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EXPLOSION INITIATING DEVICE

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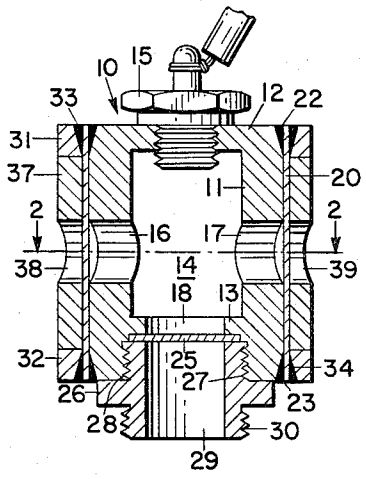


Fig. 1

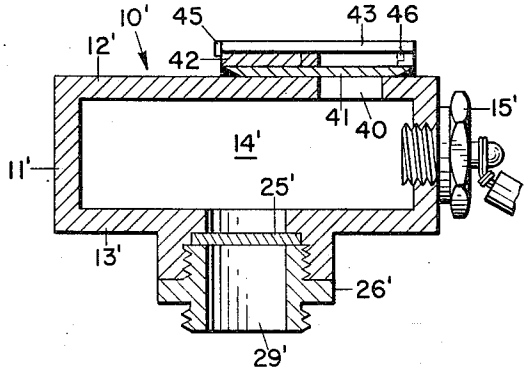


Fig. 3

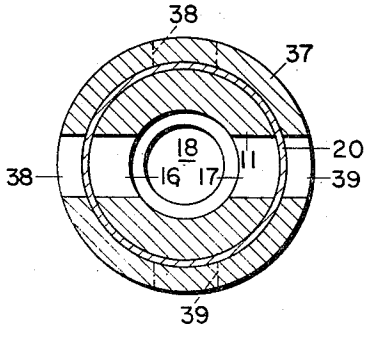


Fig. 2

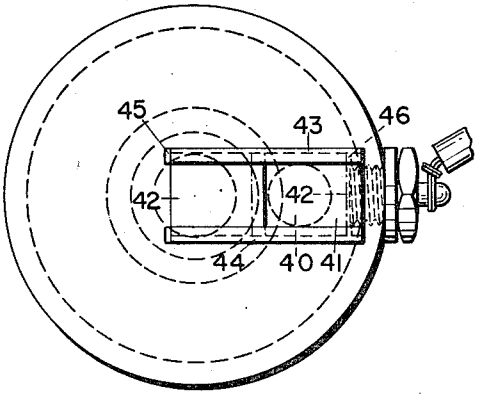


Fig. 4

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EXPLOSION INITIATING DEVICE

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

The present invention relates to an explosion initiating device having a mechanical safety means and more particularly to an explosion initiating device wherein the booster or primary ignition charge is contained in a hermetically sealed chamber, and a mechanical safety means is mounted externally of the chamber.

Heretofore, explosion initiating devices have employed a mechanical safety means in the form of a valve or plug inserted in the powder train of the device to prevent detonation of the main explosive charge should the primary charge be accidentally exploded. The valve or plug is inserted in the powder train so as to prevent communication between the primary and main explosive charges and is therefore necessarily in frictional contact with a portion of the powder train. This type of mechanical safety means is disadvantageous since the explosive substance used as the primary charge in such devices is generally friction sensitive and therefore the dangerous possibility exists that the primary charge will be exploded when the safety means is moved from the "safe" to the "armed" position. This is obviously an undesirbale feature and presents a hazard to personnel assembling the device in firing position. Furthermore, this type of safety means must extend from the powder train to the exterior of the device, and as sufficient clearance must be provided between the safety means and the device to allow relative movement therebetween, the gases generated by explosion of the primary charge upon firing of the device may escape through such clearance thereby reducing the efficiency of the device and possibly damaging the structure adjacent thereto at the time of firing. In devices such as rockets and gas generators where the explosion process continues for several seconds or longer, the escaping gases and the resulting fusion of structural parts may lead to complete failure of the device. The aforementioned clearance is also disadvantageous since moisture or other foreign matter may enter the device through the clearance and come in contact with the primary charge, thereby reducing the efficiency of the device or possibly causing it to be inoperative.

The present invention may be utilized for initiating any type of explosion and is particularly adapted for initiating the explosion of the solid propellants of rockets, catapults and the like. The invention device provides a hermetically sealed chamber which contains the booster or primary ignition charge. The mechanical safety means is mounted externally of the chamber and may be moved from the "safe" to "armed" position independently of the chamber and without disturbing the hermetic seal thereof or contacting the explosive substance therein. In this manner, the possibility of explosion of the booster charge due to friction between the charge and the safety means is eliminated since the safety means never contacts any

portion of the powder train of the device. In addition, the hermetically sealed chamber prevents the escape of gases generated upon explosion and also prevents moisture or other foreign matter from contacting the primary charge.

An object of the present invention is the provision of a new and novel explosion initiating device having a safety means which does not subject the primary charge of the device to friction upon relative movement of the safety means and other components of the device.

Another object is to provide an explosion initiating device which prevents the gases generated upon explosion of the primary charge from escaping from the device when it is fired.

A further object of the invention is the provision of an explosion initiating device which prevents moisture or other foreign matter from coming in contact with the primary charge of the device.

Still another object is to provide an explosion initiating device having a mechanical safety means which is simple in construction yet sturdy and reliable in operation.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a sectional view of a preferred embodiment of the invention,

Fig. 2 illustrates a section of the device taken on the line 2—2 of Fig. 1 looking in the direction of the arrows,

Fig. 3 is a sectional view of a modification of the device and

Fig. 4 is a plan view of the device shown in Fig. 3.

Referring now to the drawing, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Fig. 1 a hollow body member or container indicated generally by reference numeral **10** which comprises a cylindrical wall portion **11** and end wall portions **12** and **13** enclosing a chamber **14**. Member **10** is formed of a substance such as steel or the like having a high tensile strength. Disposed within and substantially filling chamber **14** is the primary or booster charge which is composed of black powder, flash powder or the like. An initiating squib **15** is suitably mounted in wall **10** as by means of screw threads such that an air tight connection is formed between the squib and the wall portion **12**. The squib extends into the interior of chamber **14** and upon actuation is adapted to explode the booster charge. The electrical leads connected to the squib are hermetically sealed thereto in a manner similar to that of conventional spark plugs utilized with internal combustion engines or the like.

As may be more clearly seen in Fig. 2, two circular openings **16**, **17** are formed in the cylindrical wall portion **11** at diametrically opposite points thereof, and a centrally located circular opening **18** is formed in wall portion **13**. A cylindrical diaphragm **20** is concentrically positioned about member **10** and is suitably connected at opposite ends thereof to member **10** as by brazing, welding or the like. It should be noted that the brazed portions **22**, **23** extend around the entire circumference of members **10** and **20** thereby providing a hermetic seal between the body member and the diaphragm.

Diaphragm **20** serves as a seal for openings **16** and **17** and is so designed that it will rupture at a predetermined pressure when subjected to the gases generated upon explosion of the primary charge contained in chamber **14**. Member **20** is formed of a suitable ductile material such as copper, aluminum or the like which has a predictable tensile strength, thereby enabling the accurate calculation

of the rupture point of the diaphragm. The tensile ductility of the diaphragm should be sufficient to enable it to elongate prior to rupturing.

A second diaphragm **25** formed of copper, aluminum or the like is provided for sealing opening **18** and is also adapted to rupture at a predetermined pressure in a manner similar to diaphragm **20**. A retainer member **26** has screw threads **27** formed on the exterior thereof adapted to cooperate with corresponding screw threads **28** formed on member **10** whereby member **26** is adapted to force diaphragm **25** tightly against the lower side of wall portion **13** and thereby maintain a hermetic seal between diaphragm **25** and member **10**. Member **26** has a longitudinally extending passage **29** centrally located therein, and when member **26** is in assembled position, passage **29** is aligned with opening **18**. Member **26** also has screw threads **30** formed on the exterior thereof which are adapted to cooperate with corresponding screw threads formed on a member which contains a second explosive charge which may be either an intermediate ignition charge or the main explosive charge. It is apparent that upon rupture of diaphragm **25**, member **26** will provide a path of communication between the two charges and enable the gases produced on explosion of the booster charge to detonate the second explosive charge.

Ring-like support members **31** and **32** are suitably secured as by brazing, welding or the like to the outer periphery of member **20** at opposite ends thereof. Brazed portions **33**, **34** preferably extend around the entire circumference of members **31** and **32** respectively to secure the support members rigidly in place. A cylindrical safety member **37** is rotatably mounted upon diaphragm **20** and ring members **31** and **32** abut opposite ends of the safety member thereby preventing axial displacement thereof. Member **37** is formed of a material having a high tensile strength such as steel or the like and has two openings **38** and **39** formed in diametrically opposite portions thereof such that when member **37** is in the position shown in Fig. 2, openings **38** and **39** are radially aligned with openings **16** and **17**, respectively. This is the "safe" position of the device and should the portion of diaphragm **20** opposite either opening **16** or **17** rupture, chamber **14** would be vented to atmosphere.

Diaphragm **20** is so designed that it will rupture at a substantially lower pressure than that which will cause diaphragm **25** to rupture. Hereinafter, the diaphragm which vents the device to atmosphere will be referred to as the low pressure diaphragm and the diaphragm which vents the device to the second explosive charge will be referrerd to as the high pressure diaphragm. To provide a satisfactory margin of safety, diaphragm **20** should rupture at approximately one-tenth the pressure which is required to rupture diaphragm **25**. The desired rupture point of the high and low pressure diaphragms may be obtained by varying the material or changing the thickness of the diaphragm. Furthermore, since the size of openings **38** and **39** determines the effective area of the low pressure diaphragm which is subjected to the pressure of the gases within chamber **14**, the rupture point thereof may be adjusted by altering the size of openings **38** and **39**.

It is evident that should the explosive substance in chamber **14** be accidentally detonated when safety member **37** is in the "safe" position, diaphragm **20** will rupture and vent chamber **14** to atmosphere, thereby preventing the gases in chamber **14** from reaching a sufficiently high pressure to cause rupture of member **25**.

Since member **37** is rotatable with respect to the diaphragm **20** and body member **10**, the safety member may be rotated to a position in which openings **38** and **39** are no longer in radial alignment with openings **16** and **17**. When member **37** has been rotated ninety degrees such that openings **38** and **39** are in the phantom line position shown in Fig. 2, member **37** is in "armed" position and the device is ready to be fired. In this position, it is

evident that a solid portion of member **37** will overlie openings **16** and **17** and since member **37** is formed of a material having high tensile strength such as steel or the like, diaphragm **20** is prevented from rupturing by its inability to stretch or elongate appreciably. Therefore, the pressure within chamber **14** will increase until diaphragm **25** is ruptured, whereupon the gases will communicate with the second explosive charge which will accordingly be detonated. For maximum safety when using the device shown in Fig. 1, safety member **37** should be rotated ninety degrees in order to obtain the greatest possible misalignment of openings **16**, **17** and **38**, **39** respectively. However, it may be noted that the device may be "armed" by rotating member **37** less than ninety degrees as long as no portion of openings **38** and **39** overlies a portion of openings **16** or **17**. Suitable detent means may be provided for maintaining the safety member in "safe" and "armed" positions.

Although the openings in the cylindrical wall portion **11** have been shown for the purpose of illustration as two in number, any suitable number of openings may be employed according to the speed of burning of the booster charge within chamber **14**. If a booster charge having a fast rate of burning is employed, a greater number of openings may be required in order to insure that diaphragm **20** will rupture before the gases within chamber **14** can build up a sufficient pressure to rupture diaphragm **25**. Furthermore, whereas the openings have been disclosed as being circular, any suitable configuration may be utilized.

If it is desired to reduce the longitudinal dimensions of the device, a modification may be constructed as illustrated in Fig. 3, wherein the longitudinal dimensions of the cylindrical wall portion **11'** of the body member or container **10'** is substantially reduced and the radial dimensions of end wall portions **12'** and **13'** have been increased. The booster or primary charge is disposed within enclosed chamber **14'** in a manner similar to the device shown in Fig. 1. High pressure diaphragm **25'** and retainer member **26'** having a centrally located passage **29'** are identical with members **25** and **26** employed in the device shown in Fig. 1. Squib **15'** in Fig. 3 is also identical with squib **15** shown in Fig. 1, but is mounted in the cylindrical wall portion **11'** rather than in an end wall portion of the device. An opening **40** is provided in wall portion **12'** and is sealed by a low pressure diaphragm **41** which is suitably secured to the body member as by brazing, welding or the like. Member **41** is formed of a material similar to that of member **20** in Fig. 1 and is designed to rupture at a predetermined pressure which is substantially less than that which will cause rupture of member **25'**. Diaphragm **41** is secured about its entire outer periphery to wall portion **12'**, thereby providing a hermetic seal between the diaphragm and the body member. A safety member **42** is slidably supported by diaphragm **41** and is guided and limited in its longitudinal movement with respect to body member **10'** by a pair of tracks **43** and **44** which are rigidly secured to wall portion **12'** and have stop members **45** and **46** formed thereon.

When safety member **42** is disposed as shown in Figs. 3 and 4, it is in "safe" position, and accidental detonation of the booster charge will cause diaphragm **41** to rupture. However, when member **42** is disposed as shown in the phantom lines in Figs. 3 and 4, it is in "armed" position, and since member **42** overlies opening **40**, diaphragm **41** will be prevented from rupturing, and the gas pressure in chamber **14** will build up sufficiently to rupture diaphragm **25'** and cause detonation of the second explosive charge.

The optimum rupture pressures of the high and low diaphragms depend upon the utilization of the invention device. When it is employed to initiate a blasting charge or demolition charge, the low pressure diaphragms may have a rupture pressure in the order of 50 p. s. i., and the high pressure diaphragms may accordingly have a rup-

ture pressure of approximately 500 p. s. i. On the other hand, if the device is to be used to initiate a rocket or a gas generator, the low pressure diaphragms must withstand the normal chamber pressure of the device, since the chamber gases will have sufficient time during the explosion process to seep through the space between the body members and the low pressure diaphragms, thereby exerting pressure on those portions of the diaphragms which are not covered by and restrained by the safety members. Therefore, the low pressure diaphragms must be designed to have rupture pressures in the order of 2000 p. s. i., and the high pressure diaphragms must accordingly have a rupture pressure of approximately 20,000 p. s. i. Another solution is to employ low pressure diaphragms having rupture pressures considerably less than the pressures developed by the chamber gases and to seal the diaphragms to the body members closely adjacent to the openings venting the chambers to atmosphere by means of resistance welding or the like. In the latter case, the low pressure diaphragms will be hermetically sealed to the body members adjacent the openings therein, thereby eliminating the necessity of an additional hermetic seal.

When the primary charge consists of flash powder or a similar substance which will produce a very high temperature in chambers **14**, **14'** upon explosion, there is a possibility that such high temperatures will greatly lower the tensile strength of the low pressure diaphragms, causing them to rupture even when in the "armed" position. To eliminate this hazard, suitable heat insulation composed of a soft, pliable substance such as zinc chromate cement, putty or the like may be disposed within openings **16**, **17**, **40** to protect the low pressure diaphragms from the heat developed within chambers **14**, **14'**. Such insulation will prevent the hot gases within the chambers from appreciably lowering the rupture pressures of the low pressure diaphragms, and furthermore, since the insulation is composed of a soft, pliable substance, the pressure of the gases will be transmitted substantially undiminished to the diaphragms.

It should be noted that in both modifications of the device, the opening venting the interior of the body member to atmosphere is located nearer to the squib than the opening venting chambers **14**, **14'** to passages **29**, **29'**. This is an important feature, since should squib **15** be accidentally actuated when the safety member is in the "safe" position, the burning gases produced by the booster charge will have an opportunity to build up pressure on the diaphragm covering the opening to atmosphere prior to building up pressure on the diaphragm covering the opening which vents the chamber to the main explosive charge, thereby insuring that diaphragms **20** and **41** will be ruptured prior to rupture of diaphragms **25** and **25'** respectively.

From the foregoing, it is apparent that a new and novel explosion initiating device is provided in which the safety means does not subject the primary charge to friction upon relative movement of the safety means and other components of the device, since the safety means never contacts any portion of the powder train of the device. The hermetic seal between the diaphragms and the body members insures that the gases generated by explosion of the primary charge may not escape from the device, and that moisture or other foreign matter may not come in contact with the primary charge. The device is simple in construction and employs a minimum of parts, yet is sturdy and reliable in operation.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What I claim:

1. An explosion initiating device which comprises a hollow body member having a closed chamber formed therein, an explosive substance disposed within said chamber, means for selectively exploding said substance, a plurality of openings formed in said body member and communicating with said chamber, each of said openings being sealed by a diaphragm adapted to rupture when subjected to pressure, at least one of said diaphragms being adapted to rupture at a lower pressure than another of said diaphragms, and selectively operable safety means movably mounted on the exterior of said body member and being adapted to be positioned such that it overlies one of said openings and thereby prevents rupture of said one diaphragm.

2. In an explosion initiating device, a hollow container having an explosive substance disposed therein, means for selectively exploding said substance, a plurality of openings in said container, at least one of said openings venting the interior of said container to atmosphere, each of said openings being sealed by a pressure responsive diaphragm, at least one of said diaphragms being adapted to rupture at a lower pressure than another of said diaphragms, means for hermetically sealing said diaphragms with respect to said container, and selectively operable safety means movably mounted on the exterior of said container and being adapted to be positioned such that it overlies said one opening and thereby prevents rupture of the associated diaphragm.

3. An explosion initiating device which comprises a body member having a closed chamber formed therein, an explosive substance disposed within said chamber, a squib supported by said body member and communicating with said chamber, a first opening formed in said body member and communicating with said chamber, a first diaphragm for sealing said first opening and means for hermetically sealing said first diaphragm with respect to said body member, a second opening formed in said body member and communicating with said chamber, a second diaphragm for sealing said second opening and a retainer means for hermetically sealing said second diaphragm with respect to said body member, said retainer means having a passage formed therein, said first diaphragm being adapted to rupture at a lower pressure than said second diaphragm, said first opening venting said chamber to atmosphere and said second opening venting said chamber to said passage, and selectively operable safety means movably mounted on said body member and being adapted to be positioned such that it overlies said first opening and thereby prevents rupture of said first diaphragm.

4. A device as defined in claim 3 wherein each of said diaphragms is formed of a ductile metallic substance and said first opening is located intermediate said squib and said second opening.

5. An explosion initiating device which comprises a cylindrical body member closed at both ends and having a closed chamber formed therein, an explosive substance disposed within said chamber, means supported by said body member for selectively exploding said substance, a first opening formed in said body member and communicating with said chamber, a first diaphragm for sealing said first opening and means for hermetically sealing said first diaphragm with respect to said body member, a second opening formed in said body member and communicating with said chamber, a second diaphragm for sealing said second opening, a retainer means for hermetically sealing said second diaphragm with respect to said body member, said retainer means having a passage formed therein and being adapted to be secured to another member, said first opening venting said chamber to atmosphere and said second opening venting said chamber to said passage, and selectively operable safety means movably mounted on said body member and being adapted to be positioned such that it overlies said first opening and thereby prevents rupture of said first diaphragm.

6. A device as defined in claim 5 including a soft, pli-

able, heat insulating substance disposed in said first opening.

7. An explosion initiating device which comprises a cylindrical body member closed at both ends and having a closed chamber formed therein, an explosive substance disposed within said chamber, means for selectively exploding said substance, a plurality of openings formed in said body member and communicating with said chamber, at least one of said openings venting said chamber to atmosphere, a diaphragm disposed in sealing relationship to each of said openings, at least one of said diaphragms being adapted to rupture at a lower pressure than another of said diaphragms, and a cylindrical safety member rotatably mounted on said body member and having an opening formed therein, said safety member being adapted to be positioned such that said opening therein is located closely adjacent to and in radial alignment with said one opening in said body member.

8. An explosion initiating device which comprises a cylindrical body member closed at both ends and having a closed chamber formed therein, an explosive substance disposed within said chamber, means for selectively exploding said substance, a plurality of openings formed in the cylindrical portion of said body member and communicating with said chamber, a first diaphragm in sealing relation to each of said plurality of openings, means for hermetically sealing said first diaphragm with respect to said body member, another opening formed in an end portion of said body member and communicating with said chamber, a second diaphragm is sealing relation to said other opening, retainer means for hermetically sealing said second diaphragm with respect to said body member, said first diaphragm being adapted to rupture at a lower pressure than said second diaphragm, and a cylindrical safety member rotatably mounted on said body member and having a plurality of openings

formed therein corresponding in number to and adapted to register with said plurality of openings in said body member, said safety member being adapted to be positioned such that said plurality of openings in said safety member are out of register with said plurality of openings in said body member thereby preventing rupture of said first diaphragm.

9. An explosion initiating device as defined in claim 5, wherein said first diaphragm is adapted to rupture at a lower pressure than said second diaphragm.

10. In an explosion initiating device, a hollow container comprising a cylindrical wall having an end wall connected to each end thereof, an explosive substance disposed within said container, means for selectively exploding said substance, a first opening formed in one end wall of said container closely adjacent said last mentioned means, a first diaphragm for hermetically sealing said first opening, a second opening formed in the opposite end wall of said container, a second diaphragm for hermetically sealing said second opening, said first diaphragm being adapted to rupture at a lower pressure than said second diaphragm, and a safety member movably mounted on said container whereby said safety member may be so positioned that it overlies that portion of said first diaphragm which cover said first opening.

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