

The first case is that of mixtures of dynamite and of sal ammoniac, which develops an amount of heat inferior to that caused by the detonation of dynamite alone. The speed of decomposition of the sal ammoniac is too slow to allow time for that decomposition to be effected, and in the effect of the detonation of the dynamite is doubtless to decompose a very small part of the mixed salt, and to project the rest, which acts as an inert body. It will be seen later on that the decomposition of sal ammoniac has not sufficient time allowed, even when the explosive is stemmed in a tin tube of 0.98 and 1.57 in. in diameter.

Ammonia-alum with dynamite seems to act differently to sal ammoniac, as the quantity of heat observed is almost equal to that deduced from the combustion of the nitro-glycerine and the dehydration of the alum. It will be shown, however, later on that there is reason to doubt the correctness of this conclusion. Moreover, these facts may well explain the capricious phenomena that explosives, especially the dual explosives, produce detonating unconfined, as regards the ignition of firedamp. When an explosive is not completely detonated the reactions consequent on its detonation cannot be precisely defined, and may vary a great deal under the influence of secondary conditions.—notably, they will vary when the explosive is fired by a more or less powerful detonator, when the explosive, at the moment of detonation, is raised to a more or less high temperature, the elevation of temperature producing complete detonation, &c.

The anomalies met with in the Prussian experiments and in the French thus receive a satisfactory explanation. It is supposed, consequently, that the safety of an explosive detonating imperfectly when unconfined, cannot be completely assured if among all the possible methods of decomposition for this explosive even one is found liable to ignite firedamp. The object to be attained in the search for an explosive of perfect safety, if one exists, is therefore to find an explosive always detonating completely when unconfined without igniting firedamp, or to find an explosive which, when partially detonating, cannot take any mode of decomposition capable of igniting firedamp.

Peculiar Phenomena exhibited by Low-nitrated Cottons detonating unconfined.

A very curious fact—an apparent paradox—is that compressed mining-cotton always ignites firedamp, and compressed military cotton, though more highly nitrated, and having a higher temperature of detonation, does not always ignite it. The experiments of detonation explain this anomaly. Indeed, the detonation of a cartridge of 772 gr. of military cotton has twice successfully produced a proportionately enormous pressure, which the pressure-gauge could only imperfectly register, but which must have been higher than 58.27 in. corresponding to 341.4 units of heat, or 3,097 units per pound. The decomposition of mining cotton—nonnitric cotton—should disengage about 1,862 units of heat per pound—aqueous vapour—and the heat from complete combustion is, according to Mr. Berthelot, about 4,232 units. It is therefore perfectly evident that the gases yielded from the explosion of mining-cotton are, after the explosion, burnt almost completely when unconfined. Why does this phenomena not occur with military cotton, whose gases are also combustible? It is difficult to reply. All that can be said is that an equivalent of a nitro-cellulose of n degree necessarily yields—if it be a thing that the decomposition produces only CO_2 , CO , H_2 , O , H , and N —a volume of combustible gas ($\text{CO} + 2 \text{H}$) equal to $(48 - \frac{5n}{2}) \times 22.32$.

The volume of combustible gas increases therefore as n diminishes. It is equal to $25.5 + 22.32$ litres = 568.7 for enneanitric cellulose, and to 20.5×22.32 litres = 457.2 for endecanitric cellulose. The gases from the detonation of the former are therefore a little more combustible than those from detonation of the latter. Nevertheless, it is singular that such a slight difference should have such a marked effect. However this may be, this well-ascertained phenomena immediately explains why cottons low in nitrogen such as that yield 0.68 cubic inches of NO_2 per grain, and whose temperature of detonation should be less than $3,632^\circ \text{Fahr.}$, easily ignite fire-damp, when military cotton yielding 0.81 cubic inches of NO_2 per grain, whose temperature of detonation was about $4,748^\circ \text{Fahr.}$, does not always ignite it. The mixtures of cotton-powder = 0.68, and nitrate of ammonia containing 80 per cent. and 90 per cent. of cotton, when exploded unconfined, disengage an amount of heat greater than the theoretical quantity. The oxygen from the nitrate does not burn off enough of the gases yielded by the decomposition of the cotton for them to remain capable of being completely burnt.

Explanation of the Phenomena presented by Mixtures of Gun-cotton and Nitrate of Barium.—Pyroxyline-powder.—The same phenomena allows the suggestion of an explanation of a fact which has astonished many. Pyroxyline-powder, which contains 60 per cent. of cotton (=0.71), 30 per cent. nitrate of barium, and 6 per cent. nitrate of potash, ignites the firedamp exceptionally, although cotton alone on the one side and mixtures with larger proportions of nitrate of barium on the other side invariably ignite. Gun-cotton containing 0.71 corresponds almost to octonitric cotton; its temperature of detonation is therefore about $3,632^\circ \text{Fahr.}$ This will not ignite the firedamp if the gases from detonation do not happen to burn unconfined, for it will be demonstrated later that the apparent temperature of ignition of firedamp under the influence of explosives is about $3,992^\circ \text{Fahr.}$ If the cotton is mixed with a sufficient quantity of nitrate of barium to burn the gases yielded by the explosion the temperature of the detonation is raised to $4,622^\circ \text{Fahr.}$, if this dissociation of the carbonate after explosion is assumed. This temperature is sufficient to ignite firedamp; but if the proportion of nitrate is diminished the temperature is lowered, and the gases of the detonation are burnt sufficiently by the oxygen of the nitrate to be no longer inflammable, and to act like those of military cotton. Mixtures could therefore be found, like that constituting the pyroxyline-powder, whose temperature of detonation will be so low that they will not ignite firedamp—at least, regularly.

Force of Explosives.—Hitherto the force of explosives have not been considered. This element is not the important element in the matters that have been considered. What the worker of a fiery mine first seeks is an explosion whose temperature of ignition will be so low that the detonation