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W. E. MAHER ETAL

3,263,323

FABRICATION OF A CONTINUOUS PERIPHERAL JOINT

Original Filed Dec. 28, 1962

FIG. 1

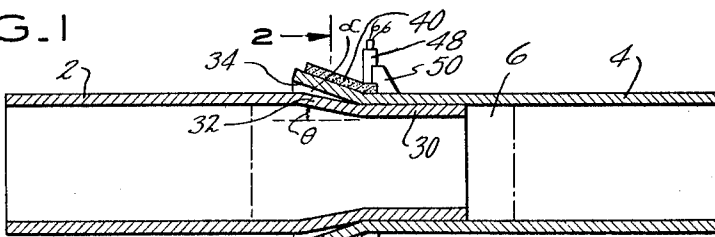


FIG. 2

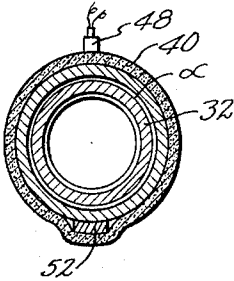


FIG. 3

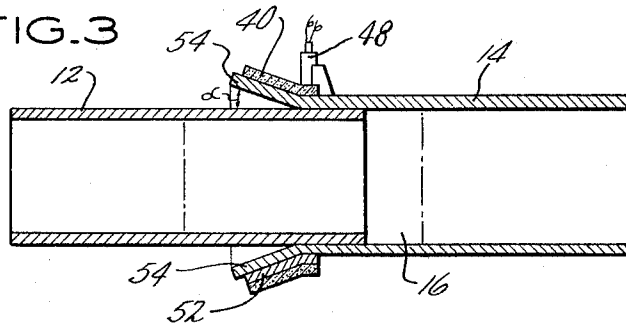


FIG. 4

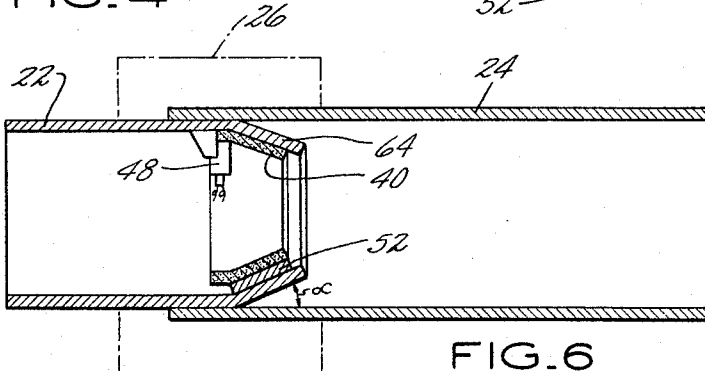


FIG. 6

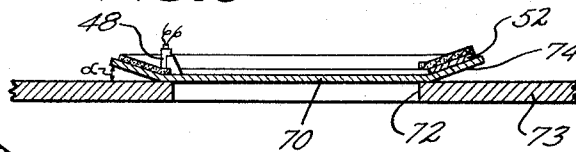
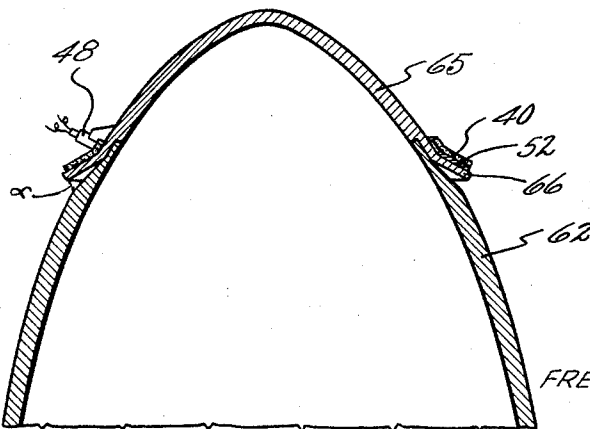


FIG. 5



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3,263,323 FABRICATION OF A CONTINUOUS PERIPHERAL JOINT

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Continuation of application Ser. No. 248,001, Dec. 28, 1962. This application Oct. 21, 1965, Ser. No. 505,132
9 Claims. (Cl. 29—470)

This invention relates to the formation of a continuous peripheral joint involving the use of an explosive charge. This application is a continuation of application Serial No. 248,001, filed December 28, 1962, to Walter E. Maher et al. for "Fabrication of a Continuous Peripheral Joint."

An object of this invention is to provide for the explosive joining of two metals in which a joint is necessary along a peripheral edge.

Another object of this invention is to provide a method whereby two metals are explosively joined along a continuous endless line from a point without having the joint weakened or not satisfactorily joined at any place along the line.

A further object of this invention is to provide a metal tab for placement on the moving flared portion of two co-operating metal parts having peripheral contact. The parts are to be explosively joined and the tab is located under the explosive so that it falls at a point on the periphery an equal distance in either direction along the periphery from the point at which the explosive is to be ignited.

Another object of this invention is to provide a method of making a satisfactory explosive seam joint between two telescoped members.

A further object of this invention is to provide a peripheral explosively formed joint around the edge of a cover over an opening.

Another object of this invention is to prevent severe cracking at a point around a circumferential or peripheral explosively formed joint which has had an explosive charge ignited at a point.

A further object of this invention is to provide a tab to absorb the effect caused by the meeting of the opposed shock waves of a circumferential joint which occurs at a point 180° from the detonating point which travels in opposite directions around the perimeter from the detonation point.

Other objects and advantages will be apparent from the specification and from the accompanying drawings which illustrate the invention.

FIGURE 1 is a sectional view of two telescoped tubes shown in readiness for ignition of the explosive charge to form a scarf joint.

FIGURE 2 is a view taken along the line 2—2 of FIGURE 1.

FIGURE 3 is a sectional view of two telescoped tubes, having a different type relationship than FIGURE 1, shown in readiness for ignition of the explosive charge to form an external lap joint.

FIGURE 4 is a sectional view of two telescoped tubes, having a different type relationship than FIGURES 1 and 3, wherein the explosive is placed internally, shown in readiness for ignition of the explosive charge to form an internal lap joint.

FIGURE 5 is a sectional view of two members shown in readiness for ignition of the explosive charge to complete a conical type device.

FIGURE 6 shows a cover or plate positioned over an opening which is in readiness for ignition of an explosive charge.

With reference to FIGURES 1 and 2, two tubes 2 and 4 are shown fixedly positioned on a holding die 6 (shown in phantom). The profile of this holding die 6 for positioning and holding the ends of the tubes preparatory to explosive joining is specifically shown and claimed in U.S. Patent No. 3,197,855 to Carter et al., entitled, Method of Explosively Forming a Scarf Type Joint which was filed with application Serial No. 248,001 (referred to above). The die itself is formed so as to be collapsible so that it can be withdrawn through one end of the tube or the other. This type of construction for a collapsible die is old in the art and any collapsible device can be used. The angular connecting portion 32 of the tube is formed having a specific angle θ , the sine of which is equal to the thickness of the material of the tube 2 divided by the desired finished scarf weld length. The offset portion 30 is formed to slidably engage the inner surface of the tube 4. The mating end of the tube 4 is formed having a flared portion 34 which forms an angle α with the frusto-conical angular connecting portion 32 of the tube 2. The tubes 2 and 4 can be held in fixed relationship by any means desired.

An explosive 40 is placed over the angular face of the flared portion 34. This explosive extends over an area including the bend in the tube 4 to a location on said flared portion 34 including the length of the frusto-conical section 32 of the tube 2. The explosive used can be of the flexible sheet type. One type is the Du Pont EL-506 series. Further information on this type explosive is set forth in U.S. Patent No. 2,992,087.

A detonator 48 is positioned at a point on the explosive adjacent the bend in the tube 4 where the flared portion 34 starts. The detonator 48 is held in position by a support 50. This support can be a block of clay which can be manually kneaded or manipulated to properly fit any location at which a detonator needs support. The detonator 48 can be of the standard commercial type which may be ignited by the closing of a circuit at a control point located a safe distance from the detonator and resulting explosion. Other type detonators can be used.

At a point 180° from the location of the detonator 48 a metallic tab 52 is placed between the explosive 40 and the flared portion 34. The tab is positioned so that its center is approximately on the 180° mark. While the width of this tab can vary, it appears as if a width of approximately 1/2" is optimum for peripheral lengths to be joined which are 6" or over, (this tab width being 1/2 of the peripheral length) and should extend from approximately the bend in the flared portion 34 of plate 4 to a point on the flared portion approximately equal to the length of the angular portion 32 of tube 2.

Example: in the construction of a tank from 0.050" type 347 stainless steel, having a 9 1/2" diameter, a tab, 1/2" x 1" x 0.050" of the same material was used and positioned 180° from the location of the detonator. A one inch wide by 0.200" thick annular formation of a flexible sheet of the Du Pont EL-506 series was placed around the moving flared portion of the joint to be formed and the resulting pressure reinforcement occurred over the surface of the tab. This pressure reinforcement is a localized increase in pressure due to the meeting of the pressure front or waves traveling through the strip of explosive from the cap in opposite directions around the periphery of the joint to be formed.

While 1/2" was used as the width of the tab in the above example, the tab should be of such a width so as to insure that the increase of pressure due to the meeting of the traveling pressure front or waves will meet thereover. The thickness of the tab 52 can vary and it appears that the range in which the best results are obtained is the use of a tab having from 1/3 to five times the thickness of

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the moving plate. While it is not part of this invention, one method of determining a satisfactory angle α and a satisfactory amount of explosive to be used is referred to in the U.S. patent to Carter et al. referred to above (F-366).

In FIGURE 3, two tubes 12 and 14 are shown fixedly positioned on a holding die 16 (shown in phantom). This die is formed so as to be easily removable from the interior of the tubes. In forming this type of joint, which is a lap type joint, one end of tube 12 is merely inserted into an end of tube 14 having a flared portion 54. The flared portion 54 forms an angle α with the outer surface of the tube 12.

An explosive 40 is placed around the angular face of the flared portion 54 in the same manner as in the formation of the scarf joint above. A detonator 48 is positioned at a point on the circumference of the explosive adjacent the bend in the tube 14 and a metallic tab 52 is placed with its center at a point 180° from the location of the detonator 48 between the explosive 40 and the flared portion 54.

In FIGURE 4, the formation of an internal lap joint is shown with the two tubes 22 and 24 fixedly positioned in place within a holding die 26 (shown in phantom). This die is formed so as to be easily removable from around the external surfaces for the tubes. In forming this type of joint, which is an internal lap joint, one end of a tube 22 is merely inserted into one end of a tube 24. The end of the tube 22 inserted is formed having its end inwardly flared such as shown at 64. The flared portion 64 forms an angle α with the inner surface of the tube 24.

An explosive 40 is placed around the interior angular face of the flared portion 64 and is held in position by any means desired such as by adhesive tape. The detonator 48 is positioned at a point on the circumference of the explosive adjacent the bend in the tube 22 and a metallic tab 52, as previously set forth, is placed at a point 180° from the location of the detonator 48 between the explosive 40 and the flared portion 64.

In FIGURE 5, a cone-shaped member 65 is shown in place over an open-ended member 62. The arrangement of the joint is similar to that shown in the preceding figures with the detonator 48 being positioned an equal distance in either direction from the metallic tab 52 which is placed beneath the explosive charge 40 and the moving plate 66 on the cone-shaped member 64.

FIGURE 6 shows a cover 70 located over a hole 72 in a plate 73 in readiness for explosive joining. (It is to be understood that the peripheral joint described is not limited to use only with a cover and a plate with a hole, but includes all uses.) The opening 72 can be of any shape and need not be circular. The cover 70 is then made having a peripheral edge which will overlap the edge of the opening 72. The covering edge of the cover is flared upwardly as at 74 to form an angle α with the plate 73. The explosive 40 is placed around the top of the flared portion 74 in a similar manner to the other joints and the tab 52 is placed at a point an equal distance in each direction from the detonator 48.

While the tab should generally be of the same material as that of the moving plate, if another material is used, it should be one which cannot set up a galvanic cell action if parts of the tab are joined to the moving plate during the joining process.

It is to be understood that the invention is not limited to the specific forms herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

We claim:

1. Method of making a circumferential joint from metals capable of being explosively joined to each other:

- (a) selecting a first metallic member;
- (b) selecting a second metallic member of a material and geometry which will explosively bond to said first member, one of said members being provided

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with a flange which will form an acute angle with the surface of said other member when said members are positioned in cooperating relationship with said second member engaging said first member;

(c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member adjacent the flange and said angular flange being positioned so that said flange of said one member can be explosively driven against said other member to join the two members;

(d) supporting both of said members in said cooperating relationship;

(e) providing a continuous explosive charge on the flange of said one member on the surface away from said other member where it extends over the other member, a metallic tab between said charge and the face of said flange at one location, and detonating means in position to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said one member can be explosively driven against said other member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width not exceeding a maximum of approximately $\frac{1}{2}$ of the length of said flange, said metallic tab having a thickness of from $\frac{1}{8}$ to 5 times the thickness of said flange; and

(f) igniting said detonating means.

2. Method of making a circumferential joint from metals capable of being explosively joined to each other:

(a) selecting a first metallic member;

(b) selecting a second metallic member of a material and geometry which will explosively bond to said first member, said second member being provided with a flange which will form an acute angle with the surface of said first member when positioned in cooperating relationship engaging said first member;

(c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member adjacent the flange and said angular flange being positioned so that said flange of said second member can be explosively driven against said first member to join the two members;

(d) supporting both of said members in said cooperating relationship;

(e) providing a continuous explosive charge on the flange of said second member on the surface away from said opening where it extends over the first member, a metallic tab between said charge and the face of said flange at one location, and detonating means in position to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said second member can be explosively driven against said first member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width not exceeding a maximum of approximately $\frac{1}{2}$ of the length of said flange, said metallic tab having a thickness of from $\frac{1}{8}$ to 5 times the thickness of said flange; and

(f) igniting said detonating means.

3. Method of making a circumferential joint from metals capable of being explosively joined to each other:

(a) selecting a first metallic member;

(b) selecting a second metallic member of a material and geometry which will explosively bond to said first member, one of said members being provided

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with a flange which will form an acute angle with the surface of said other member when said members are positioned in cooperating relationship with said second member engaging said first member;

- (c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member adjacent the flange and with said angular flange being positioned so that said flange of said one member can be explosively driven against said other member to join the two members;
 - (d) supporting both of said members in said cooperating relationship;
 - (e) providing a continuous explosive charge on the flange of said one member on the surface away from said other member where it extends over the other member, a metallic tab between said charge and the face of said flange at one location, and detonating means spaced equidistant in each direction from said tab to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said one member can be explosively driven against said other member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width not exceeding a maximum of approximately $\frac{1}{2}$ of the length of said flange, said metallic tab having a thickness of from $\frac{1}{8}$ to 5 times the thickness of said flange; and
 - (f) igniting said detonating means.
4. Method of making circumferential joint from metals capable of being explosively joined to each other:
- (a) selecting a first metallic member;
 - (b) selecting a second metallic member of a material and geometry which will explosively bond to said first member, one of said members being provided with a flange which will form an acute angle with the surface of said other member when said members are positioned in cooperating relationship with said second member engaging said first member;
 - (c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member adjacent the flange and with said angular flange being positioned so that said flange of said one member can be explosively driven against said other member to join the two members;
 - (d) supporting both of said members in said cooperating relationship;
 - (e) providing a continuous explosive charge on the flange of said one member on the surface away from said other member where it extends over the other member, a metallic tab between said charge and the face of said flange at one location, and detonating means spaced approximately 180° from said tab to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said one member can be explosively driven against said other member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width not exceeding a maximum of approximately $\frac{1}{2}$ of the length of said flange, said metallic tab having a thickness of from $\frac{1}{8}$ to 5 times the thickness of said flange; and
 - (f) igniting said detonating means.

5. Method of making a circumferential joint from metals capable of being explosively joined to each other:

- (a) selecting a first metallic member;
- (b) selecting a second metallic member of a material and geometry which will explosively bond to said

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first member, one of said members being provided with a flange which will form an acute angle with the surface of said other member when said members are positioned in cooperating relationship with said second member engaging said first member;

- (c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member adjacent the flange and with said angular flange being positioned so that said flange of said one member can be explosively driven against said other member to join the two members;
 - (d) supporting both of said members in said cooperating relationship;
 - (e) providing a continuous explosive charge on the flange of said one member on the surface away from said other member where it extends over the other member, a metallic tab between said charge and the face of said flange at one location, and detonating means in position to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said one member can be explosively driven against said other member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width of approximately one-half of an inch, said metallic tab having a thickness of from $\frac{1}{8}$ to 5 times the thickness of said flange; and
 - (f) igniting said detonating means.
6. Method of making a circumferential joint from metals capable of being explosively joined to each other:
- (a) selecting a first metallic member;
 - (b) selecting a second metallic member of a material and geometry which will explosively bond to said first member, one of said members being provided with a flange which will form an acute angle with the surface of said other member when said members are positioned in cooperating relationship with said second member engaging said first member;
 - (c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member adjacent the flange and with said angular flange being positioned so that said flange of said one member can be explosively driven against said other member to join the two members;
 - (d) supporting both of said members in said cooperating relationship;
 - (e) providing a continuous explosive charge on the flange of said one member on the surface away from said other member where it extends over the other member, a metallic tab between said charge and the face of said flange at one location, and detonating means in position to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said one member can be explosively driven against said other member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width not exceeding a maximum of approximately $\frac{1}{2}$ of the length of said flange, said metallic tab having a thickness of approximately the thickness of said flange; and
 - (f) igniting said detonating means.
7. Method of making a circumferential joint from metals capable of being explosively joined to each other:
- (a) selecting a first metallic member;
 - (b) selecting a second metallic member of a material and geometry which will explosively bond to said first member, one of said members being provided

with a flange which will form an acute angle with the surface of said other member when said members are positioned in cooperating relationship with said second member engaging said first member;

- (c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member adjacent the flange and with said angular flange being positioned so that said flange of said one member can be explosively driven against said other member to join the two members;
- (d) supporting both of said members in said cooperating relationship;
- (e) providing a continuous explosive charge on the flange of said one member on the surface away from said other member where it extends over the other member, a metallic tab between said charge and the face of said flange at one location, and detonating means in position to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said one member can be explosively driven against said other member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width of approximately one-half of an inch, said metallic tab having a thickness of approximately the thickness of said flange; and
- (f) igniting said detonating means.

8. A method of making a circumferential joint from metals capable of being explosively joined to each other:

- (a) selecting a first cylindrical metallic member;
- (b) selecting a second cylindrical metallic member which will slideably engage said first member, said second member being of a material and geometry which will explosively bond to said first member; one of said members being provided with a flange which will form an acute angle with the surface of said other member when said members are positioned in cooperating relationship with one of said members extending around said other member;
- (c) positioning said first member in cooperating relationship with said second member, with one of said members completely engaging said other member circumferentially and with said angular flange being positioned so that said flange of said one member can be explosively driven against said other member to join the two members;
- (d) supporting both of said members in cooperating relationship;
- (e) providing a continuous explosive charge on the flange of said one member on the surface away from said other member where it extends over the other member, a metallic tab between said charge and the face of said flange at one location, and detonating means in position to ignite the charge so that the

traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said one member can be explosively driven against said other member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width not exceeding a maximum of approximately $\frac{1}{2}$ of the length of said flange, said metallic tab having a thickness of from $\frac{1}{8}$ to 5 times the thickness of said flange; and

- (f) igniting said detonating means.
- 9. A method of making a circumferential joint from metals capable of being explosively joined to each other:
 - (a) selecting a first cylindrical metallic member;
 - (b) selecting a second cylindrical metallic member which will slideably engage said first member, said second member being of a material and geometry which will explosively bond to said first member, said second member being provided with a flange which will form an acute angle with the surface of said first member when said members are positioned in cooperating relationship with one of said members extending around said other member;
 - (c) positioning said first member in cooperating relationship with said second member, with said second member completely engaging said first member circumferentially and with said angular flange being positioned so that said flange of said second member can be explosively driven against said first member to join the two members;
 - (d) supporting both of said members in cooperating relationship;
 - (e) providing a continuous explosive charge on the flange of said second member on the surface away from said first member where it extends over the first member, a metallic tab between said charge and the face of said flange at one location, and detonating means in position to ignite the charge so that the traveling pressure fronts resulting from said igniting will meet over said metallic tab to join the two members, said charge being of such sufficient explosive force so that said second member can be explosively driven against said first member to join the two members, said metallic tab extending in length for approximately the width of the charge at that location, said metallic tab having a width not exceeding a maximum of approximately $\frac{1}{2}$ of the length of said flange, said metallic tab having a thickness of from $\frac{1}{8}$ to 5 times the thickness of said flange; and
 - (f) igniting said detonating means.

No references cited.

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