

[54] **FRAGMENTATION WRAP FOR EXPLOSIVE WEAPONS**

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Related U.S. Application Data

[62] Division of Ser. No. 145,695, May 21, 1971.

[52] U.S. Cl. **102/67, 102/64**

[51] Int. Cl. **F42b 13/48**

[58] Field of Search **102/64, 67**

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Primary Examiner—Benjamin A. Borchelt

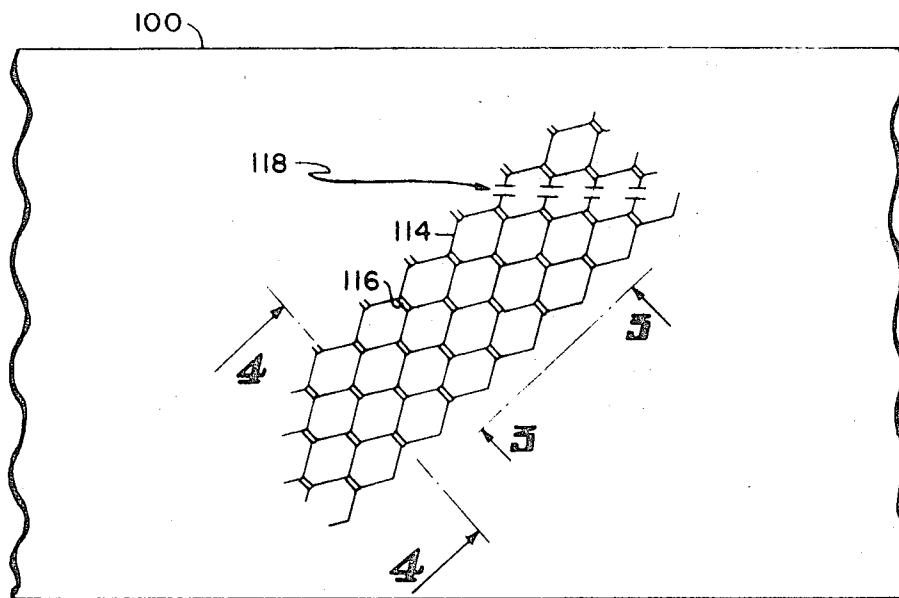
Assistant Examiner—H. J. Tudor

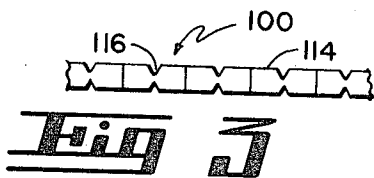
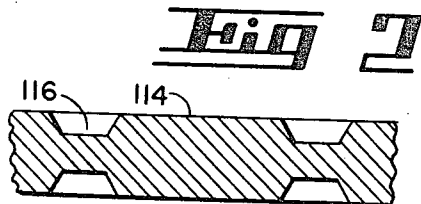
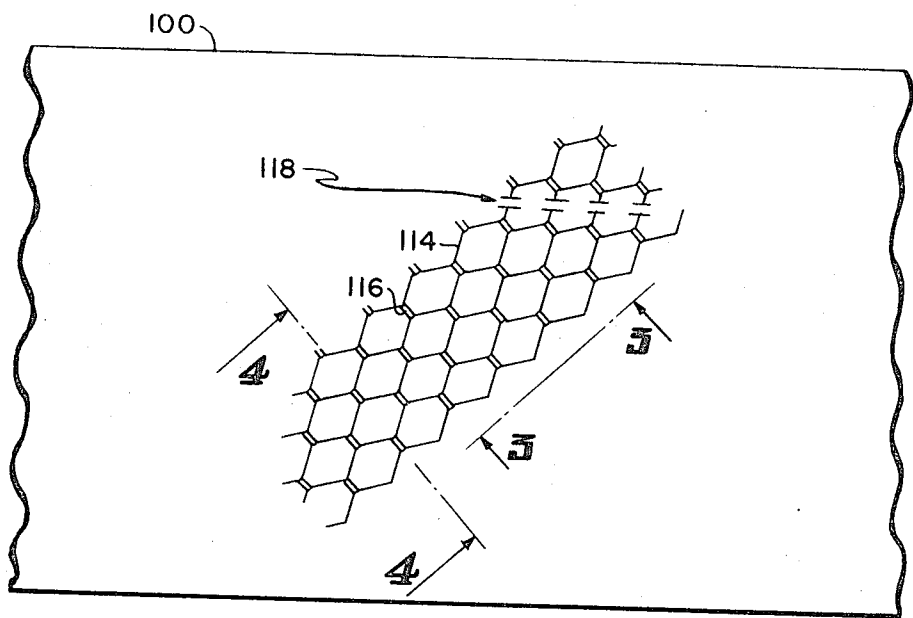
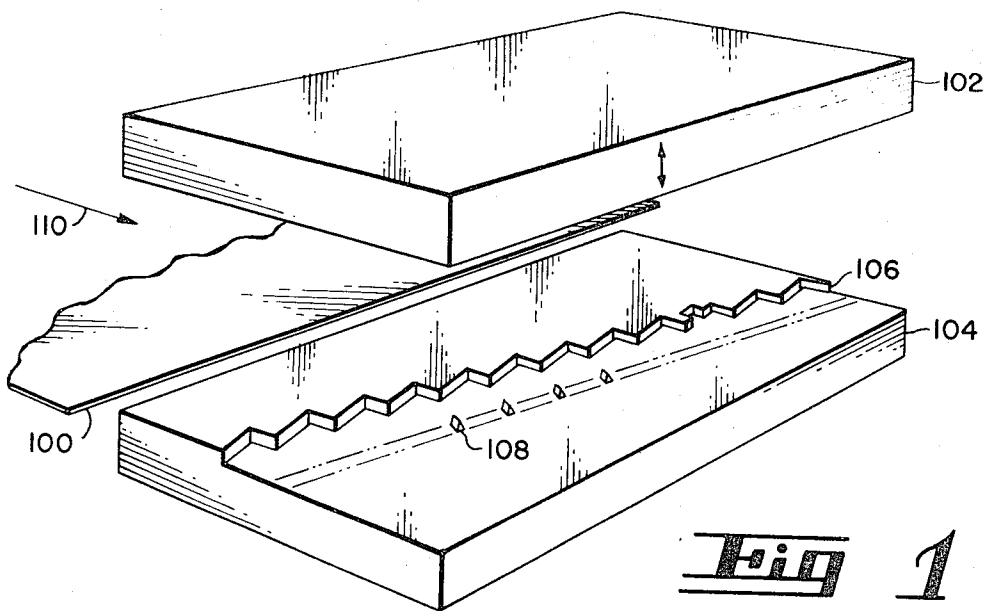
Attorney—Charles M. Hogan and Eugene C. Goodale

[57] ABSTRACT

A fragmentation wrap for explosive weapons is disclosed. The fragmentation sheet for explosive weapons having a predefined fragmentation shape therein is fabricated by the progressive flattening, shearing and/or indenting of hot or cold rolled steel. The complete fragmentation wrap may be a single layer or multi-layer wrap which is conformed to enclose a bomb or the like.

4 Claims, 21 Drawing Figures





6 Sheets-Sheet 2

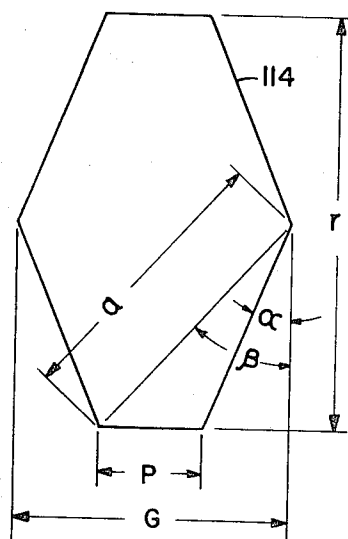


Fig 5

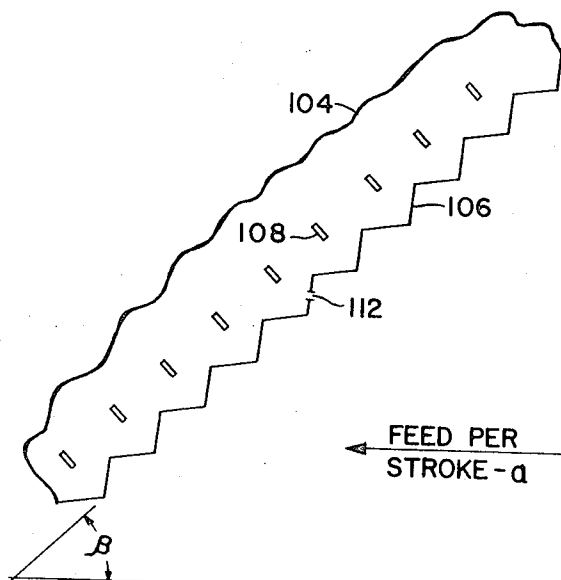


Fig 6

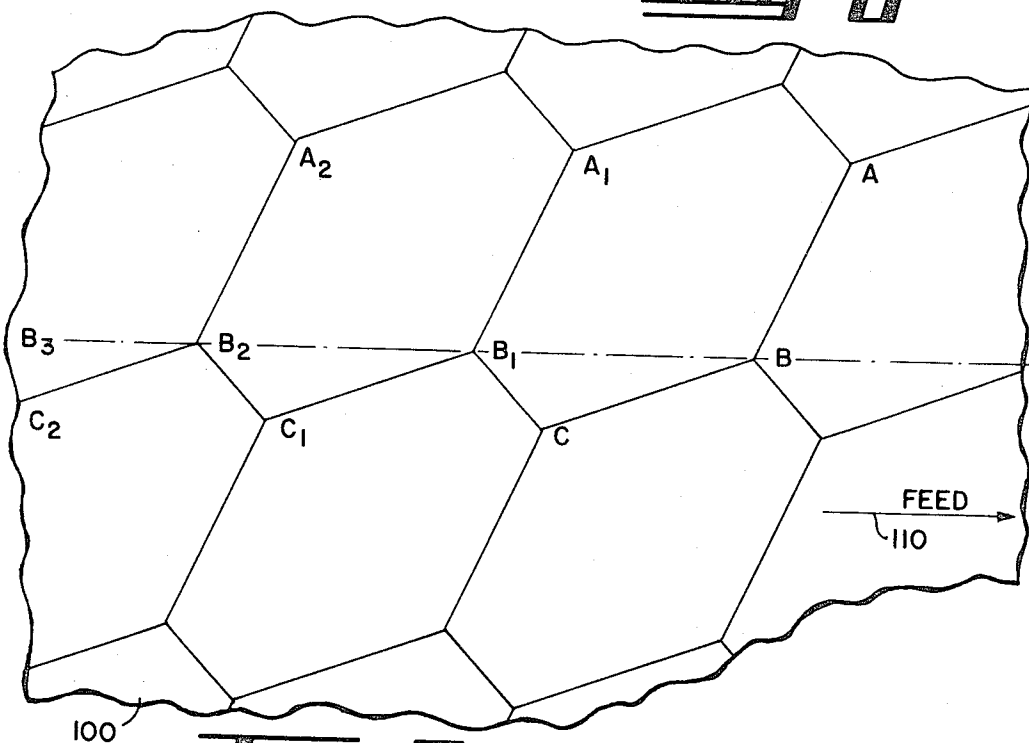


Fig 7

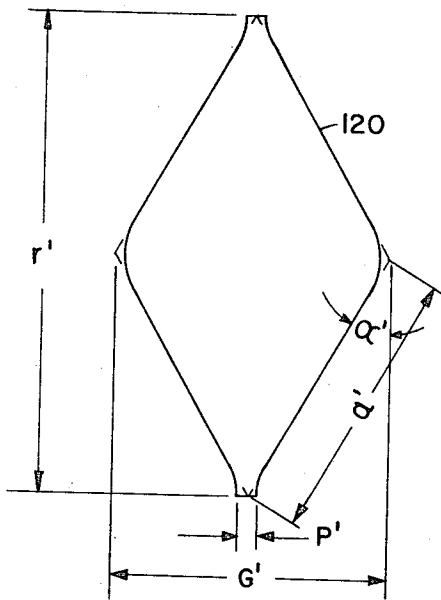


Fig 8

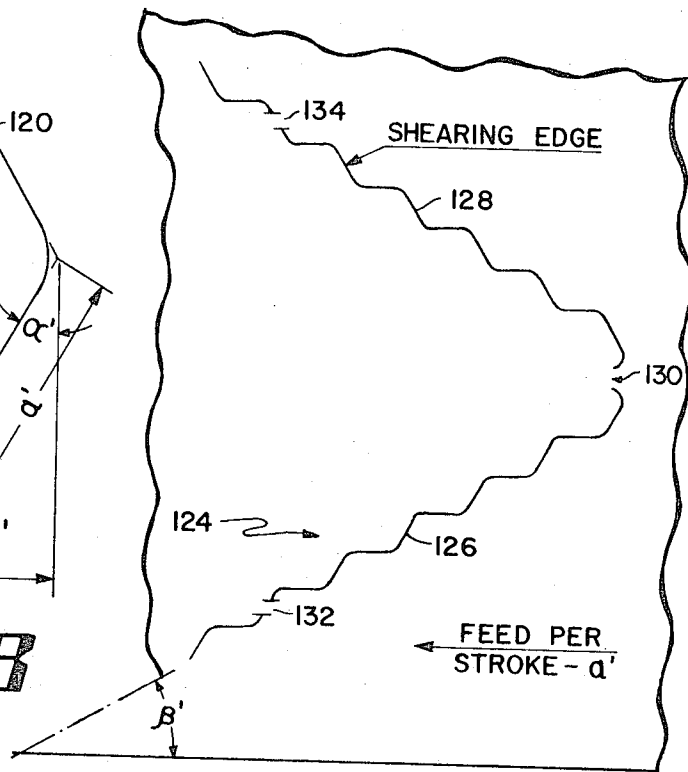


Fig 9

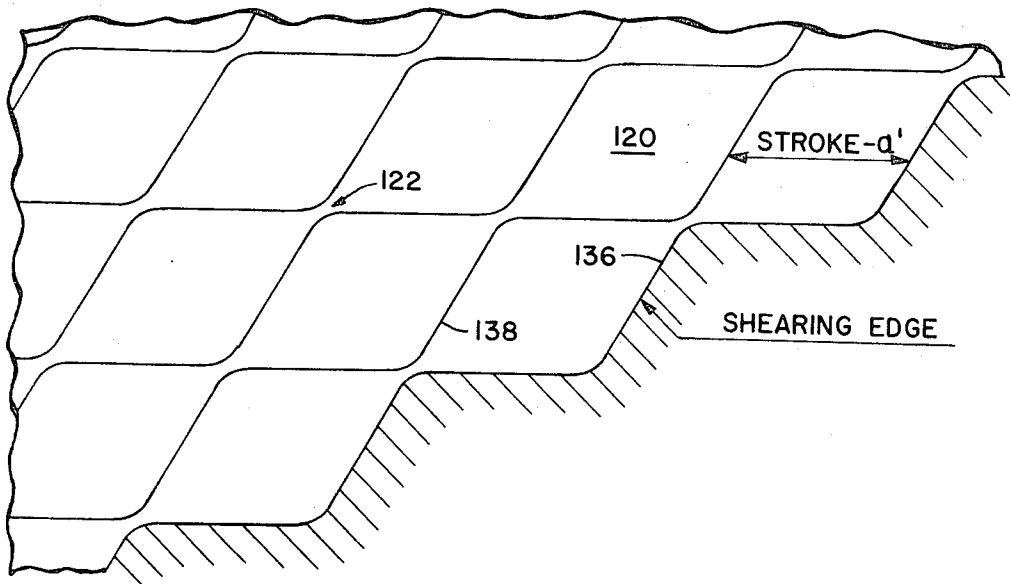
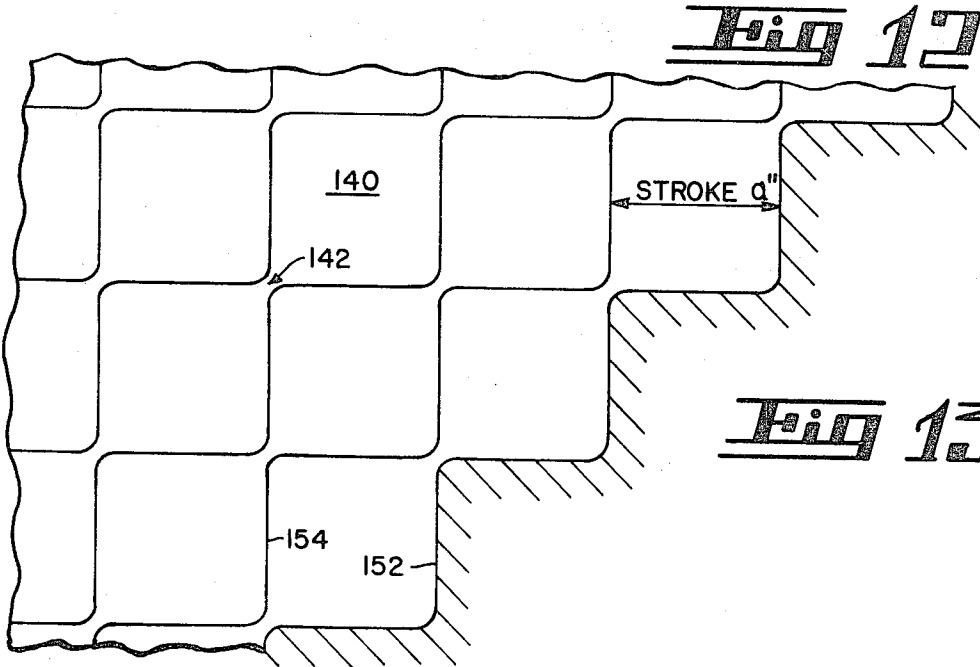
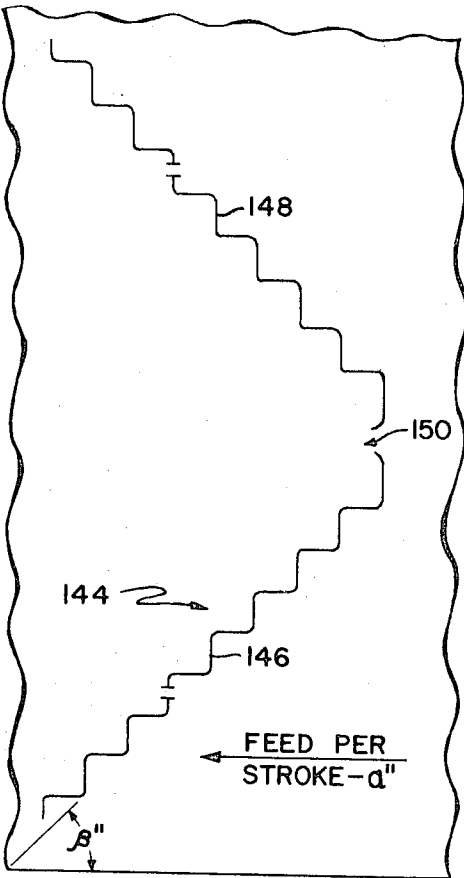
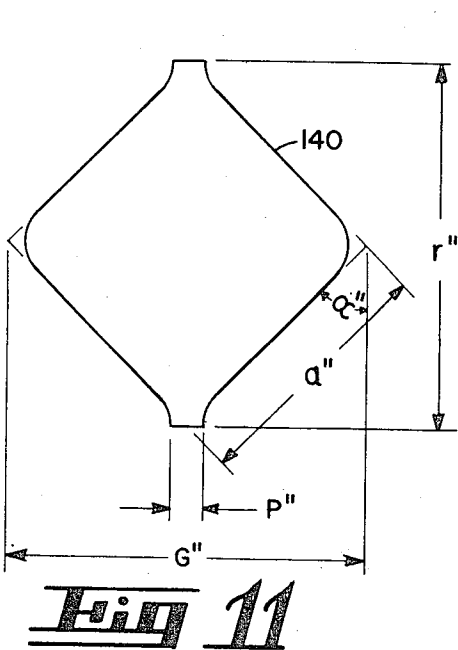
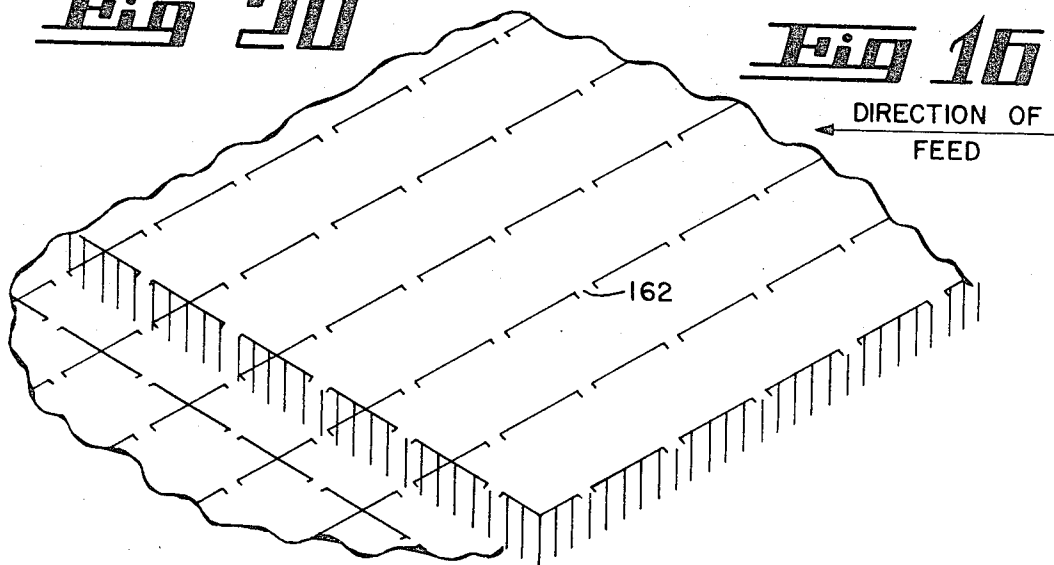
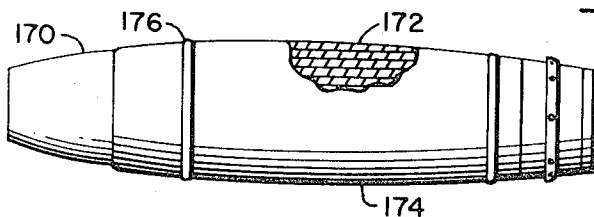
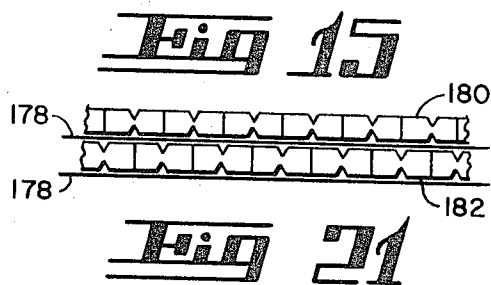
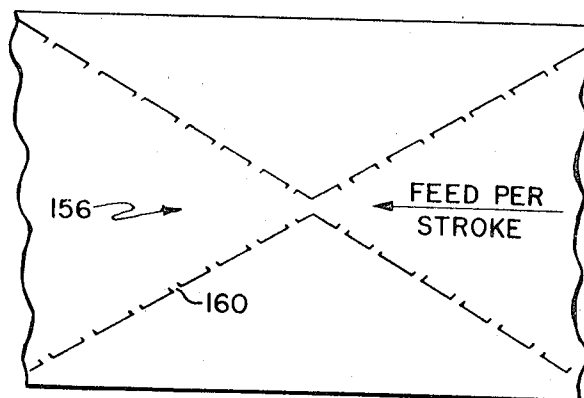
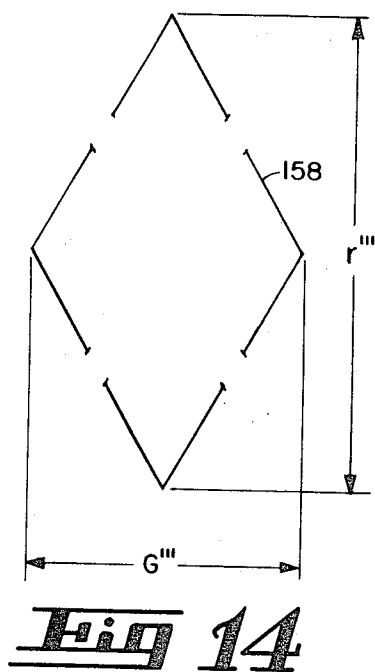


Fig 10





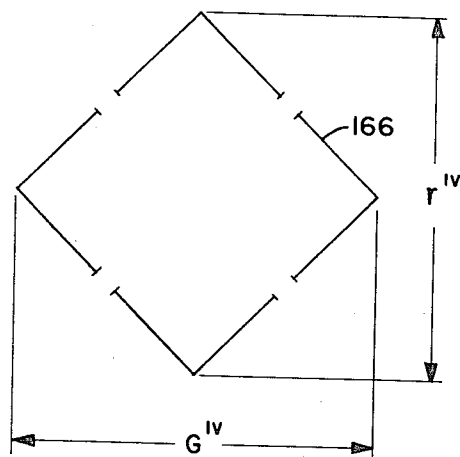


Fig 17

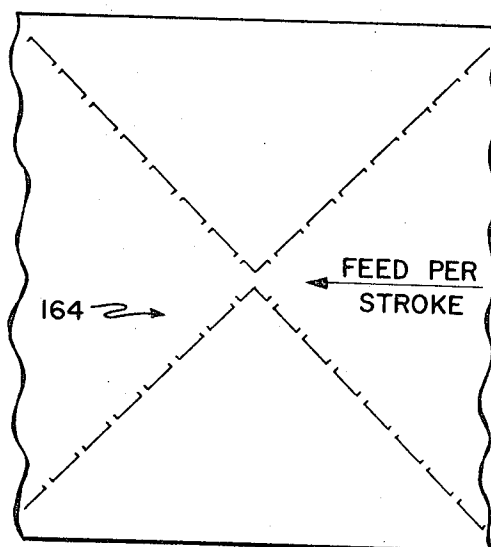


Fig 18

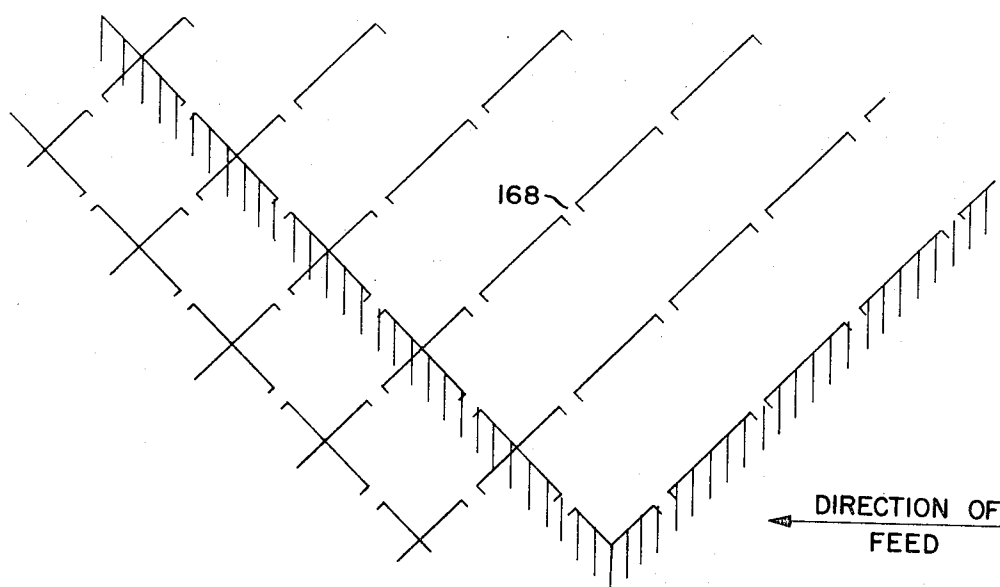


Fig 19

FRAGMENTATION WRAP FOR EXPLOSIVE WEAPONS

This application is a division of Ser. No. 145,695, filed May 21, 1971.

The invention herein described was made in the course of or under a contract with the Department of Defense.

BACKGROUND OF THE INVENTION

The present invention relates generally to explosive weapons of the fragmentation type and more particularly to new controlled fragmentation wraps for projectiles and missiles in which the fragmentation wrap may be mass produced having predefined fragmentation shapes.

Various methods have been used heretofore to produce fragments of varying size and shape when a fragmentation-type weapon is exploded. None of the previous methods are entirely satisfactory for producing fragmentation wraps of a sufficient size to encompass large bombs, missiles and the like. One well-known method of fabricating controlled fragmentation warheads is by the process of casting the warheads in a casting form having a groove pattern. Due to the time intervals involved in the casting operation and the required size of wraps needed for the large bombs, this method is impractical for mass production purposes since it requires numerous casting forms in order to compensate for the time losses in each casting form and a prohibitively large manufacturing plant to install the numerous casting forms required. Moreover, experience has shown that cast-produced warheads are unsatisfactory due to erratic fragmentation and due to pulverization into useless chaff a substantial portion of the warhead.

Another less than satisfactory procedure which has been suggested is the use of presized fragments held in place by thin sheets of metal and adapted to be disbursed upon the detonation of the explosive charge associated therewith.

A still further less-than-satisfactory method consists of sawing notches or grooves in stock bars, forming the bars into rings and welding the ends thereof together. Surface grinding the two faces of the rings to make them flat and parallel, supercoincidentally stacking the rings in a suitable jig, and copper brazing, in a hydrogen furnace, the side faces of adjacent rings to form a hollow tube for encasing an explosive charge. These methods are inherently complex, time-consuming, and impractical for mass production of fragmentation wraps of large dimensions.

A further object of this invention is to provide a fragmentation wrap having predetermined fragment shapes, the fragmentation wrap being of such a dimension that it may be utilized in conjunction with large explosive weapons.

SUMMARY OF THE INVENTION

This invention provides for new and improved fragmentation wraps for explosive weapons. The fragmentation wrap of this invention is fabricated by the feeding of a hot or cold rolled steel sheet progressively through shearing dies. The die makes repeated shearing cuts and/or indentations in the sheet at a predetermined angle from the normal of the sheet direction. This action simultaneously flattens the sheet. Each

shearing cut is displaced by a predetermined linear feed. The repeated shearing cuts and/or indentations combine to define and provide the desired fragmentation shape. The fragmentation sheet so fabricated may be used in a single layer wrap for the explosive weapon or a plurality of sheets in sandwich form may be utilized.

Other details, uses, and advantages of this invention will become apparent as the following description of the exemplary embodiment hereof presented in the accompanying drawings proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings show present exemplary embodiments of this invention in which:

FIG. 1 is a diagrammatic perspective view illustrating the manner of fabricating a progressive shear pattern in a sheet in accordance with the preferred concept of this invention;

FIG. 2 is a plan view of a portion of a fragmentation wrap sheet made in accordance with the present invention;

FIG. 3 is an elevation view taken along lines 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken on the line 4—4 of FIG. 2;

FIG. 5 is a diagrammatic representation of a desired fragment shape generally shown in FIG. 2;

FIG. 6 is a diagrammatic plan view of the die illustrated in FIG. 1;

FIG. 7 is a diagrammatic partial view of the fragmentation pattern of FIG. 2;

FIG. 8 is a diagrammatic representation illustrating another exemplary fragment shape;

FIG. 9 is a diagrammatic plan view illustrating another exemplary die to form the fragment shape of FIG. 8;

FIG. 10 is a diagrammatic partial view of the fragment pattern formed by the die of FIG. 9;

FIG. 11 is a diagrammatic representation illustrating a further exemplary fragment shape;

FIG. 12 is a diagrammatic plan view of a die used to form the fragment shape of FIG. 11;

FIG. 13 is a diagrammatic partial view of the fragment pattern formed by the die of FIG. 12;

FIG. 14 is a diagrammatic representation illustrating a still further exemplary fragment shape;

FIG. 15 is a diagrammatic plan view of a die used to produce the fragment shape of FIG. 14;

FIG. 16 is a diagrammatic partial view of a fragment pattern formed by the die of FIG. 15;

FIG. 17 is a diagrammatic representation illustrating another exemplary fragment shape;

FIG. 18 is a diagrammatic plan view of a die used to produce the fragment shape of FIG. 17;

FIG. 19 is a diagrammatic partial view of a fragment pattern formed by the die of FIG. 18;

FIG. 20 is an elevation view of a typical bomb incorporating the fragmentation wrap of this invention; and

FIG. 21 is a partial elevation view of a multi-layer fragmentation wrap.

DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Referring now to FIG. 1 in describing the method of the invention, a planar sheet of hot or cold rolled steel 100, or of any metallic material or alloy suitable for

such purposes, is passed axially in the direction of arrow 110 between opposing dies 102 and 104. The dies are constructed to have a cooperating shear edge 106. In the first embodiment of this invention, the dies also have indented die elements 108 displaced from the shearing edge 106. The dies 102 and 104 may both be movable in a vertical direction. In the illustrated embodiment shown, die 104 is stationary. The die 102 is then vertically driven towards the stationary die 104 by a suitable press (not shown). The dies 102 and 104 will cooperatively engage the sheet 100 to perform the desired flattening, shearing and/or indenting functions described hereinbelow. Means are provided to move the sheet 100 through the die at a predetermined linear feed or rate.

The means for feeding the sheet and press, which are not shown, may be driven by any suitable motive power means and may be interconnectingly geared and synchronized so that the sheet is fed a predetermined incremental distance during each press stroke. At the end of each stroke, the dies perform the flattening, shearing and/or indenting whereupon the sheet is again moved the prescribed distance for the subsequent action of the dies. Each action of the dies provides a partial fragment pattern on the sheet. Each pattern is placed at an angle to the axial feed of the sheet. As the sheet is incrementally fed through the dies at the predetermined feed per stroke, additional partial patterns are formed sequentially on the sheet. The sequential partial patterns combine to provide the desired fragment effect.

One desired fragment shape is generally shown in FIG. 5. The pattern shape is fully defined by its symmetry and the dimensions P , G and r . From these dimensions, the following relationships exist:

$$\text{arc tan } \alpha = (G - P)/r$$

$$\text{arc tan } \beta = (P + G)/r$$

$$2a = \sqrt{r^2 + (P + G)^2}$$

FIG. 7 illustrates how the individual fragments of FIG. 5 may be arranged within the sheet 100 to gain 100 percent material utilization. The arrow 110 indicates the direction of feed of the sheet 100 relative to the dies. It may be observed that the lines AB, BC, and CB₁ are repeated as A₁B₁, B₁C₁ and C₁B₂ by the linear displacement a . A subsequent displacement by the distance a will generate lines A₂B₂, B₂C₂, and C₂B₃. Referring now to FIG. 6, an exemplary die utilized to provide the fragmentation pattern of FIG. 7 is shown in diagrammatic plan view. The die is provided with a continuous shearing edge 106. As the sheet 100 is passed between the dies at a feed stroke a , the dies will progressively shear the sheet 100 along the lines AB, BC, then A₁B₁, B₁C₁, then A₂B₂, B₂C₂, etc., for each linear displacement of the sheet 100. It is thus seen that the shearing edge 106 will progressively shear the fragmenting pattern into the sheet 100 except that the short sides CB₁, C₁B₂, etc., will not be provided.

The lines CB₁, C₁B₂, etc., may be provided by utilizing a progressive die setup wherein a plurality of indenting dies or punches 108 are linearly displaced from the shearing edge 106 by a distance of at least the stroke or a multiple thereof. Since the sheet 100 will expand along the shearing edge due to the heat generated therein due to the shearing operation, it is necessary that the indenting step take place separate from the shearing step in order to compensate for the die ex-

pansion due to heat rise. It should be noted that the indenting punches 108 may be displaced either behind or ahead of the shearing edge 106. In order to have the fragmentation sheet 100 held together without the necessity of joining each fragment to another, the sides CB₁, C₁B₂, etc., are indented rather than sheared. In this way, the individual fragments are held together by the indented area. An unsheared zone is left at each edge of the sheet 100 in order to insure coherency of the sheets. Furthermore, the shearing edge 106 may be interrupted as at 112 to provide a solid unsheared bar the linear length of the sheet 100 to provide an additional zone for maintaining the individual fragment in place. FIG. 2 shows a plan view of a fragmentation sheet 100 formed with the die described in FIG. 6. The individual fragment shapes or elements 114 are held together by the indented area 116 (FIGS. 3 and 4). A typical zone where shearing is omitted is indicated generally at 118 in FIG. 2. The zone 118 results when the shearing edge 106 (FIG. 6) has an interrupted shearing edge 112.

Another exemplary embodiment of this invention is shown in FIGS. 8 and 10. The fragment element 120 is seen to be a diamond shape. In this embodiment, the indenting step is not needed. The individual fragment elements 120 are held together by a tie connection 122. The fragment sheet of FIG. 10 may be fabricated by using a shearing die 124 (FIG. 9) which has the desired shearing edge 126. The die 124 is seen to comprise a similar shearing edge 128. The use of shearing edges 126 and 128 permits the full width of the fragment sheet to be sheared simultaneously. It is seen that the shearing edges 126 and 128 are separated by a non-shearing area 130. Thus, a zone of non-sheared sheet will effectively join both sides of the finished fragmentation sheet. Additional strength and support for the fragmentation sheet may be provided through the use of additional interruptions 132 and 134 in the shearing edges so as to provide additional linear zones of non-shearing. It should be noted, however, that the die 124 may comprise only a single shearing edge similar to FIG. 6 and still provide the desired fragmentation sheet structure. In FIG. 10, the edge 136 represents a sheared pattern formed by the shearing edge 126 of die 124. The next sheared edge 138 is linearly separated from edge 136 by a distance equal to stroke a' .

Referring now to FIGS. 11 and 13, the fragment element 140 is seen to be square shaped. The fragment elements 140 are joined by the non-sheared connecting tie 142. The die 144 comprises shearing edges 146 and 148 interrupted by a non-shear area 150. In FIG. 13, the sheared edges 152 and 154, formed by shearing edge 146, are separated by a linear distance of stroke a'' . Due to the method of progressively advancing the fragment sheet through the dies, it may be noted that the resulting sheared edges are commonly in a straight line along the outlines of the fragments. This provides for a greater uniformity of dispersal of the fragments.

By utilizing a die 156 in the shape shown in FIG. 15, the fragment shape 158 (FIGS. 14 and 16) is shown. The die 156 has dual shearing edges for the left half and right half of the fragmentation sheet. Each shearing edge has a plurality of interrupted non-shearing portions 160 to provide tie areas 162 between each fragment element 158, in this instance, it is seen that each individual fragment 158 has a tie 162 along each of its geometric edges. The fragment elements 158 are

formed by the progressive cross-shearing of prior sheared edges.

The die 164 of FIG. 18 is similar to that described for the diamond shaped die in FIG. 15. The die 164 provides a fragmentation sheet having individual fragment elements 166 (FIGS. 17 and 19) tied together by tie areas 168.

Although the dies hereinabove described have been illustrated as planar, it may be noted that roll-type dies may also be utilized to provide the necessary shearing and/or indenting to make the necessary fragment elements. In the fragmentation wrap design formed by the method of this invention (FIGS. 16 and 19) each fragment is attached to its neighbor by an unsheared bridge or tie. These bridges can be alternated from top to bottom for each specific shearing edge by the placement of the interrupting non-shearing portions of the shear edge. This produces the sheet uniformly tied together which may eliminate the continuous linear tie bar from end to end of the sheet except at the center where the notching dies or rolls face each other.

In general, the function of the dies are the same and variations in the fragmentation design is incorporated into the die proper. In all cases, the material passes through the dies in repetitive steps or increments of a given feed stroke (in the case of planar dies) or at a proper spacing between shearing edges (for roll dies.)

In the case of "roll dies," the shearing pattern is interrupted as required to provide necessary tie bars between individual fragment elements.

FIG. 20 generally shows a bomb 170 about which a fragment wrap 172 has been placed. The fragmentation wrap 172 is contoured to match the exterior shape of the bomb. An outer aluminum skin or the like 174 (partially cut away) serves in a dual capacity as a structural member and fairing to provide a smooth aerodynamic surface. Suitable means such as steel bands or the like 176 secure the skin and fragmentation wrap to the bomb together with a retention device (not shown).

The fragmentation wrap 172 may be a single layer (FIG. 3) or a multi-layer, as the designs dictate. FIG. 21 shows an elevation view of a typical multi-layer fragmentation wrap. To avoid welding of the individual fragments to one another due to the energy generated by the explosion, a layer of kraft paper or the like 178 is cemented inside each of the fragmentation layers 180 and 182. This paper may also be used to identify the side of the sheet for correct forming.

It can be seen from the foregoing description, that this invention provides a novel method for producing

fragmentation wraps through the progressive shearing of partial fragment patterns repetitively on a sheet of material. The partial patterns are formed so as to combine to provide the desired fragment shapes. Indenting dies may be used together with the shearing dies for some designs. Accordingly, the objectives of this invention hereinabove set forth have been accomplished.

While present exemplary embodiments of this invention have been illustrated and described, it will be recognized that the method of this invention and fragmentation wrap thereby formed may be otherwise variously embodied and practiced by those skilled in the art.

What is claimed is:

1. A fragmentation wrap for wrapping around the exterior of explosive devices such as bombs, missiles and the like comprising a continuous planar sheet of metal having individually shaped fragment elements formed therein, a plurality of substantially linear shear lines repetitively formed in said sheet in slanted relation to the sides of said sheet, said shear lines being linearly displaced along the length of said sheet an incremental distance according to the fragment design, said substantially linear shear lines defining a partial perimeter of a geometric shape wherein adjacent repetitive shear lines combine to define the individual fragment elements of a given geometric shape, said fragment elements being connected together by unsheared portions of the perimeter.

2. The fragmentation wrap according to claim 1 in which the shear lines are partially discontinuous wherein additional non-sheared links connect the individual fragment elements linearly along the length of the fragmentation wrap.

3. The fragmentation wrap according to claim 2 in which said fragmentation wrap is conformed about the exterior surface of an explosive device, and further comprising a thin skin covering the outside surface of said fragmentation wrap to provide a smooth external aerodynamic surface, said skin serving as a structural part and as a fairing for said explosive device; and a pair of bands secured around said skin and fragmentation wrap at a front and rear thereof to hold said wrap and skin against the explosive device.

4. A fragmentation wrap according to claim 1 further comprising a second planar sheet having sheared fragment elements formed therein; and means interposed between said sheets to prevent welding of fragment elements together due to the energy generated during explosion of the explosive device.

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