POWDER, PRESSURE & REGULATION

Powder has a dramatic effect on shotgun and rifle performance. Historically, we understand to a degree the significant change between Black Powder and Smokeless Powders. To the eye then, one would assume a double rifle... say of the 450/400 3” vintage as an example, would react well to Ammunition so labeled, be it Ely Kynoch or B.E.L.L. Wrong!

To appreciate and enjoy any English Firearm to the fullest, a complete understanding of the powder contained within the loads intended for its use, should be of paramount to the would be user.

POWDERS

A gun is an instrument whereby the controlled detonation of certain gases or powder results in the safe expulsion of a projectile from its muzzle. These powders are termed *propellants.*

Propellants are varied as the application. Many changes have been made over the years to perfect the sporting and military powders used today.

In order to obtain regular ballistics, a propellant must be stable and not sensitive to shock, temperature, or long periods of storage. It must burn at a controlled rate, round after round, in order to produce a heated gas which when expanded, generates pressure which in turn propels the projectile. A propellant which burns too fast increases pressure quickly. This stress on the *breach* and *chamber* area would break a gun not so strengthened; therefore a slower, continuous burning powder is desirable.

Case capacity adds another element. A slow burning powder in a large case can produce equally rapid increases in pressure. Consequently and ideally, a cartridge would then include a measure of progressive *propellant* capable of moving a projectile down a given distance of barrel with a slow burning powder displacing minimal excess case capacity. Such propellants are called ***“progressive powders”.***

In a shotgun, many ways unlike a rifle, a large charge of powder delivering high pressure at the muzzle is very undesirable. It has been learned that when the desired velocity had been quickly achieved that pattern dispersion was improved when a nominal pressure was experienced at the muzzle. Also note as lack of resistance in a shotgun smooth bore does not require constant pressure down the barrel as terminal velocity has been achieved upon firing; where a rifle barrel requires sustained pressure throughout the barrel until exit. **“Muzzle blast”** is another unnecessary product of muzzle pressure.
So we find a ***propellant*** requirement for shotguns to be a low pressure, quicker burning powder. The ideal gauge for this formula is the 12 gauge gun with 1 ¼ oz. shot. Why?

Because the smaller diameter of the bore the more resistance. The more resistance, the greater the pressure.
But what about the larger gauges? Good question.
The 10 gauge has about the same chamber pressure of the dainty .410. The difference lies in constriction true but add to that size and weight of the shot or projectile providing the resistance. So a small gauge has high pressure issues the same as larger ones.

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Powders can be defined in one of three categories: those whose substance cannot be **penetrated** by hot gases; those that are **partially penetrated**; and those which are **penetrable.**

It should be evident therefore that the first type could only burn on the surface; the second a combination of surface and partially internal; while the last burns inside and out due to total penetration of hot gases.

NON-POROUS POWDERS

Those powders of the first category, termed **"non porous",** are controlled by limiting the surface area of the propellant. These can be sticks or grains.

Cordite powder is an example of a non-porous powder. Made up in sticks, the rate of burn is controlled by the shape, length and cross section of the powder.

Cordite varies in degree to which it is intended.
A *circular cross section*, the combustion is initiated on the surface. However as the burn continues, the surface area becomes smaller. The result is a smaller and smaller combustion. A poor progressive powder.
A flat taper cross section, the combustion begins on the outside maintaining a constant shape during combustion.
A tubular stick cross section, in this case the powder burns from the inside making a larger surface area while the outside is diminished simultaneously. The result is a constant burn rate during combustion.
A cylindrical stick in cross section has perforations thru the sides as well as the length. In this type, combustion increases as the burn advances, giving a progressively faster burning result.
A stick of powder is composed of two different types of propellants. The outer layer a slow burning powder, combined with a inter core of fast burning powder, resulting in a true inter progressive combustion burning powder.
Progressive powder is a term described in Mr. Nobel's 1869 patent. This example is technically the only progressive powder but, due the physical size difficulties of this type, it is most associated with ordinance.

The term **"progressive powder"** is used today in reference to any powder which displays the characteristics of low initial pressure and constant barrel pressure. But, do not refer to those which have been **"surface moderated".**

Surface moderated powders are those in which the surface has been coated with a limiting substance. These have been used in small arms where the practicality of progressive powder to be reduced in size is unworkable.

Cordite, a non-porous powder can be either granule or stick form. The stick powder burns slower than an equal weight of granules due to the increase of surface area on the exposed ends. Therefore, granules are more inclined to be used in small arms which allows for ease in loading and handling, while the sticks remain for large case capacity cartridges.

SEMI-POROUS POWDERS

The second type of powder is one in which the hot gases of combustion partially penetrate the surface of the powder. This is to say the powder is non-porous, as in the Cordite example and well perforated as like a progressive powder, with this difference: Porous powders derive their holes and perforations chemically.

During the manufacturing process, powder grains are mixed with very fine particles. The grains are then treated with a chemical solvent which removes the particles leaving a semi-porous powder. The rate which this type of powder burns can be controlled by the size and amount of particles induced in the manufacturing process.

These powders are most commonly used in shotgun and small rifle cartridges.

POROUS POWDERS

The third type of powder is one in which the hot combustion gases thoroughly penetrate during burning. Powders of this type are termed **Nitrocellulose**.

To the eye this powder would appear to be so much cotton and do this lack of visual substance one would expect the powder to be extremely volatile. Such would no doubt be the case except for the incorporation of a non-explosive retardant. This non-explosive component retards the progress of combustion which stabilizes the burn, making a powder which can be easily handled and loaded as well.

POWDER COMPOSITION

BLACK POWDER:

Black Gunpowder, the oldest propellant known, is still safe to use, stable at various temperatures, and maintains a shelf life of 100 years or more provided the powder is not contaminated by moisture.

The chemical composition of Black Powder is:
Saltpeter…………………..75%
Charcoal………………….15%
Sulphur.…………………..10%

After these chemicals are thoroughly mixed together they are then compressed, after this process the powder cut and broken into grains of various sizes. These variations of sizes, as well as shapes and perforations, control combustion.

The size of the grain was classified by number. As a finished product the most common and used in British shotguns was No. 4 T.S. (Triple Strength). A powder known for best results and purity of chemical ingredients.

Potassium Nitrate (saltpeter) in composition as black powder, has some undesirable side effects after combustion. Namely smoke. The gases formed from the 75% nitrate formula generate and inefficient 44% per cent of the combustion gas, leaving 56%... volatile solids. This 56 % waste combustion explains the enormous quantity of smoke seen after firing a black powder weapon.

Efforts were made to improve the smoke condition by the use of other nitrates as a substitution for potassium.

Sodium Nitrate was used in the place of potassium because of the similar reaction in the powder formula. However, while the result was cost effective and generally produced higher combustion, sodium has a unique attraction to moisture. Once damp the powder was virtually worthless.

Barium Nitrate, was another attempt to cure the problems of smoke and the shortcomings of moisture contamination. But, as a replacement of potassium it was not to be. Barium produces large quantities of residue in the barrel (fouling) from unignited powder. Reduce smoke however it did, and can be seen as the first real attempt toward the development of a truly smokeless powder.

Pyrodex is a **modern** black powder refinement. Composed of the same chemicals of potassium nitrate, charcoal and sulphur; Pyrodex has a binder added to their mixture. This adds to the overall cohesiveness of the powder and lends itself to a different manufacturing process.

In addition to the powder being bonded or glued if you will, it is further moderated with another chemical which produces a more progressive burn. The end result is less powder residue and fouling. A welcome improvement.

One of the significant advantages is that the auto-ignition temperature is 750 degrees. Some 50% higher than black powder. And while this higher ignition temperature could present some disadvantages to flintlock shooters, it does make for a much safer powder to use, store and transfer.

NITROGLYCERINE POWDERS

The discovery of the compound known to the world as nitroglycerine was achieved in 1846. The compound is made by treating glycerin with nitric and sulphuric acids.

Many years of experimentation with this extremely volatile and sensitive substance was done before it could be used for any worthwhile purpose. The many accidents that occurred kept the development at bay and prohibited its use in other countries until an accidental discovery in 1875 changed the history of explosives forever.

It is said that the inventor Nobel, had painted a cut on his hand with a solution of collodion. Accidentally, his hand became contaminated with nitroglycerine. The collodion, he noticed had gelatinized.

Experiments carried out in 1862 in his attempt to stabilize the clear oil substance of nitroglycerine, Nobel tried absorbing it in various materials. One of those materials was cellulose or wood pulp, which among other things lead to the development of **Dynamite**. Continuing along these lines of experiment together with the acquired knowledge of collodion, was developed **Collodion Cotton.**

Collodion Cotton. Collodion combined with nitroglycerine forms a gelatin. This gelatin combined with cotton (cellulose), forms nitrocellulose and was called **Blasting Gelatin**. Also called **Jelly Nitro** in a more refined form today.

Blasting Gelatin:
Nitroglycerine………………..92%
Collodion Cotton……………...8%

Ballistite. In 1887 Nobel discovered a method to control the very violent explosive nature of Blasting Gelatin and make it suitable as a propellant.

Nitroglycerine with Collodian Cotton was immersed in water. Mixed, this solution formed a mass, with the texture of rubber. Heat rolled out and compressed to separate the water in fine paper like sheets, the product was then cut into various size flat grains.

This gelatinized powder is volatile. Containing no nitrates, it produces little smoke except perhaps from moisture. Pure in the sense that it is 100% explosive compound.

Development over the years has corrected some of the earlier problems associated with this powder. Temperatures were high, often combined with small quantities of residue in the barrels (Nitric acid), caused corrosive problems which will be covered later.

Cordite Mark I. This is a British powder used in rifles. In its original form it consisted of:
Nitroglycerine……………….58%
Guncotton…………………...37%
Mineral Jelly…………………5%

The problem with this propellant is that it was severely erosive. The mineral jelly in the composition was added to retard the process of the mixture by cooling the gases during combustion. I'm afraid it wasn't enough. For many a gunsmiths bone yard the remnants of fine early rifles can be seen.

As in most nitroglycerine powders the high temperature gases would bypass the projectile and burn away the throat area continuing on to the lands and groves. The freckling you have seen in some of the more fortunate rifles are reminders of this malady.

Many of these rifles so affected still shoot very well. The problem of course lies not with retained accuracy, but with **pressure.**

Initially free boring occurs with throat wear, raising pressures well beyond proof limits. Eventually your fast moving .240 and .275 flanged cartridges however will loose substantial velocity from gas blow by.

Cordite M.D.. Is a "modified" improvement over the difficult Mark I. The problems were never quite overcome but, barrel life was improved with the new formula:
Nitroglycerine………………30%
Guncotton…………………..65%
Mineral Jelly………………...5%

Explosives and Ordinance Powders

Well in this area of discussion I'm afraid and I have been told to proceed with caution. So I will consult with my peers on this section but will introduce some food for thought as it pertains to a new area of projectile flight of interest to me and that is Hypersonic Flight. In order to achieve High Velocity (Over 6,000 fps) and Hypersonic flight (Over 10,000 fps) one has to address a combination of things to get there. We have discussed to some degree here in the "News" about Projectiles and now we come to the issue of Powders. This is why we have had this little discourse or history lesson to bring us to where **Karl Lippard projectiles and ammunition** steps off the planetary scale. Considered dangerous to many to discuss such ammunition or projectiles I think I will part here until my parameters are established and then hopefully we can bring you into the 21st century

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Stay with us for "Part Two".

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