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ZIP CARTRIDGE

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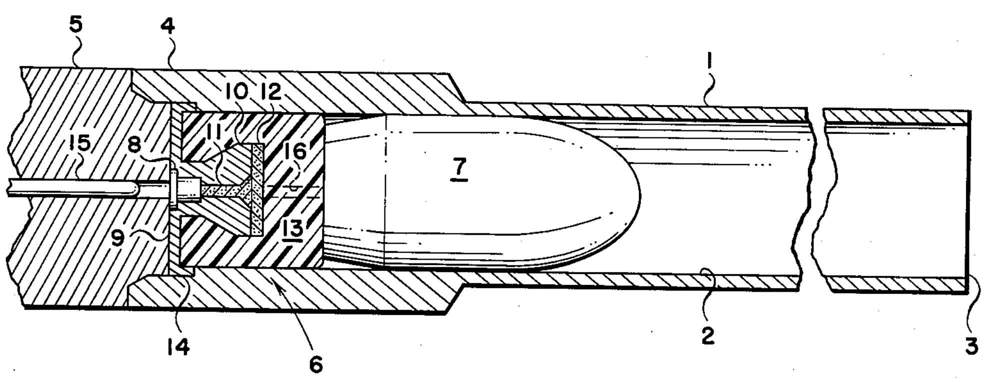

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This invention relates to an explosive shell assembly and further to ordnance devices utilizing the explosive shell assembly.

A continuing problem in the explosive shell in ordnance art has been the noise, flash and smoke associated with the discharge of such devices. Attempts to significantly reduce or eliminate such undesirable by-products of detonation of such devices have not been completely successful. U.S. Patent 3,007,409, for example, while claiming a device capable of muffling the noise of detonation, permits flash and smoke to escape in conventional fashion.

In accordance with the invention, there is described an explosive shell assembly and an ordnance device that offer the advantages of simplicity in design and the ability to use conventional explosives and yet provide for a significant reduction or elimination of the noise, flash and smoke heretofore connected with such devices.

More particularly, the explosive shell assembly of the invention comprises a driven element, for example, a conventional projectile and a driving element adjacent the driven element and adapted to act on and propel the driven element. In essence, the driving element of the shell assembly comprises an expandable casing and an explosive propellant charge imbedded in the casing, the casing having a minimum ultimate tensile strength sufficient to prevent rupture thereof when expanded by the generated force of detonation of the charge. By means of this configuration, the force of detonation of the propellant charge is transmitted to the casing, the expansion of which does work on the adjoining projectile.

The advantages of the invention are accordingly realized by making the casing containing the explosive propellant charge an active member in transmitting the force of explosion. Since the casing remains continuous, that is, does not rupture when expanded, the products of detonation of the explosive charge are confined within the casing. Elimination of the flash and smoke and a significant reduction in the noise heretofore associated with devices of this type is thereby achieved. Since the particular type of explosive charge utilized in the shell assembly of the invention is not critical, the assembly has the added advantage of permitting the art to utilize existing explosive technology in practicing the invention. Illustrative of explosive charges suitable in devices of this type are pentaerythritol tetranitrate (PETN), cyclotrimethylenetrinitramine (RDX), mild detonating fuze (MDF), lead azide, lead styphnate and nitrocellulose.

A more complete understanding of the invention is facilitated by reference to the drawing which is a side elevational view, partially in section, of one illustrative ordnance device of the invention utilizing the explosive shell assembly of the invention.

As shown in the drawing, the device comprises a barrel **1** having a bore **2** extending therethrough. One end of bore **2** is open forming muzzle **3**. The opposite end of the bore is adapted to receive and engage by means of barrel lip **4**, a breech block **5**. The breech block **5** is held in engagement with barrel **1** by, for example, a sliding bolt not shown. Adjacent breech block **5** is the explosive shell assembly of the invention. As depicted, this assembly consists of a driving element **6** and a driven element **7**. Elements **6** and **7** may be preassembled to form a unit assembly prior to insertion in the bore, for example, as the bullet in a small bore rifle. Alternatively, elements **6** and **7** may be loaded separately in the bore of, for example, a mortar.

The driving element **6** consists in this embodiment of a conventional percussion primer **8** located in the base **9** of support member **10** which acts as a common support for relay charge **11** and the main propellent charge **12**. As shown, that portion of member **10** which supports charges **11** and **12** is embedded in an expandable casing **13** which will be subsequently described in greater detail. The base portion **9** of member **10** terminates in end portion **14** which engages barrel **1** as shown. Elements **8** and **11**, the detonation means for detonating main charge **12**, are in turn activated by a conventional firing pin **15** located in breech block **5** coaxial with primer **8**. Firing pin **15** is illustrative of various conventional initiation means.

In operation, firing pin **15** strikes and initiates primer **8** which in turn initiates relay charge **11** which has sufficient output to detonate main charge **12**. The ensuing gas and shock pressure axially expands casing **13** against the driven element projectile **7**. This expansion drives projectile **7** down bore **2** and out muzzle **3** at a velocity dependent upon the quantity of explosive used. The ensuing noise, flash and smoke is significantly reduced or eliminated due to casing **13** which does not rupture thereby confining all explosive by-products. It is understood, however, that under certain conditions it may be desirable to deliberately vent the explosive by-products. In such instances an orifice **16** would be located as shown to slowly vent the residual pressure through bore **2**. In such a controlled vented situation noise, flash and smoke would be significantly reduced below conventional silencing and flash suppressing devices. Naturally, in certain embodiments it may be desirable to eliminate relay charge **11** and have the detonation means acting on main charge **12** consisting only of, for example, percussion primer **8**. Charge **12** in this instance would illustratively consist of a spiral of MDF explosive embedded in the casing and attached directly to the primer.

In one actual operation of the device similar to that depicted in the drawing, driven element **7** was a 40 mm. projectile weighing 0.4 pound. The projectile was propelled without noise, flash or smoke at a calculated velocity of 60 to 70 feet per second. A conventional shotgun primer **8**, initiated by firing pin **15**, was used to initiate relay charge **11** consisting of 1.5 grains of lead azide. Charge **11** in turn detonated main charge **12** which was a spiral loop of 3 grains RDX explosive inside an MDF cord. The explosive had a dentonation rate of 7,000 meters per second and was embedded in casing **13**. Casing **13** was formed of polyurethane and was molded against aluminum support member **10** by conventional techniques. For this particular operation no external vents were provided. The elongatable casing **13** which initially was two inches long elongated ⅜ of an inch upon detonation of the charge but did not rupture and was not ejected down bore **2**. The casing wall thickness between charge **12** and projectile **7** was one-half of an inch.

The choice of material for the casing **13** in which the propellant charge **12** is embedded is dependent upon the type of explosive utilized for the propellant charge. In order to be successful, the casing material must exhibit sufficient elongation in order to perform useful work against driven element **7** and, further, must have a sufficient minimum ultimate tensile strength to prevent rupturing of the case material when elongated by the generated force of detonation of the propellant charge. It can be appreciated that the generated force detonation and gas pressure of the propellant charge and the characteristics of the casing material surrounding the charge are interdependent with smaller detonation forces requiring smaller ultimate tensile strengths and larger detonation forces requiring larger ultimate tensile strengths to preclude rupture of the casing and to ensure the total confining of the products of detonation of the charge within the casing. The following Table I is illustrative of the dependency of the casing material characteristics on the explosive force of detonation of the propellant charge. In this table there is set forth the required minimum preferred and optimum casing material characteristics for a propellant charge having a detonation rate of 7,000 meters per second. As is understood by the art, explosive compositions are typically characterized in terms of detonation rates. These values are found, for example, in military handbooks such as TM9–1910, page 324. The characteristics in following Table I are based on ASTM specifications.

Table I

Characteristics	Minimum	Preferred	Optimum
1. Ultimate Tensile Strength (p.s.i.).	600	At least 2,000	At least 4,000.
2. Hardness Shore A	30	At least 80	At least 82.
3. 300% Modulus (p.s.i.)	250	At least 1,000	At least 1,450.
4. Shear Die C (lbs. per inch).	80	At least 200	At least 375.

Based upon the preceding discussions, it is considered within the skill of the art to determine the equivalent characteristics when smaller or large detonation forces are utilized. Detonation rates smaller than 7,000 meters per second will naturally permit the ulitization of a casing material having smaller characteristics than those set forth in Table I. Detonation rates greater than 7,000 meters per second will of necessity dictate the use of a sheath material having characteristics larger than the minimum characteristics set forth in Table I in order to prevent rupture of the casing material. Naturally, the characteristics set forth in Table I are dependent not only on the particular choice of casing material utilized but the thickness of the casing material. In general, increasing the thickness increases the characteristics set forth in Table I. Accordingly, the particular choice of casing material and the thicknesses utilized are discretionary to the art, provided that the resulting combination of material and thickness thereof exhibits characteristics equivalent to those set forth in Table I for a detonation rate of 7,000 meters per second. It is to be appreciated that the invention is not limited to a casing formed of a single material. Casings formed of two or more differing materials, for example, a thin wall metal tube contouring an inner plastic tube are within the scope of the invention provided the resulting composite casing body exhibits characteristics in accordance with Table I.

Naturally, any elongation of the casing against the adjoining driven element will perform work. However, practical propellent velocities for the driven element are generally achieved when the elongation of the casing is in the order of at least 150 percent. Materials exhibiting a greater elongation characteristic, desirably in the order of at least 500 percent, enhance the propellent velocity attained by the driven element.

While certain preferred embodiments of the invention have been specifically disclosed herein, it is understood that the invention is not so limited. Many variations will be apparent to those skilled in the art and the invention is to be given the broadest interpretation within the scope of the appended claims.

What is claimed is:

1. An explosive shell assembly comprising an expandable casing, a propellent charge embedded in said casing, means for detonating said propellent charge, said casing remaining continuous when expanded by the generated force of detonation of said propellent charge and a projectile adjacent said casing, said projectile being engaged and propelled by the expansion of said casing.

2. An explosive shell assembly in accordance with claim 1 wherein the minimum ultimate tensile strength of said casing and the detonation rate of said propellent charge are interdependent, with a detonation rate of 7,000 meters per second, requiring a minimum ultimate tensile strength of 600 p.s.i.

3. An explosive shell assembly in accordance with claim 2 wherein said casing exhibits characteristics equivalent to a minimum hardness of 30 A., a minimum 300% modulus of 250 p.s.i. and a minimum shear die C of 80 pounds per inch for a detonation rate of said propellent charge of 7,000 meters per second.

4. An explosive shell assembly having a driven element and a driving element, said driving element comprising a support member, detonation means supported by said support member for detonating a propellent charge, an expandable casing, one surface of said casing affixed to and supported by said support member, another surface of said casing contacting said driven member, a propellent charge encapsulated in said casing and contacting said detonation means, said casing remaining continuous when expanded by the generated force of detonation of said propellent charge and said driven element being propelled by the expansion of said casing.

5. An explosive shell assembly in accordance with claim 4 wherein said casing exhibits characteristics equivalent to a minimum ultimate tensile strength of 600 p.s.i., a minimum hardness of 30 A., a minimum 300% modulus of 250 p.s.i. and a minimum shear die C of 80 pounds per inch for a detonation rate of said propellent charge of 7,000 meters per second.

6. An explosive shell assembly in accordance with claim 5 wherein said casing exhibits characteristics equivalent to an ultimate tensile strength of at least 2000 p.s.i., a hardness of at least 80 A., a 300% modulus of at least 1,000 p.s.i., and a shear die C of at least 200 pounds per inch for a detonation rate of said propellent charge of 7,000 meters per second.

7. An explosive shell assembly in accordance with claim 6 wherein said casing exhibits characteristics equivalent to an ultimate tensile strength of at least 4,000 p.s.i., a hardness of at least 82 A., a 300% modulus of at least 1,450 p.s.i. and a shear die C of at least 375 pounds per inch for a detonation rate of said propellent charge of 7,000 meters per second.

8. An explosive shell assembly in accordance with claim 7 wherein said casing has a minimum ultimate elongation of 150 percent.

9. An ordnance device comprising a barrel, a bore extending through said barrel, one end of said bore being open to define a muzzle, the opposite end being adapted to receive a breech block, an expandable casing in said bore adjacent said breech block, a propellent charge embedded in said casing, detonation means in said casing for detonating said propellent charge, said casing remaining continuous when expanded by the generated force of detonation of said propellent charge, initiation means in said breech block for initiating detonation of said detonation means and a projectile adjacent said casing on the muzzle end of said bore, said projectile being engaged by and propelled through said bore by the expansion of said casing.

10. An ordnance device in accordance with claim 9 wherein the minimum ultimate tensile strength of said casing and the detonation rate of said propellent charge are interdependent with a detonation rate of 7,000 meters per second requiring a minimum ultimate tensile strength of 600 p.s.i.

11. An ordnance device in accordance with claim 10 wherein said casing exhibits characteristics equivalent to a minimum hardness of 30 A., a minimum 300% modulus of 250 p.s.i. and a minimum shear die C of 80 pounds

per inch for a detonation rate of 7,000 meters per second.

12. An ordnance device in accordance with claim **11** wherein said casing exhibits characteristics equivalent to an ultimate tensile strength of at least 2,000 p.s.i., a hardness of at least 80 A., a 300% modulus of at least 1,000 p.s.i. and a shear die C of at least 200 pounds per inch for a detonation rate of 7,000 meters per second.

13. An ordnance device in accordance with claim **12** wherein said casing exhibits characteristics equivalent to an ultimate tensile strength of at least 4,000 p.s.i., a hardness of at least 80 A., a 300% modulus of at least 1,450 p.s.i. and a shear die C of at least 375 pounds per inch for a detonation rate of 7,000 meters per second.

14. An ordnance device in accordance with claim **13** wherein said casing has a minimum ultimate elongation of 150 percent.

15. An ordnance device comprising a barrel, a bore extending through said barrel, one end of said bore being open to define a muzzle, the opposite end of said bore being adapted to receive a breech block, a driving member adjacent said breech block and a projectile adjacent said driving element on the muzzle side of said bore, said driving element comprising a support member, detonation means supported by said support member for detonating a propellent charge, an expandable casing, at least one surface of said casing being supported by said support member, a propellent charge embedded in said casing and contacting said detonation means, said casing remaining continuous when expanded by the generated force of detonation of said propellent charge, initiation means

in said breech block for initiating said detonation means and a projectile contacting said casing, said projectile being propelled through said bore by the expansion of said casing.

16. An ordnance device in accordance with claim **15** wherein said casing exhibits characteristics equivalent to a minimum ultimate tensile strength of 600 p.s.i., a minimum hardness of 30 A., a minimum 300% modulus of 250 p.s.i and a minimum shear die C of 80 pounds per inch for a detonation rate of said propellent charge of 7,000 meters per second.

17. An ordnance device in accordance with claim **16** wherein said casing has a minimum ultimate elongation of 150 percent.

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