GUNPOWDER

Gunpowder is a mechanical mixture of Potassium Nitrate, Charcoal, and Sulphur plus a small amount of water. Today the standard mixture of ingredients is as follows:

KNO_3	= 75%
Sulphur	= 5%
Charcoal	= 10%.

The Potassium nitrate provides the oxygen. KNO_3
The Charcoal provides the fuel.
The Sulphur acts as a binder and adds energy to the mixture. It also enters into the chemical reactions taking place when gunpowder burns by reacting with potassium nitrate and becoming potassium sulphide thus tying up some of the Carbon dioxide, which would otherwise become potassium carbonate. This would mean less gas being produced. It also slows the chemical reactions taking place.

Flame, spark and friction easily ignite gunpowder. When dry it is compatible with most metals but will attack almost all metals when moist.

Gunpowder is known by several names.

Gunpowder	British
Blackpowder	American
Poudre noir	French
Schwarzpulver	German
Polvere negra	Italian
Polvora negra	Spanish
Chornyi porokh	Russian
Yuenyaku or Kokoshoku-yaku	Japanese

The physical properties of gunpowder.

FORMULA	IGNITION POINT	POWER	burning rate
$74KNO_3 + 16C_6H_2O + 32S$	510^0	10	300

The properties of gunpowder as an explosive are determined by its physical nature. Since it is a mechanical mixture of substances, none of which are themselves explosive, any reactions must

perforce take place between each individual particle. As a result of this, gunpowder will not detonate and requires confinement to achieve its full explosive effect.
Gunpowder acts in the following manner when ignited:

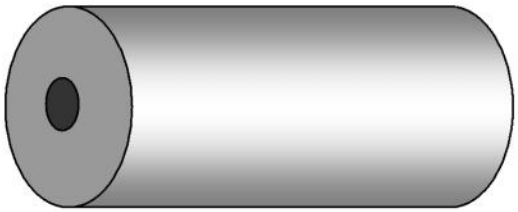
$74KNO_3 + 16C_6H_2O + 32S \longrightarrow 56\ CO_2 + 3CH_4 + 2H_2S + 4H_2 + 8K_2S_2O_3 + 2KCNS + (NH_4)_2 + CO_3 + 14CO + C + 3S$

Approximately 15% of these chemicals are solids that are deposited in the bore of the weapon. This is one of the great problems with gunpowder and it is not something that can be avoided.

Now that the substance had finally arrived, the users of the day began to encounter problems with this exceedingly dangerous material. The early problems for the explosives technicians (it is a bit early to call them explosives experts) related to the formulation and the control of the substance. Originally the ingredients were mixed in a loose powder form which was simply known as powder. This mixing took place at the gun site wherever that might be. This was done because they soon discovered that if you mixed the ingredients elsewhere and then transported it the substance separated into its constituent parts. This original powder had no name other than the powder or gunpowder, however the introduction of the type of powder called 'corned" because it was shaped like a piece of corn required that the old loose powder be given a name so that people knew which powder was being discussed. The name chosen was "Serpentine" because of the shape of the early matchlock ignition system. Serpentine powder had several major drawbacks:

- It tended to separate into its constituent parts during movement,
- Over ramming tended to reduce its explosive force and,
- It is very hygroscopic.

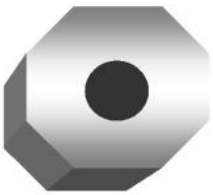
The explosive workers of the day commenced mixing the ingredients in a moist condition, which was then pressed into a cake and then broken up into pieces, the pieces then being coated with graphite. This process solved the problems of over-ramming and separation. The problem of hygroscopicity will never be completely overcome, as the potassium nitrate is by nature hygroscopic. The next step in learning to control the burning rate was the realization that an increase or decrease in the surface area of the explosive went some way toward controlling the rate. Large grains equal smaller surface area therefore slower burning, smaller grains equal large surface area therefore faster burning. This resulted in the introduction of the type of Gunpowder called "Pebble" because the grains were produced in a form very much like pebbles. The ultimate step in this process was the introduction of the types called “Mammoth” which was just as it sounds, a large grain of gunpowder with a hole down the middle. This powder gave very steady, almost neutral burning and was ideal for large calibre weapons. Capt. T.J. Rodman developed mammoth powder in 1861. "Prism" powder is also as it sounds. A large grain of gunpowder shaped as a prism. It is readily apparent that the grains have a small surface area in relation to the amount of gunpowder and the shapes lend themselves to packing neatly inside charge bags thus giving a small charge container for maximum efficiency. The smaller surface area slows down the explosive reactions a little so that prism and mammoth powders could be used in larger calibre guns with manageable pressures.



MAMMOTH POWDER
This powder was one large grain the approximate size of the bore which was an attempt at getting GP to burn neutrally.

The proportions of Prism powder were

KNO3 = 79%
Charcoal = 18%
Sulphur = 3%



Several other versions of prism powder existed and some of these were:

PRISMATIC POWDERS

P Brown & SBC 79% 18% 3%

EXE 77 1/16 17 10/16 5 5/16

The proportions of Gunpowder may be varied over a wide range without any obvious effect, as the following table will clearly demonstrate. What is not obvious is that there is a percentage of water in the mixture that plays a part in the overall behavior of the gunpowder. The burning rate is affected more by the surface area of the grains than the mixture ratio, which, as shown below can be varied without any adverse results. The purity and fineness of the ingredients also play an important part in how the gunpowder will burn. A variation in the timber used to produce the charcoal will also affect the burning rate.

COUNTRY	KNO3	CHARCOAL	SULPHUR
ROGER BACON	37.5	31.25	31.25
AMERICA 1775	75.2	13.5	11.3
AMERICA today	75	15	10
AUSTRIA	75.5	14.5	10
BELGIUM	75	12.5	12.5
CHINA 1200	72.6	19	8.4
ENGLAND 1600	75	12.5	12.5
ENGLAND today	75	15	10
FRANCE	75	12.5	12.5
GERMANY	74	16	10
HOLLAND	70	16	14
ITALY	75	15	10
PORTUGAL	76	13.5	10.5
RUSSIA	75	15	10
SPAIN	75	12.5	12.5
SWEDEN	75	15	10
SWITZERLAND	76	14	10
TURKEY	75	15	10

The development of prism powder was just about as far as the engineers of the day could go in controlling this nasty gunpowder beast. They did create some other types along the way as remedies for problems that occurred and some of these are:

SULPHURLESS GUNPOWDER

Sulphurless Gunpowder consists of a mixture of

70.5% KNO_3 and
29.5% Charcoal

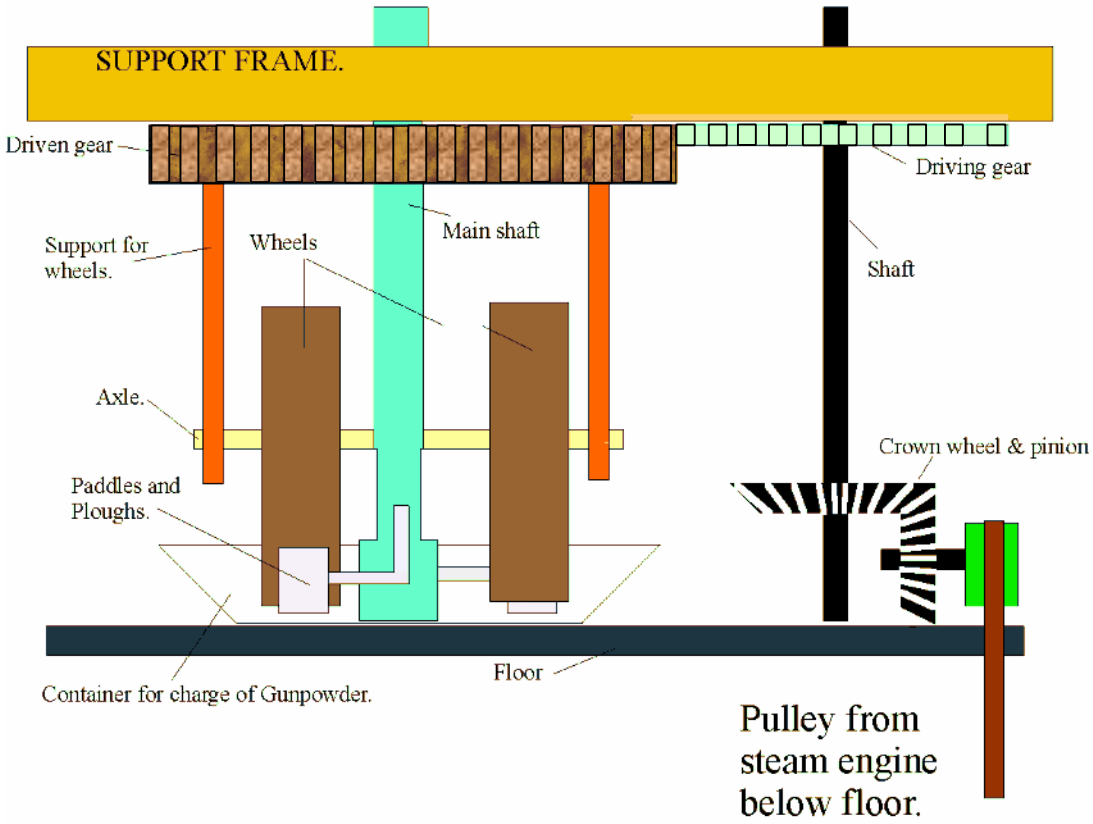
It is made in the same way as ordinary gunpowder and is referred to as SFG, meaning Sulphurless Fine Grain. It is more easily ignited than ordinary Gunpowder and is used to a considerable extent in pyrotechnic compositions since many of these mixtures form sensitive or unstable compounds when in contact with Sulphur. It was originally introduced for igniters of Cordite cartridges because the Sulphur reacted with Cordite Mkl. The absence of Sulphur as a moderating influence ensures that SFG burns somewhat hotter than other types of Gunpowder, thereby generating more pressure in the breech.

BROWN POWDER

Gunpowder is black because the charcoal used is normally black, however some types of wood will produce a brown charcoal. Using this type of charcoal will produce what is called "brown" powder. This has the advantage that it is slightly less smoky than black powder and it gives slightly greater velocity. In comparison with "black", Brown powder is slightly more difficult to ignite but unfortunately it is more sensitive to friction. This powder was also known as “Cocoa” especially in the American services where it was used as late as 1898 in the Spanish/American war. Some examples of Brown powder as shown below:

Country	Saltpetre	Brown C	Sulphur
England	79	18	3
England	77.4	17.6	5
Germany	78	19	3
Germany	80	20	0
France	78	19	3

GUNPOWDER.

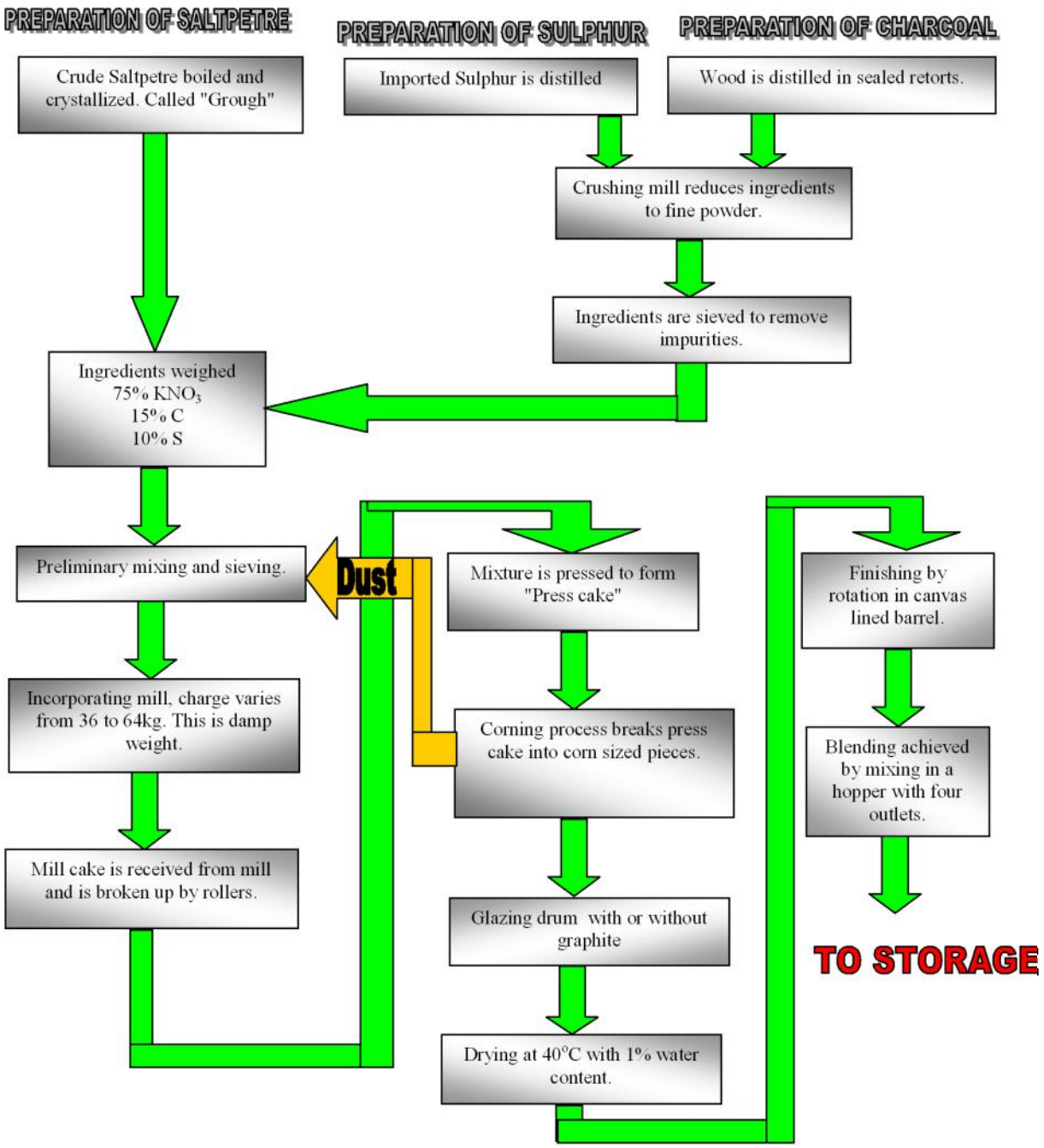


SCHEMATIC LAYOUT OF

INCORPORATING MILL.

The wheels used in these mills were from 4 to 8 tonnes in England and from 8 to 10 tonnes in the USA. Each wheel was provided with a scraper so that it did not pick up large lumps. The paddles and plows were made from either phosphor bronze or hardwood. The wheels were also offset so that they did not run in the same path thus ensuring a good mixing. The wheels themselves were made at various times from stone, iron and phosphor bronze.

THE MANUFACTURE OF GUNPOWDER



Gunpowder is made by first taking the raw ingredients and grinding them in mills to very fine degree. Taking great care that the Sulphur mill is well earthed to prevent ignition by static electric sparks. The Potassium nitrate was suitable for use as received from the refinery. Potassium nitrate was also extracted from old gunpowder that had deteriorated while in storage. Approximately 40kg of the three ingredients were weighed out in the necessary proportions, allowing a small extra margin for the moisture content in the potassium nitrate. The materials were given a coarse mixing in a mechanical mixer, which consists of a drum inside of which are a series of arms. These arms and the drum rotate in opposite directions thus ensuring a good mix. The ingredients are then passed through a sieve before being sent to the Incorporating mill.

In the mill the charge, which is now known as the "green" charge and is approximately 136kg, is placed on a flat iron bed with 2 rollers mounted much like a set of steam-roller wheels and with leather covered wooden ploughs and rakes mounted below and in front of the rollers. The entire apparatus is driven by whatever power source was available at the particular time in history. The rotary motion of the rollers and the sweeping action of the ploughs ensured a complete blending of the ingredients. The blending process was carried out for approximately 3 hours with the wheels turning about 10 times a minute. The mill was provided with a water flushing system so that any untoward ignition was instantly deluged with water. The green charge was also dampened down with distilled water to maintain the moisture levels. The content was dependent on the use for which the powder was intended. The milled cake produced contained approximately 2% to 4% water content.
Two-percent powder was destined for use as small arms powder
Four-percent was for guns of larger calibre.

The incorporating time was in the order of 3 to 6 hours but it could be reduced if necessary such as during the First World War when it was reduced to 2 hours. At the end of that war all those "short milled" powders were very quickly declared obsolete.

The milled cake is then passed through some rollers which reduced it to a fine state called "Mealed" the pressure at this stage is kept to approximately 4 kg per sq. cm to reduce friction to a safe level. This meal is then passed through a hydraulic press where it is pressed to approximately 28 kg per sq. cm. great care is taken to ensure that the press was well earthed at this time. The press cake is then broken up and passed downward through a series of inclined screens and rollers so that the grains become progressively finer. At this stage the dust is removed by passing the grains through a rotating dust reel.

The grains are then polished by rotating in a drum for several hours with the addition of graphite to enhance the moisture resistance of the gains. Some powders are glazed without the addition of graphite. Drying takes place in the stoving room where steam heating is used to dry the grains, which are spread out on wooden trays. The last stage is to remove any dust produced during the drying and to give the grains a last polish. The dried and polished grains are then placed in a large hopper with four outlets along with three or four other batches of gunpowder. The gunpowder is then poured into four containers the contents of these containers is poured back into the hopper then split into the four containers again this procedure is continued until complete blending of the batches is achieved.

British Grades of Gunpowder

SIZE	PASSES THROUGH	RETAINED BY
P3	.75 "	.375"
G3	.375"	187"
G7 (KNOWN AS RLG 2)	.25"	No. 8 SIEVE
G12 (KNOWN AS RFG 2 or FG.)	No 8 SIEVE	No. 16 SIEVE
G20	No. 16 SIEVE	No. 25 SIEVE
G40	No. 25 SIEVE	No. 52 SIEVE
MEALED POWDER	No. 150 SIEVE	No. 240 SIEVE
FUZE POWDER	.0336 "	No. 25

British sieve sizes

No. 8 = .081"
No.16 = .0305"
No. 25 = .0236"
No. 52 =
No. 150 = .0041"
No. 240 = .0026"

Abbreviations

RFG = Rifle Fine Grain
RPP = Rifle Pebble Powder
RLG = Rifle Large Grain
SMI = ?

AMERICAN BLACKPOWDER
Nominal composition

Potassium Nitrate	= 74%
Charcoal	= 15.6%
Sulphur	= 10.4%

And they grade their powder in the following manner.

A1 = igniting charges and primers
A2 = flash reducers
A3 = Special purposes
A4 = Base charges, friction primers, smoke puff charges and spotting charges.
A5 & A6 = blended together for primers, pellets, safety fuse, and tracer igniters.
A7 = chemical ammunition

A1 is the coarsest granulation and A7 is the finest. A1 through A4 are glazed with graphite.

USA Black powder granulation

DESIGNATION	SIZE (in mm)	APPLICATION
CANNON	3.35	25mm bore and upward.
Fg	1.75	Large bore Rifle and Carbine calibres.
FFg	1.45	Small Rifle, Large pistol and shotguns.
FFFg	.96	Small bore cartridges and muzzle loaders.
FFFFg	.43	Very small cartridges, blanks and priming.
MEAL	.25	Fine priming powder, pyrotechnic additive.

The Americans also use a composition based on
Sodium Nitrate, which is as follows:

Sodium Nitrate	= 72%
Charcoal	= 16%
Sulphur	=12%

Sodium Nitrate based powder is graded according to the following:

Class A = saluting charges
Class B = Practice bombs
Class C = Torpedo impulse charges
All classes are graphited (Class A is the finest granulation)

The gunpowder made from Sodium Nitrate was introduced by Lammot duPont in the interests of economy because Sodium Nitrate is cheaper to obtain. They are however more hygroscopic, slower burning and slightly less energetic. The Americans seemed happy to tolerate these drawbacks for the large savings obtained by the use of Sodium Nitrate.

There is a compound called "Benite" which is being used in place of black powder in some situations and it is composed of the following:

Nitrocellulose	= 40%
Potassium Nitrate	= 44.3%
Sulphur	= 6.3%
Charcoal	= 9.4%

Testing has shown this material behaves in much the same way as a single base propellant (q.v.).

Much work has been carried out on a substance called "PYRODEX" which was to be the replacement for gunpowder. It consists of the following ingredients:

Gunpowder and a mixture of pyrotechnic compositions.

Unfortunately it has not lived up to the expectations eagerly awaited by the blackpowder shooters. Several factories have mysteriously exploded and have in fact killed the originator of the powder.

A note to the thinker.

It seems fashionable today that with the mention of the discovery of gunpowder goes the immediate assumption that it was used solely for the propulsion of missiles to deal death and destruction to all and sundry. That it was the agency by which nations fell, the feudal system was destroyed and all the ills of mankind exacerbated by this new and fiendish invention.

Not entirely true!

It has been used for many worthwhile purposes, such as the entertainment of millions with fireworks right up to the present day. It enabled cheaper, deeper and more profitable mining which gave us the wherewithal to develop better, more equitable societies. Because of the greater access to coal and minerals the science world was enriched beyond belief and it freed many men from toil and drudgery doing things by hand. Because of its liberating influence we were freed from the restrictions of horsepower.

It enabled greater engineering projects than hitherto possible thus bettering our living conditions.

It gave us more and better chemicals in life as the scientists investigated the chemical world around us. As our society became more affluent men began to address all the social evils of the old world and began to introduce social reform. As we became richer we were able to look further afield for new lands into which to spread and develop new nations.

And not the least, it has given decent men the wherewithal to resist the tyrant bent on world enslavement.