

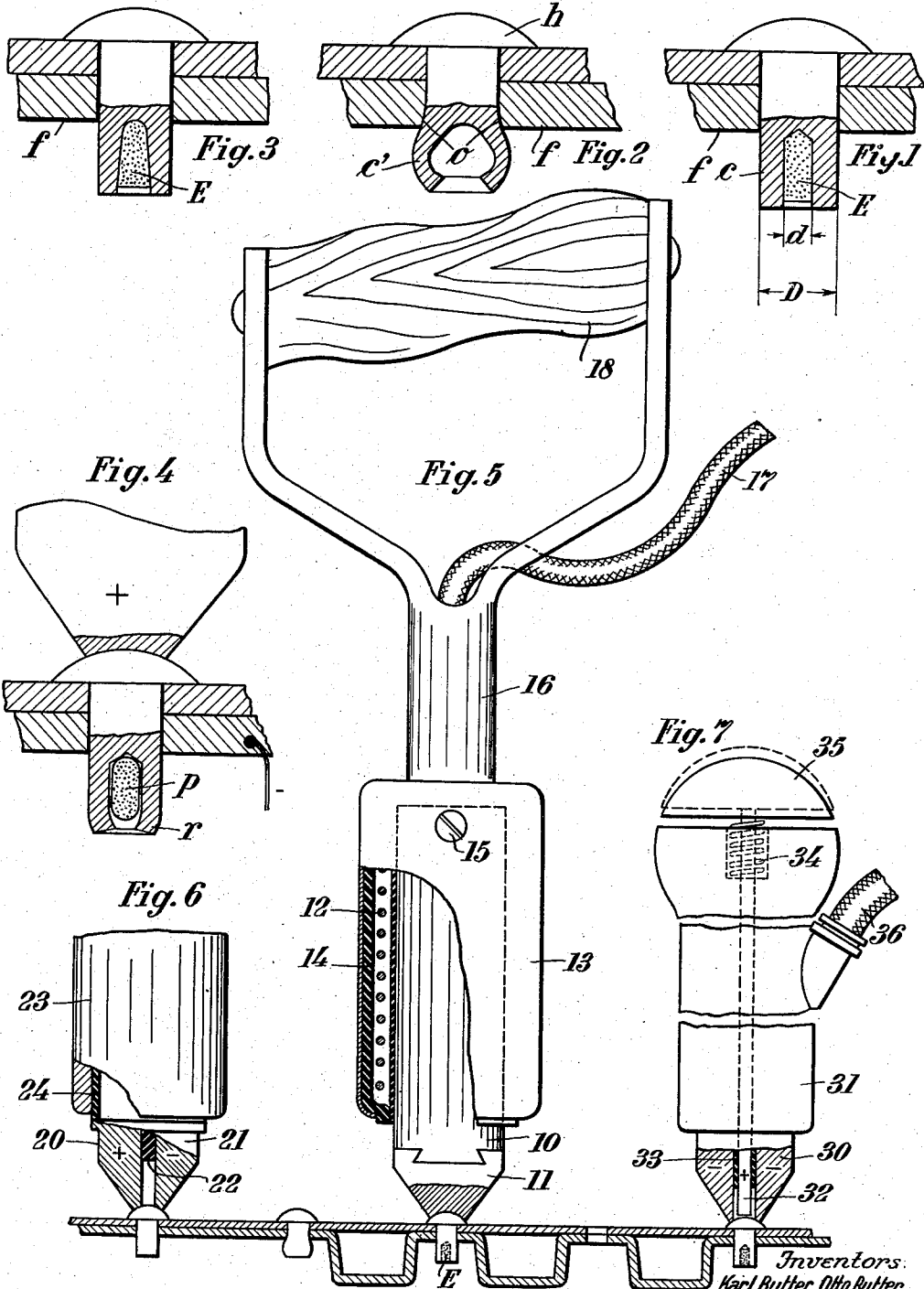
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EXPLOSION RIVET

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EXPLOSION RIVET

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Our invention relates to improvements in rivets of rather unusual design, namely which are adapted to be upset by the detonation and expansion of an explosive charge.

Of rivets of this class, hereinafter briefly called "explosion" rivets a few species are known in the art, in all of which the shanks of the rivets are formed with a chamber enclosing the explosive charge and being hermetically sealed.

Another structural feature characteristic of known rivets of the explosion type consists therein, that they are provided with and carry enclosed within them means for detonating the explosive charge, namely a sensitive cap cooperatively associated with a firing pin or a time fuse.

As a matter of fact explosion-rivets presenting the said structural features and consisting of so many parts indicated above are very costly fastening means and are therefore not fit for general application on a large scale.

One of the principal objects of our invention is to provide improved rivets of the explosion type, which are designed in such manner, that they can be made even by unskilled labour as articles of mass production and at much lower cost than those known heretofore.

A special feature of the improved rivets concerned consists therein, that they are simplified in their design to such an extent, that they may be made in all sizes—including the very smallest sizes, measuring a small fraction of an inch in diameter, and of all those metals used for ordinary rivets, including the softer metals such as copper, aluminium and alloys thereof.

In connection therewith the invention aims at avoiding serious drawbacks, found in the course of our experiments to be inherent to rivets of the explosive type and of known design, and which will be understood from the following facts: It sometimes occurs, that the explosive charge on detonating instead of uniformly expanding the shank of the rivet so as to give it a bulged shape resembling a barrel, simply tears off the extreme end portion or point of the shank, or will blow a hole squarely into the body of the shank, through which the gaseous products of the explosion escape: As a matter of course rivets deformed in this unexpected manner do not securely hold together the structures, metal plates etc. to be joined by riveting, but are apt to be loosened and to be dropped off altogether.

We attribute these drawbacks

(1) To irregularities occurring in the manufacture of the explosion rivets concerned, wherein for instance the drill for boring the chamber con-

taining the explosive agent may become slightly displaced eccentrically by accident instead of retaining its strictly central position.

(2) To the irrational character and distribution of internal stresses imparted into the rivets concerned during the manufacturing operations, and last but not least

(3) To the labouriousness and difficulties occurring in correctly determining, proportioning and dispensing the respective quantities of the explosive agent required for properly bulging rivets of different sizes and of different metals in the closing operation; more so, since usually extremely small quantities of the explosives concerned are needed, amounting to a few milligrams only for rivets of the smaller sizes and of softer metals as widely used nowadays, for instance in the construction of aircraft, flying machines, Zeppelin air ships, sea planes etc.

Another noteworthy feature of the invention consists in the design of the rivet so that it may be exploded by heat and used in places difficult of access, and may be safely handled and used by unskilled labor.

A further important feature of rivets designed according to this invention lies in the fact, that the explosive charge can be easily and speedily fixed within the shank of the rivets even by untrained hands just before they are used, thereby avoiding the risks involved in storing and transporting large quantities of rivets in loaded condition.

The nature and scope of this invention is briefly outlined in the appended claims and will be more fully understood from the following specification taken together with the accompanying drawing, in which

Fig. 1 shows an explosion-rivet designed according to this invention, partly in section,

Fig. 2 shows, how the rivet shown in Fig. 1 is expanded and deformed by the detonation of the explosive charge,

Figs. 3-4 show structurally modified rivets designed according to this invention,

Fig. 5 is an elevation, partly in section, showing a heating device for detonating the explosive charge, designed according to this invention,

Figs. 6 and 7 show structurally modified heating devices.

The innermost end of the recess in the rivet shown in Fig. 1 is of conical shape while in the slightly modified form shown in Fig. 3 the innermost end of the recess is hemispherical in shape.

With the objects in view outlined above explosion-rivets designed according to this inven-

tion are provided with a shank, the lower section *c* of which is of tubular shape, viz. being formed with a hole or recess, which extends from the point end of the shank thereinto and contains the explosive charge.

Good results have been obtained with rivets, in which lead azide ($\text{Pb}(\text{N}_3)_2$) was used as explosive agent, and which were so proportioned in length and width, that the tubular section *c* projected over the lower face *f* of the metal plates or other structures to be joined for a distance about equal to the diameter *D* of the rivet shank; and in which the ratio of the diameter *D* of the rivet shank to the diameter *d* of said recess was about 8:3 (Fig. 1).

The explosive agent *E* is put in pulverulent form into said recess to its full capacity and finally compressed so as to be in intimate contact with the inner walls of the recess.

Rivets so proportioned and loaded as indicated above presented in upset condition—after the detonation of the explosive charge *E*—the cross sectional shape shown in Fig. 2. It will be noted in Fig. 2, that the expanded section *c'* of the rivet has been expanded against and is in forceful contact at *o* with the walls of the rivet hole, thus effecting a tight joint and a wedge like grip, which tends to press the plates to be joined against the rivet head *h*.

We have found in the course of our research work and extensive experiments, that lead azide ($\text{Pb}(\text{N}_3)_2$), an explosive substance known heretofore as a combustion initiator and mostly used in preference to fulminating mercury, is a suitable explosive agent for the purposes of this invention, because of not being so sensitive to blows and percussion as fulminating mercury, but being sensitive to heat.

Explosion-rivets designed according to this invention and being charged with lead azide or a kindred explosive agent are adapted to be exploded in a very rapid manner for instance by applying heat to the head *h* of the rivet from a convenient source of heat.

A heating device which has been proved useful in practice for exploding explosion-rivets, designed according to this invention, is shown by way of an example in Fig. 5 and comprises:

(1) a member 10 formed with a pointed head 11; the latter is preferably made of a metal highly resistive to corrosion in heated condition such as silver and is detachably fixed by a dove-tail joint,

(2) a heat producing electric resistance-coil 12 surrounding said member,

(3) a casing 13 lined with insulating material 14, within which the said member 10 is detachably fixed by means of a clamping screw 15, and

(4) a tubular forked shaft 16 carrying an electric cable 17, which cooperatively connects said resistance coil 12 with an electric circuit, and being provided with a handle 18.

As seen in Fig. 5 the operation of the heating device is as follows: The member 10 of the device, which is formed at its pointed head 11 with a recess substantially matching the upper face of the rivet heads, is pressed in heated condition against the latter by the operator, whereupon the heat flowing by conduction to the explosive charge *E* causes its detonation. In practice an electric heating device of the type shown in Fig. 5 and consuming about 300 watts has given satisfactory results in exploding speedily explosion-rivets of the smaller sizes as shown in full scale in Figs. 5-7.

As a rule the detonation of the explosive charge will follow almost instantaneously, after the heating device has been placed upon the rivet head.

With regard to the promptness of the explosion following the administration of heat to the rivet particularly good results were obtained in the course of our experiments on using as explosive agent lead azide mixed, coated or otherwise closely associated with an organic superoxide or another combustion initiator sensitive to heat of the tetracene group.

By mixing lead azide with about one third of $\text{C}_2\text{H}_5\text{ON}_3$ —namely a combustion initiator known in the art as "guanylnitrosaminoguanilyltetracene" the explosive charge will detonate at temperatures ranging as low as 100-150 centigrades and within a period ranging from one second to three seconds after the administration of heat to the head of the rivet, depending on the conductivity for heat of the respective metals from which the rivets are made.

Various other changes and modifications may be conveniently made in the selection of an appropriate explosive agent from the great number of propellants and detonators available, in the structural details of explosion rivets of the improved design described above, and in the means for detonating the explosive charge, without substantially deviating from the spirit and the salient ideas of this invention.

The invention lends itself to the application of explosive agents, which react upon other forms of energy applied, from without, besides heat: For instance radiant electric energy liberated through electric discharges in the form of sparks may be used to advantage for closing rivets designed according to this invention, more so since the explosive charge of the rivets is exposed to and can be reached by electric and other waves entering through the open end of the recess of the rivets.

Another form of radiant energy available for the purposes of this invention are high frequency or ultra-short sound waves having about 200,000 cycles per second.

In using other forms of energy than heat for exploding the explosive rivets concerned the detrimental influence, which heat may occasionally have upon the strength of rivets made of light metals, aluminium and alloys thereof, and the structures to be joined may be eliminated.

In using heat as detonating energy the promptness of the detonation may be further enhanced, and at the same time twisting, buckling and other undesirable deformations of delicate structures to be joined by the explosion rivets concerned, which may occur through the administration of heat, be avoided by coating the rivet shank and the lower face of the rivet head with a thin layer of insulating material—not shown—preferably applied thereto in liquid condition, such as a solution of shellac or like resinous matter. Similarly the said solution may be spread to advantage around and into the rivet holes.

In special cases, where for instance on account of safety regulations imposed by the police or insurance companies the storage of a large number of explosion rivets in loaded condition is not permitted, the explosive charge may be inserted into the recess of the rivets shortly before they are used, namely either in pulverulent condition, as referred to above with reference to Figs. 1 and 3, or in the form of a pill or lump *p*, which may be conveniently retained by slightly con-

tracting the extreme end portion of the rivet shank as indicated at *r* in Fig. 4.

We have found, that it is preferable not to cover up at all the explosive charge of the rivet—
5 as by a stopper or lid of felt, impregnated card board etc., nor even by a coat of wax, pitch, shellac etc.,—in order not to obstruct the passage for the expanding gases produced by the detonation, but to allow them to freely escape.

10 In the event of an explosion of even a large number of rivets designed and loaded according to this invention occurring by accident, which are closely assembled in a heap, little danger would arise, since the rivets are not apt to be blown to
15 pieces.

With regard to the employment of lead azide as explosive agent another valuable feature consists therein, that humidity will not appreciably impair the power and promptness of its detonation, especially where the charge is in compressed
20 condition.

Still another valuable feature consists therein, that the quantity of lead azide to be charged into the rivets may be varied within relatively wide
25 limits.

While with explosion-rivets of the old type having a sealed chamber, in which the gaseous products of the explosion are imprisoned, even an excess of 5% to the exact quantity of the explosive agent required for properly bulging the rivet
30 shafts may be fatal and cause their destruction, with rivets designed according to this invention the presence of an excessive quantity of explosive agent will not matter—since the explosion
35 gases are free to escape.

Instead of electrically heating the rivet head alone, as seen in Figs. 6-7, the rivet shank may be conveniently included in the heating operation as indicated in Fig. 4, which is otherwise self
40 explanatory.

It will be understood that, "mutatis mutandis" the invention is equally applicable to rivets having shafts of conical or other shape differing from the cylindrical one, also to bolts and like fasten-
45 ing means, which although acting like rivets are not rivets in the strict sense of this term.

Another heating device designed for exploding rivets according to this invention is shown in Fig. 6 and comprises: Two electrodes 20, 21, spaced from each other by a layer of insulating material 22, a casing 23 lined with insulating
5 material 24, within which said electrodes are fixed, and a handle and an electric cable (both not shown) cooperatively associated with said casing and electrodes.

The heating device shown in Fig. 7 comprises: 10

A tubular electrode 30 having a central channel and being secured within a casing 31,

A pin shaped electrode 32 slidably fixed within its mate by means of a tube of insulating material 33 and being resiliently supported from casing
15 31 by a spring 34,

A knob 35 attached to said pin shaped electrode for operating the latter, and a cable 36 connecting said electrodes with an electric circuit.

As to the operation of said heating devices, 20 afore described, figures 6 and 7 are self explanatory.

What we claim is:

1. In a rivet the combination with a shank, of a recess longitudinally extending into the
25 shank, of an explosive charge within said recess, the latter being open at one end and allowing the explosive gases to escape into the air.

2. A rivet having the features outlined in claim 1, the innermost portion of said recess present-
30 ing a hemispherical vault.

3. A rivet having the features outlined in claim 1, the innermost portion of said recess terminating substantially on line with the lower face of the structures to be joined. 35

4. A rivet having the features outlined in claim 1, the recessed section of the rivet shank projecting over the lower face of the structures to be joined by riveting for a distance about equal to the diameter of the shank. 40

5. A rivet having the features outlined in claim 1, the explosive charge of which being sensitive to moderate heat so as to be detonated by heat applied to the rivet from without.

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