United States Patent

[11] 3,611,932

[72] Inventor **Irvin G. Clator**
Dahlgren, Va.

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[73] Assignee **The United States of America as represented by the Secretary of the Navy**

[54] **SHAPED WAVE GENERATOR**
8 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **102/22,** 102/DIG. 2
[51] **Int. Cl.** **F42b 1/00**
[50] **Field of Search** ..... 102/22–24, DIG. 2

[56] **References Cited**

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2,604,042	7/1952	Cook	102/DIG. 2
2,628,559	2/1953	Jasse	102/DIG. 2
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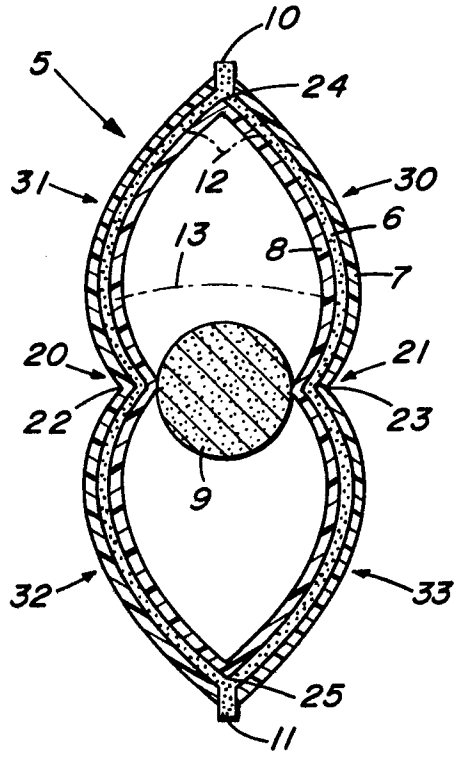
Primary Examiner—Verlin R. Pendegrass
Attorneys—Edgar J. Brower, Arthur L. Branning and T. O. Watson, Jr.

ABSTRACT: A layer of explosive having its shape correlated to its explosive force and detonation rate to form, upon initiation, a shock wave of the desired shape. A layer of fragmenting material may be provided to initiate, by impact, the entire surface of a charge having the same shape as the shock wave, and a backing layer may be provided to direct the explosive force in the desired direction.



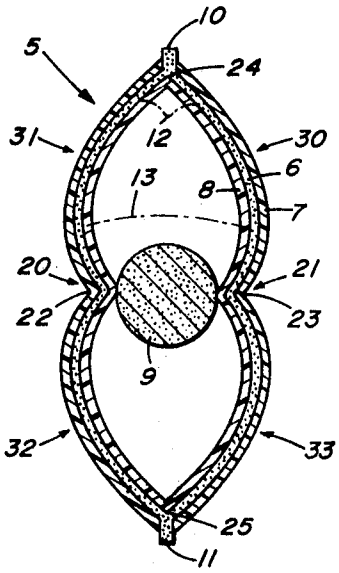


FIG. 1

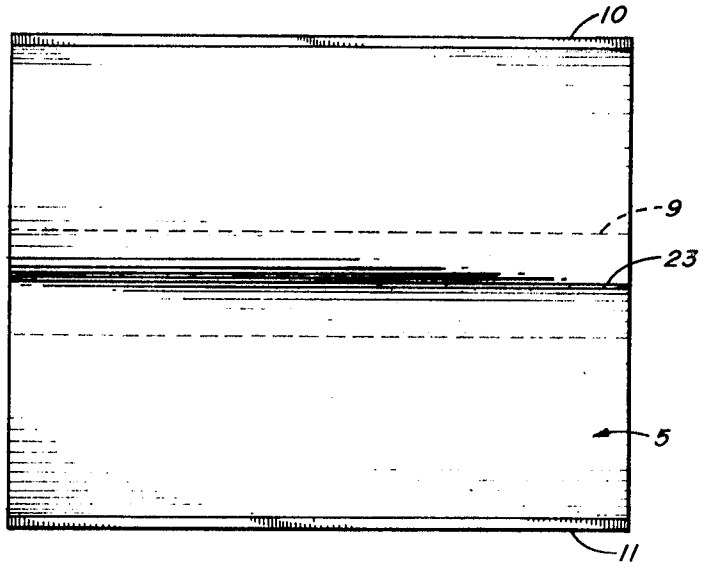


FIG. 2

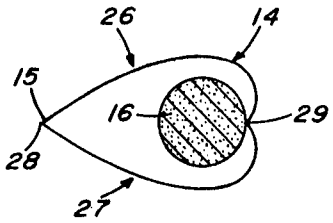


FIG. 3

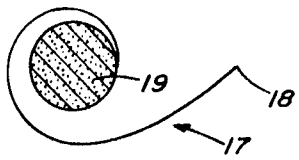


FIG. 4

INVENTOR
IRVIN G. CLATOR

BY Thomas O. Watson Jr.
ATTORNEY

SHAPED WAVE GENERATOR

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The present invention relates to a new explosive device wherein the natural shock wave conforms to a predetermined shape. More particularly, the present invention relates to an explosive device wherein a detonation front is propagated through a layer of explosive to generate a shock wave which arrives at a surface of the desired shape.

A shock wave having a predetermined shape is useful in many environments. In many industrial applications of explosives improved results are obtainable when the explosive charge is initiated simultaneously in a plurality of points along its surface. For example, when a linear or wedge-shaped charge such as that described in U.S. Pat. No. 2,605,704, for slotting pipe and the like, is initiated at a plurality of points in a straight line along its surface rather than at one point, increased uniformity of penetration is obtained. Also, in a method of joining metal elements explosively as described in U.S. Pat. No. 2,367,206, localized initiation of the explosive charge surrounding the metal sleeve in the assembly sometimes results in damage to the juncture, while such damage does not occur when a sleevelike charge is initiated at a plurality of points defining a circle around one end of the charge. A shaped shock wave can be used to ignite the entire surface of an explosive charge, of the type detonatable by a shock wave, at one time.

The use of a series of individual initiators, such as blasting caps, to effect the simultaneous initiation at a number of points along a straight or curved line is not always feasible because the eccentricities of individual initiators, although slight enough to be generally ignored, preclude the accomplishing of the desired truly simultaneous initiation. Moreover, the mechanical assembly of a large number of the initiators adjacent to the surface of the high explosive to be initiated is extremely difficult, if not impossible, due to space requirements. The shattering action of the individual initiators also may prohibit the use of a large number of the initiators in close proximity because of their destructive effects.

A device which generates a shock wave, all points of which will arrive simultaneously at a shaped surface, is useful in applications other than the detonation of explosives. For example, U.S. Pat. No. 2,604,042 describes a method whereby a metal surface is embossed by means of a plane detonation front. Moreover, the use of such a surface wave generator is exceedingly valuable in basic investigation of explosive phenomena. For example, in a fundamental study of the subjection of objects to explosive superpressures, i.e., the exceedingly high pressures of short duration generated by a high explosive, a determination of the effect of a shaped detonation front is of interest.

Prior art devices such as the one disclosed in U.S. Pat. No. 3,035,518 employed explosive trains (paths containing explosives) to guide a plurality of detonation fronts so that they arrive simultaneously at various points along a desired boundary. Devices such as this are useful. However, they necessitate a complex framework of explosive trains, particularly where a curved or spherical shock wave is to be formed. Furthermore, all points on the surface of an explosive charge cannot truly be initiated simultaneously. Only those portions that are immediately adjacent the end of an explosive train are ignited simultaneously.

OBJECTS OF THE INVENTION

An object of the present invention is the provision of a shock wave generator which generates a shock wave of a desired shape.

Another object is to provide a device which will initiate the entire surface of a shaped explosive charge at one time.

A further object of the invention is the provision of a device which will produce a closed-converging shock wave.

In order to achieve these objects and to overcome the above-described disadvantages of the prior art, applicant has provided a shell containing explosive material, the shell being shaped such that upon initiation of said explosive material at one or more portions, propagation of the detonation front will generate a shock wave of the desired shape.

BRIEF DESCRIPTION OF THE DRAWINGS

With these and other objects in view, as will hereinafter more fully appear and which will be more particularly pointed out in the appended claims, reference is now made to the following description taken in connection with the accompanying drawings in which:

FIG. 1 shows an end view of a preferred embodiment of the invention;

FIG. 2 illustrates a side elevation of the device shown in FIG. 1; and

FIGS. 3 and 4 show, schematically, alternate embodiments of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more particularly to the drawings, FIG. 1 shows a preferred embodiment of the shaped wave generator which is designed to generate a cylindrical, converging detonation front. The shaped wave generator is in the form of a shell **5** which is made up of a layer of explosive **6** sandwiched between two sheets of fragmenting material **7** and **8**. The illustrated embodiment is for use with an explosive **9** which may be detonated by impact. Therefore, inner layer **8** of fragmenting material is provided so that upon detonation of the explosive **6**, layer **8** will fragment and the fragments will be driven by the shock waves into the surface of charge **9**. If an explosive of the type that may be detonated by a shock wave were used for charge **9**, the inner layer of fragmenting material **8** would not be necessary. Further, outer layer **7** could be made of material that does not fragment upon detonation of explosive **6**, since this layer merely provides a support for explosive **6** and forms a backing member for directing the force of the explosion towards the explosive charge **9**. Thus, a rigid, reusable shell could be provided. Another alternative would be to eliminate the sandwiching layers **7** and **8** completely and provide a shell made up entirely of explosive material. This would be possible because the shock wave from an explosion travels with equal force in all directions from the point of explosion.

Referring again to the illustrated embodiment, shell **5** is made of two facing halves **20** and **21**. Each half is shaped like two elongated spirals of one-fourth revolution having their innermost edges joined at **22** and **23**. The outermost edges of quarter-spirals **30**, **31** and **32**, **33** are joined at line wave generators **10** and **11**, respectively. The line wave generators are used to detonate explosive **6** at portions **24** and **25** simultaneously, detonation fronts then propagating through the explosive in arms **30**, **31**, **32** and **33** of shell **5**.

A detonation front propagates through an explosive faster than the shock wave caused by detonation travels through air. Because of this fact and because of the shape of shell **5**, a cylindrical, converging shock wave is formed at the surface of charge **9**. To see this more clearly consider the progression of the shock wave generated by the top half of shell **5** toward the surface of charge **9**. Immediately after detonation of the explosive at portion **24**, the shock wave will be shaped as at **12**. As the shock wave travels from **12** to **13** it is being elongated to be equal in length to the circumference of the upper half of charge **9**. Because the detonation fronts in arms **30** and **31** travel faster than the shock wave, this elongation can be accomplished and at the same time the shock wave will be relatively straight at **13**. As the shock wave travels from **13** to the surface of charge **9**, the detonation fronts move the ends of the

shock wave toward charge 9 faster than the center of the shock wave because of the shape of arms 30 and 31. This gives the shock wave the desired curvature by the time it reaches the surface of charge 9. Since portions 24 and 25 of explosive 6 are detonated simultaneously, a shock wave is also generated in the lower half of shell 5 and it arrives at the lower surface of charge 9 at the same time the shock wave generated in the upper half of shell 5 arrives at the upper surface of charge 9.

FIG. 3 shows another embodiment of the invention, in which shell 14 is detonated at point 15, the detonation front propagating through the explosive in shell 14 so that a cylindrical converging shock wave is formed at surface 16.

Shell 14 in shaped like two spirals of one-half revolution 26 and 27 having their respective outer ends joined at 28 and their respective inner ends joined at 29. Detonation portion 15 is at the juncture of the outer ends.

FIG. 4 shows an alternate embodiment of the invention, in which the explosive in shell 17 is ignited at portion 18, the detonation front propagating through the explosive so a cylindrical converging shock wave is formed at surface 19. Shell 17 is shaped like a spiral of one revolution, detonation point 18 being at the outer end of the spiral.

The above-described embodiments have all related to the formation of cylindrical converging shock waves. However, it is possible to design an explosive shell so that it will produce a shock wave, either converging or diverging, of any desired shape. For example, a planar wave could be formed by a planar shell oriented at an angle to the plane of the wave to be formed. Similarly, a surface of revolution could be designed so that a spherically converging shock wave could be formed. Also, it is possible to use a plurality of explosives, each having a different detonation rate or a different explosive power and to correlate the shape of the shell with these factors to obtain a shock wave of the desired shape. This means that a shell could be shaped, within limits, to conform to a particular space requirement, and still produce a shock wave of the desired shape.

Having thus described the invention, what is claimed is:

1. A device for creating a shock wave form of a desired shape comprising:
- a layer of explosive; and
- means for initiating at least one portion of said explosive layer, a detonation front thereby being propagated through said layer;
- the shape of said explosive layer being correlated with the detonation rate and explosive power of the explosive in said layer whereby the shock wave caused by propagation of said detonation front assumes the desired shape;
- the preinitiated position of said at least one portion of said explosive layer being spaced from a position of the shock wave in its desired shape by a greater distance than another portion of said explosive layer;
- the space between said at least one portion and the position of the shock wave in its desired shape being void of explosive material.

2. A device according to claim 1 wherein said explosive layer is adjacent one side of a backing layer, said backing layer serving to direct away from said backing layer the explosive force of said explosive.

3. A device according to claim 1 wherein the explosive layer is shaped like an elongated spiral of one revolution, said one portion which is initiated by said initiating means being at the outer end of said spiral, whereby a closed, converging cylindrical wave form is generated.

4. A device for creating a wave form of a desired shape comprising:
- a layer of explosive; and
- means for initiating at least one portion of said explosive layer, a detonation front thereby being propagated through said layer;
- the shape of said explosive layer being correlated with the detonation rate and explosive power of the explosive in said layer whereby the shock wave caused by propagation of said detonation front assumes the desired shape;
- the explosive layer being shaped like two elongated spirals of one-half revolution in facing relation with their respective outer and inner edges joined together, said one portion which is initiated by said initiating means being at the juncture of said outer edges, whereby a closed, converging, cylindrical wave form is generated.

5. A device for creating a wave form of a desired shape comprising;
- a layer of explosive; and
- means for initiating at least one portion of said explosive layer, a detonation front thereby being propagated through said layer;
- the shape of said explosive layer being correlated with the detonation rate and explosive power of the explosive in said layer whereby the shock wave caused by propagation of said detonation front assumes the desired shape;
- the explosive layer being made up of two halves in facing relation, each half being shaped like two elongated spirals of one-fourth revolution joined together at their innermost edges, the halves being joined together at the outermost edges of the spirals, there being two portions which are initiated by said initiating means, one at each juncture between said two halves, whereby a closed, converging, cylindrical wave form is generated.

6. A device according to claim 1 wherein said layer of explosive is adjacent a primary charge having a surface of said desired shape, said primary charge being made of explosive which may be detonated by a shock wave, the wave form generated from the explosive layer serving to ignite the entire surface of said primary charge at one time.

7. A device according to claim 1 wherein said layer of explosive is adjacent a primary charge having a surface of said desired shape, said primary charge being made of an explosive which may be detonated by impact, said device further including a fragmenting sheet between said explosive layer and said primary charge, propagation of said detonation front and the resultant shock wave serving to fragment said sheet and drive said fragments against the surface of said primary charge thereby initiating the entire surface of said primary charge at one time.

8. A device for initiating the entire surface of a primary-shaped explosive charge at one time comprising:
- means for initiating said primary charge disposed in a surrounding relationship with respect to said primary charge;
- means for propelling parts of said initiating means toward said primary charge in a predetermined order; and
- means for activating said propelling means;
- said initiating means being shaped such that the parts of said initiating means all reach the surface of said explosive charge at one time.