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Ohio Mining Journal

Title: Explosives

Creators: [Morris, Joseph L.](#)

Issue Date: 1894

Citation: Ohio Mining Journal, no. 22 (1894), 20-26.

URI: <http://hdl.handle.net/1811/32662>

Appears in Collections: [Ohio Mining Journal: Whole no. 22 \(1893 - 1894\)](#)

EXPLOSIVES.

BY CAPTAIN J. L. MORRIS.

Explosives are of far more importance among the comforts of life than most persons have any knowledge of. Without explosives, we could not make iron or steel, or make a single piece of glass, or build a substantial building of any kind or a railroad or canal; and without powder, all our fine-drawn theories about coast defenses or military organizations, drills and equipments would be pure nonsense. Let the listener stop a moment and try to imagine a state of society without explosives to mine our coal, iron ore, limestone and building stone. This, of course, would carry with it the total annihilation of all iron and steel tools or machines. Our saws, hatchets and axes would at once disappear, and we would step away back to the stone age. There could be no substantial buildings built without powder to blast stone for the foundation, and the greater part of all red brick are now made from blasted material. None of our fine block stone pavements could be gotten out without blasting explosives, and blasting has to open the quarries where our fine stone trimmings for brick fronts are gotten. True, the ancient Egyptians appear to have gotten out and hauled very large blocks of stone without powder, but that is now a lost art, for which great search has been made without success. The very pleasant practice of taking an annual vacation for pleasure and healthy recreation would have to be abandoned. There could be no buggies, carriages or street cars to take us to the station or steamboat landing, and there could be no rushing railroad train to take us at the rate of thirty or forty miles per hour to the cool, inviting, health-giving summer resort or to the coke regions of Pennsylvania where this institute visited last summer; and as for steamboat travel or a trip across the ocean in six, seven, or eight days, it would be utterly impossible, for without blasting to get out iron ore, coal and limestone, there could not be a single one of our fine floating and swift rushing floating palaces, for the best floating craft that could then be had would be a burned-out canoe, which we might, if we could find a suitable long splinter from a lightning-riven tree to use as a paddle. And there could



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not be any nice basket of provisions to accompany us for even one day off to the woods, with its fine assortment of pies, cakes, or cookies, for without blasting there could be no iron cook stoves or ranges to cook these on, nor any extra-fine roller process flour to make them from. But the best grinding or cooking that could be had would be two women grinding at the mill and then mixing it with water, and, without bolting or salting it, working it into cakes and baking it on the coals, fresh for every meal; and our fair lady friends could not have a nice new dress (just made for the occasion), with latest patterned towers of very fancy-colored trimmings, for without blasting there could be no iron or steel to make the carding, spinning or weaving machinery to make the fancy dress goods, nor a pair of scissors to cut them, nor a needle to sew them, or even a pin to hold them in position. In short, without the blasting of minerals, we would have to abandon all that steam engines now help to produce. All our comfortable home furniture, kitchen, bed-room and parlor sets, and carpets, would be unknown, and we would at once step into the simple style of living, practically, as Adam and Eve did when they first started house-keeping outside the gates of the Garden of Eden.

GUNPOWDER.

A compound of nitre, charcoal, and sulphur, employed as an explosive. In proportion, approximately, 75 per cent. nitre, 15 per cent. charcoal, and 10 per cent. sulphur. In common blasting powder, nitrate of soda is substituted for nitre (or saltpetre). The saltpetre comes from the Indies, and is shipped from Calcutta. A cheaper grade, but not less effective, is made by the conversion, in this country, through a chemical process, of nitrate into nitre of saltpetre. Brimstone comes from Sicily.

Nitrate of Soda.—This article is shipped from Valparaiso and other South American ports; mined in Peru and Chili.

The date and author of the invention are buried in obscurity. Sebastian Munster (1544) wrote concerning it, that tradition and literature generally ascribed the discovery of "the dreadful cannon" to the year 1380, and that the majority believe the inventor to have been a monk, adding that the villain who brought into the world so mischievous a thing is not worthy that his name should remain in the memory of man. This allusion refers to "Black Marthel," or Berthold Schwartz, a monk of the Hartz or the Rhine-land, concerning whom there is much dispute. The following condensed extract from a long chronological statement compiled by Rziha, shows the controversy about Schwartz to be of Subordinate importance :

A. D. 80. The Chinese (according to tradition) had already obtained from India a knowledge of gunpowder.

A. D. 215. Julius Affricanus (according to Meyer) described its preparation.

A. D. 690. The Arabs used fire-arms against Mecca, bringing knowledge of them from India. From this time on, the allusions to the use of gunpowder became far more numerous and authentic. Plainly, its military use was revived in Germany, and carried thence to Italy. There is a record of a powder-mill at Augsburg in 1340; and in 1344 Petrarch describes the terrible effects of the newly invented, but already widely used, powder and cannon. In 1378 the English had four hundred cannon before St. Malto; in 1397, mines were exploded with powder before Herat; and the same tactics were employed on a larger scale at Belgrade in 1441, and by the Turks in 1529 at Vienna and 1565 at Malta. England imported gunpowder from Sweden and elsewhere until 1560, when its domestic manufacture began.

The employment of gunpowder for blasting rocks is far more recent than its military use. In 1613, Martin Weigel, Chief Superintendent at Freiburg, proposed boring and blasting in mines.

Reckoning from 1613, the process was carried to England by German miners after 57 years, to Sweden after 111 years. For 72 years the bore holes were closed with solid plugs instead of clay tamping; for 83 years the practicability and advantage of small holes were unknown; and for more than a century the operation of blasting was considered as merely auxiliary to the work of pick, gad, hammer and chisel. The manufacture of powder has been greatly improved, from time to time, in mechanical details, effecting both the safety of the process and the quality of the product. The first step was the preparation of the ingredients.

The mixture is commenced by pulverizing the charcoal and sulphur together. They are rolled in barrels with small iron balls for about six hours, and are ultimately reduced to extreme minuteness. The saltpeter is then added, and another rolling with zinc or copper balls is given. The mixture is then carried to the mill, where it is moistened with water, and placed in a large, circular pan or trough, in which iron wheels, weighing several tons and having broad treads, are rolled by machinery, triturating and kneading the powder into the most intimate mechanical union. The milling is the most dangerous part of the process, and a year seldom passes at a powder factory without one or more explosions at the wheel mills, though the precautions are such that these accidents are seldom disastrous.

The powder withdrawn from the wheel trough is very lumpy and irregular, it is, therefore, reduced by a breaker to a fine meal, in which it is transferred to a very powerful press. The meal is stacked into the form of a cheese, 2 or 2½ feet square and 3 or 4 feet high, consisting of layers of powder 1 to 2 inches thick, separated by plates of copper or vulcanite. The press reduces the bulk of the powder nearly one half, and delivers it in sheets five-eighths of an inch thick, which, in hardness, lustre, and fracture, resembles thick slates. The degree of pressure to be given is one of the most important considerations in the process of manufacture, since the ultimate density of the powder is determined by it, and in turn determines the rate of combustion. By merely varying the degree of pressure, the powder may be made either violently and destructively explosive, or mild and easy in its action. The press cakes are broken into grains by passing them through corning mills, and the different sizes of grains are separated by passing the whole over a succession of sieves of varying mesh. The grains thus obtained are sharply angular, and require rounding and smoothing to prevent their thin edges from being ground into dust by the wear of transportation and handling. While still moist, the powder (now granulated) is put into rolling barrels, slowly revolved from six to twenty-four hours, and when withdrawn, smooth, lustrous, and free from angularity. Sometimes the glazing is heightened by the addition of a minute quantity of graphite. A single table spoonful of this substance will impart its peculiar lustre to half a ton of fine powder. Its presence has no appreciable effect upon the action of the powder, nor upon its preservation. The last operation — drying — takes place in a room heated by steam to 130° or 140° F.

Some months after the arrival of Irenee Du Pont in the United States from France, circumstances called his attention to the bad quality of powder made in this country, and gave him the first idea of erecting works for its manufacture. He returned to France, his native country, in January, 1801, and, having formerly been connected with the Government powder works, was enabled to secure plans and models. Returning to the United States in August of that year with some of the machinery, he commenced the erection of works on the Brandywine River, near Wilmington, Del. After many disappointments and losses, his energy and courage surmounted every obstacle. The company which he was the founder of, is, no doubt, the largest manufactory of gunpowder in the world.

The first to manufacture gunpowder west of the Allegheny Mountains were the Austins, who, in 1833, erected works near

Akron, Ohio. Later on, they became owners of the works established near Cleveland by Isaac Brayton in 1851. In 1867, the Akron and Cleveland works were conso'idedated under the name of the Austin Powder Co. of Cleveland, since which time the company has continued to increase in importance as manufacturers of sporting and mining powder. The company has just completed a new and expensive plant for the manufacture of sporting powder, in Solon Township, on the Cleveland & Canton R. R., which enables the company to increase its output of mining powder at the old works located just outside of the City of Cleveland.

As an old miner in the United States of America for the last thirty-one years, and having used nearly all the brands that have been manufactured in the country, I must say that for all practical purposes in which powder is used, I have had better results with the Austin powder than any other.

Powder is a dangerous thing,
On this we'll all admit;
And yet we cannot get along
Without it in the pit.
Electric power will mine the coal,
And drill without a frown;
But must get Austin powder
To make the coal come down.

THE CHAIR: Gentlemen, you have heard Mr. Morris's paper. He always honors us with a little reminder of his office as poet laureate of the institute. The paper is now before you for discussion.

PROF. HENRY C. LORD: I have been very much interested in this paper of Captain Morris, as it recalled an experience of my own, some few years ago, when I can hardly say I had the pleasure, and still I will put it that way, of spending about two months in a powder mill near Xenia, Ohio. It is situated on the Little Miami River, about three miles from Xenia. One of the most interesting things, I think, to an outsider, is the precaution taken about that very matter of explosion. The works occupy an extent of ground there of about a mile or a mile and a half long and perhaps a mile wide. There is not a two-story building or a stone building or a brick building in the entire thing. The buildings are very small, and they are all frame. Like the

United States government publication that was sent out with regard to the precautions to be taken against the tornado; they summed up by saying: "Do not build your buildings to withstand tornadoes. Build them cheap, so you can build again after the tornado is past." These buildings are isolated. The power was supplied to them by means of wire ropes. Steam engines were located in some cases as far as nearly a thousand feet from the building in which the power was used. Each building was surrounded at a distance of perhaps thirty feet from the building by a high wall a good deal like a base-ball back stop; that is, it was a frame structure made out of boards about 6 inches wide, and separated with air spaces. Some of the buildings—the most dangerous buildings, had large earth embankments built up around them. With regard to the power of the explosion, there is one of the large glazing mills there in which the powder is mixed with the black lead and polished, which has quite an extensive foundation. The foreman takes you over there and points you to the foundation, and tells you that was done by an explosion. There is a large hole in the ground, and the whole thing was excavated by one of the explosions that occurred a few years ago.

Another precaution which is taken is this: the soda houses, as they are called, the places where the nitrate of soda is used, always have a sign, "Do not throw water on this building if it catches on fire." This is one of the things you must not do. If you get water on it, then an explosion occurs. I thank you for your attention. I enjoyed the paper very much.

MR. J. A. HANLON: I think it is on account of the extreme modesty of the Captain that he left out part of the information on the question of explosives. He failed to say that it was on account of explosives that he has gained the title of Captain. If it was not for the explosives, we would not have had the war in which he gained his title.

THE CHAIR: The question of the manufacture of explosives, of course, is one of great interest now-a-days, and it is a curious thing that with the growth of these extremely danger-

ous explosives, or high explosives, that the manufacture appears to be attended with less and less risk. I was reading recently some articles regarding the manufacture of what is called explosive gelatine, which is a jelly-like mass, made by dissolving gun cotton in nitro-glycerine. When you dissolve about 7 per cent. of gun cotton in nitro-glycerine, it turns to a jelly, which is safer than nitro-glycerine. It does not run so easily as nitro-glycerine and does not freeze so easily. I was surprised to learn that in a number of years in England there had not been a single accident from this explosive, an explosive which is ten times as violent as gunpowder, the precautions have become so extreme.

I understand that there is a paper here by Mr. Hibbs on "Mine Surveying," which I believe is to be presented by Mr. E. D. Haseltine.