and sultry day—that is to say, very humid, the boiler, strongly heated by the sun, being burning hot on the outside, and the internal temperature exceeding 104° Fahr. On account of these atmospherical conditions, these two experiments should be considered as somewhat abnormal. This point will be considered hereafter.

Study of New Explosives not igniting Firedamp.

The example of pyroxyline powder showed that it was possible to find an explosive which, fired without an envelope, did not ignite gaseous mixtures. The manufacture of similar explosives might be examined, so as to establish the general conditions which should be fulfilled.

Dynamite and Soda Crystals.—As has been seen in the historical introduction, a Prussian explosive manufacturing company has tried a mixture of dynamite with powdered soda. An intimate mixture of No. 1 Vonges dynamite with soda crystals, very freely powdered, does not ignite firedamp, exploding without envelope, when the mixture of the two substances is made with equal weights of both materials.

Dynamite and Crystallized Sulphate of Soda.—The carbonate of soda was replaced by crystallized sulphate of soda, with ten equivalents of water. It was ascertained that the mixture of dynamite and sulphate of soda in equal parts does not ignite firedamp, although the mixture containing two-parts of dynamite to one-part of sulphate does ignite it.

Dynamite and Ammonia-alum.—The sulphate and carbonate of soda are not only effervescent, but are also liable to become deliquiscent under atmospheric conditions which may occur in mines. They may, however, be replaced by a very hydrated salt, very stable, and having the advantage of being almost completely volatised when decomposed at a high temperature—viz., ammonia-alum. A mixture of dynamite and alum in equal parts did not ignite gas, but a mixture of two parts dynamite to one of alum ignited the firedamp once out of three tests. A mixture of four parts to dynamite to one of alum ignited it.

Dynamite and Sal Ammoniac.—If, in the preceding mixtures, the substancess added to the dynamite act by absorbing a part of the heat of the explosion in the volatilisation of water, the use of hydrated salt is not indispensable to procure the same result. It suffices that the salt be susceptible of decomposition at high temperature, thus absobing heat; and it is an advantage, as regards the useful effect of the mixture, that the products of decomposition should be gaseous. Sal ammoniac was considered very stable at ordinary temperatures, and is decomposed wholly into gases only at a high temperature. For such purposes the sal ammoniac should be very finely powdered—which is rather difficult—and very intimately mixed. With mixtures containing 67 per cent. of dynamite and 33 per cent. of sal ammoniac the gas was ignited. With mixtures of 60 per cent. dynamite with 40 per cent. of sal ammoniac ignition occurred once out of three experiments, but with mixtures of equal weight of dynamite and sal ammoniac there was no ignition of gas.

Dynamite and Coal-dust.—Most varieties of coal freely give off volatile products when raised to a low temperature. It was therefore permissible to suppose that mixtures of coal-dust and dynamite might produce the same effect as the mixtures as previously described. Dust of three kinds, from difierent coals, were supplied—one from Blanzy gave, on calcination in a closed vessel, 40 per cent. of volatile matter; the second, from Drocourt, Pas de Calais, contained 27·86 per cent. of volatile matter; lastly, the third, from Dourges, Pas de Calais, contained 23·6 per cent. of volatile matter. Mixtures containing one part of dynamite and one part of Blanzy—two tests—two parts dynamite and one part coal-dust—one test—and even four parts dynamite to one part of coal-dust—one test—did not ignite the firedamp. With equal weights there was no ignition either with the Drocourt or the Dourges coal-dust.

These experiments are interesting, but there is not much prospect of finding, in mixtures of dynamite and coal-dust, an explosive showing any security, for, in spite of the results of the experiments, it seems possible that with coal a little more inflammable, or under peculiar circumstances difficult to define, the coal raised to a high temperature may burn in the air. The result obtained with lignite renders this reservation necessary.

Dynamite and Lignite-dust.—Brown Coal.—Lignite yields a still larger proportion of volatile matter than coal. A brown coal coming from Germany, powdered under rollers at the Sevran Powder-mill, was used, containing 62·4 per cent. of volatile matter. A mixture of two parts dynamite and one part of lignite ignited firedamp. This result, although apparently contradictory to the former, is easily accounted for, if it is considered that not only is lignite much more inflammable than coal, but also that, on distillation, a kind of charcoal inflammable at a low temperature is produced.

Dynamite and Nitrate of Ammonia.—Guided by the theoretical reasons subsequently explained, experiments were made with mixtures of dynamite and nitrate of ammonia. These mixtures differ, however, from those which are known under the name of ammonia-dynamite, in that, not desiring to increase the mechanical effect of the explosive, the excess of oxygen in the dynamite and in the nitrate was not utilised by the addition of any carbonaceous substance. An intimate mixture of 20 per cent. of dynamite—No. 1 Vonges—and of 80 per cent. of nitrate, exploded unconfined, in two experiments did not ignite the gaseous mixture. Nitrate of ammonia does not play here altogether the same role as substances like sal ammoniac, because it is itself an explosive, and gives off heat in decomposing into nitrous oxide—N_2O—and water—H_2O—but it gives off less than dynamite, and explosive effect of the mixture is consequently diminished. The theory of this phenomena will be hereafter considered.

Gun-cotton and Salammoniac.—Gun-cotton has been mixed with various substances. This mixing is most difficult, and was effected under the lightest stones at the powder-mill. The first experiments were made with mixtures of mine gun-cotton and salammoniac. A mixture of 80 per cent. of mine cotton with 20 per cent. of salammoniac did not ignite firedamp; but a mixture of 75 per cent. of cotton and 25 per cent. of salammoniac did ignite it. It would be necessary, in order to insure a sufficent degree of security, to increase the proportion of salammoniac, but in doing so a non-explosive point is soon reached. Similar mixtures were, therefore given up.