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FILLER FOR PROJECTILES

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This invention relates to improvements in explosive shell-fillers for armor piercing projectiles, and has for one of its objects the production of an explosive adapted to the filling of projectiles which when compressed or compacted under high pressure into the projectile will remain permanently friable, elastic and semi-plastic.

Another object of the invention is the production of an explosive shell-filler composition which may be loaded into projectiles with facility and safety under high pressure and which will after compression be extremely insensitive to shock or frictional detonation and deflagration while its explosive ingredient normally is so sensitive.

A further object is to provide an explosive which is non-hygroscopic and which will not be subject to chemical change or deterioration during long storage periods.

It has heretofore been the universal practice in the loading of armor piercing projectiles either to cast the shell-filler solidly into the projectile or to compress it therein with such pressure as to insure that it will not subsequently set up or be further compressed by the shock of firing or impact. It is known that the sensitiveness of an explosive to shock is increased by making it more compact and rigid, which localizes the effects of impact. However, heretofore the necessity of avoiding the creation of friction between the explosive and the walls of the projectile due to the movement of the explosive on firing or impact with armor is so great that the shell-filler has nevertheless been unsafely compressed into the projectiles at great pressures in order to insure rigidity of the shell-filler after loading. In addition to the devices of casting and compression, various provisions such as the addition of binders like paraffin, resin, less sensitive explosives, etc., and also paper or fabric cartons or coverings have been employed in an effort to decrease the sensitiveness and to secure additional rigidity of the shell-filler.

The provisions just mentioned have practically eliminated the danger of premature explosion due to the shock or firing the projectile in the gun, and to a certain extent have reduced the tendency of the shell-filler to explode prematurely from the shock incident to penetration of armor at normal angles of impact. However, with the comparatively recent requirement that armor piercing projectiles be capable of penetrating armor at oblique angles of impact, the above provisions have been found to be inadequate for the reason that when penetrating armor at oblique angles, the projectile itself is deformed by the excessive forces to which it is subjected, and no matter how rigid or densely compacted the shell-filler may be, it also is violently deformed in the same manner as the projectile causing frictional impact of the explosive filling with the interior wall of the projectile as well as between the particles of the thus disrupted explosive filling resulting heretofore in its premature detonation and deflagration since the stress arising from said deformation substantially supplements that due to impact with the armor. It is therefore manifest that the difficulties presented are not to be solved simply by securing higher density and greater rigidity of the shell-filler, but its solution requires the devising of a high explosive shell-filler composition of the detonating class which is substantially insensitive to detonation and deflagration by the combined impacts with the armor and of deformation in piercing such armor, but substantially preserve its sensitivity to detonation by the usual detonating means.

A further obstacle against extending the present methods of shell-filling is that the risks attendant to the loading operations are increased with an increase in the loading pressure. Also larger and more powerful loading presses are required and the final result heretofore has been a rigid mass of explosive which is correspondingly more difficult to detonate as well as more sensitive to detonation by the combined impacts with the armor and of deformation in piercing such armor at an angle.

It is known that the sensitiveness of explosives to impact may be decreased by mixing them with a soft, plastic substance which will reduce the friction between particles and de-

crease the effect of shocks to which the explosive may be subjected, such as mixing therewith materials such as paraffin, resin, gums, balsams and gelatines, which substantially decrease the sensitiveness of the explosive constituent to detonation by the detonating means. When applied to shell-fillers to meet the aforesaid armor piercing difficulties now being experienced these materials, however, possess the disadvantage that by their use the particles of the shell-filler are cemented together, so that when the resulting rigid mass is violently deformed during penetration of armor, the particles or crystals of explosive are crushed or broken tending to produce premature explosion.

To meet the difficulties recited above I have discovered that any of the aromatic nitro class of explosives in crystalline form may be employed as a shell-filler and composition which may be compressed into the projectile at very high pressure with practical safety and facility and yet remain premanently friable, elastic and semi-plastic, and which will therefore adapt itself readily and without excessive or deflagrating or detonating friction due to the extreme stresses of impact of its containing projectile with armor as well as to the changes in the form of the projectile which occur to the greatest extent during the penetration of armor at an angle, thereby reducing the danger of premature explosion.

Heretofore, the high explosives of the detonating class, particularly the picrates and the trinitrotoluene groups, upon detonation produce fumes that may be permanently harmful especially in such usually enclosed quarters as require the piercing of armor to enter, and my composition armor piercing projectile filler substantially relieves the permanency of said harmful characteristics of either or both of its said explosive constituents.

To accomplish these objects and results and to obtain the most desirable characteristics of the shell-filler from every standpoint, in the invention herein disclosed the granules or crystals of explosive are coated with a firmly adhering, elastic, powdered lubricant, such as a stearate, and an excess of lubricant is provided to fill interstices and to separate the individual particles, said stearate being ground finer than the explosive. The explosive after being so treated may be safely compressed under high pressure into the projectile body by hydraulic pressure or other suitable means.

The class of aromatic nitro-explosives comprises tetranitro-methylaniline, hexanitro-diphenylamine, trinitro-benzene, trinitrotoluene, ammonium picrate, sodium picrate, trinitro-dimethylaniline, trinitro-cresol, and picric acid. Of the constituents of this class I have successfully employed trinitrotoluene and ammonium picrate, and from their structures and common characteristics the same beneficial results are attainable with substantially like admixture with the other constituents of said class.

For the purpose of my invention I have found that zinc stearate as a lubricant and cushioning material has every desired quality. Zinc stearate possesses the peculiar quality of adhering readily to other materials without having any tendency for the particles of the zinc stearate itself to stick together. The particles of explosive when coated with zinc stearate therefore have a high degree of mobility which, in connection with the elastic cushioning properties of the zinc stearate, renders the explosive mixture, even after high compression, friable, elastic and semi-plastic. I have found that 2½% to 5% of zinc stearate mixed with an explosive, such as trinitrotoluene or ammonium picrate, gives a composition of desirable chemical and mechanical characteristics differing substantially from those of either or both of its said explosive constituents and of maximum density for a given pressure. When using this percentage of zinc stearate there is no loss of sensitivity to detonation by the usual timing detonating means with substantially no diminution of its explosive force since, because of the lubricating qualities of the zinc stearate, the actual amount of explosive material which may be charged into the projectile at a given pressure is greater than when the explosive is used without the zinc stearate and the safe pressure to which my composition may be subjected is greatly increased over that of its constituent explosive, and I have safely used pressures as high as fifteen thousand (15,000) pounds per square inch with my composition. From the standpoint of friability, elasticity and plasticity, however, it may be desirable to increase the amount of zinc stearate above that required to obtain maximum density, the limit in this direction being set by the ability of the explosive mixture to produce complete fragmentation of the projectile in which it is used. Amounts of as great as 15% of zinc stearate have been used without serious loss of explosive force of the shell-filler.

Of the class of metallic stearates, I have employed with substantially the same satisfactory results zinc stearate, tin stearate, cadmium stearate and aluminum stearate, but I prefer to use zinc stearate for economic reasons.

It is known that trinitrotoluene and ammonium picrate in their crystalline form are especially adapted for charging shells because of their relative chemical stability, durability, insensitivity and great explosive power. In carrying out my invention I therefore add to a crystalline or granular explosive, preferably trinitrotoluene or ammo-

nium picrate, a suitable amount of zinc stearate, which is mixed therewith in a suitable mixing machine until the particles of explosive are coated with an adhering layer of zinc stearate and the mixture is thoroughly blended. The mixture is then compressed into the projectile in the usual manner. When compressed at pressures as great as 15,000 pounds per square inch, which is safely applicable to my composition of zinc stearate and trinitrotoluene or ammonium picrate, my said composition remains permanently friable, elastic and semi-plastic.

My said composition of zinc stearate and said trinitrotoluene or ammonium picrate, in substantially the proportions named, substantially retards the normal sensitiveness to deflagration and to detonation by impact of said explosive constituents such that without said stearate admixture either of said explosives have heretofore usually been detonated as well as deflagrated by the combined stresses of impact with armor at such an angle that the projectile is substantially deformed, whereas with said admixture of either of said explosives with said stearate results in such an armor piercing shell-filler composition that its projectile container may pierce armor at a substantial angle and be substantially deformed thereby without liability to detonation or deflagration by the potent combined forces of impact with armor and of such deformity of the projectile and its content as is usually occasioned by piercing armor at an angle, and my said composition may usually be relied upon to detonate only by its detonating means ordinarily set to detonate the shell-filler a given distance within the vessel or fortification whose armor its container has penetrated, where the normal toxic or other permanent harmful effects, upon the occupants of such usually enclosed quarters protected with said armor, of the gas arising from said detonated explosive constituent when used and detonated alone, are, by said stearate content of my said composition modified so as to relieve said permanent effects.

On analysis, the process of pressing said granular or crystalline explosives to obtain a particular density of my composition becomes simply the safe application of sufficient mechanical power to force the particles into such positions and density of the mass that the interstices between them are reduced. In so doing, some of the granules or crystals are broken and others are forced into such positions that they present an elastic resistance to further compression. It will therefore be apparent that the use of such a lubricant facilitates the safe pressing of such crystalline or granular explosives and in fact, when using zinc stearate as such lubricant, a marked improvement in the safety and facility of loading has been obtained in practice, in addition to thereby changing the normal characteristics of its explosive constituent so that the sensitivenesss of my composition to detonation by the usual detonating means remains substantially the same as that of its explosive constituent alone; while the sensitiveness of my composition to detonation, as well as to deflagration, by said combined forces of impact upon armor and of such deformation as is occasioned by the piercing of armor at an angle is so stabilized that it is not detonated or deflagrated thereby, while either of its explosive constituents are detonated as well as deflagrated usually thereby, and that the detonated gas of my composition is normally not permanently harmful in the usually enclosed space where said detonation is designed to occur, while said gas of either of its explosive constituents may be so harmful in such space. While this substantially changes the characteristics of such explosives to detonation as well as deflagration by the combined forces of shell impact and distortion due to piercing relatively heavy armor at a substantial angle, the normal sensitiveness of such explosives to detonation by the usual timing means provided therefor remains substantially unchanged.

A further advantage in the use of zinc stearate is that it is insoluble in water or alcohol and is not easily wetted and therefore, after the explosive particles are coated with it, the shell filler is rendered less hygroscopic and in storage is not liable to deteriorate nor to form dangerous compounds which are very unstable and sensitive to detonation, and heretofore were formed by the reaction of either of said explosive constituents when used alone, upon the interior surface of the projectile, but which reaction and its said effect are prevented in my composition.

From the above it will be seen that my invention provides an explosive shell-filler for filling armor piercing projectiles which after compression is friable, elastic and semi-plastic; which gives a high density of loading; which is extremely insensitive to shock or friction; which is non-hygroscopic and not liable to chemical change or deterioration; and which is loaded with safety and facility. It therefore possesses in a high degree the qualities requisite for the uses for which it is intended.

My invention, however, is not restricted to the use of zinc stearate, since other stearates, palmitates, oleates, resinates or other forms of metallic soaps I have found suitable for carrying out the objects of my invention. It is therefore to be understood that various changes may be made in the proportions and constituents of the explosive shell-filler without departing from the scope of the invention as defined in the appended claims.

What I claim is:—

1. A shell filler comprising a mixture of ammonium picrate and a zinc soap.

2. A shell filler comprising a mixture of crystalline ammonium picrate and a zinc stearate.

3. A filler for armor piercing projectiles comprising a mixture of an aromatic nitro-explosive and a metallic soap.

4. A filler for armor piercing projectiles comprising a mixture of an aromatic nitro-explosive in crystalline form and a metallic soap in crystalline form of from substantially 2.5 to 15 percent of the mass.

5. A filler for armor piercing projectiles comprising a mixture of an aromatic nitro-explosive and a zinc soap.

6. A filler for armor piercing projectiles comprising a mixture of an aromatic nitro-explosive and a zinc soap, each in crystalline form, said soap being substantially 2.5 to 15 percent of the mass.

7. A shell filler comprising a mixture of an aromatic nitro-explosive and a metallic stearate, the latter being substantially 2.5 to 15 percent of the mass.

8. A shell filler comprising a mixture of an aromatic nitro-explosive in crystalline form and a metallic stearate.

9. A shell filler comprising a mixture of an aromatic nitro-explosive and a zinc stearate.

10. A shell filler comprising a mixture of an aromatic nitro-explosive in crystalline form and a zinc stearate.

11. The method of rendering an explosive normally sensitive to detonation insensitive to deonation by impact, substantially commensurate with that of a containing shell impacting with and penetrating substantial armor at an angle, consisting of mixing with an aromatic nitro-explosive a metallic soap.

12. The method of decreasing the sensitiveness to detonation by impact of an explosive normally sensitive thereto, consisting of mixing with an aromatic nitro-explosive a metallic soap.

13. The method of rendering an explosive normally sensitive to detonation insensitive to detonation by impact, up to the degree commensurate with that of a containing shell impacting with and penetrating substantial armor at an angle, consisting of mixing with an aromatic nitro-explosive a metallic soap in different proportions of from substantially 2.5 to 15 percent of the mass.

14. The method of decreasing by different degrees the sensitiveness of an explosive normally sensitive thereto, consisting of mixing with an aromatic nitro-explosive a metallic soap in different proportions of from substantially 2.5 to 15 percent of the mass.

15. The method of decreasing the sensitiveness to detonation by impact of an explosive normally sensitive thereto, consisting of mixing with an aromatic nitro-explosive a metallic soap each in the form of dry particles.

16. The method of decreasing the sensitiveness to detonation by impact of an explosive normally sensitive thereto, consisting of mixing with said explosive a metallic soap each in the form of dry particles with said soap particles being substantially powdered, and forming substantially from 2.5 to 15 percent of the mass.

17. The method of rendering an explosive normally sensitive to detonation insensitive to detonation by impact, substantially commensurate with that of a containing shell impacting with and penetrating substantial armor at an angle, consisting of separately reducing an aromatic nitro-explosive and a metallic soap to the form of dry particles and intimately mixing said particles, with said soap being from substantially 2.5 to 15 percent of the mass.

18. The method of rendering an explosive normally sensitive to detonation insensitive to detonation by impact, substantially commensurate with that of a containing shell impacting with and piercing substantial armor at an angle, consisting of separately reducing a trinitrotoluene explosive and a metallic soap to the form of dry particles with said soap particles being relatively finer and intimately mixing said particles, with said soap being from substantially 2.5 to 15 percent of the mass.

19. The method of decreasing the sensitiveness to detonation by impact of an explosive normally sensitive thereto, consisting of mixing a trinitrotoluene explosive and a metallic soap each in the form of dry particles and compressing under high pressure portions of the mass into the volumes and forms in which said mixture is desired to be exploded.

20. The method of decreasing the sensitiveness to detonation by impact without substantially changing its normal characteristics of detonation by the usual detonating means, consisting of mixing an explosive and a metallic soap, the latter being substantially 2.5 to 15 percent of the mass.

21. The method of decreasing the sensitiveness to detonation by impact without substantially changing its characteristics of detonation by the usual detonating means, consisting of mixing a trinitrotoluene explosive and a metallic soap, the latter being substantially 2.5 to 15 percent of the mass.

22. The method of decreasing the sensitiveness to detonation by impact without substantially changing its characteristics of detonation by the usual detonating means, consisting of mixing ammonium picrate and a metallic soap.

23. The method of decreasing the sensitiveness to detonation by impact without substantially changing its characteristics of detonation by the usual detonating means, consisting of mixing ammonium picrate and me-

tallic soap each in the form of dry particles.

24. The method of decreasing the sensitiveness to deflagration of an explosive normally sensitive thereto, consisting of mixing an aromatic nitro-explosive with a metallic soap.

25. The method of rendering the detonated gases of an explosive of the shell-filler class less harmful to the occupants of closures wherein shells so filled may explode, consisting of mixing with an aromatic nitro-explosive zinc stearate.

26. The method of rendering an explosive normally sensitive to detonation insensitive to detonation by impact, substantially commensurate with that of a containing shell impacting with and piercing armor at a substantial angle, consisting of separately reducing ammonium picrate explosive and a metallic soap to the form of dry particles with said soap particles being relatively finer and intimately mixing said particles with said soap being substantially 2.5 to 15 percent of the mass.

27. The method of decreasing the sensitiveness to detonation by impact of an explosive, consisting of mixing ammonium picrate explosive and a metallic soap each in the form of dry particles and compressing under high pressure portions of the mass into the volumes and forms in which said mixture is desired to be exploded.

28. The method of decreasing the sensitiveness to detonation by impact without substantially changing its characteristics of detonation by the usual detonating means, consisting of mixing an ammonium picrate explosive and a metallic soap, the latter being substantially 2.5 to 15 percent of the mass.

Signed at Washington, District of Columbia, this 29th day of March, 1924.

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