

## Experimental researches on the decomposition of some explosives in a closed vessel; composition of the gases formed

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form of the circuits be altered, the variation of the stream of force emanating from one of the currents in the direction of the other is comprised in the terms  $d(I'V)$  and  $d(IV)$ ; and in order to value the action of a circuit upon itself it suffices to regard the factor  $U$  as variable. We thus find again the known equations of electrodynamic induction-currents.

The same mode of reasoning permits us to take account of the changes which have happened in exterior magnets, and of the magnetization produced by currents on masses of soft iron.—*Comptes Rendus de l'Académie des Sciences*, April 27, 1880, t. xc. pp. 981-984.

EXPERIMENTAL RESEARCHES ON THE DECOMPOSITION OF SOME EXPLOSIVES IN A CLOSED VESSEL; COMPOSITION OF THE GASES FORMED. BY MM. SARRAU AND VIEILLE.

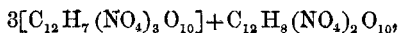
These researches were undertaken for the purpose of determining the conditions of the employment of gun-cotton in mines.

Since the important improvements introduced by Mr. Abel into the manufacture of gun-cotton, this explosive is prepared in homogeneous masses of determined form and density, it is kept without danger in the wet state, and its explosive force, comparable with that of dynamite, is much greater than that of gun-powder; consequently its use in mines affords great advantages. It presents, however, an inconvenience in that its explosion produces mephitic gases injurious to the workmen in the galleries. In fact its decomposition gives rise to the formation of carbonic oxide. This can be obviated by adding to the gun-cotton an oxidizer, such as a nitrate.

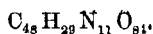
In this memoir we make a comparative study of the products formed, the heat evolved, and the pressure developed by the explosion in a closed vessel,—1st, of pure gun-cotton\*; 2ndly, of a mixture of equal parts of gun-cotton and nitrate of potass; 3rdly, of a mixture of 40 parts of gun-cotton and 60 of nitrate of ammonia; 4thly, of nitroglycerine; and, 5thly, of ordinary mining-powder†. We exhibit today the results of our study of the gases formed during the explosion in a closed vessel.

Some previous experiments having shown that the nature and the composition of the gases depend on the conditions of their production, and particularly on the pressure under which they are formed, we operated upon gases collected in a closed test-tube,

\* The composition, by weight, of gun-cotton, deduced from organic analysis, and verified by elementary analysis of the products of decomposition, has led us to regard the products of the manufacture current at the Moulin-Blanc works as a mixture of 3 eq. of trinitrated and 1 eq. of binitrated cellulose—



corresponding to the rough formula



† This powder consists, from its manufacture, of 62 parts saltpetre, 20 parts sulphur, and 18 charcoal.

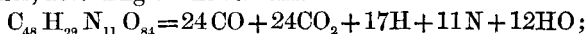
measuring the maximum pressure in the tube. The volumetric analysis of the gaseous products was completed by the absolute measurement of the volume occupied, at 0° temperature and normal pressure, by the gases from a determined weight of explosive. These are the principal results obtained:—

(1) *Gun-cotton*.—The composition and volume of the gases were determined under four conditions, differing by the mean density of the products. It follows from the numbers of experiment that, when the density augments, the proportion of carbonic oxide progressively diminishes, that of carbonic acid increasing.

The following formulæ, which very well represent the composition of the gases produced under the four conditions of our experiments, show what is the law according to which the decomposition of the substance is modified by the pressure; they correspond to the decomposition of 1 equivalent of gun-cotton ( $C_{48}H_{29}N_{11}O_{84}$ ):

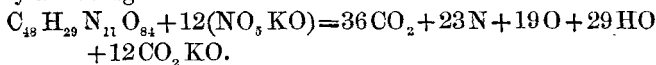
Density.	Formula of decomposition.
0.010 . . . .	$33CO + 15CO_2 + 8H + 11N + 21HO$
0.023 . . . .	$30CO + 18CO_2 + 11H + 11N + 18HO$
0.200 . . . .	$27CO + 21CO_2 + 14H + 11N + 15HO$
0.300 . . . .	$26CO + 22CO_2 + 15H + 11N + 14HO$

They indicate that, for increasing values of the density of loading, the carbonic oxide and carbonic acid tend to be produced in equal volumes, according to the formula



and it may be assumed that this formula represents sensibly the mode of decomposition realized under ordinary conditions in practice, in which gun-cotton is generally used in very dense charges.

(2) *Gun-cotton with Nitrate of Potass*.—The analysis of the gases shows that the oxidation of the explosive is incomplete under low densities of charge, although the proportion of the oxidant may be considerably higher than that which theoretically corresponds to complete combustion; but at 0.3 and higher densities carbonic oxide disappears, and the decomposition of the mixture takes place regularly according to the formula

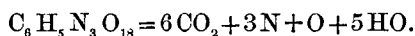


(3) *Gun-cotton with Nitrate of Ammonia*.—The combustion is complete, even under low densities of charge. The results of analysis show that the reaction corresponds to the equation

$C_{48}H_{29}N_{11}O_{84} + 22(NO_3H, NH_3) = 48CO_2 + 55N + 117HO + 3O$ , the first member of which represents exactly the composition of the mixture (deducting the humidity and the saline residue contained in the gun-cotton); while the second member is established on the supposition that the decomposition of the nitrate generates, in one of the modes studied by M. Berthelot, oxygen, nitrogen, and water.

(4) *Nitroglycerine*.—According to a remark by M. Berthelot, the composition of the products of an explosion can be foreseen when the explosive contains sufficient oxygen to transform the elements

into more highly oxidized stable compounds. This condition is fulfilled by nitroglycerine; in fact, experiment proves that its decomposition in a closed vessel is represented by the theoretic equation



(5) *Mining-powder*.—The composition of the gases was found sensibly the same for densities equal to 0·3 and 0·6; it is given below.

In a recapitulation we infer from these results the qualitative and quantitative composition of the gases furnished by each explosive under the normal conditions of its employment. The following Table gives the volume (in litres) of each of the gases, per kilogram of the substance, under those conditions:—

	CO.	CO <sub>2</sub> .	H.	N.	O.	C <sub>2</sub> H <sub>4</sub> .	HS.	Total.
Pure gun-cotton . . . . .	234	234	166	107	..	..	..	741
Gun-cotton with nitrate of potass . . . . .	..	171	..	109	45	..	..	325
Gun-cotton with nitrate of ammonia . . . . .	..	184	..	211	6	..	..	401
Nitroglycerine . . . . .	..	295	..	147	25	..	..	467
Ordinary mining-powder	64	150	4	65	..	4	17	304

—*Comptes Rendus de l'Académie des Sciences*, May 3, 1880, t. xc. pp. 1058–1060.

#### SUMMARY OF THE LAWS WHICH GOVERN MATTER IN THE SPHEROIDAL STATE. BY P.-H. BOUTIGNY.

I. *Temperature*.—The temperature of bodies in the spheroidal state is always below that of their ebullition: it is +97° for water.

II. *Non-equilibrium of Temperature*.—The substance in the spheroidal state never places itself in equilibrium of temperature with the vessel which contains it; its temperature is always in a state of stable equilibrium, whether it be in a capsule with free access of air or in the muffle of a cupel furnace. But if the body in the spheroidal state does not place itself in equilibrium of temperature, the vapour emanating from it always does so. These two phenomena are manifested very clearly when the operation is performed in a hollow sphere arranged *ad hoc*.

III. *Reflection of Radiant Heat*.—Matter in the spheroidal state reflects radiant heat.

IV. *Volume and Mass of the Spheroids*.—The volumes of matter in the spheroidal state are in the inverse ratio of their density; and their masses are equal among themselves.

V. *Repellent Force at a sensible Distance*.—This law is the most important of all, the richest in deductions; for we regard it as the antagonist of universal attraction.

On the floor of the Panthéon, in the axis of the cupola, upon a good charcoal fire a large platinum capsule is placed, and its temperature raised to the utmost possible. This being arranged, water is poured down from the top of the Panthéon (about 70 metres

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