June 12, 1951 L. A. BURROWS ET AL 2,556,465

EXPLOSIVE RIVET

Filed May 25, 1945

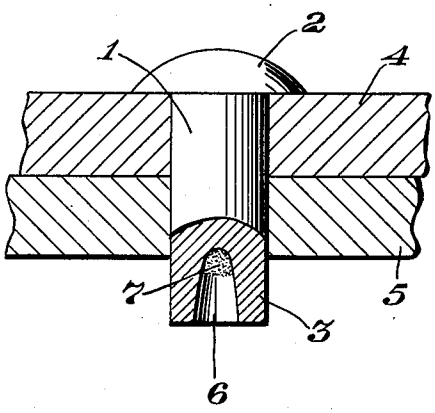


Fig. 1

OLD FORM

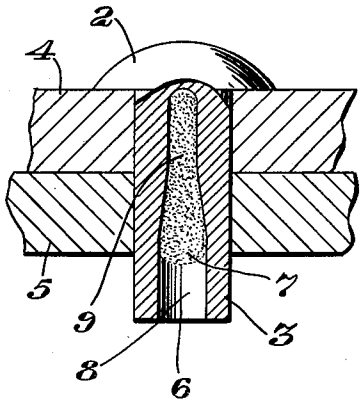


Fig. 2

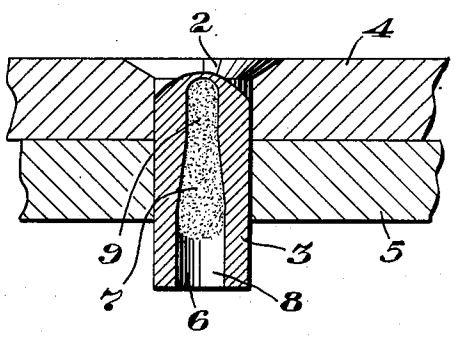


Fig. 3

Lawton A. Burrows INVENTORS
Walter E. Lawson
BY Thos A. Wilson
ATTORNEY

Patented June 12, 1951 2,556,465

UNITED STATES PATENT OFFICE

2,556,465

EXPLOSIVE RIVET

Lawton A. Burrows, Woodbury, N. J., and Walter E. Lawson, Wilmington, Del., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

Application May 25, 1945, Serial No. 595,738

1 Claim. (Cl. 85—40)

1

This invention relates to an improved rivet intended for securing together superposed sheets of material or other objects and containing within a cavity in said rivet an explosive charge adapted on explosion to bulge the side walls and thereby effect a firm gripping of the sheets.

The present application is an improvement of our co-pending application, Serial No. 426,150 filed January 9, 1942, which application was issued on October 29, 1946 as Patent Number 2,410,047.

Explosive rivets have become a highly important aid to industry within the past few years and are applicable in many places where the ordinary type of rivet cannot be used, particularly in uses where access to one side is difficult or impossible. Explosive rivets comprise ordinarily metal fastening devices having a head and a shank, the shank being provided with a cavity into which an explosive charge is loaded. Customarily the cavity extends slightly beyond the far edge of the second plate to be secured. The charge is detonated by application of a heated surface to the head of the rivet whereby the entire rivet becomes heated above the firing temperature of the explosive. At the moment of explosion, the walls of the rivet become expanded or bulged so that the metal sheets to be joined become firmly held together.

Rivets of the explosive type have given very successful results when used under suitable conditions. They have not been entirely satisfactory, however, under certain circumstances, especially where the rivets were inserted into somewhat oversize holes such as would give easier and speedier rivet insertions.

An object of the present invention is an improved explosive rivet effecting tighter and stronger joints than prior art rivets of this type and applicable under conditions where unsatisfactory results have previously been obtained. A further object is such a rivet so designed at to allow a more efficient loading of the explosive charge. A still further object is an explosive rivet affording tighter junctions where the rivets are used in holes allowing considerable clearance. Additional objects will be disclosed as the invention is described more at length in the following.

We have found that the foregoing objects are accomplished, and the disadvantages encountered with prior art devices overcome, when we employ a rivet having a cavity extending longitudinally through a substantial part of the shank, and desirably entering from the shank

2

end, this cavity comprising a main portion of a diameter between 0.4 and 0.6 of that of the shank and an extended portion of a substantially smaller diameter than that of the main portion. A preferred diameter for the extended portion is between 0.2 and 0.4 of the diameter of the shank. Desirable results are obtained when this portion of reduced cross section extends substantially to the head of the rivet. The charge will be so loaded that the increment in the main cavity is at least slightly beyond the further surface of the second sheet to be joined while the portion in the cavity extension of reduced diameter blasts the rivet metal into tight connection with the walls of the metal through which the rivet is inserted.

Rivets constructed in accordance with the present invention are illustrated in the accompanying drawing, in which Figure I is a cross-sectional elevation cut-away of an explosive rivet of the prior art inserted in a perforation in two sheets to be connected. Figure II is a round headed rivet according to the present invention, while Figure III shows an improved rivet of the countersunk type.

In Figure I, 1 represents a rivet of the explosive type, as disclosed in the prior art and used commercially, said rivet being inserted in perforations in the superposed metal sheets 4 and 5. The rivet shown has a head 2 and a shank 3, and a cavity 6 extending into the shank and opening from the shank end. Into this cavity an explosive charge 7 has been loaded, this charge being positioned so that the greater part of it is slightly below the far surface of sheet 5. When this charge is brought to explosion by the application of a heating surface to the head of the rivet, the force of the explosion causes the expansion of the walls of the rivet so that the metal sheets are held firmly together.

In Figure II, a modified rivet according to the present invention is shown, adapted to be inserted through sheets of material in the manner shown in Figure I. The round head of the rivet is designated again by 2 and the shank by 3. This rivet likewise has a cavity 6 entering through the shank, into which the explosive charge 7 is loaded. This rivet differs in that the cavity is made up of two portions, one of larger diameter 8 and an elongated portion 9 of considerably smaller diameter, this latter part extending substantially to the head of the rivet. With such a cavity design, not only is there explosive in the larger diameter portion that acts to hold the sheets together on explosion but there is also

explosive in the narrower, extended portion that blasts the rivet metal into tight connection with the sheets substantially throughout a great part of their entire thickness.

In Figure III, a countersunk type rivet has the head **2** and the shank **3**, with a cavity **6** therein. Again the explosive charge is positioned in both the larger and the smaller diameter portions, **8** and **9**, respectively, so that an advantageous riveting effect is secured.

The rivets of the type described in the foregoing may be made of various metals, the only requirement being that said metal possess sufficient ductility to allow satisfactory expansion of the walls without rupture. While such metals as copper, brass, Monel metal and various steel alloys are applicable, the rivets used in airplane construction, one of the most important fields of use, are generally of aluminum or its alloys.

The size of the rivets will, of course, depend on the thickness of the plates to be secured but a common sized aluminum rivet may have a head spread of 0.3 to 0.4 in. and an over-all length of 0.2 to 0.5 in. With what is designated as a $\frac{3}{16}$ in. rivet, for example, having a shank diameter of 0.202 in., a suitable diameter of the main cavity in the shank will be 0.101 in. and that of the extended cavity 0.052 in. We find it important to have the diameter of said main portion of the cavity between 0.4 and 0.6 of the shank diameter. The extended portion of the cavity of narrower opening should have a diameter equal to between 0.2 and 0.4 of that of the shank. The depth of the cavity should be sufficient generally to have it go substantially to the head of the rivet, in order to obtain maximum efficiency, but should not be enough to leave a deficiency of metal at the head end so that dimpling or eruption will occur there when the charge is exploded.

In loading the rivets according to our invention, we find it desirable to press the charges to a suitably high density, depending on the type of explosive used. Greater uniformity of density results in the case of the extended cavity rivets of our invention when the loading and pressing are done in at least two operations. In order to facilitate loading and promote uniformity in density, we find it desirable to have the walls of both larger and smaller portions of the cavity generally parallel to the longitudinal axis of the rivet. Moreover, the cavity as a whole should be generally stream-lined in contour; that is to say, there should be no connecting walls between the main and the extended portions that are at right angles to said longitudinal axis. While this is less essential with double pressing of the combined charges, such a design is still desirable, in order to avoid dead-end corners.

Various types of explosive charges may be used in the rivets of the present invention. One suitable explosive, for example, may comprise a blend of lead azide and tetrazene in a 90–10 ratio. We find a very desirable loading to be a mixture of aluminum powder, nitromannite and tetrazene, such as a 48–27–25 proportion of these respective ingredients. With such a blend, a density of charge of 1.6–1.9 may be satisfactorily used. It will be understood, of course, that the charges in the larger and smaller diameter cavity portions may differ in their respective compositions, if so desired.

The rivets of the design and arrangement described in the foregoing possess superior characteristics to those of the prior art explosive rivets. When, for example, the former type was fired in slightly oversize holes, a condition that makes for convenience and rapidity of inserting the rivets in place, insufficient rigidity of connection frequently resulted. While the tensile and shear strengths were ordinarily satisfactory, the joint tightness was less than desired. With the improved rivet of the present invention, however, the joint tightness is markedly increased under such conditions and suitable rigidity is obtained. The feature of a cavity comprising a main portion and an extended portion of smaller diameter has the advantage over a cavity of the same total length but of the larger diameter throughout in that the latter type sacrifices shear strength because of the decreased body of metal in the rivet. Our improved rivet, moreover, is superior to one having the same total length of cavity but of the smaller diameter in having a larger amount of explosive at the position where substantial bulging of the rivet walls is desired, whereby a more secure fastening results.

While the invention has been described adequately and at length in the foregoing, it will be appreciated that many variations may be introduced in details of design and arrangement and conditions of loading, without departure from the spirit of the invention. We intend to be limited, therefore, only by the following claim.

We claim:

An explosive rivet for securing together superposed objects wherein the rivet is positioned within aligned holes of the superposed objects so that the rivet head is in contact with the outer surface of said objects and a length of the rivet shank projects beyond the inner surface of said objects, said rivet comprising a head and a shank, a centrally-disposed cavity extending longitudinally through said shank, said cavity consisting of a main portion open at the end of the shank opposite the head and having a diameter of from 0.4 to 0.6 times that of the shank, the length of said main portion being greater than the length of the shank projecting beyond the inner surface of the superposed objects, and a second portion of said cavity extending from said main portion substantially to the juncture of the shank and the head, said second portion having a diameter of from ½ to ⅔ that of the main portion; and a detonating explosive charge within all of said second portion and that part of the main portion adjacent the second portion to a point slightly beyond the inner surface of the superposed objects.

LAWTON A. BURROWS.
WALTER E. LAWSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,286,382	Mead	Dec. 3, 1908
1,400,401	Allan	Dec. 13, 1921
2,080,220	Butter et al.	May 11, 1937
2,378,118	Widrich	June 12, 1945
2,387,742	Burrows	Oct. 30, 1945
2,398,633	Gazada	Apr. 16, 1946

FOREIGN PATENTS

Number	Country	Date
467,515	Great Britain	June 17, 1937