Compressed Gun Cotton.

BY M. EISSLER.

Through the systematic study of Abel, an eminent chemist, this material has now attained quite a position in England, as by means of his analytical and synthetical researches he has found the causes of the instability observed in that substance, and has traced its occasional liability to undergo spontaneous combustion to the presence of minute quantities of foreign substances of comparatively unstable character, produced by the action of nitric acid upon resinous or fatty substances retained by the cotton fibers.

Some parts of his mode of manufacture may be considered comparatively safe, as he carries it on with the material in a wet, therefore uninflammable state. His mode of converting it into a minute state of division is the main improvement which he introduced, as it allows of a more perfect cleansing, and then its conversion into highly compressed masses is the main feature of his mechanical modifications; otherwise, he admits, one has only to follow Von Lenk's plan, and adhere to his rules.

The process of manufacture, as pursued by Prentice & Co. or the Liverpool Cotton Company, is as follows:

Clean cotton, picked as free as possible from foreign matter, is brought into a uniform and open condition, by being passed through a carding engine.

The rolls thus obtained are dried in a triple cylinder, by means of a steam jacket.

When completely dried it is placed in large tins and carefully covered.

After standing in these till quite cold, the cotton is weighed out in quantities of 1 pound each, and carried by a boy to the dipping vessel. Here each pan is charged with about 12 gallons of a mixture of 3 volumes of sulphuric acid, 1·84 specific gravity, and 1 volume of the strongest nitric acid, the whole being kept cool during the action by currents of cold water, which circulate around the vessel.

In this mixture the cotton is dipped, and after it has been in about three minutes the workman lifts it on to a grating, just above the acids. Then, with a movable lever, he gently squeezes it until, roughly speaking, it retains about ten times its weight of the liquid.

Thus saturated with the acids, it is allowed to remain in well-covered earthenware pots for twenty-four hours, the pots during this time standing in a shallow trough containing water to keep down the temperature, sufficient acid being added to cover the cotton. The chemical change in the cotton is now complete, and the further processes are for washing and pressing.

First, the large excess of acid is driven off by a centrifugal machine, and the waste acid is caught by a jacket surrounding the revolving portion of the machine, and collected in a receiver. These machines are on the principle of the wringing machines employed by laundries to dry clothes (whizzer).

On leaving the centrifugal machine the gun cotton has to be washed. This operation also requires great care, because the acids which the gun cotton yet retains would give rise to a considerable development of heat if mixed slowly with water. At such an increased temperature the gun cotton would be decomposed, or "fired," as it is technically called. Therefore it has to be brought at once in contact with a large body of water.

To perfect the washing, the cotton is subjected to the action of water for one, two, or three weeks, and afterward boiled in large vats by the injection of steam. By this latter operation the less stable compounds are destroyed and extracted, and the purified gun cotton is transferred to the heating tanks

This is a simple contrivance for converting the gun cotton into pulp. It is a machine similar to the one used in paper mills and called Hollander.

The pulp is now removed from the tank to a poacher, where it is agitated with a large quantity of water by a wheel, and here it has to be washed till it answers the heat test, which the chemist now applies.

When his report is favorable, the pulp is transferred to a vat and mixed with a small quantity of caustic soda.

The further processes of abstracting the water and moulding the pulp into cartridges or other shapes, is performed by hydraulic pressure or other pressing machines, which are very ingeniously arranged, and great credit is due to the manufacturers for the nice and elaborate machinery they have adopted for the treatment of their products.

Where the cartridges are made under light pressure they are put on perforated trays, and dried in chambers heated with hot air.

In establishments where the gun cotton is mixed with oxidizing salts, these are mixed in regular gunpowder incorporating mills, of light but very elegant pattern.

The great difference between the process of manufacture described above and that of Von Lenk consists in the introduction of the pulping operation devised by Abel. This improvement admits of very searching purification, and also of more reliable testing, and of the subsequent compression.

PROPERTIES.

Before it has been reduced to pulp, gun cotton has the same appearance as the original fiber, but it is harder to the touch; it has neither taste nor smell.

It is insoluble in water, ether, or alcohol. Dilute acids and alkalies have no action upon it, but a lower substitution product is formed by the action of nitric acid of the specific gravity, 1 45.

Strong sulphuric acid dissolves it with difficulty.

Caustic potash dissolves it.

Much uncertainty prevailed for a long time as to whether gun cotton was liable to spontaneous combustion or not. As I have shown in my former articles, it had been used in Austria for twelve years, where it underwent the severest tests, and was held by the best authorities to be perfectly safe, but it was at last rejected on account of its instability, and also that other governments abandoned it after experimenting with it extensively. Prof. Abel, in his valuable researches, ascribes the reason of its decomposition to be mainly due to impurity, generally resulting in the process of manufacture, from the action of the acids on resinous matter in the imperfectly washed cotton, and certainly the experience of the last few years speaks in favor of his theory, as no accidents from that score are on hand.

It is only in late years that the true cause of chemical instability, which belongs to the whole class of nitrated organic compounds, has been clearly defined, it being the life question of our modern high explosives.

After their nitration a certain portion of acid—sulphuric, nitric, and hyponitric—always adheres to those compounds, more or less, according to their form and structure. From a liquid explosive substance like nitro-glycerine, the acids are easily washed out by churning it with water first and then with alkaline solution. But a granular, flocky, or fibrous material, like cotton, retains the acids with far greater tenacity, particularly the nitrous and hyponitric acids, which every nitrated organic compound has a strong tendency to retain.

It is quite clear that if there is hyponitric acid present, that highly corrosive material, which attacks almost every organic compound, even at the ordinary temperature, must be removed; if not, it will slowly but surely lead to an incipient decomposition, which, acting on a nitrated substance, sets free portions of dioxide of nitrogen or hyponitric acid.

From nitro-glycerine the corrosive acid is washed out with the utmost facility, and from the moment when the importance of that operation became fully appreciated it has never been neglected. Hence the chemical stability exhibited by dynamite under all conditions of climate.

Although nitro-glycerine has exhibited, upon the whole, greater chemical stability than gun cotton, yet it acquires that superiority only after being thoroughly purified from acid at the factory. When it contains free hyponitric acid it cannot be stored at all in hot weather, and even during the course of its manufacture it has several times given rise to a decomposition, ending with explosion and loss of life. The instability of the crude article contrasts so strongly with the stability of the pure nitro-glycerine in dynamite as to remove every trace of doubt regarding the decomposing influences of the adhering acids.

FUMES.

Among the most grievous complaints of miners about modern explosives is the poisonous nature of the fumes emitted, which exposes them to most serious inconveniences.

The gaseous products of the explosion of gun cotton differ from those of nitro-glycerine, as gun cotton lacks 24·24 parts of oxygen in 100 for the complete conversion of its carbon into carbonic acid, consequently we have the following to be the percentage composition of the resulting gases:

Carbonic oxide	28·55
Carbonic acid	19·11
Marsh gas	11·17
Nitric oxide	8·83
Nitrogen	8·56
Aqueous vapors	21·93
Total	98·15

The large amount of carbonic oxide is very deleterious and even dangerous when pure gun cotton is exploded in a close place.

It is very clear to my mind why English manufacturers have adopted the admixture of oxidizing salts (saltpeter, nitrate of baryta) with gun cotton, as the oxygen contained in the salts effects a more complete combustion, rendering the resulting gases less obnoxious than those resulting from pure gun cotton.

GUN COTTON IN MINING OPERATIONS.

In the compressed form gun cotton is susceptible, like nitro-glycerine and its preparations, of explosion through the agency of an initiative detonation (cap). Compressed gun cotton may therefore be applied with the same facility as dynamite and analogous substances in all mining and blasting work. On a whole the mixture of gun cotton and salts is not as sensitive to concussion as dynamite, consequently an extra strong cap is required to detonate it. As the highest nitrated product of cellulose (trinitro) still demands 24·24 parts of oxygen for the conversion into carbonic acid of the carbon in 100 parts, it is evident that the most explosive gun cotton producible must be inferior in explosive power to nitro-glycerine, which contains a very slight excess of oxygen. Some authorities claim that, in spite of its high state of compression to which English manufacturers have brought it, its strength is much less than dynamite.

Here, also, it is clear why the English manufacturers have adopted the use of an admixture of oxidizing salts, as stated before; but the question will present itself: Is not the quickness of the explosion less rapid through this admixture than of pure cotton?

Where great local action is required, nitro-glycerine or dynamite competes advantageously with those substances. Some careful comparative experiments made by the German engineer corps, at Graudentz, with Nobel's dynamite and Abel's compressed gun cotton (made at the English government works), demonstrated that dynamite produced somewhat greater local or shattering effects than gun cotton.

The plastic condition of dynamite and similar preparations gives them an advantage over the rigid, compressed gun cotton in blasting operations, as plastic powders may be inserted more readily into rugged and uneven bore-holes, and may be made, by application of pressure, thoroughly to fill the part charged. Every miner is aware of the importance of having his charge well home in the bottom of his hole, filling the whole cavity. And this can only be accomplished with a plastic powder.

The increased effect derived from this mode of applying plastic explosives is far greater than is generally believed.

Volume for volume, it is impossible to put the same weight in a bore-hole for a certain given space; or, in other words, if one has a cartridge of dynamite, say one inch diameter and four inches long, and one of compressed gun cotton of the same size, the dynamite cartridge will weigh more; consequently one has more explosive material in the same space, owing to the higher specific gravity of dynamite, and as a consequence larger bore-holes are required when using gun-cotton, which increases the cost of mining.

The cartridges of compressed gun cotton are rigid, stiff, and every miner knows there should be no air chamber round the charge, for the expansion which it causes not only lessens the power in proportion to its dilution, but actually decreases the tension of the gas in a much greater measure. Stiff cartridges cannot be introduced into a bore-hole without leaving a considerable air chamber round the charge, particularly as bore-holes generally deviate a great deal from the circular shape.

It is difficult to calculate even approximately the relative proportions of the unoccupied space and the charge, but certainly the loss will amount to considerable. When a loose mass of gun cotton is ignited in the air it burns rapidly away without any explosive effect. But if the ignition takes place in a closed chamber, the gases first produced immediately penetrate the mass of the cotton, and the whole is instantaneously decomposed. According to some authorities gun cotton will not explode below a temperature of 280° Fah.

Gun cotton has the great advantage over dynamite that it does not freeze, and therefore needs no thawing out, which is appreciated in cold climates. It does not suffer from exudation, and when properly made has good keeping qualities.

One great advantage again of nitro-glycerine and its preparations is that they remain unaltered under water, and can be used in wet bore-holes with the same facility as in dry holes, and although compressed gun cotton, when containing 10 per cent or 15 per cent of water, can be exploded, it requires a very strong exploder or a dry primer to accomplish it, consequently for work under water dynamite is preferred.

The cost of these two materials also differs greatly; the expense of producing gun cotton must be 20 per cent or 25 per cent higher than dynamite; therefore, when the question of competition arises, the latter has the advantage.

In the last six or seven years there have been brought forward in England (since Abel perfected his system of reducing gun cotton to a fine state of division and compressing it) several special preparations of gun cotton, for which peculiar merits are claimed by their advocates. One of those preparations, manufactured by the Gun Cotton Company, is a mixture of finely divided gun cotton and saltpeter. Another, the Tonite Company, at Faversham, mixes gun cotton with nitrate of baryta. Which of these is the best practical experience alone can form the estimate.—*Mining and Scientific Press.*

ENGINEERING INVENTIONS.

An improved bridge has been patented by Mr. August W. Brenner, of Coleman, Texas. The object of this invention is to construct substantial bridges of wood adapted for long spans, and which can be put up where iron bridges would be too expensive. The invention consists in a bridge composed of arches having a central trussed portion, and ends formed as trusses that support the central portion and sustain the end thrust.

An improvement in ore washers has been patented by Mr. Burrall A. Peirce, of Mouth of Wilson, Va. The invention consists in combining guides and swinging shovels on the ends of blades, the latter arranged on the rotary shaft of an ore washer.

TEN years ago a blast furnace which would make 400 tons of metal per week on 600 tons of fuel was considered a big thing. We have blast furnaces in Pittsburg which produce 1,500 tons of metal per week on less than 1,500 tons of fuel. The old method of heating permitted the flame to pass out of the furnace stack at a temperature of 3000° F. We are now using the regenerating stoves in Pittsburg, and do not let the gases out until we have utilized all the heat except 300°.

THE International Geographical Institute of Berne has put forward a project for the establishment of an international school for training travelers. The programme of study is a formidable one, and is divided into two distinct divisions. The first includes instruction in numerous branches of knowledge more or less necessary for a traveler, and the second practical training in the field.