UNITED STATES PATENT OFFICE.

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EXPLOSIVE COMPOUND.

974,900. Specification of Letters Patent. Patented Nov. 8, 1910.

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To all whom it may concern:

Be it known that I, Hudson Maxim, of the borough of Brooklyn, city of New York, State of New York, have invented a new and useful Improvement in Explosive Compounds, which invention is fully set forth in the following specification.

The present invention relates to improvements in explosive compounds, and has especial reference to the manufacture of smokeless gunpowder.

The object of the invention is to provide a pyroxylin compound which shall be sufficiently plastic at ordinary temperatures or at slightly elevated temperatures, to permit of the material being molded or formed into any desirable shape of grains suited to use in firearms or cannon, and without the use or employment of any volatile matter as a solvent. In other words, to provide a material capable of gelatinating pyroxylin without the employment of any volatile solvent requiring to be evaporated from the compound after it has been granulated or otherwise formed; and furthermore to provide a solid non-volatile solvent of pyroxylin, as well as a novel process for the manufacture of smokeless gunpowder.

It is a further object of the invention to provide a smokeless powder compound or colloid which shall be capable of fusion and capable of being fused at a temperature below the point of ignition, so that when the powder is fired in a gun fusion shall take place in advance of and proceed in advance of and simultaneously with combustion. Consequently, the two processes, fusion and combustion, going on together, cause the powder to burn more rapidly and to be consumed through a greater web thickness during a given period of time and under a given pressure in a gun, than would be the case if no fusion occurred.

By being able to consume the powder through a greater web thickness, the granulation may be much coarser, and the web thickness or wall thickness between multiperforations much greater, and consequently the amount of acceleration due to the multiperforations greatly enhanced. Heretofore, this result has been attempted by making smokeless powders very rich in nitro-glycerin or other oxidizing agents, and by making them both soft and rich in nitro-glycerin, like British cordite. No fusion taking place in these compounds the oxidizing agents have been depended upon to produce rapidity of combustion, and for this reason the products of combustion are much hotter and richer in oxygen, and consequently erode the gun with much greater rapidity than the smokeless powder like that described in the present invention, which is not over-rich in oxygen or oxidizing agents. Furthermore, such smokeless powders rich in oxidizing agents, under higher pressures become dangerous, for the reason that the rate of combustion is more likely to change and proceed toward detonation—in other words, such powders rich in oxidizing agents have what is known as a critical point, and are liable to produce dangerous pressures and blow up the gun, especially when high pressures are employed. Furthermore, obviously, when a smokeless powder compound like the present compound, is capable of being consumed through a relatively great thickness of material under a given pressure, the initial area per unit of weight of material is correspondingly decreased, and consequently the initial pressure in the gun is proportionately decreased, and a quantity of powder capable of maintaining a nearly uniform pressure to the muzzle may be employed and without undue initial pressure.

Heretofore, in the manufacture of smokeless gunpowder, it has been the general practice to dissolve pyroxylin or gelatinate the same to render it of suitable plasticity by means of a volatile solvent, such as a mixture of ether and alcohol or of acetone, etc., and which solvent must be dried out of the material to fit it for use. It frequently requires months to effectually accomplish the drying, and even then in grains of massive proportions such as are necessary for large cannon, there is a certain residual quantity of solvent which cannot be practically eliminated even in several months, especially with such a compound as the nitrocellulose smokeless powder at present employed by the United States Government, consisting solely of a grade of pyroxylin known as pyro-nitro-cellulose, gelatinated by the ether and alcohol mixture.

It has been found in practice that such a smokeless powder as the last named, even though great care be taken in drying it, will burn more rapidly after having been kept for a year or so, owing to the continued loss of more or less of the residual solvent which causes the powder not only to burn with greater rapidity but to be more brittle, so that the ballistic results after keeping the powder for a long time are inferior to those results when it is first finished. Higher pressures are produced with lower velocities after the powder has become overdry from keeping for a long time,—that is to say, for a year or more.

In carrying out my invention, I preferably employ about 40% of tri-nitranisol or tri-nitro-methyl-phenyl ether, and 60% of pyroxylin, preferably that known as pyro-nitro-cellulose. The tri-nitranisol is a powerful solvent of all grades of pyroxylin when a mixture of the tri-nitranisol and the pyroxylin are heated together to a temperature about that of the fusion point of the tri-nitranisol, that is to say, about 65° C. I have found, however, that it is not necessary in practice to heat the material to this temperature in order to effect the gelatinization of the pyroxylin in the method of manufacture hereinafter described; but greater rapidity of incorporation is secured, and therefore it is preferable to employ such a temperature or thereabouts. I have found that more rapid incorporation and gelatinization is effected if the pyroxylin be wet and the ingredients mingled in a wet condition, the wet condition being maintained until near the end of the operation whereat the finished powder grain is turned out.

In manufacture, I preferably proceed as follows:—Tri-nitranisol and the pyroxylin are mixed without being dried; which saves the drying of the gun-cotton. A mixer or incorporating machine is used. This is preferably done at normal atmospheric temperature and below the melting point of the solid solvent. The material is then taken from the mixer and passed and repassed between rolls, by which the more perfect incorporation and gelatinization of the guncotton is effected; the temperature of the rolls being maintained at about or above 65° C., and in order to prevent the too rapid drying of the material, hot water is dropped, or allowed to trickle upon the material while being rolled. When the material has been thoroughly incorporated and the guncotton thoroughly gelatinated by the tri-nitranisol, the material in sheets from the rolls is passed to another and cooler pair of rolls, preferably running in a warm room or one maintained at high summer heat, that is to say, from 80 to 100° F. These are the finishing rolls, and are not maintained at quite so high a temperature as the first-mentioned rolls, for the reason that the powder is now rolled in the absence of water until the moisture remaining in it is eliminated, when the powder is rolled into a desired thickness for cutting up into powder grains. I sometimes, however, proceed by drying the sheets of material from the first rolling before rerolling them on the finishing rolls. The room is maintained at an elevated temperature, for the reason that the material is apt to become brittle while in thin sheets if the room is allowed to become too cold, or the temperature of the sheets to fall too low. When, however, the temperature is maintained as above described, the material is maintained in a plastic condition and is readily rolled and molded as may be desired, and at a temperature not exceeding that at which the stability of the powder is unaffected, that is to say, without overheating the powder material.

Of course, I may roll the material into grains while yet in a wet state on the first pair of rolls, and then dry the water from the grains afterward, but I preferably proceed as above set forth. I have found, furthermore, that the addition of nitro-glycerin produces a smokeless powder which is very much more elastic and flexible and burns with greater rapidity than that consisting of only nitro-cellulose and tri-nitranisol. This modified formula may be about 15 per cent. of nitro-glycerin, 40 per cent. of tri-nitranisol and 45 per cent. of pyro-nitro-cellulose, mixed and incorporated as before described. The addition of this quantity of nitro-glycerin is not sufficient to render the products of combustion injurious in their erosive action upon the gun, while it facilitates considerably the process of manufacture, and reduces the required temperature for gelatinization, and at the same time produces a more flexible powder grain, which may be made in the form of long rods or strips that may be handled and transported without danger of breaking.

While I have described a mixture of 40 parts tri-nitranisol to 60 parts pyro-nitro-cellulose as the preferable mixture when employing these two ingredients alone, still I may vary this composition. I may, for instance, employ equal parts of these ingredients, or I may employ as low as 25 per cent. of tri-nitranisol and 75 per cent. pyro-nitro-cellulose, and I have actually succeeded in making homogenous and perfectly gelatinated powder grains with this mixture, but it is considerably more difficult than when employing the ingredients in the preferred proportions.

The plasticity of the compound may be varied within wide limits by increasing or decreasing the proportion of the pyroxylin, without varying the proportion with respect to each other of the tri-nitranisol and nitro-glycerin.

When it is required to make a compound which shall be very stiff and rigid, then a larger percentage of the pyroxylin is used. When a softer and more plastic consistency is required, then the proportion of the pyroxylin is reduced. Furthermore, when a slower burning powder is required or when it is desired to lessen the temperature of the products of combustion, then the proportion of the tri-nitranisol is increased and the proportion of the nitro-glycerin is reduced, while the proportion of pyroxylin may remain constant. And when a more rapidly burning powder is wanted and one which will be consumed through a greater thickness of material in the gun, then the proportion of the tri-nitranisol is reduced and the proportion of the nitro-glycerin is increased, while the proportion of the pyroxylin may remain unchanged.

While I have expressly mentioned, and prefer to use tri-nitranisol, I may use tri-nitro-phenetol, or a mixture of them, but I prefer to use tri-nitranisol because it contains a higher percentage of oxygen as well as being a more active solvent of pyroxylin and a large percentage may be used with pyroxylin without making a smoke-producing powder, while at the same time a smaller percentage is required to effect its gelatinization. It is much more difficult to thoroughly gelatinate the pyroxylin to form an amorphous product which shall contain a low enough percentage of tri-nitro-phenetol to produce a smokeless powder without the use of additional oxidizing agents, such as nitrate of barium, or an unduly large percentage of nitro-glycerin.

Tri-nitro-toluene may be employed in conjunction with tri-nitro-phenetol or tri-nitro-anisol. The fusion point of the compound is considerably lowered below that of tri-nitro-toluene which has a fusion point of 75° C. By lowering the fusion point the process of gelatinization of the pyroxylin is facilitated and is effected at a lower temperature than when tri-nitro-toluene is employed without another solid solvent having a lower fusion point than itself.

In effecting, as hereinbefore described, the gelatinization of the pyroxylin with tri-nitranisol, a temperature is maintained during the incorporation and gelatinization somewhat elevated, and preferably at, or slightly above the fusion point of the tri-nitranisol, namely; 64° to 65° C. When, however, nitro-glycerin, especially a large percentage, is employed, which is a solvent of the tri-nitranisol and which may be a solvent of the pyroxylin also, then the gelatinization may be effected at ordinary temperature, but the work is always facilitated by the employment of a somewhat elevated temperature. Obviously, furthermore, a volatile and common solvent of the tri-nitranisol and pyroxylin, such as acetone, may be employed, which would greatly facilitate the incorporation and gelatinization of the pyroxylin at ordinary temperature, but as such a volatile solvent must necessarily be evaporated from the compound afterward, and before granulation, it is better not to employ such volatile solvent, but instead to employ a somewhat elevated temperature. This obviates the necessity of drying the powder after it has been granulated, in order to remove the volatile matter.

What is claimed is:—

1. A smokeless gunpowder, consisting of a mixture of tri-nitranisol, pyroxylin, and an oxidizing agent, as described.

2. A smokeless gunpowder consisting of a mixture of tri-nitranisol, pyroxylin, and nitro-glycerin, as described.

3. An explosive consisting of a gelatinated mixture of pyro-nitro-cellulose and tri-nitranisol.

4. The hereindescribed process of making smokeless gunpowder, which consists in mixing together pyroxylin, nitro-glycerin and tri-nitranisol and gelatinizing the resulting mixture.

5. The hereindescribed process of gelatinating pyroxylin, which consists in incorporating with pyroxylin, tri-nitranisol and nitro-glycerin heating the said mixture, maintaining the pyroxylin wet during the gelatinization thereof and subsequently drying the compound.

6. A smokeless gunpowder, consisting of a mixture of a tri-nitro-alkyl-phenyl ether, and nitro-cellulose made into a colloid.

7. A smokeless gunpowder, consisting of a mixture of a tri-nitro-alkyl-phenyl ether, nitro-cellulose and an oxidizing agent made into a colloid.

8. A smokeless gunpowder, consisting of a mixture of a tri-nitro-alkyl-phenyl ester, nitro-cellulose and nitro-glycerin made into a colloid.

9. A smokeless gunpowder, consisting of a mixture of a tri-nitro-alkyl-phenyl ether and pyro-nitro-cellulose made into a colloid.

10. A smokeless gunpowder, consisting of a mixture of a tri-nitro-alkyl-phenyl ether, pyro-nitro-cellulose and an oxidizing agent made into a colloid.

11. A smokeless gunpowder, consisting of a mixture of tri-nitro-alkyl-phenyl ether, pyro-nitro-cellulose and nitro-glycerin made into a colloid.

12. A smokeless powder comprising a mixture of tri-nitranisol and tri-nitro-phenetol and pyroxylin made into a colloid.

13. A smokeless powder comprising a mixture of tri-nitranisol, tri-nitro-phenetol, pyroxylin and an oxidizing compound made into a colloid.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HUDSON MAXIM.

Witnesses:
R. L. SCOTT,
ELISHA K. CAMP.