40 may be of a volume suitable for containing the die end 56 of a self-piercing rivet.

Fig.5 illustrates an example of a method 500. For example, the method 500 may be for replacing a self-piercing rivet 12.

At block 502 a fitted self-piercing rivet 12 is removed.

Any suitable method for removing a fitted self-piercing rivet 12 may be used. For example, removing the self-piercing rivet 12 may comprise drilling out the fitted self-piercing rivet 12.

In examples, removing the self-piercing rivet 12 creates a hole 16 through the material that had previously been the site of the riveted joint.

At block 504 a patch 10 for use in replacement of a self-piercing rivet 12 is located in the hole 16 created by removal of the self-piercing rivet 12.

In examples, the patch 10 may be applied from a first side 58 of the material stack 28.

5

In examples, the patch 10 may be as described in relation to Figs 1 and/or 2.

The patch 10 may be located in the hole 16 by inserting the protrusion 14 of the patch 10 into the hole 16. See, for example, Figs 4 and 7.

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In examples, the protrusion 14 of the patch 10 may provide an interference fit 20 with the hole 16 to maintain the patch 10 in position in the hole 16.

At block 506 a new, that is to say, a replacement rivet 30 such as a self-piercing rivet 30 is applied at the location of the patch 10. Any suitable method for applying the new self-piercing rivet 30 at the location of the patch 10 may be used.

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In examples, the replacement rivet 30 is applied from a second side 60 of the material stack 28.

20

For example, a die 54 may be positioned in the recess 40 of the patch 10 and a self-piercing rivet driven into the material of the protrusion 14 by a punch. See, for example, Fig 7. The SPR 30 when driven into the material to join the material stack, can be considered to have a punch end 55 and a die end 56.

25

As the new SPR 30 is driven into the material of the protrusion 14 the displaced material of the protrusion 14 may be forced back into the recess 40. This provides the advantage that the button created by application of the new SPR 30 will not be larger than the original button of the original SPR 12.

30

In examples, the application of the new self-piercing rivet 30 may hold a repaired or replacement panel on a vehicle part 44.

In examples, the patch 10 and replacement rivet 30 are applied from opposite sides of the material stack 28.

Fig 6 illustrates an example of another method 600. For example, the method 600 may be for replacing a self-piercing rivet 12.

At block 602 a fitted self-piercing rivet 12 is removed. Block 602 corresponds to block 502 of Fig 5 and may be as described in relation to block 502 of Fig 5.

At block 604 at least one panel of material is removed from a material stack 28 from which the fitted self-piercing rivet 12 was removed. For example, the removed panel 50 may be damaged panel of a vehicle part 44 of a vehicle 46.

At block 606 the hole 16 created by removal of the self-piercing rivet 12 is modified. Any suitable method for modifying the hole 16 may be used. For example, the hole 16 may be chamfered using a countersunk drill or a machine driven hole punch to create a hole having the required shape.

At block 608 adhesive 26 is applied to at least a portion of at least one surface of the flange area 18 of the patch 10. Any suitable adhesive may be used. For example, any suitable adhesive for adhering the patch 10 to the material stack 28 may be used.

In examples, the adhesive 26 may comprise single or two component adhesives and/or polyurethane structural adhesives and so on. Other adhesive materials and compounds are useful.

At block 610 the patch 10 is located in the modified hole 16. The flange 18 is placed in abutment with the surface 58 of the material stack 28 and the patch is arranged so that the protrusion extends into the hole 16. This corresponds to block 504 of Fig 5 and may be as described in relation to block 504 of Fig 5.

In examples, the patch 10 is applied to the first side 58 of the material stack 28, wherein said first side is a side of the material stack opposite to the location of the damaged panel 50.

At block 612 a new panel of material 52 is located on the material stack 28 to be fixed to the material stack 28 by application of the new SPR 30 at the location 48 of the patch 10. Any suitable method for locating the new panel of material 52 on the material stack 28 may be used.

5

In examples a panel of a vehicle 46 may be located on the material stack 28 to replace a damaged panel that has been removed.

10 In examples, the panel to replace the damaged panel that has been removed is located on the second side 60 of the material stack 28 wherein the second side is opposite the first side 58.

At block 614 a new self-piercing rivet is applied at the location 48 of the patch 10. This corresponds to block 506 of Fig 5 and may be as described in relation to block 506 of Fig 5.

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In examples, the new self-piercing rivet is applied to the second side 60 of the material stack opposite to the side where the patch 10 is applied.

20 In examples, methods 500 and 600 may be considered methods for repairing one or more items such as one or more vehicles.

Fig 7 illustrates an example of a method for replacing a self-piercing rivet 12. Fig 7 is split into 7 parts labeled A to G respectively.

25 Part A of Fig 7 illustrates a fitted SPR 12 in a material stack 28 that comprises a panel of material 50 that is damaged and is to be removed.

30 In part B of the example of Fig 7 the SPR 12 has been removed and hole 16 created by removal of the SPR 12. In part B of the example of Fig 7 the SPR 12 has been removed by drilling out of the SPR 12. The material stack 28 has a thickness or height h_s which includes a thickness or height h_p of the damaged panel 50.

In part C of the example of Fig 7 the panel of material 50 has been removed from the material stack 28. The thickness or height of the remaining material in the material stack after removal of the damaged panel is $h_s - h_p$.

- 5 In part D of the example of Fig 7 the hole 16 has been modified. In part D of the example of Fig 7 the hole 16 has been chamfered.

10 In part E of the example of Fig 7 a patch 10 has been located in the hole 16 created by removal of the SPR 12. In the example, the patch 10 is as described in relation to Figs 1 and or 2.

15 In part E of the example of Fig 7 the protrusion 14 of the patch 10 has been inserted into the hole 16 and has formed an interference fit 20 with the hole 16. The height h of the protrusion is less than the height of the remaining material, $h_s - h_p$, after the removal of the damaged panel, so that it does fits within the hole 16 and does not protrude into the plane of the replacement panel or sheet 52.

20 Furthermore, adhesive 26 has been applied to a surface of the flange area 18 of the patch 10 to adhere the patch 10 to the material stack 28.

The protrusion 14 of the patch 10 is substantially continuous, such that, when inserted in the hole 16, it substantially covers or closes the hole.

25 In part E of the example of Fig 7 a new panel of material 52 has been located on the material stack 28. The new panel of material 52 is to be fixed to the material stack 28 by application of a new SPR 30 at the location 48 of the patch 10.

30 The new panel of material 52 replaces the removed panel of material 50 and in the example is for repairing a panel on a vehicle 46.

In part F of the example of Fig 7 a die 54 has been located in the recess 40 of the patch 10. The patch 10 has therefore provided a location aid 42 for the application of a new SPR 30 at the location 48 of the patch 10.

In part G of the example of Fig 7 a new SPR 30 has been applied at the location of the patch 10. The new SPR 30 has extended into the material of the protrusion 14 of the patch 10 to join the material stack 28, including the new panel of material 52, together.

- 5 The method illustrated in the example of Fig 7 may be considered a method for repairing a vehicle part 44 and/or a vehicle 46.

As used herein “for” should be considered to also include “configured or arranged to”. For example, a patch for use in replacement of a self-piercing rivet should be considered to also
10 include a patch configured to or arranged to be used in replacement of a self-piercing rivet.

Examples of the present disclosure provide a number of advantages. For example, examples of the present disclosure provide for application of a new self-piercing rivet at a location previously used for a self-piercing rivet joint.

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In addition, examples of the present disclosure provide for consistent, secure SPR joints to be created when replacing SPR joints.

It will be appreciated by one skilled in the art that the patches and methods described herein
20 and illustrated in the Figures may be adapted in order to be applied with a type of rivet other than a SPR as may be desired. For example, it will be appreciated by a person skilled in the art that the method shown in Fig 7 may be adapted in order to be applied with a type of rivet other than an SPR and that the example of Fig 7 is given by way of example of how patch 10 may be employed to effect an economical repair of a riveted joint.

25

The blocks illustrated in Figs 5 and 6 may represent steps in a method. The illustration of a particular order to the blocks does not necessarily imply that there is a required or preferred order for the blocks and the order and arrangement of the block may be varied. Furthermore, it may be possible for some steps to be omitted.

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Where a structural feature has been described, it may be replaced by means for performing one or more of the functions of the structural feature whether that function or those functions are explicitly or implicitly described.

The term 'comprise' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use 'comprise' with an exclusive meaning then it will be made clear in the context by referring to "comprising only one.." or by using
5 "consisting".

Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as
10 claimed.

Features described in the preceding description may be used in combinations other than the combinations explicitly described.

15 Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

20 Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis
25 has been placed thereon.

CLAIMS

1. A patch for use in replacement of a self-piercing rivet in a material stack comprising at least two material sheets, by spanning a hole left by removal of a self-piercing rivet such that a replacement rivet can pierce the patch and thereby be retained in the hole, the patch comprising:
- a flange for abutment, in use, against a surface of a material stack to be joined, and a protrusion, extending from the flange, for extending, in use when the flange is in abutment with a surface of a material stack, into a hole created by removal of a self-piercing rivet from a material stack.
2. A patch as claimed in claim 1, wherein the patch is arranged to at least substantially close a hole left by removal of a self-piercing rivet.
3. A patch as claimed in claim 1 or claim 2, wherein the protrusion is at least substantially continuous.
4. A patch as claimed in any preceding claim, wherein the flange comprises a first portion extending from the protrusion in a first direction and a second portion extending from the protrusion in a second direction.
5. A patch as claimed in claim 4, wherein the second direction is opposite to the first direction.
6. A patch as claimed in claim 5, wherein the protrusion at least substantially extends continuously between the first flange portion and the second flange portion.
7. A patch as claimed in any preceding claim, wherein the flange surrounds the protrusion.
8. A patch as claimed in claim 7, wherein the flange defines an aperture, and the protrusion extends from the edge of the aperture to at least substantially close the aperture.
9. A patch as claimed in any preceding claim, wherein the protrusion is circular.

10. A patch as claimed in any preceding claim, wherein the protrusion is chamfered such that it decreases in diameter away from the flange.

11. A patch as claimed in any preceding claim, wherein the protrusion defines a recess on the side opposite to the direction of extension of the protrusion from the flange.

12. A patch as claimed in claim 11, wherein the recess is of a size and shape to aid location of a die for fixing of a self-piercing rivet.

13. A patch as claimed in claim 11 or claim 12, wherein the recess is of a volume suitable for containing the die end of a self-piercing rivet, in use.

14. A patch as claimed in any preceding claim, the self-piercing rivet being for joining a material stack comprising at least two material sheets, the material stack including a replacement sheet, replacing at least a portion of a damaged sheet.

15. A patch for use in replacement of a self-piercing rivet as claimed in any preceding claim, wherein the flange area provides at least one surface for receiving adhesive to adhere the patch to a material stack that is to receive a replacement self-piercing rivet.

16. A patch for use in replacement of a self-piercing rivet as claimed in any preceding claim, wherein the patch is comprised of metal.

17. The combination of a patch as claimed in any preceding claim and a material stack comprising at least two material sheets, the material stack including a replacement sheet replacing at least a portion of a damaged sheet, wherein the replacement sheet is positioned on a first side of the workpiece, and the patch is positioned on the opposing, second side of the workpiece.

18. The combination of a patch and workpiece as claimed in claim 17, and a rivet, wherein the rivet extends through the replacement sheet and the patch, the punch-end of the rivet being located in the replacement sheet and the die-end of the rivet extending through the patch.

19. A vehicle part comprising at least one patch as claimed in any of claims 1 to 16, or the combination of a patch and a workpiece as claimed in claim 17 or claim 18.
20. A vehicle comprising at least one patch as claimed in any of claims 1 to 16, or the combination of a patch and a workpiece as claimed in claim 17 or claim 18.
21. A method for replacing a self-piercing rivet from a workpiece comprising at least two panels of material, the method comprising:
removing the self-piercing rivet to be replaced;
10 locating a patch as claimed in at least one of claims 1 to 16 so that the protrusion extends into a hole created by the removal of the self-piercing rivet; and
applying a new self-piercing rivet at the location of the patch so that it pierces the patch.
22. A method as claimed in claim 21, wherein the rivet is applied through the hole in the workpiece to pierce the patch.
23. A method as claimed in claim 21 or claim 22, comprising modifying the hole created by removal of the self-piercing rivet in order to accommodate the protrusion of the patch.
24. A method as claimed in claim 23, wherein modifying the hole created by removal of the self-piercing rivet comprises chamfering the hole.
25. A method as claimed in claim 24, wherein modifying the hole comprises chamfering the hole so that the dimensions of the hole in the area in which the protrusion of the patch is located substantially correspond to those of the protrusion to aid location of the protrusion in the hole.
26. A method as claimed in any of claims 21 to 25, wherein after the self-piercing rivet to be replaced is removed from the material stack, at least a portion of at least one panel of material is removed from the material stack after removal of the fitted self-piercing rivet.
27. A method for replacing a self-piercing rivet as claimed in any of claims 21 to 26, wherein after the self-piercing rivet to be replaced is removed from the material stack, the

method comprises locating a new panel of material on the material stack to be fixed to the material stack by application of the new self-piercing rivet at the location of the patch, wherein the new panel is located on a first side of the material stack and the patch is located on a second, opposing side of the material stack.

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28. A method as claimed in claim 27 when dependent on claim 26, wherein the new panel of material is located in the area from which the at least a portion of at least one panel of material was removed.

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29. A method for replacing a self-piercing rivet as claimed in claim 27 or claim 28, wherein the replacement self-piercing rivet is applied from the first side of the material stack towards the second side of the material stack.

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30. A method for replacing a self-piercing rivet as claimed in any of claims 21 to 29, comprising applying adhesive to at least a portion of at least one surface of the flange area of the patch for adhering the patch to a material stack.

20

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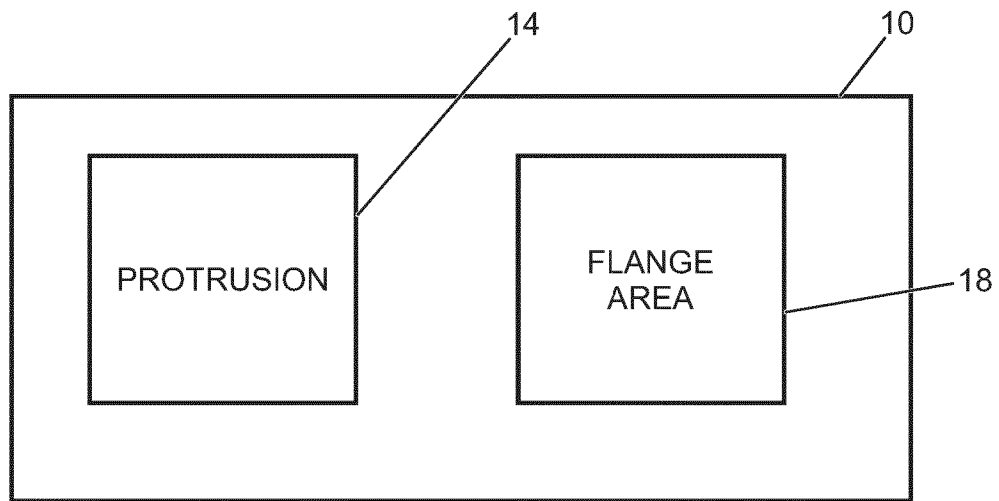


FIG 1

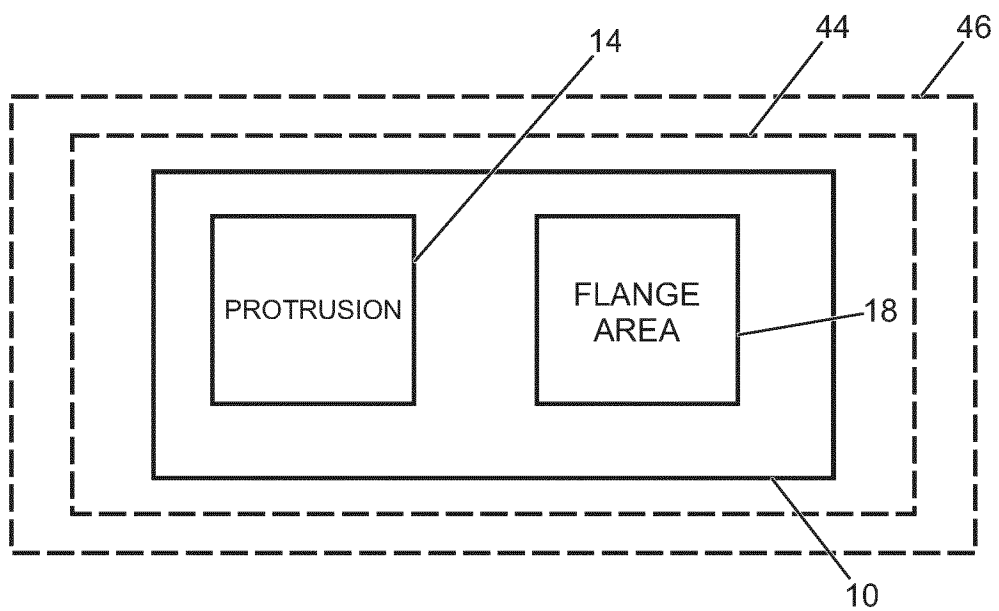


FIG 2

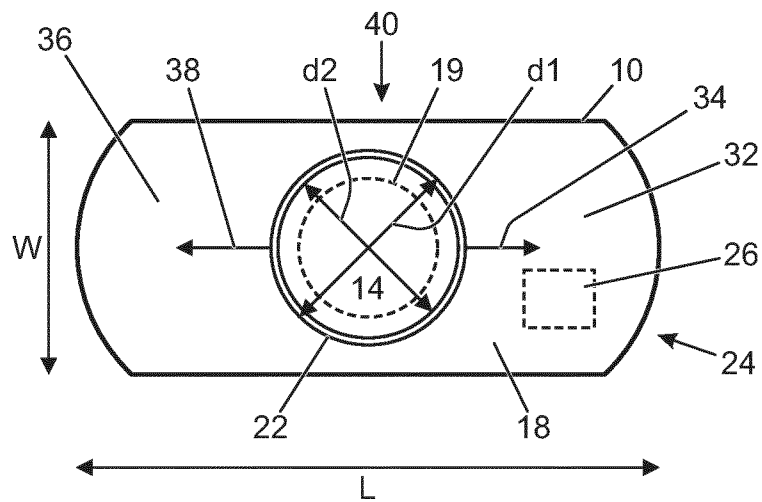


FIG 3A

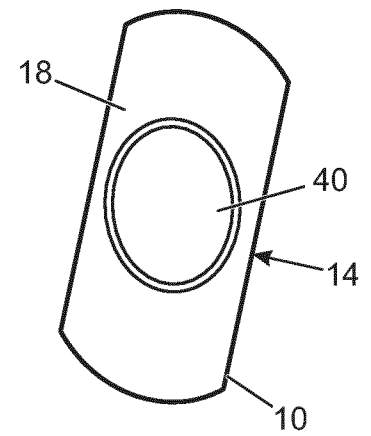


FIG 3B

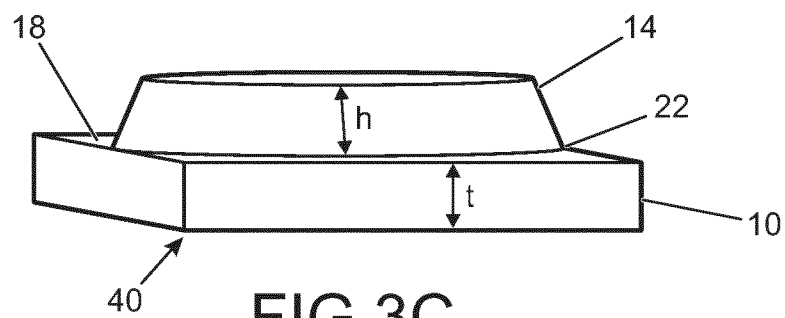


FIG 3C

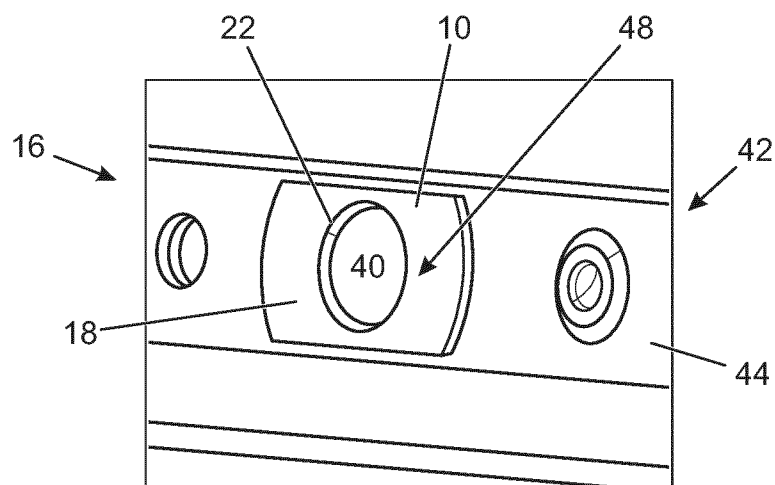


FIG 4

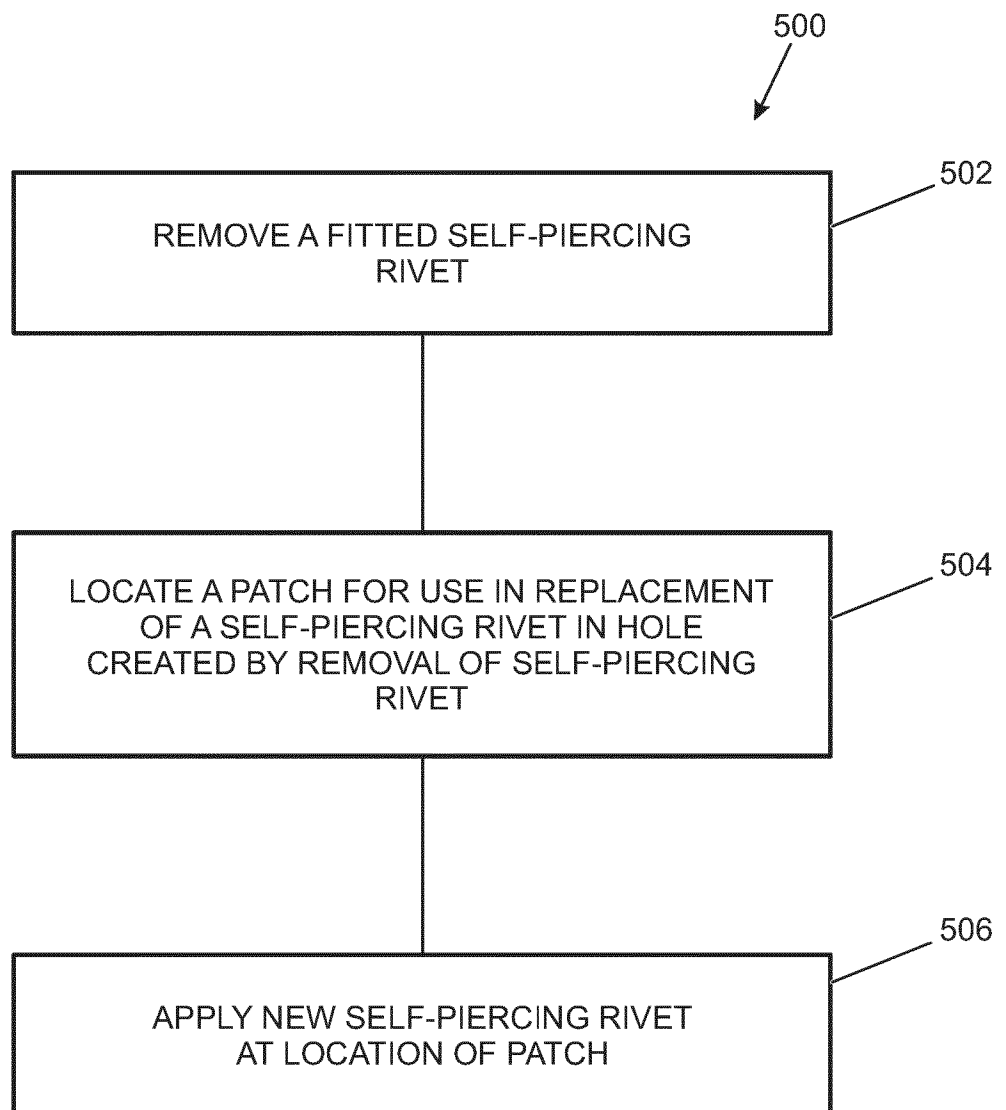


FIG 5

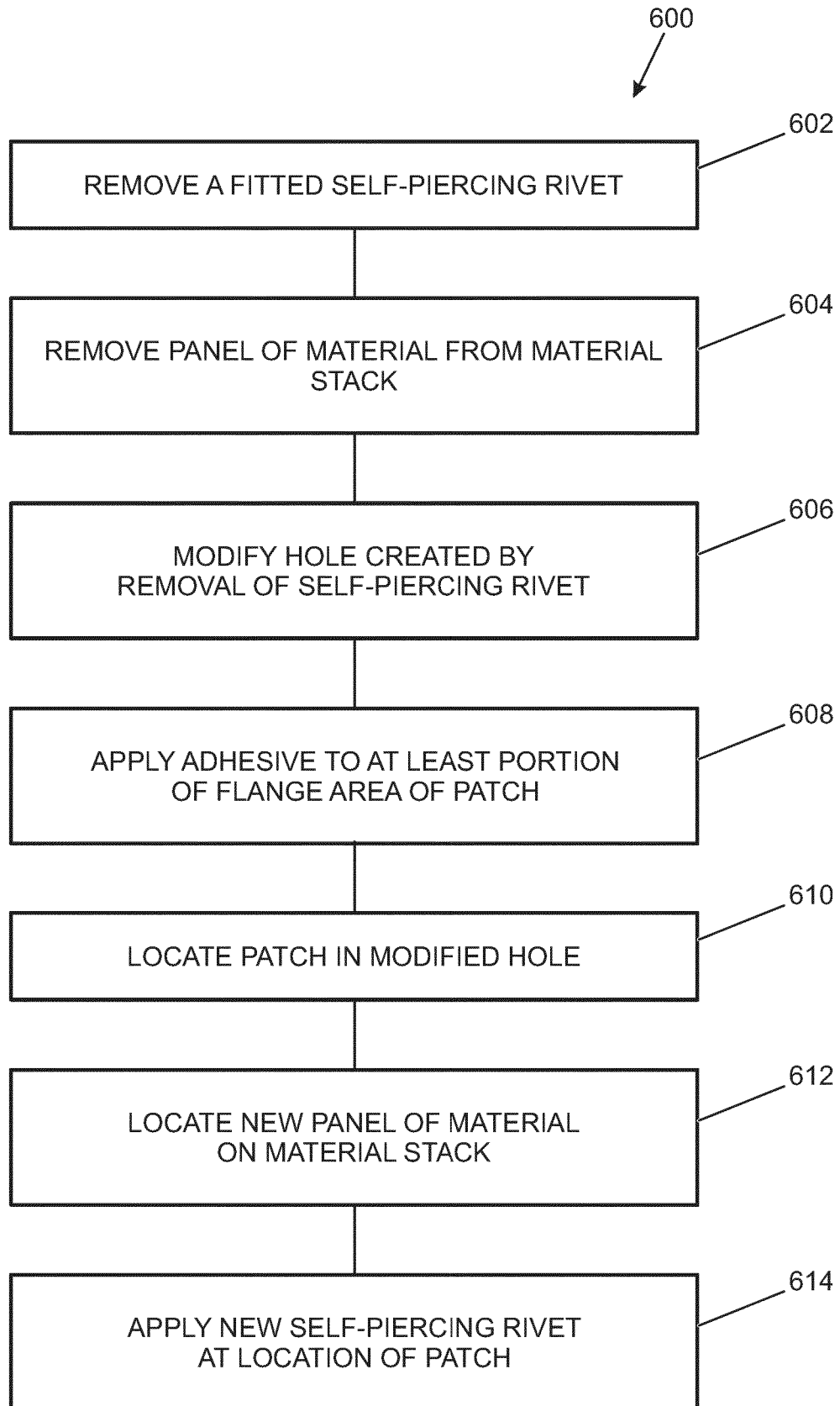


FIG 6

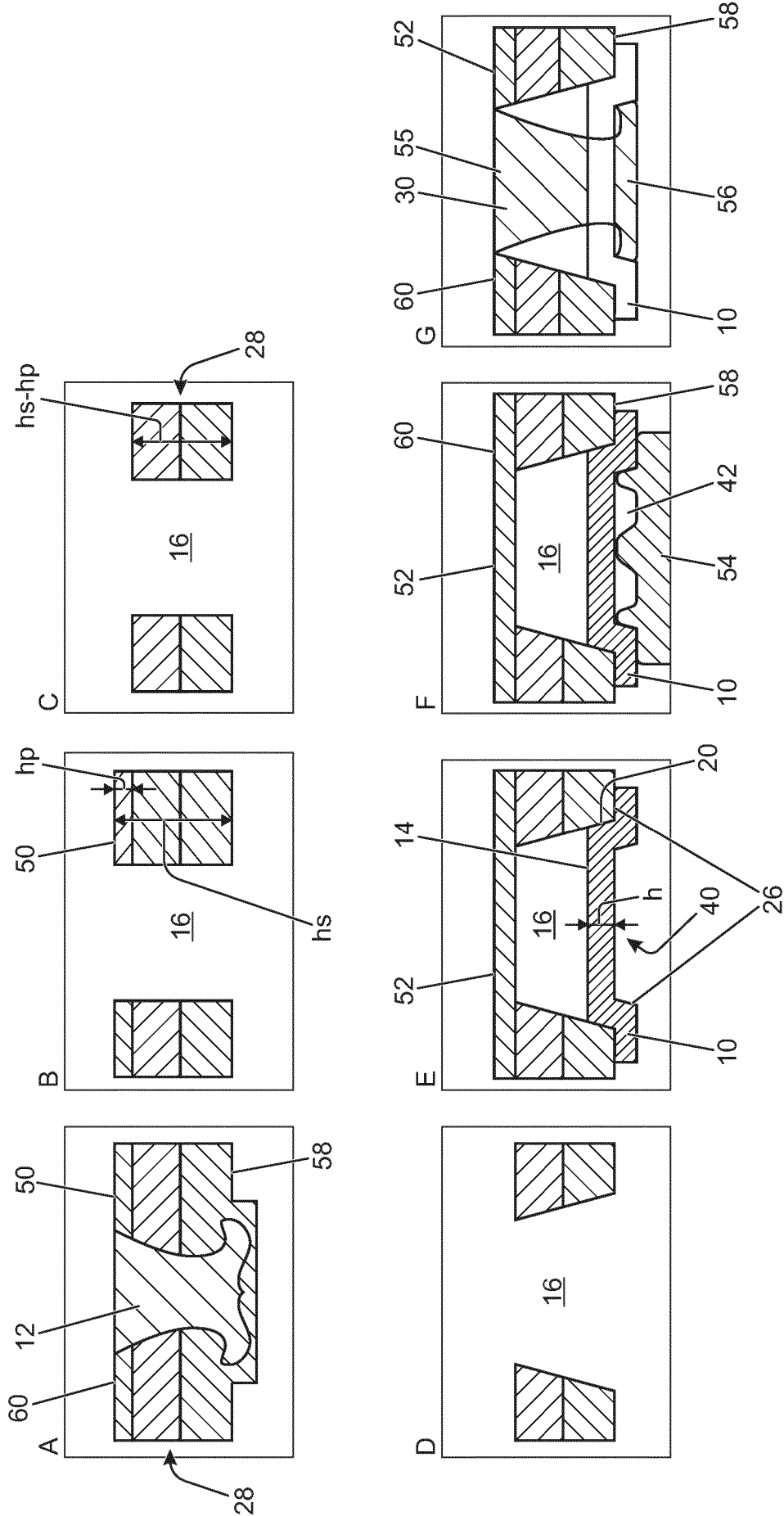


FIG. 7

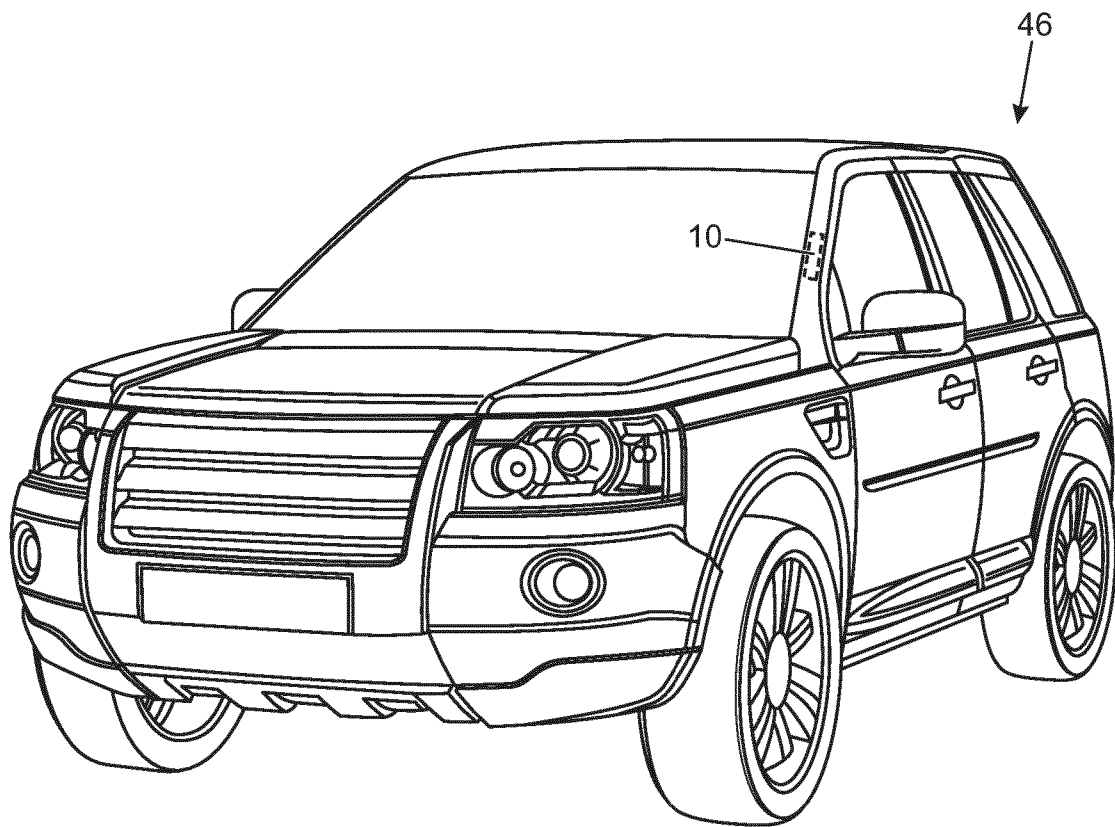


FIG 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/080218

A. CLASSIFICATION OF SUBJECT MATTER INV. B21J15/02 B21J15/14 B23P6/00 B21J15/50 B23P19/06 ADD.		
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) B21J B23P B29C		
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) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/016111 A1 (MUELLER RUDOLF [DE] ET AL) 29 January 2004 (2004-01-29) claim 40; figure 1 -----	1-30
X	JP 2006 234154 A (NITTO SEIKO KK) 7 September 2006 (2006-09-07) paragraph [0010]; figure 4 -----	1-13,16
☐ 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 4 May 2017	Date of mailing of the international search report 11/05/2017	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Augé, Marc	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/080218

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004016111	A1	29-01-2004	AU 5466801 A 08-10-2001
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JP 2006234154	A	07-09-2006	NONE
