

# UNITED STATES PATENT OFFICE.

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## EXPLOSIVE.

No. 850,119.

Specification of Letters Patent.

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*To all whom it may concern:*

Be it known that I, OSWALD SILBERRAD, a subject of the King of Great Britain and Ireland, and residing at 51 Shooter's Hill road, Blackheath, in the county of Kent, England, have invented certain new and useful Improvements in Explosives, of which the following is a specification.

My invention relates to nitroglycerin explosives, and is especially applicable to disruptive explosives for blasting purposes. Various explosives of this class have been heretofore manufactured in which wood-pulp or the like and an oxidizing agent, such as sodium nitrate, have been mixed with a jelly formed by dissolving nitrocellulose in nitroglycerin. These explosives have, however, certain disadvantages, the chief of which are exudation, liability to deteriorate through hydrolytic decomposition, lack of plasticity, a tendency to freeze, and a tendency to crumble.

The object of this invention is to produce a series of nitroglycerin explosives having any desired power and velocity of detonation, according to the varying grades of rock or other material on which they are to be applied, the explosives being at the same time free from the disadvantages above referred to and cheaper to manufacture than any explosives of the same power hitherto produced.

In selecting the most effective composition for blasting rocks of any particular degree of toughness it is necessary to consider the velocity of detonation as well as the gas volume evolved on combustion. In preparing the explosive it is also necessary to consider the properties of the explosive as regards size of detonator necessary to give effective explosion. The physical properties of the finished explosive and its form and keeping qualities are also of importance, the best form for blasting purposes being that of a plastic mass. At the same time it is found that substances added to give the desired qualities in some respects interfere with other desirable qualities of the explosive. For instance, in deciding the ratio of soluble nitrocellulose to nitroglycerin a balance must be drawn between difficulty of detonation, on the one hand, and liability to exude, on the other. It is therefore essential in order to produce the best result to consider the effect on the explosive properties of the composition of ingredients added for the purpose of improving

or preserving the physical properties and generally to consider the effect of each addition as regards every property it gives to the explosive. The cheapest source of power for explosives is a mixture of wood-meal, pitch, resin, or sulfur with a suitable oxidizing agent, the cheapest of which at the present time is sodium nitrate. Such mixtures are, however, far too weak for practical use, necessitating the addition of a high explosive. The cheapest high explosive for the purpose is nitroglycerin, which is most conveniently added in the form of a jelly produced by dissolving soluble nitrocellulose in nitroglycerin. I find that the best practical results are obtained by the addition of such a jelly containing about four per cent. of soluble nitrocellulose to dopes of wood-meal, pitch, sulfur, or resin and sodium nitrate or other oxidizing agent.

My experiments show that a product of the most suitable consistency is obtained by mixing the nitroglycerin jelly with a dope containing wood-meal thirty per cent. and sodium nitrate seventy per cent. in the proportion of about fifty-two parts jelly to forty-eight parts dope. I also find that the same consistency is obtained with dopes containing a bituminous substance, such as pitch or resin, twelve per cent. and sodium nitrate eighty-eight per cent. in the proportion of about thirty-four parts jelly to sixty-six parts dope. It will be seen, therefore, that by the use of suitable proportions of the wood-meal dope and bituminous dope I am enabled to vary the proportion of nitroglycerin jelly, and thus vary the power of the explosive, without altering its consistency, and according to my invention I utilize this difference in the absorptive properties of the dopes in order to produce explosives of different powers and velocities of detonation suitable for various grades of rock and yet in all cases of perfect plasticity.

My invention consists in the production of an explosive of given power and velocity of detonation and of the most suitable consistency by adding to a jelly of nitroglycerin and soluble nitrocellulose suitable proportions of wood-meal or resin or pitch dopes.

My invention further consists in the production of explosives containing the mixtures *a*, *b*, *c*, and *d*, described below, in approximately the following proportions:

Mixture <i>a</i> .....	58.3 parts
Mixture <i>b</i> .....	(36.7 minus <i>x</i> ) parts
Mixture <i>c</i> .....	( <i>y</i> times <i>x</i> ) parts
Mixture <i>d</i> .....	5 per cent.



Mixture *a* consists of—

5	Nitroglycerin.....	85.84 parts.
	Soluble nitrocellulose.....	3.52 parts.
	Naphthalene.....	.82 part or pitch
	Resin.....	.82 part/1.64 parts.
	An oxidizing agent the equivalent of oxygen.....	3.4 parts oxygen.

Mixture *b* consists of—

10	An oxidizing agent the equivalent of oxygen.....	25.7 parts oxygen.
	Wood-meal.....	30 parts.

Mixture *c* consists of—

10	Resin or pitch.....	12 parts.
	An oxidizing agent the equivalent of oxygen.....	33.3 parts oxygen.

Mixture *d* consists of—

15	Sulfur.....	1.0 part.
	Sodium benzoate.....	.1 part.
	Ammonium perchlorate.....	3.9 parts.

In the mixtures *a b c* sodium nitrate would be commonly used, the proportions being  
 20 nine parts in mixture *a*, seventy parts in mixture *b*, and eighty-eight parts in mixture *c*. In mixture *d* the ammonium perchlorate may be replaced by any suitable oxidizing agent, the proportion being determined by the oxygen available in the agent chosen. The particular oxidizing agent used will depend upon  
 25 the purpose for which the explosive is intended. For instance, for use under water, an insoluble oxidizing agent, such as manganese dioxid or an oxid of lead, may be used.

The value of  $\gamma$  is about 2.5, but will vary slightly according to the absorptive properties of the particular wood-meal used, while the quantity  $x$  varies with the power and  
 35 rate of combustion of the explosive required, as hereinafter described.

In the explosives above described and in similar explosives I find that the resin or pitch, in combination with the other ingredients, has also the effect of forming an air-tight joint between the explosive used and its wrapper, minimizing the effect of moisture.

In carrying my invention into effect—for  
 45 example, in the production of an explosive suitable for blasting the toughest rocks—I use mixtures as above described taking  $x$  less than ten. For rocks of medium toughness  $x$  would be taken equal to about fifteen, while for the softest rocks  $x$  equals about  
 50 thirty-seven. These examples will sufficiently show the nature of the effect produced as regards power and velocity of detonation of the various compositions made  
 55 according to my invention.

In preparing the explosive according to my invention the nitroglycerin jelly is prepared by standing the nitroglycerin in  
 60 troughs until it is heated to about 120° Fahrenheit, and the nitrocellulose is then added, the mixture being continually stirred until the mass is thoroughly mixed. After about two hours the jelly so formed is kneaded until it assumes a uniform consistency. The dopes *b* and *c* are meanwhile

separately mixed and are then added to the nitroglycerin jelly and the whole incorporated in any known form of incorporating-machine. The proportion of the dopes will be chosen according to the work for which the  
 70 explosive is required, as mentioned above. It will be understood that the mixture *d* is non-essential and may be omitted, if desired, or according to circumstances. The mixture *d*, if required, is incorporated at the  
 75 same time and renders it possible to use the explosive with small detonators. It will be found that with this addition detonators containing about 0.5 grams of fulminate are sufficient to give excellent results with all  
 80 grades of explosives according to my invention.

In the compositions given I have specified sodium nitrate as the oxidizing agent. I may, however, use potassium salts or the  
 85 chlorates, the latter being preferable where moisture is to be feared, or in cases where a very cool explosive is required ammonium nitrate is most suitable. Ammonium perchlorate may also be used throughout as the  
 90 oxidizing agent and is only suitable where the most violent detonation is required. The effect of chlorates is to somewhat increase the velocity of detonation, and this must be considered in determining the value of  $x$  in the  
 95 above equation.

The deliquescent properties of explosives containing hygroscopic oxidizing agents are remedied to a great extent by the physical properties of the mixture, which by reason of  
 100 the resin and naphthalene or pitch in presence of the jelly makes an air-tight joint with the containing wrapper in which the explosives are most conveniently made up. Exudation is rendered harmless by the presence of  
 105 the naphthalene, which is capable of dissolving in nitroglycerin. The naphthalene tends to sub-lime, and so concentrate on the surface of the explosive, where it readily combines  
 110 with any traces of nitroglycerin which may exude. Phenanthrene or like sub-limable hydrocarbon capable of dissolving in nitroglycerin may be substituted for this purpose. The quantity of such hydrocarbons, should, however, not exceed about 0.5 per cent. in  
 115 the explosives designed for any particular power and velocity of detonation, as if they are present in greater proportions an alteration will in time be produced in the composition of the explosive. If the proportion is  
 120 kept below 0.5 per cent., the loss from this very dilute and highly-viscid solution is so slow that no measurable alteration occurs in the course of many years.

Apart from the effect produced by the bituminous dope on the velocity of detonation the presence of resin or pitch is desirable in order to retard hydrolytic decomposition and to protect the explosive from the effects of  
 125 air and moisture. For this purpose the pro- 130



portion of resin or pitch should not be less than 0.8 per cent. of the nitroglycerin-nitrocellulose jelly. The presence of naphthalene, either added as such or present in the pitch, is also beneficial, in that it lowers the freezing-point of the explosive. It is also found that sodium benzoate in the proportion of about 0.1 per cent. has a beneficial effect on the keeping properties of the explosive.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A nitroglycerin explosive containing a mixture consisting of eighty-six parts of nitroglycerin, from three to four parts of soluble nitrocellulose, 1.6 parts of pitch and an oxidizing agent equivalent to from three to four parts of oxygen, a mixture containing thirty parts of wood-meal and an oxidizing agent equivalent to twenty-five parts of oxygen; a mixture containing twelve parts of pitch, and an oxidizing agent equivalent to

thirty-three parts of oxygen substantially as described and in the proportions specified.

2. A nitroglycerin explosive comprising fifty-eight parts of a mixture containing eighty-six parts of nitroglycerin, from three to four parts of soluble nitrocellulose, 1.6 parts of pitch and an oxidizing agent equivalent to from three to four parts of oxygen; from ten to thirty-seven parts of a mixture composed of thirty parts of wood-meal, and an oxidizing agent equivalent to twenty-five parts of oxygen, and about 2.5 parts of a mixture composed of twelve parts of pitch, and an oxidizing agent equivalent to thirty-three parts of oxygen, substantially as and for the purpose described.

In testimony whereof I affix my signature in presence of two witnesses.

OSWALD SILBERRAD.

Witnesses:

WM. W. ADAMS,

BERTRAM H. MATTHEWS.