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EXPLOSIVELY JOINING METALS TO FORM A CONTINUOUS SHEET

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FIG. 1

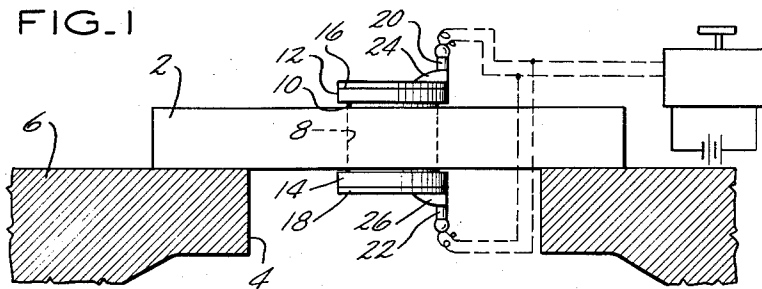
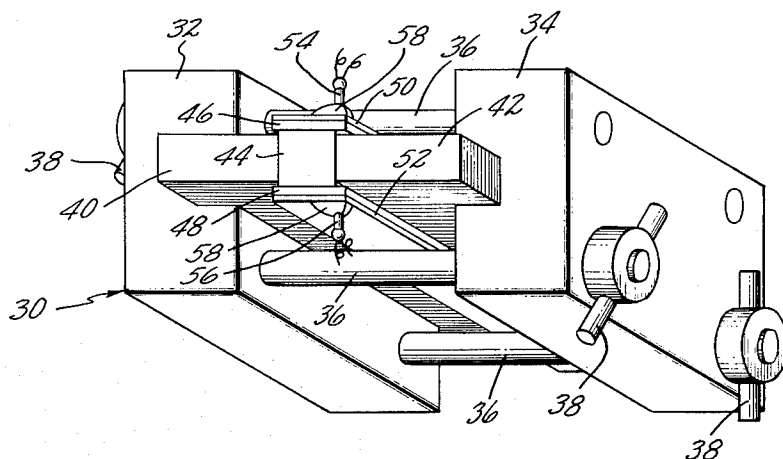


FIG. 2



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EXPLOSIVELY JOINING METALS TO FORM A CONTINUOUS SHEET

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6 Claims. (Cl. 29—470.1)

This invention relates to the method of forming a complete sheet of metal comprising placing a plug within a hole in the metal plate or between two metal plates.

An object of this invention is to place a plug within a hole in a plate and joining said plug to said plate by igniting an explosive charge on each side of said plug.

Another object of said invention is to provide a driver plate on each side of the plug against which each charge is detonated simultaneously.

A further object of this invention is to join two plates by a filler plug which extends along the length of the ends of the plates to be joined. The plates to be joined are fixed in position so that the filler plug acts in the same manner as a circular plug when it is driven inwardly from both ends by explosion along the ends thereof.

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

FIG. 1 is a side view of the method showing the plug inserted in readiness for the simultaneous explosive charges to be set off by a detonator attached to the explosive on each end of the plug by a hand operated ignition system.

FIG. 2 is a perspective view showing two plates held in position with a filler plug therebetween with strips of explosive located on each side of the filler plug with detonators affixed thereto to provide simultaneous detonation.

With reference to FIG. 1, a plate 2 is shown mounted over an opening 4 and a table 6. A hole 8 in the plate 2 is positioned over the hole 4. A plug 10 is positioned in the hole 8 snugly so as to be held therein by friction. A driver plate 12 is affixed to the top of the plug 10 and a driver plate 14 is affixed to the bottom thereof. These driver plates may be held in position by any means desired. For example, the bottom plate 14 may be held on by adhesive tape. The plates extend over the edge of plug 10 to prevent the explosion from driving any extraneous matter, including products of combustion, between the plug 10 and plate 2.

An explosive is placed over each face of the plug 10; that is, the top face and bottom face. Here again, this explosive may be held in position by any means desired. This explosive can be of the flexible sheet type. One type is the Du Pont EL-506 series. Further information on this type of explosive is set forth in U.S. Patent No. 2,992,087.

A detonator 20 is positioned at the edge of the sheet of explosive 16 placed on the upper driver plate 12 and a detonator 22 is placed on the explosive sheet 18 which is affixed to the lower driving plate 14. Detonators 20 and 22 are held in position respectively by supports 24 and 26. These supports 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 can be of the standard commercial type which is ignited by the closing of a circuit at a control point located a safe distance from the detonator and resultant explosion.

An example is set forth below showing materials on

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which subject invention has been used with reference to plugs.

Example 1:

Material: Copper to Copper

Thickness of sheet: $\frac{7}{16}$ "

Thickness of plug: $\frac{1}{2}$ "

Diameter of plug: .750"

Sheet thickness of EL-506A: .825"

The amount of explosive to be used is an amount in which the total pressure due to the addition of the coincident pressure waves caused by the meeting of the compressive shock waves of detonated explosive will be slightly less than the dynamic compressive ultimate strength of the metal plug in order to keep a crack from forming within the plug perpendicular to the axis of the plug. With reference to FIG. 2, a holding and positioning die 30 having sheet metal holding end members 32 and 34. These end members 32 and 34 are held in position by rod members 36, positioned at each end of the members 32 and 34. They are adjustable in length by turning one end thereof such as is shown at 38.

Two plates 40 and 42 are shown in position with an extended plug 44 located between the free ends thereof. The action of the movable rods 36 permits the members 32 and 34 to be moved outwardly to receive the plates 40 and 42 and extended plug 44. When they have been placed within the die 30, the rods 36 can be shortened to hold the two plates 40 and 42 and plug 44 together in tight engagement.

A driver plate 46 is placed along the top of the plug 44 and a driver plate 48 is placed along the lower face of the plug 44. Here again, these plates may be held in position by any means desired.

The driver plate 46 has a sheet of explosive 50 affixed thereto extending for the entire surface of the plate and the driver plate 48 has an explosive strip 52 affixed thereto extending over the entire area of the plate.

A detonator 54 is placed at one end of the explosive charge 50 and a detonator 56 is placed in a like position on the explosive charge 52. Each detonator 54 and 56 is held in position by support 58. This support is similar to the supports referred to above. The ignition means for igniting the detonators 54 and 56 simultaneously is similar to the ignition means shown in FIG. 1. Any other means for simultaneously initiating explosion of the two sheets 50 and 52 at the same point can be used.

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

We claim:

1. Method of filling a hole in a metal plate with a metal plug wherein the metals are capable of being explosively joined:

- placing a metal plug in the hole so as to fit snugly, said plug being thicker than the plate;
- positioning said plug so that it extends on each side of said plate a small amount;
- placing a driver plate on each end of said plug;
- placing an explosive charge on each open face of each driver plate; and
- igniting said charges simultaneously to cause the side surfaces of the plug to effect a joint.

2. Method of filling a hole in a metal plate with a metal plug wherein the metals are capable of being explosively joined:

- placing a metal plug in the hole so as to fit snugly, said plug being thicker than the plate;

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- (b) positioning said plug so that it extends on each side of said plate a small amount;
 - (c) placing a driver plate on each end of said plug which extends outwardly from the periphery of the plug;
 - (d) placing an explosive charge on each open face of each driver plate; and
 - (e) igniting said charges simultaneously to cause the side surfaces of the plug to effect a joint.
3. Method of filling a hole in metal plate with a metal plug wherein the metals are capable of being explosively joined:
- (a) placing a metal plug in the hole so as to fit snugly, said plug being thicker than the plate;
 - (b) positioning said plug so that it extends on each side of said plate a small amount;
 - (c) placing a plate on each end of said plug;
 - (d) placing an explosive charge on each open face of each plate; and
 - (e) igniting said charges simultaneously to cause the side surfaces of the plug to effect a joint with said metal plate.
4. A method of forming a complete sheet of metal comprising:
- (a) filling the area of an opening defined by the sheet with a plug having two ends, said plug being thicker than the sheet and having each end extending from its respective side of the sheet,
 - (b) placing a driver means in contact with each end of said plug, each driver means having one surface engaging its cooperating end of said plug and a second surface facing away from its cooperating end for receiving a force adapted to act through said driver means and toward the end of said plug,
 - (c) placing an explosive charge on each second surface of each driver means, which when ignited will not cause a total pressure of pressure or shock waves meeting within the plug which will crack said plug,
 - (d) igniting said charges simultaneously.
5. A method of forming a complete sheet of metal comprising:
- (a) fixing two plates with their ends spaced apart,
 - (b) filling the area between the plates with a plug which is thicker than the plates and extends on each side of said plates,

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- (c) placing a driver plate on each side of said plug,
 - (d) affixing an explosive charge on each open face of each driver plate, which when ignited will not cause a total pressure of pressure or shock waves meeting within the plug to exceed the dynamic compressive ultimate strength of the plug,
 - (e) igniting said charges simultaneously.
6. Method of filling a hole in a metal plate with a metal plug wherein the metals are capable of being explosively joined:
- (a) placing a metal plug in the hole so as to fit snugly, said plug being thicker than the plate;
 - (b) positioning said plug so that it extends on each side of said plate a small amount;
 - (c) placing a driver plate on each end of said plug, each of said plates being larger than the end of said plug on which it is placed;
 - (d) positioning each driver plate so that its edge extends over the edge of the cooperating end of the plug;
 - (e) placing an explosive charge on each open face of each driver plate; and
 - (f) igniting said charges simultaneously to cause the side surfaces of the plug to effect a joint.

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