

# UNITED STATES PATENT OFFICE.

HIRAM STEVENS MAXIM, OF LONDON, ENGLAND.

## MANUFACTURE OF EXPLOSIVES.

SPECIFICATION forming part of Letters Patent No. 436,898, dated September 23, 1890.

Original application filed December 19, 1888, Serial No. 294,087. Divided and this application filed September 18, 1889. Serial No. 324,336. (No specimens.) Patented in England November 8, 1888, No. 16,213; in France December 15, 1888, No. 194,792, and in Spain February 20, 1889, No. 8,991.

*To all whom it may concern:*

Be it known that I, HIRAM STEVENS MAXIM, mechanical engineer, a citizen of the United States, and a resident of London, England, have invented certain new and useful Improvements in the Manufacture of Explosives, (for which I have obtained patents in the following countries: in Great Britain, No. 16,213, dated November 8, 1888; in France, No. 194,792, dated December 15, 1888, and in Spain, No. 8,991, dated February 20, 1889,) of which the following is a specification.

This application is a division of an application filed by me December 19, 1888, Serial No. 294,087.

My invention relates to the manufacture of explosives for use in fire-arms and for other purposes.

The main object of my said invention is to provide an explosive which will be comparatively smokeless, or will by its combustion produce much less smoke than ordinary gun-powder, and which when used in a fire-arm will burn slowly as compared with ordinary gun-cotton and will exert a high and continuous pressure on the projectile.

Gun-cotton has most of the elements or qualities requisite in an explosive for use in fire-arms—that is to say, when properly prepared it is stable and very powerful, it produces but a small quantity of smoke, does not injure metallic cartridge-cases, and is not sufficiently hygroscopic to impair its efficiency. As hitherto manufactured, however, it has the disadvantage that it is too quick or sudden in its action. I obviate this defect by my invention, hereinafter described.

Attempts have heretofore been made to manufacture explosives from collodion obtained by the treatment of the low grades of gun-cotton with ether and alcohol. By the "low grades of gun-cotton" I mean those which are readily soluble in ether or alcohol or in a mixture of these substances, and which contain but a small percentage of oxygen. These low grades of gun-cotton are unstable, do not withstand the action of sunlight, and as they do not contain sufficient oxygen to consume all of the vegetable matter of which they are

composed they produce in burning a large quantity of smoke.

When gun-cotton is dissolved, it forms a thick gelatinous mass, which is very difficult to manipulate by the means heretofore used for this purpose. Moreover, in the methods of manufacture heretofore adopted a very large quantity of liquid or solvent is required to bring the gun-cotton to such a consistency that it can be spread out to be dried. Consequently the manufacture of explosives from gun-cotton has hitherto been very costly.

In my application filed December 19, 1888, Serial No. 294,087, I have described a process of manufacturing explosives from gun-cotton which involves the novel feature of treating the gun-cotton with a solvent—such as acetone, ethylic acetate, or the like—in the condition of vapor. The method also involves the plan of placing the gun-cotton in an air-tight cylinder or receiver, exhausting the air, then admitting the solvent, and then forcing the material out through a contracted aperture and dividing it up into small pieces.

My present invention is in the nature of a modification of this process, the main object being to diminish the rapidity of explosion, as previously stated. This I have found may be done by partially gelatinizing or dissolving the gun-cotton and then compressing it, and thus forming it into very hard sheets or cakes, which may be cut or divided into pieces or grains of any desired size.

In carrying out my invention I take a suitable quantity of high-grade or highly-explosive gun-cotton and reduce it to pulp in a paper-pulping machine, rag-engine, or other convenient machine. I then wash it thoroughly with water or other suitable liquid to remove any free acid that it may contain, and then dry it. The dried pulp is then moistened with acetone and subjected to the action of a mixture of six parts of ether to one of alcohol until it is partially dissolved. When it has thus been sufficiently softened, it is compressed into a solid cake or sheet and allowed to dry.

The press used for thus forming the partially-dissolved gun-cotton into sheets or



cakes should be a very strong one, and the pressure applied to the material should be very high—higher than it would be likely to encounter in the gun. I prefer to subject  
 5 the material to a pressure of from twenty to forty tons per square inch. In some cases it may be advantageous to apply a moderate amount of heat to the material while in the press. The cake or sheet of solidified or com-  
 10 pressed gun-cotton thus obtained is cut up into small cubes or pellets. These cubes may have their corners rounded by rumbling or other suitable means.

Instead of compressing the gun-cotton in  
 15 the above-described manner, it may be forced while in a plastic condition through dies, and the strips or threads cut up after issuing from the dies.

If the explosive as thus made is found to  
 20 burn too quickly for a given purpose, any suitable substance or substances are mixed with the gun-cotton, which will have a tendency to diminish the rate of combustion thereof.

25 A mixture of mineral wax or resinous matter or of a hydrocarbon with some oxygen-bearing salt like nitrate of potash or of soda or chlorate of potash is sometimes added to or combined with the gun-cotton to facilitate  
 30 solidification and diminish the rate of burning. In some instances I combine with the gelatinized mass of partially-dissolved gun-cotton a small percentage of nitrate of potash or of soda or chlorate of potash or other oxygen-bearing salts, and in other instances a  
 35 larger percentage of chlorate of potash and about one per cent. of paraffine-wax.

A modification of the above-described process consists in first forming the gun-cotton  
 40 while in the condition of pulp into thick sheets, then cutting the sheets up into small cubes or pellets, and then treating the latter with ether and alcohol, or with ether, alcohol, and acetone or other suitable solvent, until  
 45 they are partially dissolved, and then allowing them to dry.

To obtain very large cubes, pellets, or other pieces to be used in heavy guns or ordnance, I prefer to proceed as follows—that is to say:  
 50 I place the gun-cotton or the pulp in a suitably-shaped receiver and exhaust the air therefrom, and then allow the vapor of the solvent to enter the said receiver and act on the mass until the same becomes to a certain degree  
 55 sticky or partly dissolved. Then without admitting any air I compress the mass and solidify it and withdraw it as a whole from the said receiver. Large and solid pieces may thus be formed which are quite free from air-  
 60 bubbles. Blocks of the explosive material thus formed may be cut or divided into small pieces or grains in any convenient manner.

Gun-cotton as hitherto manufactured when  
 65 used in a gun explodes too suddenly, because the high pressure set up in the chamber of the gun forces the inflamed gases into the interstices of the mass and thus instantly ignites

the whole of the said mass. When, however, it is made, as above described, in lumps or grains of considerable size and in such a state  
 70 of compression that no pressure to which it is liable to be subjected in the gun can further compress it, it can only burn from the outside of the grains, and the explosion, although  
 75 quick, will be sufficiently retarded to allow the projectile to move forward before the entire mass is in a state of ignition.

According to another modification of my process the low and soluble grades of gun-cotton are dissolved with ether, thus forming  
 80 collodion. The collodion is then intimately combined with gun-cotton, which is highly explosive, and is insoluble, or nearly so, in ether, the collodion being sufficient to cause the gun-cotton to adhere in a solid mass. As  
 85 the low grades have less oxygen than the high grades, I find it advantageous in this case to employ chlorate of potash or other oxygen-bearing salt to supply the additional oxygen required.  
 90

The gun-cotton may, if desired, be first made into paper and then partly gelatinized and compressed. I find it more advantageous, however, to first reduce the gun-cotton to pulp and then treat it as above described, this being  
 95 the most effectual method of removing the free acid usually present.

The product formed by the method of manufacture above described is very hard, resembling horn. It does not injure metallic car-  
 100 tridge-cases, is not sufficiently hygroscopic to impair its effectiveness, is very powerful, and it burns much slower than ordinary gun-cotton, while it gives very little smoke and produces a high and continuous pressure. It is  
 105 therefore well adapted for use in cases where the above qualities, and notably the absence of smoke, are desirable.

What I claim is—

1. The method or process herein described  
 110 of manufacturing explosives from gun-cotton, which consists in confining the gun-cotton in a receiver, exhausting the air from the same, then introducing a vaporized solvent into the exhausted receiver until the gun-cotton is par-  
 115 tially dissolved, then compressing it, and then dividing it up into small pieces or grains, as set forth.

2. The method of manufacturing explosive material, which consists in reducing gun-cot-  
 120 ton to pulp and drying the same, subjecting the pulp in a suitable receiver to the action of vaporized acetone or its specified equivalent, then compressing it by a pressure greater than that to which it is liable to be exposed  
 125 in a gun, and dividing it up into small pieces or grains.

In testimony whereof I have hereunto signed my name in the presence of two subscribing witnesses.

HIRAM STEVENS MAXIM.

Witnesses:

DAVID YOUNG,  
 CHAS. B. BURDON.