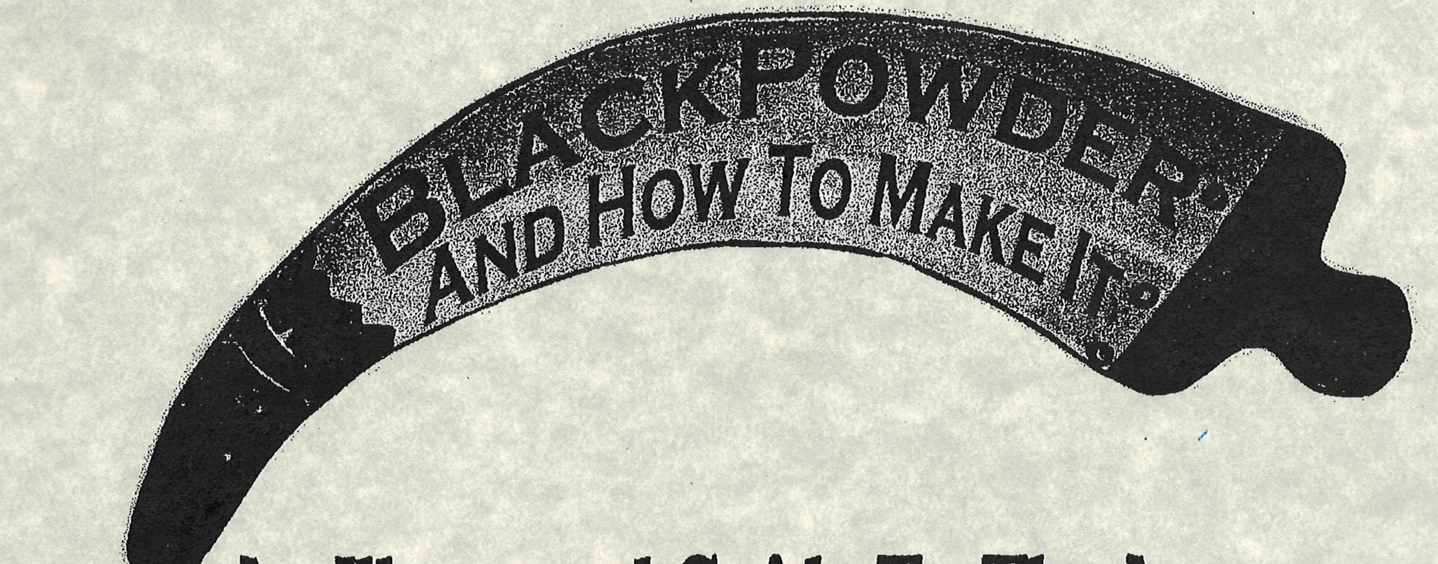
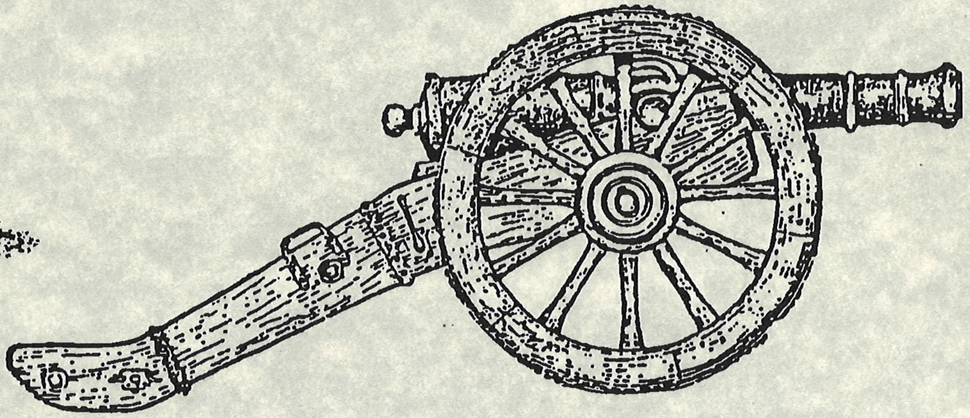
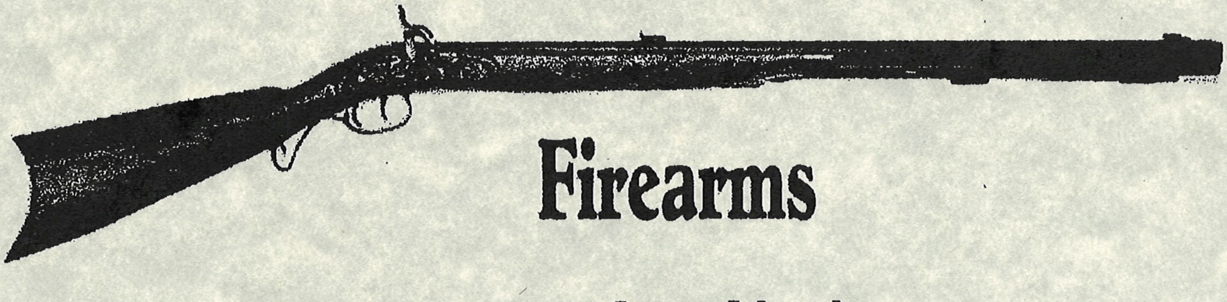


An Illustrated Guide To The Amateur Production Of Blackpowder



Especially For Use in Blackpowder



Firearms

Second Edition

By Randy & Leigh Ellis

BLACK POWDER
and
HOW TO MAKE IT

By
Randy & Leigh Ellis

In the history of mankind there has been no chemical formula that has had more profound effect on mankind than that of black powder. Even nuclear energy has not changed mankind to the extent that black powder has.

For hundreds of years the process of manufacturing black powder was a closely guarded secret. Black powder was a luxury item which was affordable to only the most powerful nations. Black powder has radically changed the history of governments through the use of guns and cannon.

The Industrial Revolution would not have happened as it did without black powder for mining coal and iron. Only black powder made the largest engineering projects of the 18th and 19th centuries possible.

NOW, for the first time, the manual **BLACK POWDER AND HOW TO MAKE IT** will show you how to make your own black powder.

The author will take you through each step and operation. He doesn't just show you how to make black powder, he tells you the reason, the **WHY** of each step and operation in easy to understand terms so that you have all the knowledge at hand to make your own black powder for use in fireworks, rockets, blasting, and in black powder firearms.

L & R Publishing
P.O. Box 3081
Everett, Wa. 98203

Library of Congress Number TX 2-430-837

L & R Publishing Company

P.O. Box 3081

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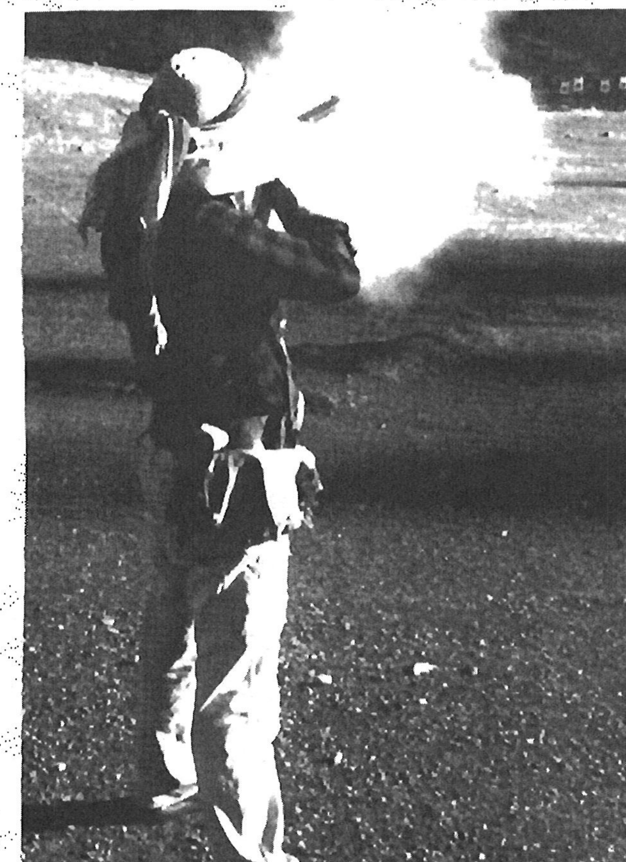

By
Randy & Leigh Ellis

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Introduction

In all the publications that we have researched dealing with black powder firearms, we have found out that you can make your own guns, you can cast your own shot, and you can make all the tools necessary for shooting black powder firearms, but not in one of these publications have we ever seen any detailed information on the production of black powder by an individual for the purpose of shooting in black powder firearms. And that is why this guide to the production of black powder has been written.

The history of black powder started at some time prior to 1000 A.D. and an observant person recognized the unique properties of a blend of potassium nitrate, sulphur and charcoal; thus black powder was developed as the first high energy composition.

The discovery of a mixture of potassium nitrate, sulphur and charcoal that is capable of doing useful work is one of the most important chemical discoveries of all time. This chemical energy made huge engineering projects possible and gave access to minerals deep within the earth, and as such, helped in bringing on the Industrial Revolution.

Much of the history of Europe is related to the availability and usage of black powder in rifles and cannons. A good powder master was essential to the military successes of the time.

The first black powder mills were established in America around the year 1775. Prior to this time, the making of black powder in the 13 colonies was a small scale household industry. In 1775, there was a small pamphlet published by Henry Wisner, a member of the Continental Congress on the making of black powder by individuals. At that time, the finest black powder came from France, and by comparison, the American produced black powder was considered much less refined. By the late 1700's there were more than 200 black powder facilities in operation in the United States. Most of the production sites were small; the largest producing just over 125 tons per year.

In 1799, a Frenchman by the name of Du Pont came to America. He had a son who had studied the manufacture of black powder in France and upon seeing the poor quality of American produced black powder, decided to start a production facility of his own.

By 1802 Du Pont was making what was considered the best black powder available.

The chemicals used for making black powder have remained the same since the Chinese wrote about it in 1044 A.D. The ratio has varied with time and location and the particular type of black powder desired.

By the 19th century, the procedure had been well standardized. The following is a brief description of how black powder was made at that time.

Before mixing the chemicals together, they would be pulverized individually by placing each chemical in wooden barrels and rotated with cannon balls. Next, they would be dried and weighed, and then mixed and placed under heavy iron wheels weighing 10 to 50 tons each. Water was then added. The length of time needed for this mixing and crushing depended on the type of powder being made. Top quality sporting powder was milled three times as long as blasting powder. After milling, by using a hydraulic press, this powder cake as it was called, was pressed into individual ingots two feet square and about two inches thick using the "stack method", which we will show later.

This pressed ingot of black powder was then put through a machine which broke it into large grains about two inches square. Then these grains were aged and sent to a chipping machine which automatically broke and screened the large grains into smaller grains of the proper "F" grade size. These fine grains of black powder were then dried and tumbled grain upon grain, until worn perfectly smooth.

At this time, graphite was added and retumbled for water resistance, and to make the grains pour more smoothly.

This is the information, the only information, that is available to the general public, except for this manual.

As you can see, trying to make black powder from this information would take years of experimentation and testing to find information like the proper ratio of chemicals, the amount of time it should be milled, the amount of moisture when it is pressed, the amount of time and pressure when pressed, the proper grain size, and ways of breaking up the ingots into proper grain size as well as a system of testing the black powder when it was finished. So that is what we did.

We took years of testing and experimentation to come up with ways to make black powder as easy as possible, so that an individual with limited resources can make black powder for rockets, fireworks, fuse and blasting, and especially for shooting in black powder firearms.

Safety was always first and foremost in our minds. We felt that safety would have to be built into every step and procedure. We also tried to stay with ready-made tools as much as possible, but we had to invent certain tools which could be made by anybody that could read and understand simple instructions.

We have broken the production of black powder into two sections; the first section shows how to make a fine powdery black powder that may be used as is for rockets, foreworks and blasting. Section Two shows how to take this fine powdery black powder and further refine it into dense grains for use in black powder firearms.

We've done a lot of research and put a tremendous amount of time, energy, and work into researching and writing this manual, and it is our sincere hope that you make this into an enjoyable hobby as an extension of your interest in black powder firearms.

The Chemicals

The first thing we'd like to say is that all your chemicals should come from the same source all the time. The reason for this is consistency. If you use chemicals from one place one time, and chemicals from a second source the next, you will not get the same results. So remember, always purchase your chemicals from the same source.

Before the modern chemical era, acquiring the potassium nitrate, sulphur and charcoal was about one half the process of making black powder. Now that the chemicals are readily available, it makes the production of black powder by an individual much easier.

NOTICE

At the time of this printing, potassium nitrate sold for 35¢ per pound, sulphur 55¢ per pound, and charcoal 75¢ per pound, when purchased in 50 pound bags.
Potassium nitrate and sulphur may be purchased from your local fertilizer supply outlet; activated charcoal may be purchased from your local chemical supplier. Use the "Yellow Pages" of your local telephone directory.

The first chemical we're going to talk about is potassium nitrate. Potassium nitrate is a white soluble solid with a melting point of 333 degrees Centigrade. It is formed by fractional crystallization of sodium nitrate and potassium chloride solutions. This potassium nitrate is usually 99% pure. It either comes granulated, powdered, or in small round balls. Potassium nitrate is the main ingredient in black powder. Black powder contains approximately 75% of potassium nitrate by weight. It has a very high oxygen content of 39.6%.

Potassium nitrate has basically one function in black powder and that is upon ignition, it produces the oxygen that is needed to burn the charcoal and the sulphur. Potassium nitrate will not explode by itself.

The second chemical we're going to discuss is sulphur. Sulphur is a yellow element with a melting point of 112.8 degrees Centigrade. Sulphur can be mined or manufactured and has been known to mankind for over 4,000 years.

It's function in black powder is mainly as a fuel, but it also acts as a firestarter. Sulphur's low melting point produces a liquid phase at a low temperature to assist the ignition process. Small changes in sulphur content can dramatically effect the ignition temperature and energy levels of black powder.

In black powder, sulphur also acts as an oxidizer. It's available as a powder, or in little round balls. Because of sulphur's very low melting point, it is one of the reasons black powder is so sensitive to spark. Sulphur makes up about 10% of black powder.

The third chemical in black powder is charcoal. Charcoal is a black form of carbon produced by partly burning or oxidizing wood in kilns from which oxygen is not allowed to enter.

Historically speaking, willow and alder have been the woods preferred for the preparation of charcoal by black powder manufacturers. Charcoal comes as either small chunks, or a fine powder. Black powder contains about 15% charcoal by weight.

Charcoal has several purposes in black powder; 1) it absorbs the potassium nitrate and sulphur; and 2) upon burning it acts as a fuel. Charcoal causes high heat and a large gas output as well as a rapid burning rate.

It is also very useful if it has been put through a tempering process that changes it into activated charcoal. The activation of charcoal turns regular charcoal into a super absorbant sponge. Upon mixing charcoal with a mixture of potassium nitrate and sulphur, the charcoal will <u>want</u> to absorb these other two chemicals.

Safety Tip:

Potassium nitrate creates oxygen upon heating and should not come into contact with any undesireable chemicals, oils, or open flame. Sulphur has a very low melting point and it can burn and should not come in contact with flame. Charcoal is easily ignited due to it's fine condition and it too should not come in contact with open flame or unnecessary heat. These chemicals are safest when they are separated from each other.

Consistency:

Consistency first, last and always. Always purchase your chemicals from the same source each time. Buying chemicals from different sources will have an adverse effect on your black powder production. Do not use charcoal briquettes. They are mostly clay and fillers and will not work for use in making black powder. Horticultural charcoal will work fine if it has been fully processed.

Chemical Ratios

Almost every country that made black powder before 1800 used a different recipe for potassium nitrate, sulphur and charcoal ratios. We have listed here the most popular ratios including the Du Pont ratio of 1804 which is the standard of today for black powder firearms.

Recipe by Bruxelles in 1560

Ratio In Percentages		500 Gram Ratio
75.00%	Potassium Nitrate	375 Grams
9.38%	Sulphur	46 9/10 Grams
15.62%	Charcoal	78 1/10 Grams

Early American & British Standards

Black Powder for Cannons

Ratio In Percentages	500 Gram Ratio
74.84% Potassium Nitrate	374 2/10 Grams
11.84% Sulphur	59 2/10 Grams
13.32% Charcoal	66 6/10 Grams

Black Powder for Rifles & Pistols

Ratio In Percentages	500 Gram Ratio
75.7% Potassium Nitrate	378 5/10 Grams
9.9% Sulphur	49 5/10 Grams
14.4% Charcoal	72 0/00 Grams

Black Powder for Blasting

Ratio In Percentages	500 Gram Ratio
64.4% Potassium Nitrate	322 Grams
20.4% Sulphur	102 Grams
15.2% Charcoal	76 Grams

Old French Standard for Military Use

Ratio In Percentages	500 Gram Ratio
75% Potassium Nitrate	375 Grams
10% Sulphur	50 Grams
15% Charcoal	75 Grams

Du Pont's Sporting Powder for Rifles and Pistols (1804)

Ratio In Percentages	500 Gram Ratio
78% Potassium Nitrate	390 Grams
10% Sulphur	50 Grams
12% Charcoal	60 Grams

Prior to World War I., core burning rockets used the following chemical ratios.

Composition A

Ratio In Percentages	500 Gram Ratio
56.2% Potassium Nitrate	281 Grams
12.2% Sulphur	61 Grams
31.6% Charcoal	158 Grams

Composition B

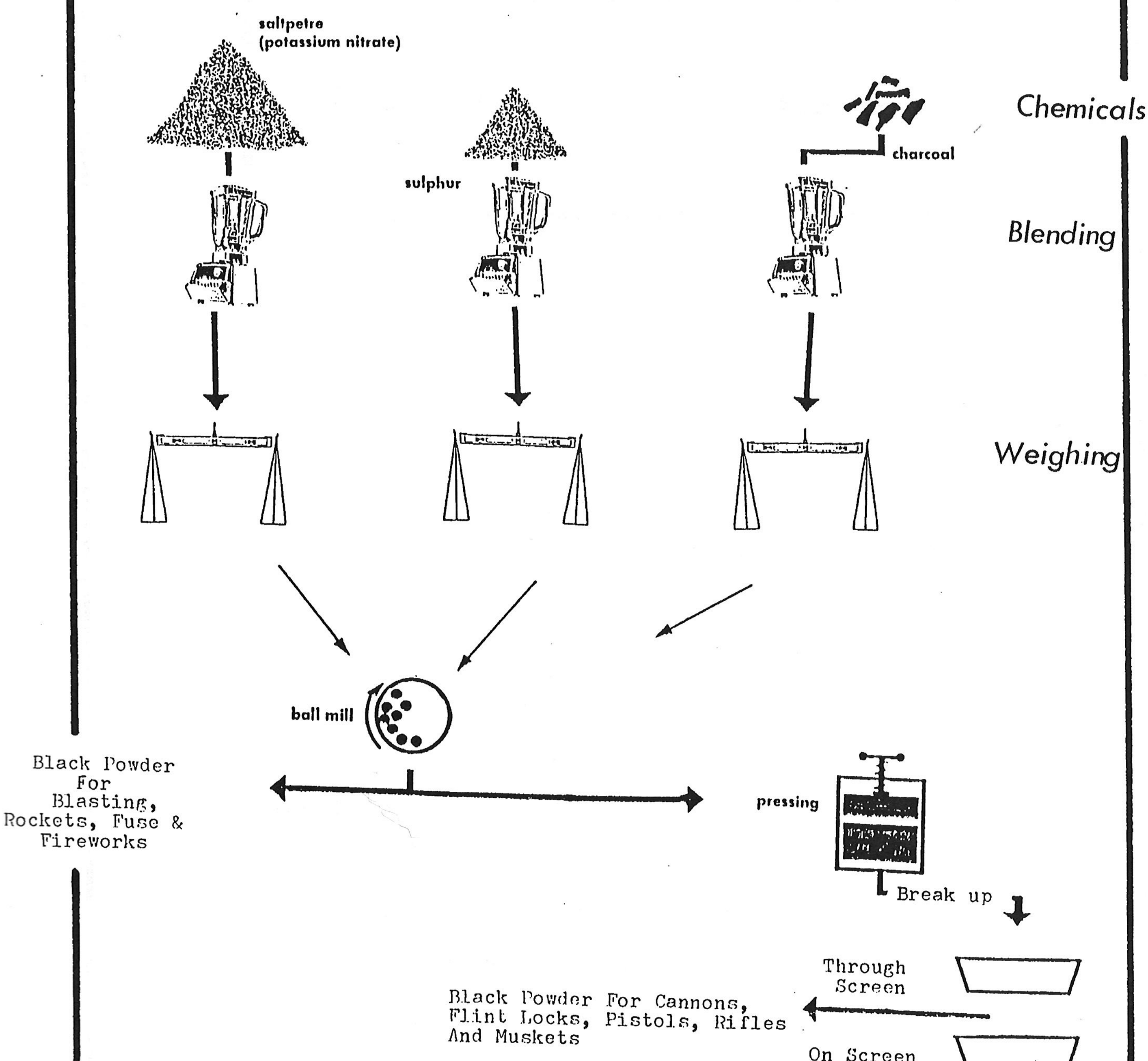
Ratio In Percentages	500 Gram Ratio
53.9% Potassium Nitrate	269 1/2 Grams
13.5% Sulphur	67 1/2 Grams
32.6% Charcoal	163 Grams

Composition C

Ratio In Percentages	500 Gram Ratio
72.8% Potassium Nitrate	364 Grams
13.6% Sulphur	68 Grams
13.6% Charcoal	68 Grams

For end burning rockets, the old French Standard was used.

The Basic Process



As you can see from the map above, the chemicals are first pulverized and weighed, then placed in a ball mill. When they are removed from the ball mill, this powder can then be used for a number of chemical projects, or you can further refine this powder into high density grains for use in black powder firearms; see Section Two.

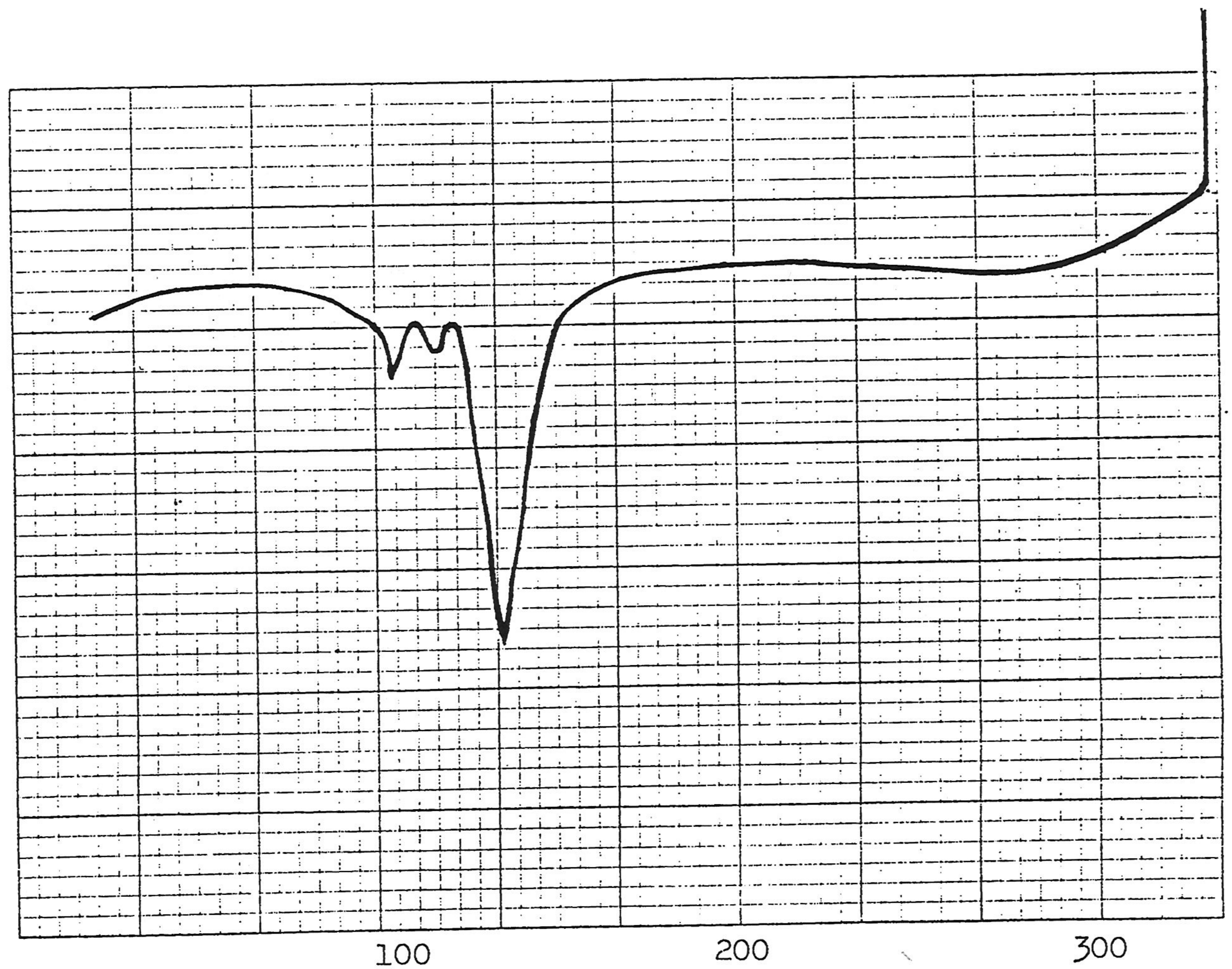
The Chemical Process

Let's heat one gram of black powder until the point of ignition and see what takes place. As we add the heat, the temperature rises at approximately 105 - 119 degrees Centigrade as shown on the chart. At this point, the sulphur melts into a liquid state. If we add more heat, and bring the temperature of the black powder up to 130 degrees Centigrade as shown on the chart, the potassium nitrate melts and starts to produce oxygen; up to 39.2% by weight. If we add more heat, the charcoal heats up and at about 330 degrees Centigrade, ignition takes place. Fifty per cent of the black powder is converted into the gases, nitrogen, carbon monoxide, carbon dioxide, hydrogen sulfide, methane, hydrogen, and sulphur dioxide; the other 50% is converted into chemical salts such as potassium sulphate, potassium carbonate, ammonium carbonate, and carbon residue. As you can see from this, the chemical process is not a simple one.

The chemical reaction of black powder upon ignition will produce 250 to 300 milleters of gas. The heat output is estimated at 500 to 750 calories (depending upon chemical ratio), at approximately 2700 to 3880 degrees Centigrade. As you can see, the reaction produces gases which occupy a much larger volumn than the solid black powder. If this reaction takes place in a confined space, a very high pressure is developed in a fraction of a second. This pressure will also have an effect on the <u>burning rate</u> of the black powder. The more pressure, the faster the black powder will burn.

The burning behavior of black powder varies in performance, depending on the situation. If you take a small pile of black powder and ignite it, it will produce a flash and a puff of smoke, but no noise. If the same black powder is sealed inside of a paper tube that is ignited, it will produce an explosion. Pour a little black powder along a line and ignite it on one end. It will burn along this line, thus a fuse. If this black powder is placed in a tube with one end open and ignited, hot gasses will flow out through the path of least resistance, making a rocket motor. If the black powder is placed in a tube with one end sealed and a lead ball placed on top, upon ignition you have a gun. As you can see, black powder has a large variety of uses to which it can be put.

Black
Powder's
Reaction
To
Temperature



Safety

Safety cannot be over-emphasized. Black powder is after all, an explosive/propellent that is very, very spark sensitive.

It is spark sensitive because of the low melting point of sulphur and the oxygen potential of potassium nitrate in combination with fine charcoal.

The following is the list of rules that must be adherred to for your own safety and the safety of those around you.

Rule #1. No smoking or heat, flame, or friction that might cause a spark, is to come in contact with black powder.

Rule #2. Watch out for static electricity. How many times have you walked across a carpet and touched a door knob or another person and had your finger snap with a small spark? This effect can and has set off black powder in large manufacturing facilities. These factories immediately ceased to exist, due to one little spark. Of course, they were dealing with hundreds, if not thousands of pounds of black powder at one time, which brings us to Rule #3.

Rule #3. Keep your mixtures low in weight. A maximum of 1000 grams.

Rule #4. Keep electrical cords and outlets away from black powder, especially when plugging in or disconnecting electrical equipment; each time a piece of electrical equipment is plugged in or unplugged, there is a small electrical spark that can ignite black powder.

Rule #5. Always have a fire extinguisher at hand.

Rule #6. Keep children and adults away from your place of manufacture, especially if they have not read or understand the safety rules.

Rule #7. Have your own place to do your black powder work and keep it locked when you're not there.

Rule #8. Check to make sure that your ball mill does not leak, for if it does, black powder might get into the windings of the electric motor and a fire/explosion could result. This is why we suggest buying only the best grade tumblers available. We have had no problem with this, but it doesn't mean it can't happen.

Rule #9. Do not let your chemical mixture come in contact with <u>any electrical motor windings</u>. These windings produce heat that might cause a fire/explosion.

Rule #10. Your ball milling should be done somewhere so if for some uncontrollable reason it detonates/explodes, it will do little or no damage to the surrounding area or people/animals.

Rule #11. Do not store more than one pound or 500 grams of black powder in any one place.

Rule #12. Always use non-ferrous tools such as wood, aluminum, brass or copper. This will drastically cut down on accidental sparking.

Rule #13. Keep it clean. This might be Rule #1. Don't let any spilled chemical or black powder stay spilled. Clean it up with a wet rag which you should always keep at hand. Wash all tools and equipment immediately after using.

Rule #14. Don't forget to use a magnet to remove any ferrous material after pulverizing.

Rule #15. Be <u>consistent</u> in keeping the safety rules.

Reminder: Remember, the finer the black powder, the easier it is to ignite, so this means that black powder is extremely volatile right after it comes out of the ball mill when it is at it's finest and driest.

The Tools

The first tool that you will need is your common kitchen blender. This blender will be used for pulverizing the individual chemicals into a fine consistency before weighing and milling.

The reason for using a blender is that it will save you 18 to 24 hours off of your milling time. It will quickly reduce the chemicals to a consistency that can be easily handled by the ball mill.

The next piece of equipment that you will need is a lapidary tumbler which we will show you how to make into an excellent ball mill for reducing the chemicals into a very fine consistency, and, at the same time, mixing them together. This piece of equipment can be had from a lapidary supply house. We suggest purchasing one of the six pound or twelve pound capacity. The ball mill will do about 90% of your work for you.

The third tool you will need is a three beam scale with a 500 gram capacity. It is possible to use a balancing beam and a known set of weights, but these you would have to construct yourself.

Drying & Pulverizing

Before pulverizing the chemicals, they need to be dried. Drying is very important. If the chemicals have moisture content, they will not pulverize correctly and caking will take place. It will also throw off your weighing system because of the weight of the water. The milling also will not be as efficient.

If there is any doubt in the moisture content of your chemicals; place all three chemicals onto separate baking sheets, making sure that each sheet contains more than enough chemicals by weight for the ratio you wish to make.

Place all three into a standard kitchen oven, put the potassium nitrate on the bottom rack and the sulphur and charcoal on the top rack. Both racks should be at the highest position. Turn the oven on and set the heat at 150 degrees Fahrenheit.

Bake the chemicals for one and a half hours and then remove the sulphur and turn the heat up to 225 degrees Fahrenheit for an additional hour and a half. These are the maximum temperatures. Do not exceed. These are, however, the minimum times and they may be exceeded if necessary. At the end of this time, turn the oven off and let the chemicals cool. Remove the trays and place the chemicals in separate one gallon ziplock freezer bags.

The next step is pulverizing. The chemicals are put inside a common kitchen blender. They will be pulverized for different times; each chemical requiring slightly different timing.

Any kitchen blender will work. Using the blender will save 18 to 24 hours of your milling time. The blender should be run on high speed for all the chemicals, and use this same speed each time you blend so the chemicals turn out the same each time.

You are looking for consistency in each step of your black powder production. Consistency from beginning to end.

Clean your blender after each chemical has been pulverized to make sure that each chemical stays pure and to make sure that all the blender parts are thoroughly dry before adding any chemicals. A hair dryer is useful for drying tools.

We're going to start with <u>pulverizing sulphur</u>. Sulphur is a fine, soft, powdery element compared to potassium nitrate and is the hardest ingredient to pulverize, especially if you try to pulverize it for more than two minutes. Two minutes is all we suggest you pulverize your sulphur for, because as soon as it becomes warm (which it will in the blender, due to the friction of the blades) it will start to melt and upon cooling, it will form hard clumps. This is just the opposite of what we're trying to achieve. A little experience here will keep this from happening. So, pulverize your sulphur for two minutes in thirty second increments, scraping the blender sides and blades well, in between the thirty second times. Fill the blender to just cover the blades, <u>no more</u>!

Now, when you're pulverizing your sulphur, you should try to pulverize it on a relatively high speed so that in your two minutes, you've totally turned your sulphur balls or granules into a very fine powder. At this point, you should let the sulphur cool in the blender for a couple of minutes and then take it out and put it in a bag and seal it up.

At this point, take the bag between your fingers and work out any clumps that are in the sulphur. If you accidentally overheated the sulphur, and there are hard clumps in the sulphur that won't break up with your fingers, let it cool completely down and replace back into the blender and pulverize it again.

Now, because of the heat buildup by the friction, if you blend too long, not only do you take a chance of compacting the sulphur in the bottom of the blender, you also take a chance of burning up the blenders' motor. We've gone through three blenders, and we speak from experience.

Note: If your sulphur comes in a fine powder, it will not need to be pulverized and this will save you a step in the process.

The next chemical we're going to pulverize is potassium nitrate. Potassium nitrate is much easier to pulverize.

Place enough potassium nitrate in the blender to just cover the blades. Turn your blender on full speed. You will be running the blender for a total of six minutes. You pulverize for two complete minutes and then stop the blender. Take off the top of the blender and scrape off any of the potassium nitrate that's on the sides or lid of the blender. After finishing scraping, put the top back on the blender and pulverize for the next two minutes.

You do this over again for a total of six minutes pulverizing time. At the end of six minutes, take the potassium nitrate out of the blender and place in a one gallon freezer bag.

The charcoal is the easiest of the three chemicals to pulverize. You take your charcoal and fill your blender one quarter of the way full and put the top on it and turn it on at your highest speed setting. Pulverize for a total of five minutes at which point take your charcoal out and put it in a one gallon freezer bag.

If you are using powdered charcoal, pulverizing will not be necessary. It is already finer than you can possibly pulverize. This will save you one step in the pulverizing process.

Safety Tip:

At the end of the pulverizing procedure, use a magnet to remove any ferrous metals that may have gotten into the chemicals during the manufacturing process. These small pieces of ferrous material can possibly cause a spark inside of your ball mill causing an explosion. We like the magnets on a stick that mechanics use. Make sure that the magnet is dry and clean before using.

Consistency:

Pulverize the chemicals for the same amount of time each time you do this process. This is necessary in order to get the same results in each batch of your black powder.

Weighing

We suggest that you make your black powder in 500 gram batches for a six pound ball mill and 1000 gram batches for a twelve pound ball mill. These chemicals should be weighed to at least 1/10 of a gram.

Now, where are you going to weigh it? You need a set of scales known as a three beam scale, or at least have access to a set of them that is capable of weighing 500 grams of chemical to plus or minus 1/10 of a gram.

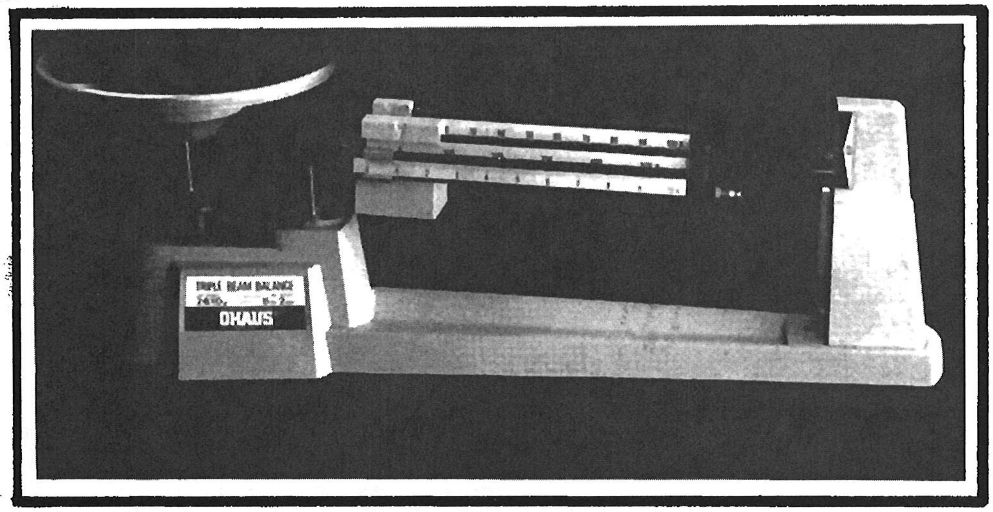
We would suggest checking at a local college or university. If you can gain access to the proper weighing equipment, take along your pulverized chemicals and enough baggies to separately weigh out enough chemicals to last you for three or four batches. If you can afford to buy a three beam scale, new or used, we would suggest it.

Another way around this expensive problem is to use a balancing beam. If you've ever seen an old Western movie where they are weighing gold or silver, you've seen a balancing beam. They put a known weight on one side of the balancing beam, and on the other side of the beam, they put the gold or silver. When the beam reaches an equilibrium, the weight of the gold or silver equaled the known weight. We made a simple balancing beam out of a carpenter's level.

The balancing beam scales we show are very accurate if assembled correctly. They are 5 to 10 times more accurate than what was available in the 1700's. We consulted with the Department of Weights and Measures on the accuracy of the balancing beam we used and found it to be within one fourth of a gram at 500 grams of weight. We are extremely happy with this accuracy at the relatively low cost.

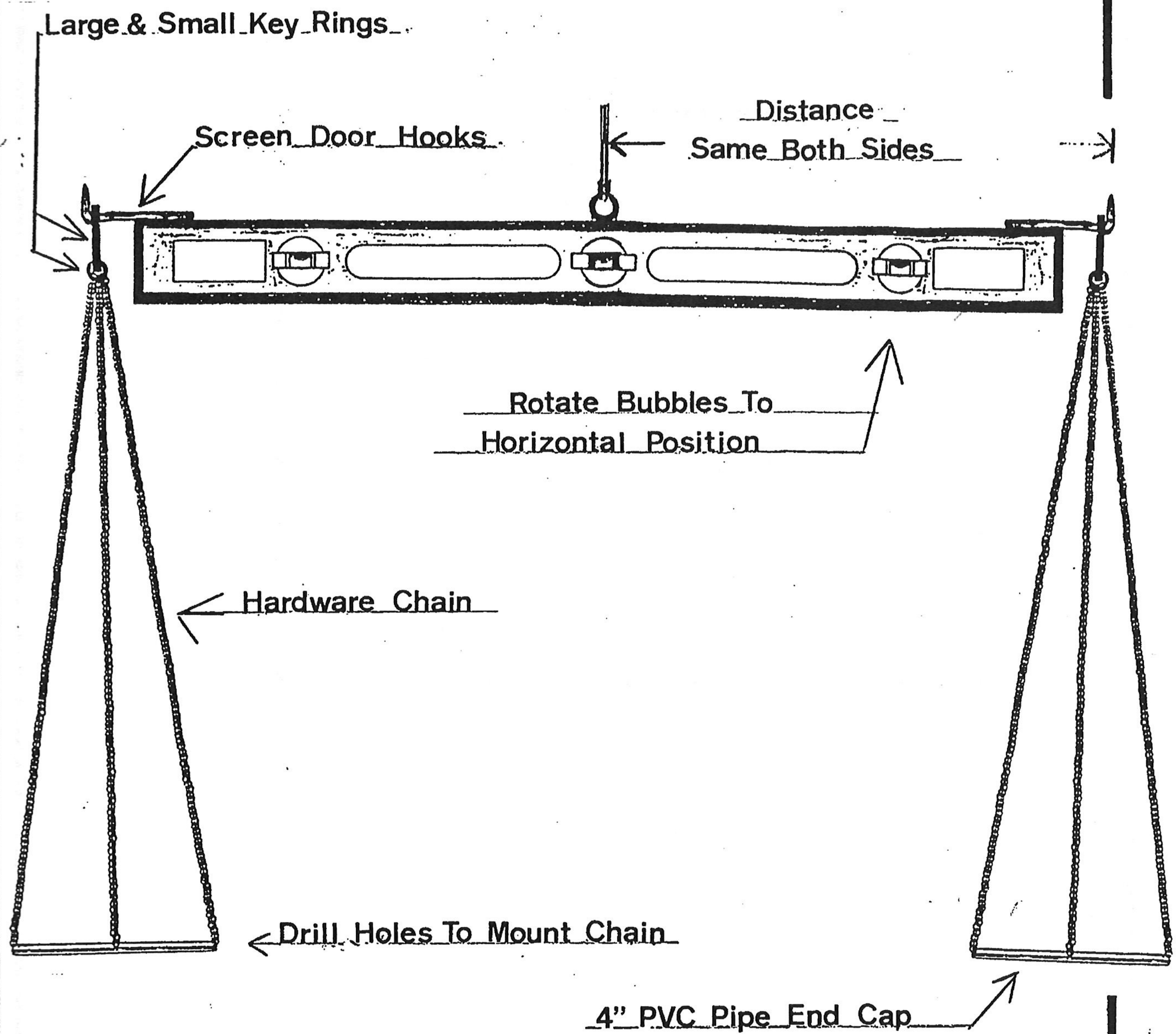
The balancing beam is fine for rockets, blasting and fireworks, but we suggest using the three beam scale for black powder gun powder, because of it's additional accuracy.

Shown below is a modern three beam scale we used in our final production of black powder gun powder. A three beam scale is accurate to 1/10 of a gram. We purchased this one from



a pawn shop for about one fourth of it's new cost.

Be sure to have your local Department of Weights and Measures check and adjust for accuracy.



Shown above is a drawing and simple instructions for a balancing beam that we made from a 4' foot carpenter's level.

Metric Conversion Table

1 Gram	=	15.43 Grains
1 Gram	=	0.0353 Ounces
1 Kilogram	=	2.2046 Pounds
1 Pound	=	0.4536 Kilograms
1 Grain	=	0.0648 Grams
1 Ounce	=	28.35 Grams
1 Pound	=	453.6 Grams

Milling

Milling is a mechanical process in which the chemicals are ground up into an extremely fine powder and mixed together.

The longer the period of time the chemicals are milled, the finer the black powder will become. The finer the powder, the more energy it will produce and the faster it will burn when it's ignited.

The mill you set up will most likely not be exactly like ours. This will be a variable in the recipe that will have to be adjusted for.

We're going to show you how to make an excellent ball mill for making your black powder from a lapidary tumbler. Lapidary tumblers are used by lapidary workers to polish gemstones, and they routinely come in four or five sizes; we suggest the use of only two sizes of tumblers.

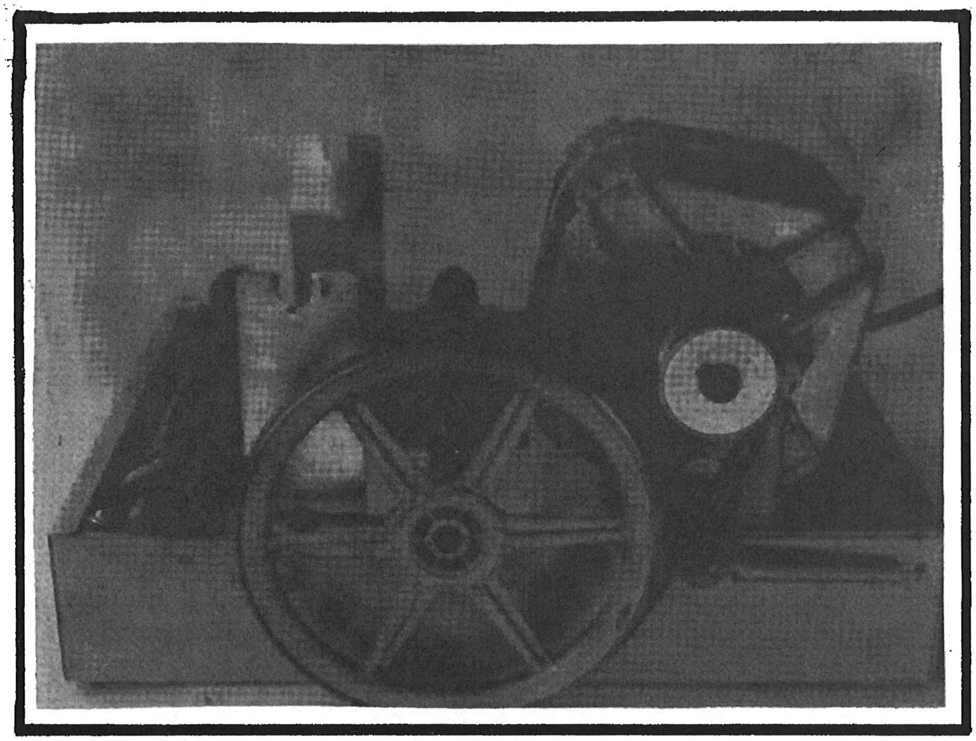
The first one is the six pound size which holds approximately one half of a gallon; it will produce 500 grams of black powder or just a little over one pound. The second tumbler we recommend holds a full gallon; it will produce 1000 grams of black powder, or just over two pounds.

The tumbler is made up of four main body parts, consisting of a base, a barrel to hold the chemicals, an electric motor, and the pulley system that converts the energy from the motor to the barrel for turning.

The tumbler, as a machine, is quite simple and by following the basic maintenance instructions provided by the manufacturer, it should give you years of satisfactory service.

You can also buy a lapidary tumbler without a motor if you are so inclined. We picked up a used washing machine motor of 1/6 hp capacity from a scrap yard for $5.00, and after using it for literally thousands of hours, it is still running strong.

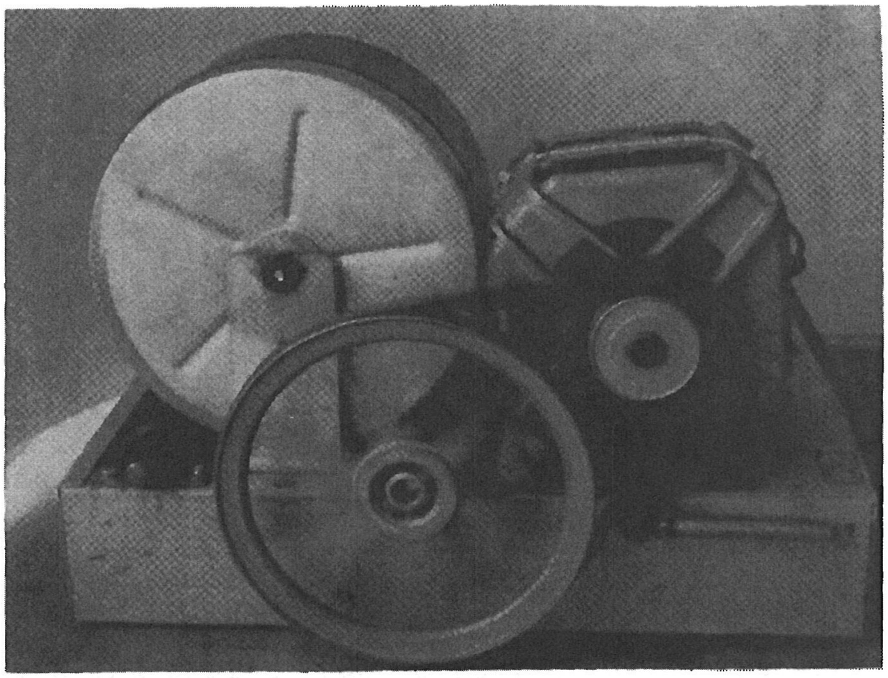
You will want your tumbler to turn at approximately one rpm per second. If your tumbler doesn't revolve this quickly, change the smaller pulley



This is the mill base. It consists of a frame, electric motor, pulleys and rollers. The smaller pulley is the one you need to change to adjust rpm. This model will hold two 6 pound drums.

to a larger one to accomplish the one rpm per second. The reason for this is that this additional speed of the mill makes the balls inside grind better and faster at this rpm and this will also help in synchronizing your ball mill with ours.

A word about noise. Tumblers usually come with plastic bearings. These bearings will have a tendency to make a certain amount of noise. This noise can be stopped by applying molydenum disulfide grease directly to the plastic bearings. The bearings will absorb it and will become quiet almost immediately.



Here a drum is in place on the base.

Now it won't do you much good to take the potassium nitrate, sulphur and charcoal and place it in the mill and tumble it all by itself. It will mix together this way but it will take almost forever for it to grind itself into a fine enough powder.

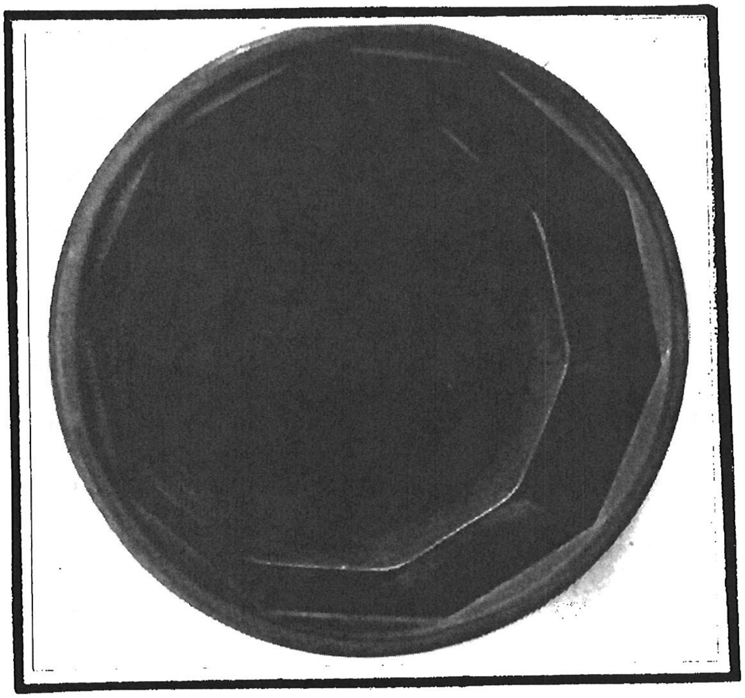
What we need here is a little help. What we need are balls that will rotate inside the tumbler and grind up and mix the chemical powder up even finer than what the blender can do.

First, you need balls that will not explode the powder, something that will not spark. The balls you place in the mill must have as large a surface area as possible for their weight. They should not be too heavy for their size for if they're too heavy they will overload the mill and most likely burn up the motor.

The balls should be readily available, easy to clean, and must be harder than the rubber that the tumbler drum is made of. So, not only do the balls grind against the walls of the tumbler, but they also grind against each other; grinding the powdered chemicals up finer and finer and mixing them together.

We tried steel balls, brass balls, tin, zinc and wooden balls; they all have their own separate disadvantages. Then we tried golf balls. Golf balls seem to have all the advantages and none of the disadvantages and not only do they meet all the previous criteria, but they also have the additional advantage of hundreds of dimples all over them.

These dimples have a tendancy to pick up and move the powder throughout the inside of the drum. The dimples carry small amounts of powder to their edges. If you look at a golf ball, you will see that in between the dimples are relatively sharp ridges. These ridges are what rub against the other



The inside of the mill drum should have 6 to 12 sides. The sides help in turning the powder and the balls over as it rotates.

golf balls. The powder gets in the dimples and is carried up and onto these ridges grinding very efficiently by the friction between the balls and the friction between the golf balls and the internal surface of the mill.

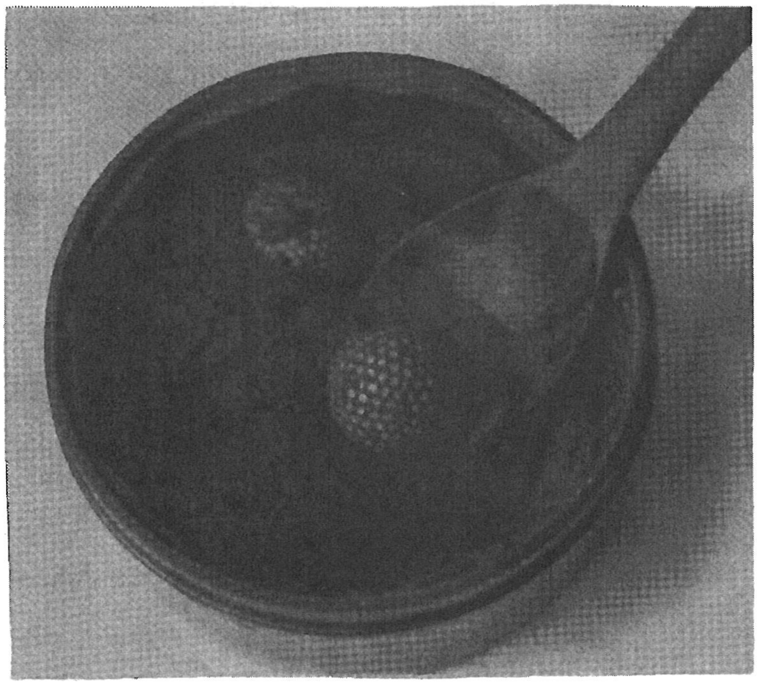
We have found through experience with other balls of different materials, that golf balls will grind the powder more efficiently than any other balls that we have put in the mill.

In the milling procedure, the first thing you need to do is to add the potassium nitrate, sulphur and charcoal that has been dried, pulverized and weighed into the milling drum.

If you have a six pound mill, use 15 golf balls, maximum. If you're using a twelve pound mill, use 30 balls, maximum. Seal the drum and put on the tumbler base.

The chemicals will be milled for a specific amount of time. At the end of this time period, you will open up the mill barrel and you will see the fine black powder dust. At this time, you remove the mixture from the mill; this is black powder, <u>not gun powder</u>. <u>This black powder is very dry and very sensitive to a spark and is extremely explosive</u>. This black powder may be used as is, for rocket propellent, fireworks or blasting powder. <u>It may not</u> be used in firearms. It's energy level to burning rate is too high.

If you use it in firearms as is, it will, at full loads, most likely blow up the firearm. See Section Two for details of refining this black powder into black powder gun powder.



For safety's sake, use a wooden spoon to remove the balls after the milling to prevent any sparking.

The starting point for milling black powder for use as gun powder is seven days. Depending on the efficiency of your equipment, you may have to extend or reduce this seven day milling time. See the chapter on Testing and Control in Section Two.

Safety Tip:

Do not forget to use a magnet to remove any ferrous metals before starting the milling process. Black powder is the most dangerous when it comes out of the ball mill because of it's very fine consistency. It's very prone to spark sensitive detonation and explosion. Place this very fine black powder into a one gallon freezer bag as soon as it is removed from the ball mill and seal it. Again, do not use this fine black powder in firearms. This black powder should be jet black; if it is gray, the charcoal you used was not fully processed. Test for power level; it may be fine for your particular needs.

Consistency:

Always mill for the same amount of time unless you are trying to improve your black powder. Do not reduce or increase milling times more than 12 hours at a time. Check results before changing milling times further. Try not to spill the chemicals after weighing and before milling. This will throw off the chemical ratio. If you spill some of the black powder after it comes out of the mill, it will not have an effect on ratio. You just lose some of the precious black powder. If you leave out one or add an extra one of the golf balls, it will have an effect on your black powder results.

Introduction 2

In this section of Black Powder and How to Make It, we will only be concerned with changing the fine, powdery black powder made in Section One into a dense, granular structure for use in black powder firearms.

Again, we stress safety and consistency in each step.

Prior to the 1700's, the black powder such as described in Section One was used in firearms, but because of it's high energy level and very fast burning rate, it was not uncommon for guns to explode and people to lose hands, arms and lives. Because of the almost instantaneous burning of this very fine black powder, the shot did not have time to move and very high breech pressures were achieved.

A notable improvement was made in the 1700's in black powder quality. In order to slow down the burning rate, black powder was pressed into ingots. This kept the breech pressure down and at the same time increased the velocity by letting the shot start to move before the power level came up to full pressure. An additional advantage to pressing was that the potassium nitrate, sulphur and charcoal would not separate from each other in transportation, as was previously the case. After being broken up into grains, it was also easier to load into the guns.

In this section we will cover the pressing of the black powder into ingots, breakup and granularization, finishing, testing and control and the assembly of tools.

In the following chapters, we will be working with a single 500 gram batch of black powder.

Pressing

Pressing is the process that we use in the manufacture of black powder gun powder. This process takes the fine black powder dust, which has been removed from the ball mill, and transforms it into solid ingots of black powder.

The main reason we press the fine black powder dust into solid ingots of black powder is to control it's burning rate. When it's pressed, it's denser and it burns slower, just like a piece of hard wood burns slower than a piece of soft wood of the same size.

The more pressure we put on the black powder through pressing, and the longer the pressure is held, the slower the powder is going to burn in relationship to what came out of the ball mill.

Another advantage to pressing is the fact that after the ingots have been broken up, you end up with grains of a certain "F" grade size. The grain size, along with the density of the grain, determines the burning rate of the powder. Smaller grains naturally burn faster than larger grains.

The energy level and burning rate to this point depends on many factors such as, the purity of the chemicals, the chemical ratio (weighing), how long it's been milled, the type of ball mill used, and the speed of the ball mill. All these factors will vary with the type of equipment that you use, and are set at this point. Now you can see why we strive for consistency, for if any one of these factors are varied from batch to batch, the energy level and burning rate will also vary.

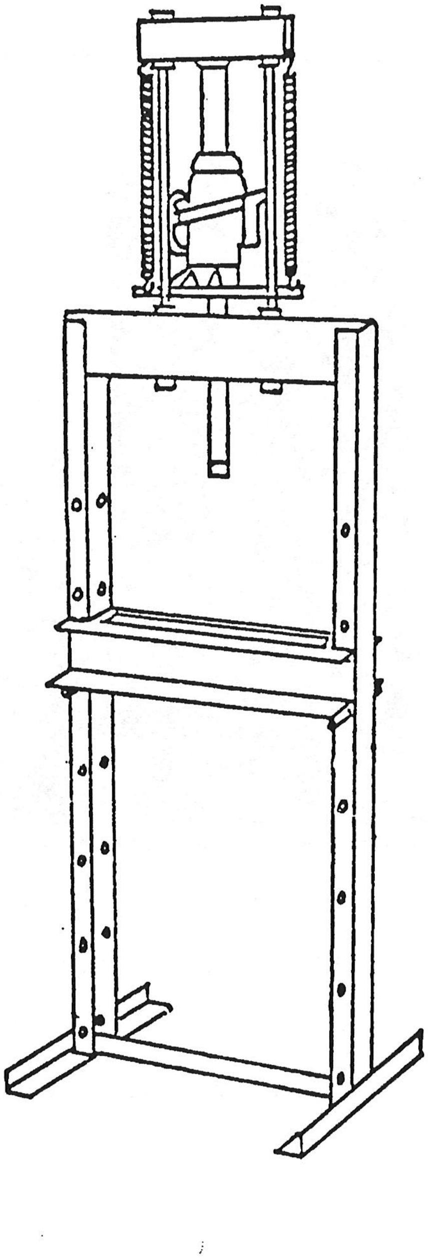
A word about pressing: Pressing does not change the energy level of black powder, only it's burning rate.

Now in pressing, the first thing you do after removing the fine black powder dust from the ball mill, is to place this fine dust into a one gallon freezer bag. Add three tablespoons of hot tap water to the bag and knead gently for 15 minutes so that this water is absorbed evenly throughout the black powder dust. This will give the black powder a 6% moisture content.

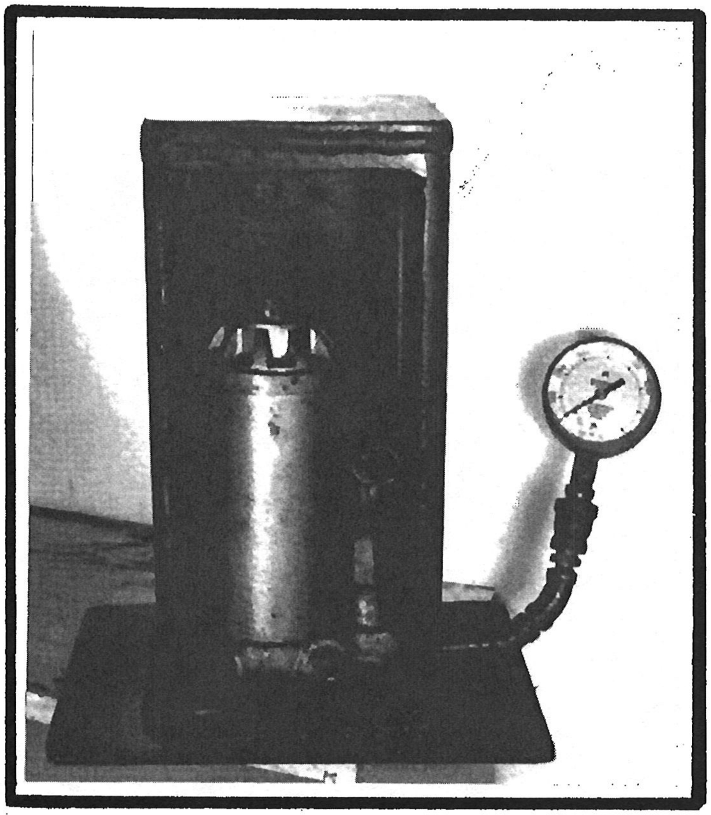
Why do we do this? Because even though the chemicals, potassium nitrate, sulphur and charcoal have been thoroughly mixed and milled, together, hour after hour, inside the ball mill, they are still three separate chemicals. Water will cause a portion of the potassium nitrate to go into solution with the water and will be absorbed by the charcoal. Upon drying, the potassium nitrate will act as a glue to hold the sulphur and charcoal together in a solid form.

After kneading this bag of black powder, the next step in the process is to double bag the black powder to prevent moisture from escaping. Place the bag in a warm place, (80 to 90 degrees Fahrenheit), for at least ten hours. The potassium nitrate is heat sensitive and warming will help it to go into solution.

This is a drawing of a commercial hydraulic press which may be used for pressing black powder. A hydraulic pressure gauge should be added.

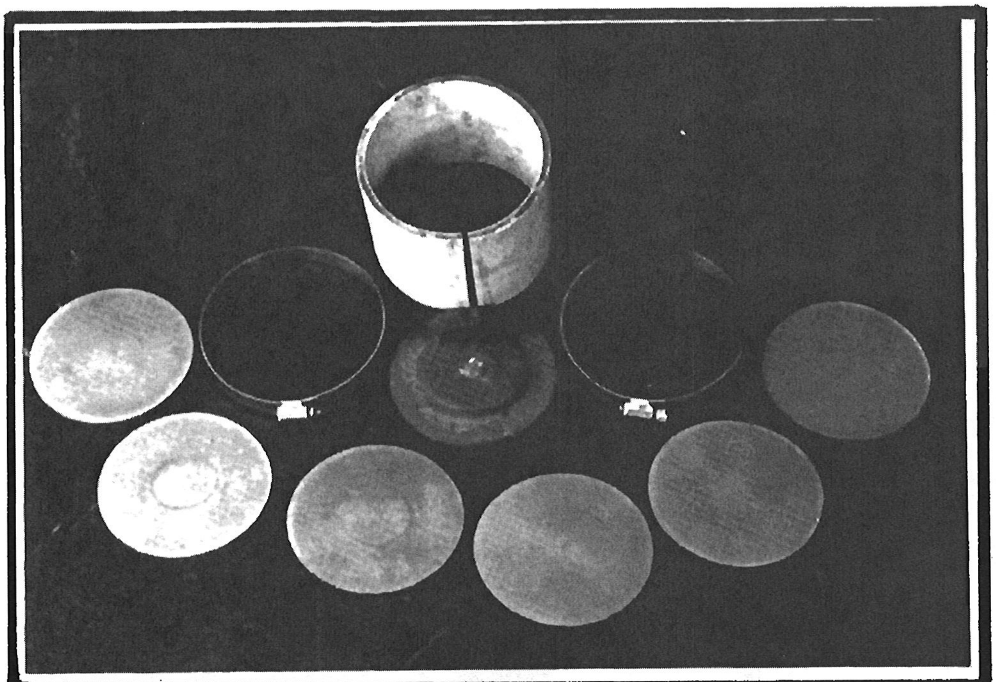


The photograph shown below is of a homemade hydraulic press. This press has a gauge with a maximum pressure reading of 4000 psi. A two ton hydraulic jack has been placed inside. The press body was made out of a piece of eight inch by



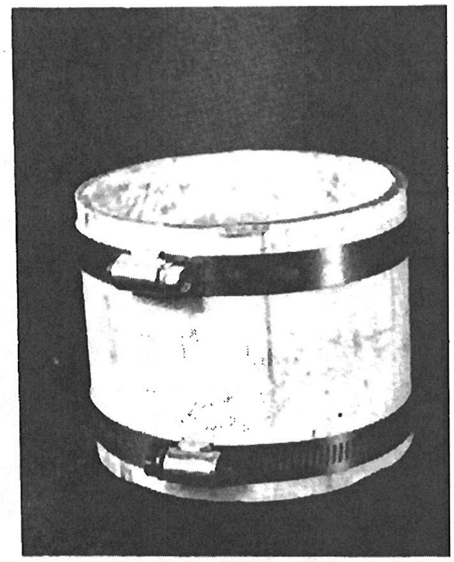
eight inch square steel tubing with an end cap and base welded on. This is a simple and cost effective alternative, when compared to the commercial hydraulic presses. It also takes up a lot less space.

The photograph shown below shows a pressing sleeve made from a piece of four inch inside diameter pvc pipe that has been cut to a length of 4½ inches. We cut a 1/8" slice out of the pipe to allow for proper fit of the bowl bottoms and expansion of the ring when the two hose clamps are removed.



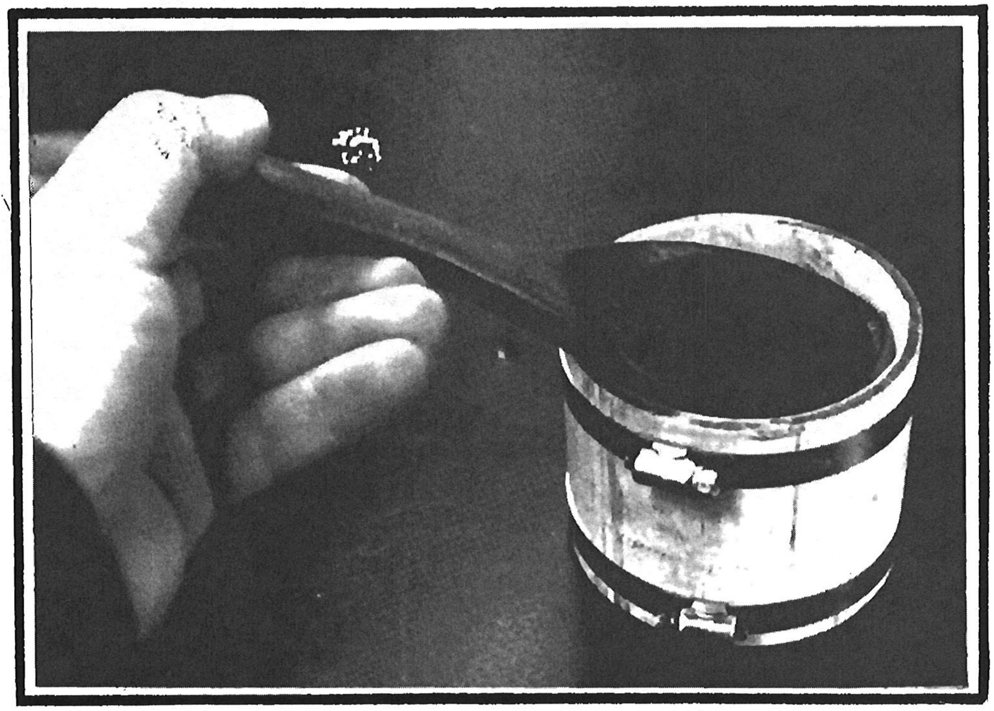
Also shown are the bowl bottoms that have been cut out of the Rubbermaid bowls. These bowl bottoms are used for spacers, along with the pressing plate. You will need eleven bowl bottoms.

The photograph shown to the right, is the assembled pressing sleeve. The 1/8" gap has been pulled and held tightly together by the hose clamps. This sleeve is used to hold the black powder and the spacers in place while the pressure is applied.

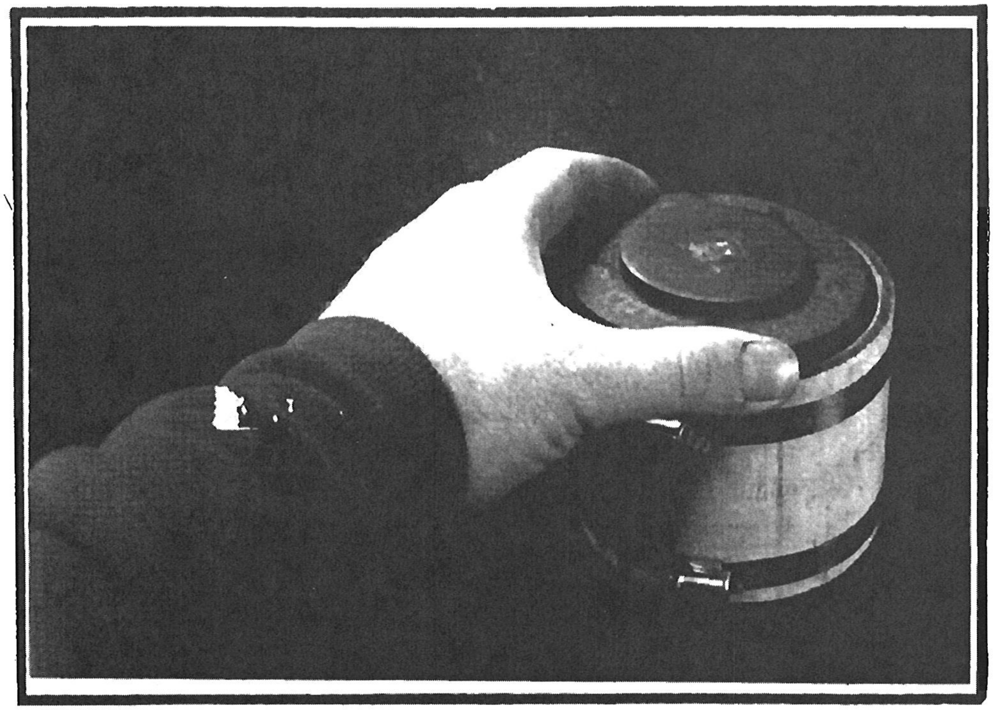


You next place the pressure sleeve on a flat surface and drop in one of the bowl bottoms (spacers), as shown in the photograph to the right.

On top of the first bowl bottom, add 1/10th of the black powder. Tamp this black powder with a wooden dowel until it's level, add another spacer and repeat this process until the black powder is all used up. See the photograph below.



At this point, you should have ten separate layers of black powder divided by ten plastic bowl bottoms. Drop in the last bowl bottom, and then place the steel pressure plate on the top. The pressure plate is made of two washers of appropriate size. The bolt holes should be filled with epoxy putty. See the photograph shown below.



Taking the completely assembled pressing sleeve, turn it upside down with the pressure plate now on the bottom and place into the hydraulic press and add pressure; see the photograph below.

<u>Ultimate Holding Pressure</u>

What is ultimate holding pressure? Let's start with pressure. Pressure is the amount of energy placed on the black powder measured in pounds per square inch (psi).

This pounds per square inch is measured on a hydraulic pressure gauge and will be referred to as HGP. This HGP has to be divided by the amount of area being pressed on to achieve pounds per square inch <u>on the black powder ingots</u>.

For example, we used a pvc pipe with a four inch inside diameter. We take this four inch circle and find it's radius. The radius of 4" is 2"; we square this 2" radius; the square of 2" is 4"; we take the 4" and multiply times pi. Pi is 3.1416. Four times 3.1416 equals 12.5664 square inches. We round off to 12.6 and for practical purposes we use 12.5.

This 12.5, or 12½ square inches, is the area we are pressing against, with the hydraulic gauge pressure (HGP).

So, if we wanted to put a 100 psi onto the black powder ingots, we would have to multiply this 100 psi by the number of square inches, which is 12.5

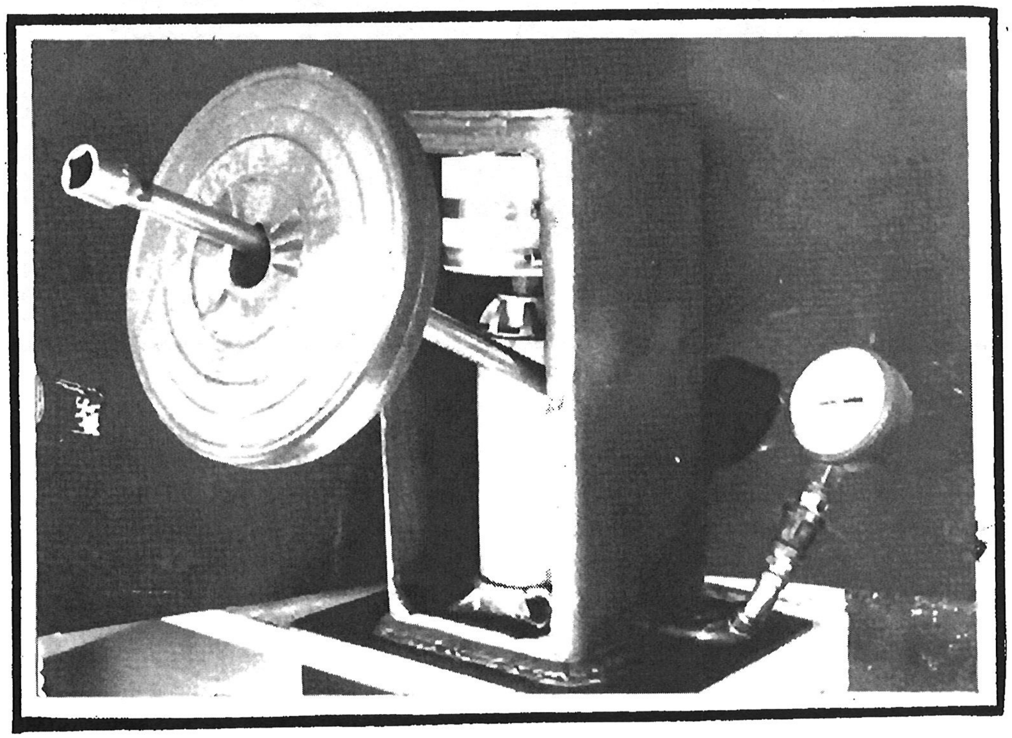
times 100, equals 1250 pounds of hydraulic gauge pressure. By using this simple formula, any pressing sleeve size area can be figured out. One hundred (100) psi is the ultimate holding pressure you will start with and you may adjust pressure as needed. Please see the chapter on Testing and Control.

Holding Pressure

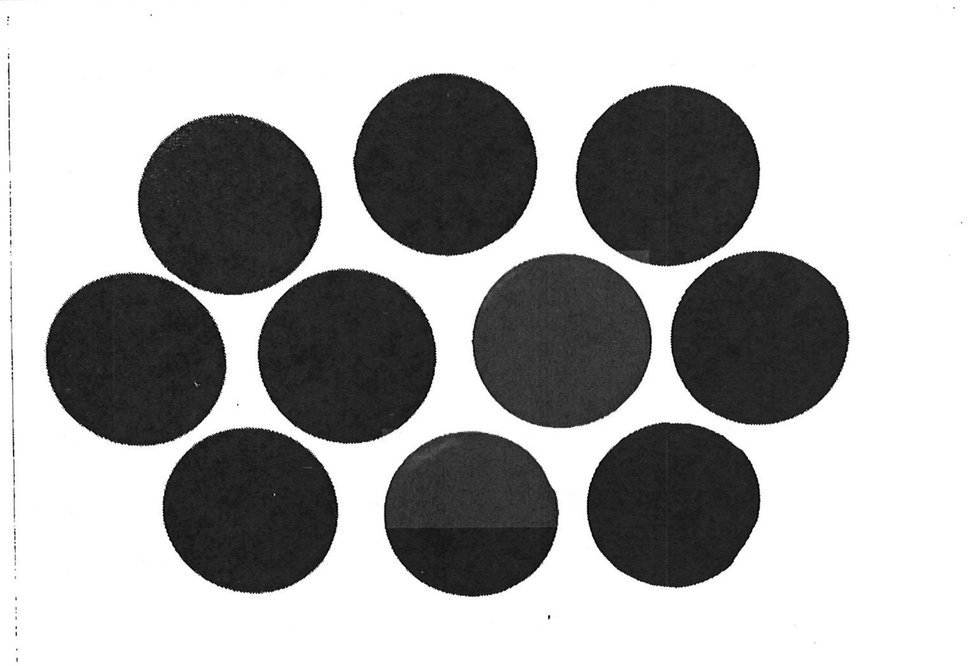
As you add pressure onto the black powder, the hydraulic gauge pressure will go up in psi. The reaction of the black powder to this pressure is compression. As the black powder is compressed, the hydraulic gauge pressure will drop. Again, you will add more pressure and the hydraulic gauge pressure will go up. Once more the black powder will compress and the hydraulic gauge pressure will drop.

Once the black powder has compressed to a point, it will hold a certain amount of pressure without the hydraulic gauge pressure dropping. This is holding pressure. If you add more pressure, the black powder will again compress, but this time the holding pressure will be higher.

The ultimate holding pressure is when you reach the <u>desired pressure</u> in psi on the hydraulic pressure gauge and the black powder <u>does not</u> compress any further. Ultimate holding pressure should stay on the black powder ingots for six hours. After the ultimate holding pressure has been reached, this technique, as shown in the photograph below, is used to make the six hours of holding time automatic. The length of the handle and the amount of weight will determine the amount of gauge pressure.



A little experimentation here will be needed, but once in place you can leave and the pressure will remain constant for the six hour period that is necessary for pressing. In the photograph shown below are 10 ingots that have been removed from the pressing sleeve after the six hour holding time.



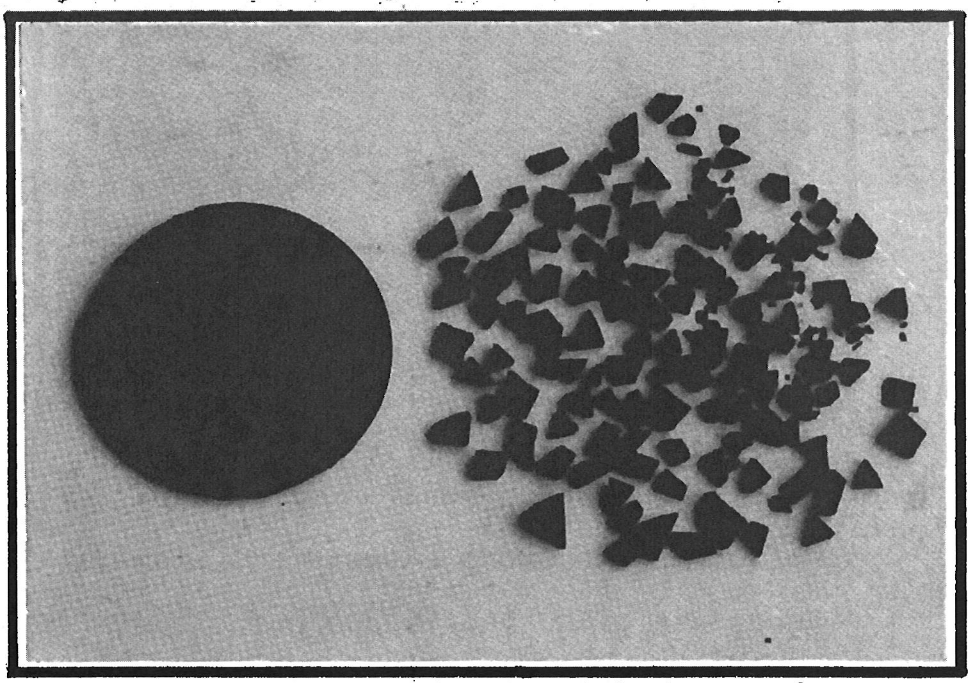
Breakup & Granularization

In breakup and granularization, we will show you how to take the ingots that you have pressed and refine them into grains of the proper "F" size for your particular needs.

Right after you have removed the ingots from the pressing sleeve, place one ingot at a time into a plastic freezer bag and break it up with your fingers. It should break up like a thick potato chip into pieces about one quarter inch of area per side. Please see the photograph on the following page.

Repeat this with each of the other nine ingots. After the ingots have been broken into chips, place all the chips into a plastic bowl and let set in a warm dry place for 24 hours. This 24 hour time period will give the potassium nitrate time to recrystallize and harden up before granularization takes place.

This 24 hour time period is the <u>minimum</u> aging time. Aging time will depend on the humidity in your area. If this aging process is not accomplished, the black powder chips, when placed in the rotary separation mill, will just return to dust instead of being broken up into grains.



The black powder ingot before and after breakup.

The granularization process will be accomplished by the Rotary Separation Mill, in combination with screening.

Place the 1/8" Rotary Separation Mill in the ball mill drum, as shown in the photograph below, and place half of the black powder chips on the inside.

Add the four 6 ounce lead balls, put the lid on and assemble the drum as shown on the following page. The four 6 ounce lead balls are round fishing weights that have had their swivels removed.

Place the drum on the rollers and mill for one hour. After one hour, remove the black powder grains and screen for the largest usable through screen size. See Screening, pages 73 - 78.

Adding the four 6 ounce lead balls.

Repeat this process with the rest of your black powder chips. The grains that will not fit through your largest through screen will have to be placed in the Fg Rotary Separation Mill and the process above is then repeated.

After screening the second time, place the grains that still will not go through the through screen into the FFg Rotary Separation Mill.

Repeat this process until all the grains will pass through your largest chosen through screen. The size of F grade through screen you have chosen will determine how many times this will have to be repeated.

Place the lid on the Rotary Separation Mill and then assemble the drum. See photograph above.

After all the black powder grains have passed through your through screen, remove all the black powder that has passed through your on screen and save it. The grains of black powder that will not pass through your on screen is the grain size you have chosen.

Depending on the atmospheric humidity in your area, it may be necessary to dry the black powder grains in the Rotary Dryer after each time it's removed from the Rotary Separation Mill. Please see Finishing, pages 79 - 83. If this is the case, the black powder grains should be aged a minimum of 24 hours after each time it's removed from the dryer and before it goes into the next smallest Rotary Separation Mill. This is necessary in order to let the potassium nitrate resolidify.

Screening & Grading

This chapter will deal with screening your powder into the different "F" grades of black powder gun powder you will be using.

During the screening process, you will use screens with different size openings to separate the different size grains from each other. Grain size determines to a very large extent the burning rate of the black powder. The smaller the grains, the faster the black powder will burn.

The American grading system was adopted from the French; it's known as the "F" system. ("F" stands for fine - the fineness of the powder.) This system is still in use today. The more "F's" in the grade, the finer the powder.

As you will see by looking at the charts in this chapter, different size screens produce different size grains. For each grain size, you will need two separate screens.

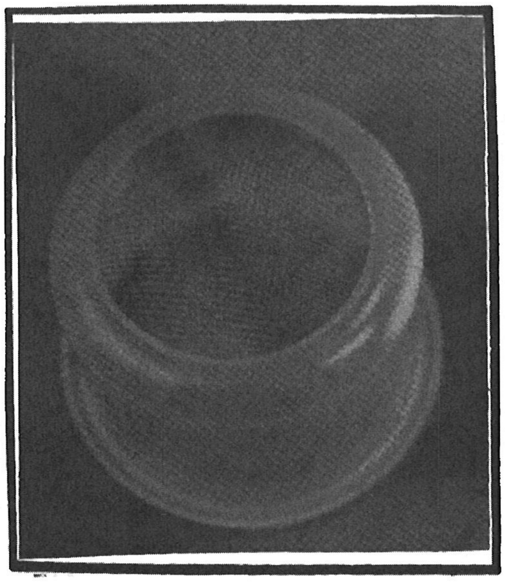
The first screen is called the through screen. It is called the through screen because the holes in this screen are the largest acceptable size for a particular "F" grade. The black powder grains that do not go through the through screen are too large and need to be broken up smaller. The grains that do go through are either the right size or they're too small.

The next screen you will need is called the on screen. The grains of black powder that went through the through screen and remain on the on screen, are the correct size for a particular "F" grade. The particles of black powder that fall through the on screen are too small for this particular "F" grade, but may be used for the next smallest "F" grade. As you can see from the chart, each on screen is the through screen for the next smallest "F" grade. For instance, we own a .54 caliber percussion rifle and we use FFg grade powder. We use a through screen of .0582 and the on screen of .0376. But we also happen to own a .44 caliber black powder revolver which uses FFFg powder. As you can see from the chart, the .0376 screen becomes our through screen and the .0170 becomes our on screen. So now to make two grades of black powder, we only need three screen sizes.

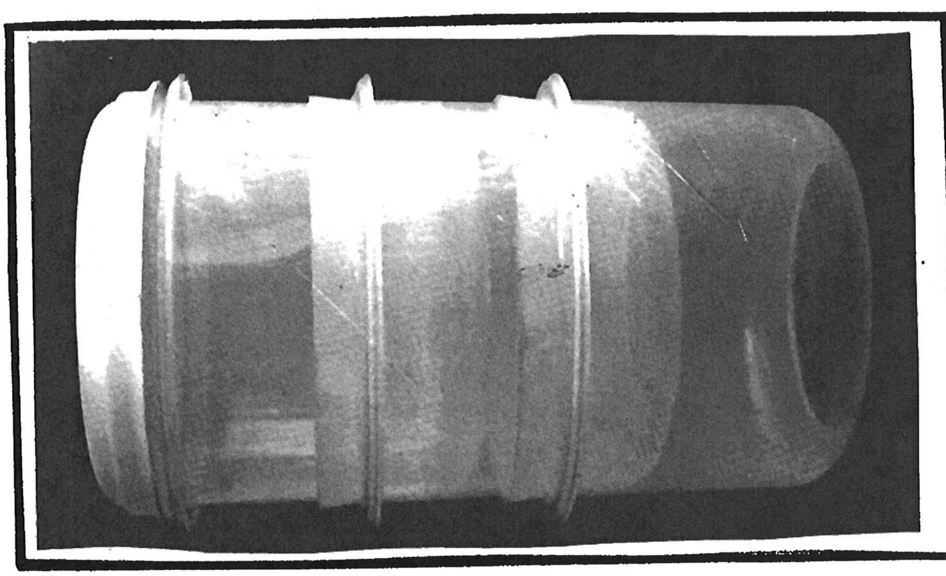
The best way to screen your black powder is a system that we have devised which we call "stack screening". This system will screen any number of different grades of powder at one time. Here is how it works.

The screens are incorporated into plastic bowls that are stacked one upon another with a solid plastic lid on the top of the unit and a solid plastic bottom on the bottom of the unit. When black powder is placed in the top unit and then shaken, the black powder is automatically sifted into the different size grades according to the size of the screens you have chosen. Each bowl will then contain it's own particular "F" grade.

The real advantage to this system is it's ease of usage and also that you don't spill any of your precious black powder. Safety is also a feature of this system; since small particles of black powder do not go into the air, there is less chance of your powder being ignited accidentally.

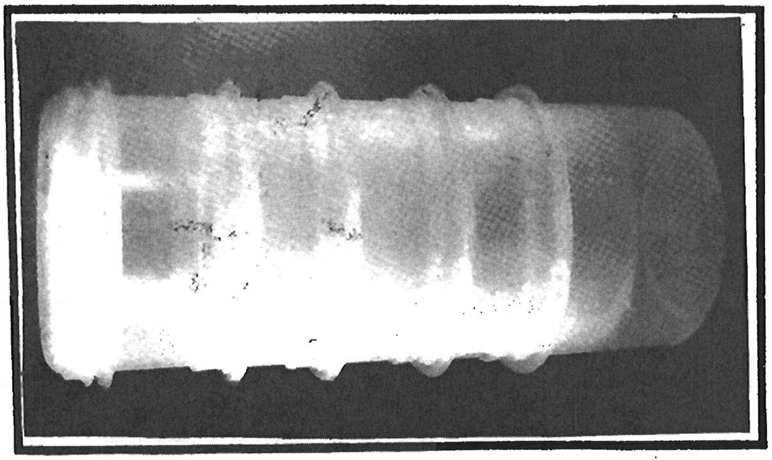


This bowl has had it's bottom cut out and a screen mounted inside.



This bowl setup has a through screen and an on screen with the lid and bowl bottom. It will separate one "F grade from the grains that are two small or too large.

After stacking the bowls, the black powder that comes out of the Rotary Separation Mill is placed into the top bowl and a vacumn is placed on the internal system by the lid. By agitating



this stack screen system, each "F" grade size will find it's proper place in the bowls. Any grade from Fg to FFFFg may be produced at the same time.

Question: What do you do with the black powder grains that are too small for a particular "F" grade?

Answer: Take this black powder and save it. When you get around 500 grams, start over again at pressing. This will almost feel like "free" powder. When repressing, use only one additional tablespoon of hot tap water.

Question: Where do you get your screens?

Answer: Check in the Yellow Pages of your phone directory for the local scientific supply outlet. They can sell you quality stainless steel screens at quality prices. Or you can be a little more thrifty and do what we did. Check with your housewares' department at your local department store or grocery store for different sized sifting screens that can be cut out of their holders and mounted into the bowl bottoms. In this way, you can create your own "F" grade system.

"F" Grade Screening Chart

Powder Grain Size	Through Screen Will Pass Through	On Screen Won't Pass Through
Fg	.0689 *	.0582
FFg	.0582 *	.0376
FFFg	.0376 *	.0170
FFFFg	.0170 *	.0111

* These are the drilled hole sizes for the Rotary Separation Mill.

Finishing

Finishing consists of three operations. The first step is polishing the black powder grains. Polishing is necessary to eliminate any sharp edges from the black powder that would break off in storage or transportation.

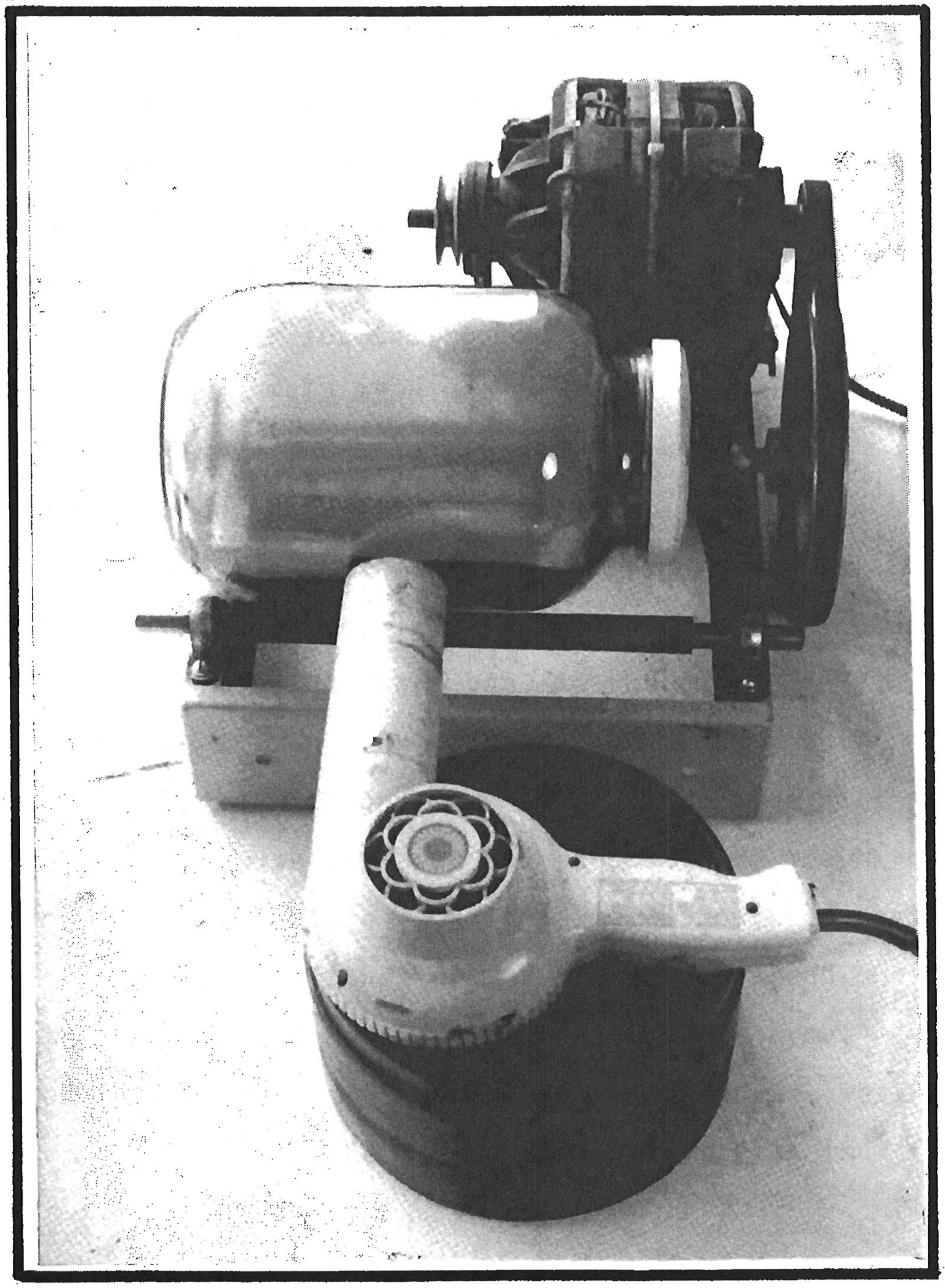
If this polishing process is not done, small particles of the black powder can break off and go to the bottom of the container, and you would end up with one "F" grade of black powder on the top and another finer "F" grade of powder in the bottom of the container. A finer powder that would burn faster. By polishing the grains of black powder, grain upon grain, rubbing themselves perfectly smooth, this problem is eliminated.

The next step in the finishing process is drying. If your black powder is not completely dry, you will not get very good results when you fire it. The burning rate and energy level will vary, depending on the moisture content, and the adjustment of the power level will be impossible. The black powder should be dried so that it has a zero percent moisture content.

The third and last step in the finishing process is glazing. Powdered graphite is applied to the grains of black powder and tumbled, providing it with a water resistant coating, that will also lubricate it, making it easier to pour.

Now, how are you going to accomplish all these steps in the finishing process easily in a reasonable amount of time? This is where the Rotary Drying Jar that was assembled in the chapter on Assembly of Tools comes in to play. The Rotary Drying Jar was devised to polish, dry, and glaze black powder all in one easy operation.

To start with, you take the Rotary Drying Jar, which you have made from a one gallon jar, and place it on the mill base. Rotate the jar with a portable hair dryer set up as shown in the photograph below. The jar is then rotated for five minutes with the hair dryer running on high.



This pre-heating is done to eliminate any moisture that may be present in the jar.

Next, place the black powder grains in the one gallon jar and place the lid on the jar with the toilet tissue in between the two screens. This system will accomplish two things at one time; the drying and the polishing of the powder. Start the dryer and the mill base and run in this manner for two hours, then let cool for 15 minutes. This 15 minute cooling time will force a large amount of the moisture from the black powder. Repeat this process again for an additional two hours. After the four hour drying time, you let it cool for an additional 15 minutes. This is the point where you add the powdered graphite, if you wish to have your black powder glazed. An additional two hour drying time will be necessary whether you add the powdered graphite or not. This gives you a total of 6 hours drying time. Any additional drying time will depend on the atmospheric moisture content in your area, and the amount of black powder in the jar as well as the amount of heat your particular dryer is putting out.

After the black powder is thoroughly dry, rescreen your powder to remove any leftover graphite and powdered dust particles that will have broken off. Seal the black powder in a plastic bag to protect it against moisture and spillage.

Testing & Control

Black powder has two distinctive and separate characteristics and as long as you keep these two characteristics separate in your mind, you should have no problem in controlling the power of black powder.

First of all is the energy level. The energy level is determined by the ratio of chemicals and the amount of time that they have been milled. The longer they're milled, the higher the energy level will be. Now this energy level is locked into the black powder as soon as you remove it from the ball mill and the processes that are done to the black powder after it comes out of the mill will have little or no effect on the energy level.

The second characteristic is burning rate. When the black powder comes out of the mill, it has a set energy level and a set burning rate. Even though the energy level can't be changed after it comes out of the mill, the burning rate can and must be controlled in order to make black powder safe for firearms.

After you make a few batches of black powder, you should have your recipe down pat. Your ball mill is going to be different than ours, and your press might not have the same reading as we have, so you are going to have to adjust. And that's what this chapter is all about. Adjusting the individual steps in making black powder so you can come out with an extremely high quality black powder for use in black powder firearms.

How are you going to find out if your black powder has a high enough energy level or proper burning rate? The only way to tell is to shoot it. Always start with one half your normal load and work up to the manufacturers suggested charge weight.

You can adjust your recipe as follows:

1. Milling longer will raise the energy level

and the burning rate.

2. Less pressure during the pressing operation will speed up the burning rate and not affect the overall energy level.

3. If the powder is burning too slow, increase the milling time and reduce the pressure during the pressing process.

4. If your powder is burning too fast, mill for less time and press with a higher psi.

Here is an example of what happens when your black powder doesn't have a fast enough burning rate. Let's say you put a specific charge of powder into your gun and you don't get the recoil, or you feel the power isn't strong enough. You add more black powder to the charge and it still doesn't seem to help. This is an indication of too slow a burning rate. The powder doesn't have enough time to burn completely before the projectile leaves the end of the barrel.

The cure for this problem is 1) when making your next batch of black powder, leave it for a longer time in the mill. This will not only increase the burning rate, but it will also increase the overall energy level. 2) Use less pressure during the pressing process. This will cause it to burn faster, thus producing more power before the projectile leaves the barrel. 3) Using a smaller grain size will increase the burning rate of black powder.

On the other hand, if your black powder seems to have too fast a burning rate, just reverse the process. Leave it in the mill for less time. This will reduce it's energy level and burning rate. You can also use more pressure during the pressing process to slow the burning rate. Using larger grains will reduce the black powder burning rate as well.

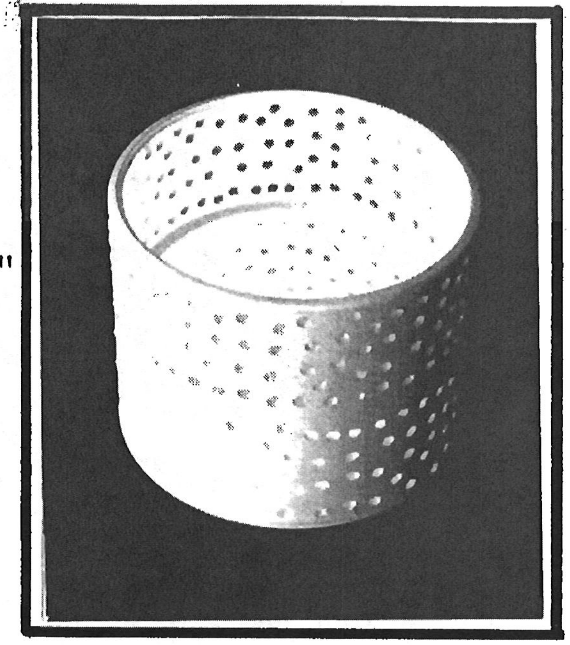
If your black powder gives you the right amount of power, but it fouls the barrel in just a few shots, this is a good indication of incomplete burning. This may be caused by 1) a slow burning rate, or 2) your black powder may not be dry enough. Powder that is not dry enough will also cause inconsistent ignition.

Assembly of Tools

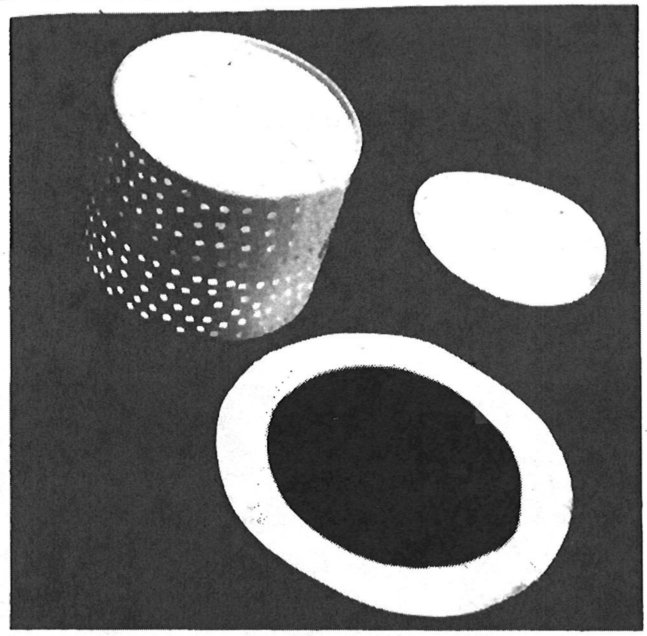
In this chapter we are going to show you how to make the tools covered in the previous chapters because they are not readily available.

The first specialty tool you will need to make is the Rotary Separation Mill. On the following page is a photograph taken of a four inch pvc pipe coupler that fits perfectly into our six pound ball mill. The holes are drilled with an electric hand drill. The hole size depends on the size of the "F" grade of black powder you want to make. See the chapter on Screening. This one has been drilled with a 1/8" drill bit. It is the first separation size that you will need.

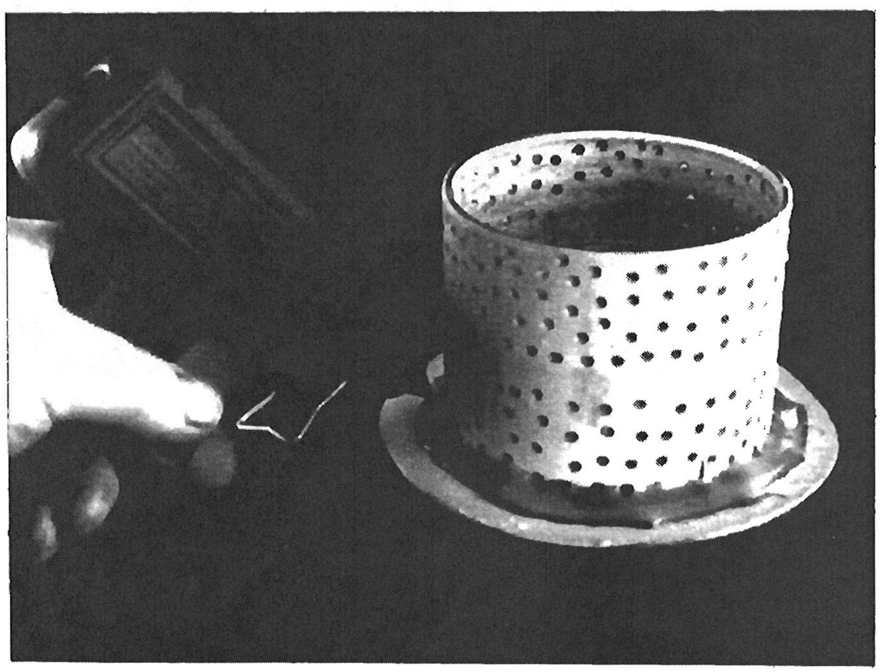
4 inch pvc pipe coupler with 1/8" holes.



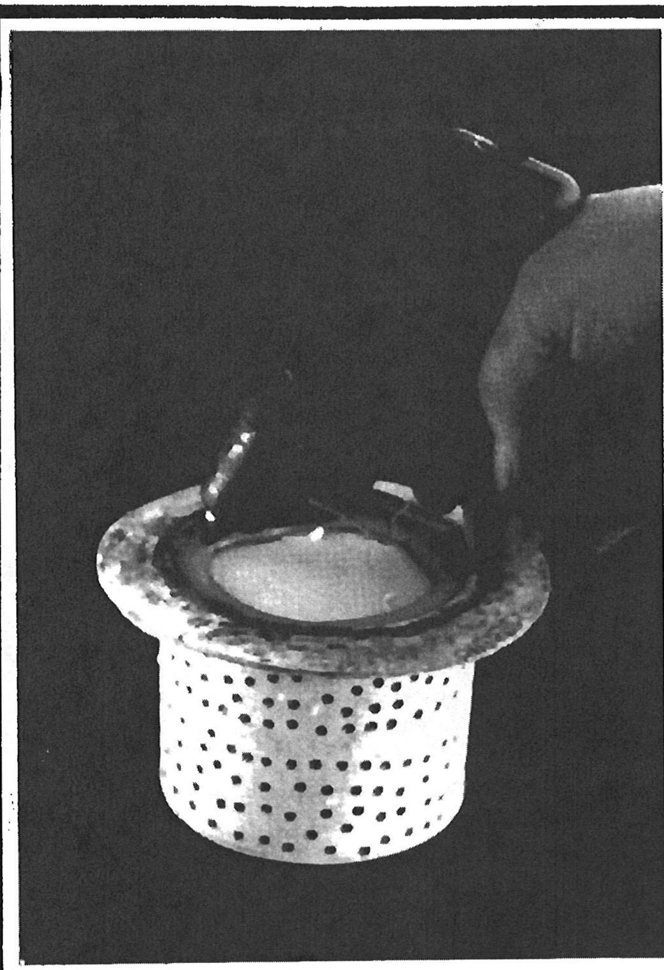
To hold the Rotary Separation Mill in the center of the ball mill drum, you will need to add a ring to one end and a bottom. These are cut from a pvc bucket with an electric jig saw. The outside dimension of the ring should be the same as the inside dimension of the ball mill. This simply made tool will save you a lot of time and effort in breaking up the black powder chips into proper "F" grade size. You will need one of these Rotary Separation Mills for each "F" grade size that you wish to produce <u>and</u> one for each "F" grade size <u>larger</u> than you wish to produce.



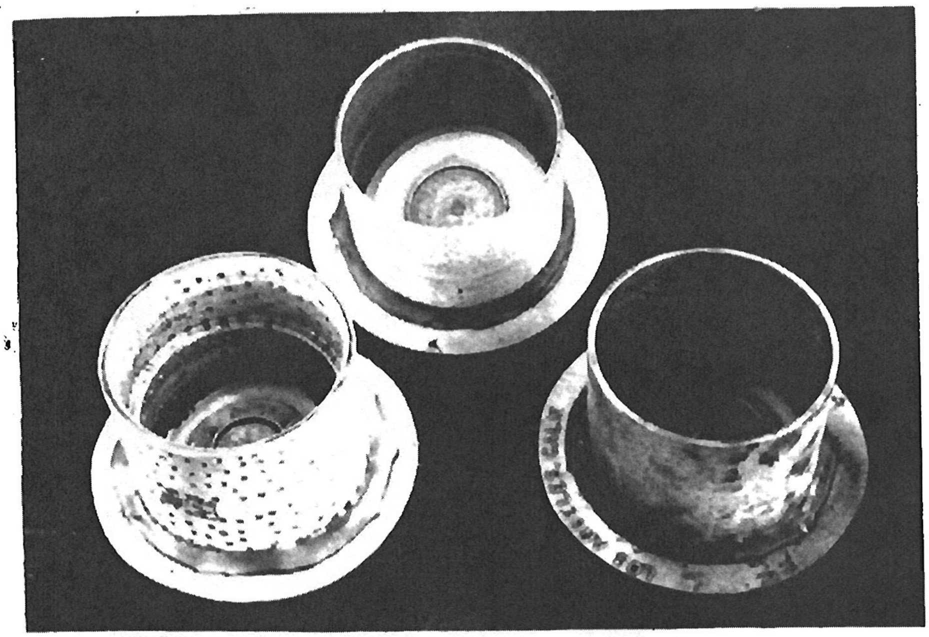
The Rotary Separation Mill, the ring and the bottom to hold it in place. In the photograph shown below, we show a 1/8" Rotary Separation Mill having it's bottom hot glued into place. We used three passes of hot glue.



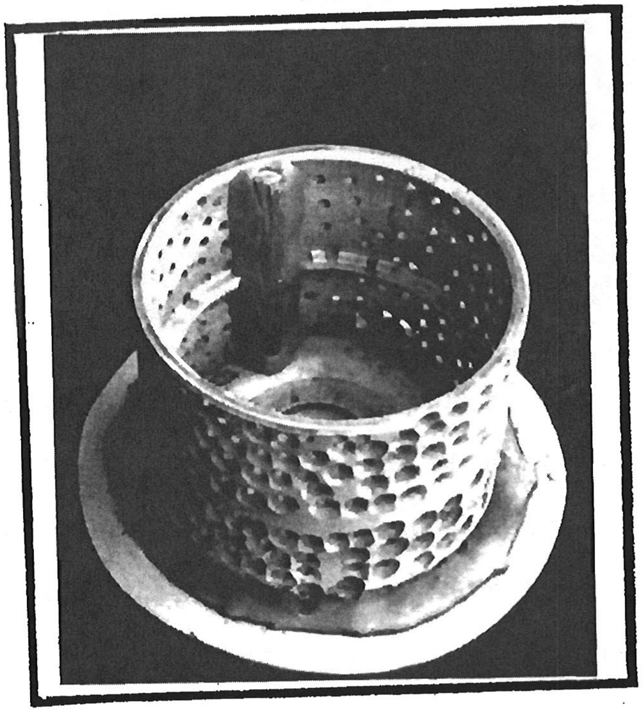
Shown below is a photograph of the 1/8" Rotary Separation Mill having it's inside bottom hot glued in place. We used three passes here too.



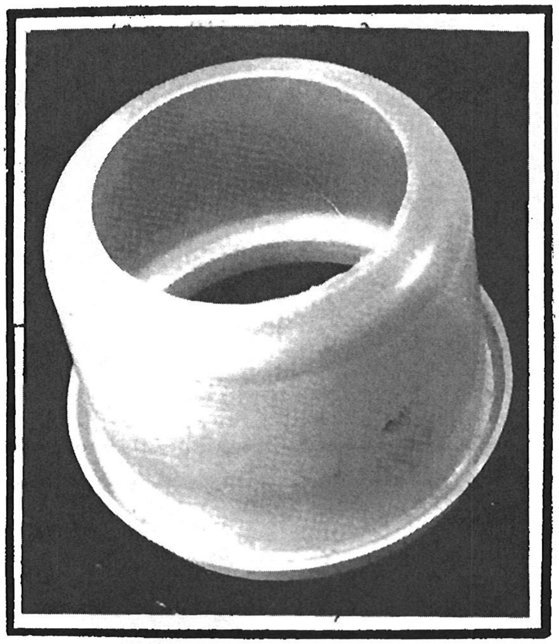
In the photograph shown below are three Rotary Separation Mills. On the left is the 1/8" mill we just assembled. On the right is the Fg mill and in the center is the FFg mill.



On the following page is a photograph of the 1/8" Rotary Separation Mill with a piece of 3/8" wood doweling added. This wood doweling acts as a "speed bump" and it's held in place with epoxy putty. It's used only with the 1/8" Rotary Separation Mill when the black powder chips are very hard and do not want to break up into grains. The lead balls are caught by this doweling and are lifted and dropped onto the chips. We have also used a larger drill bit on the outside holes to help the grains pass through.

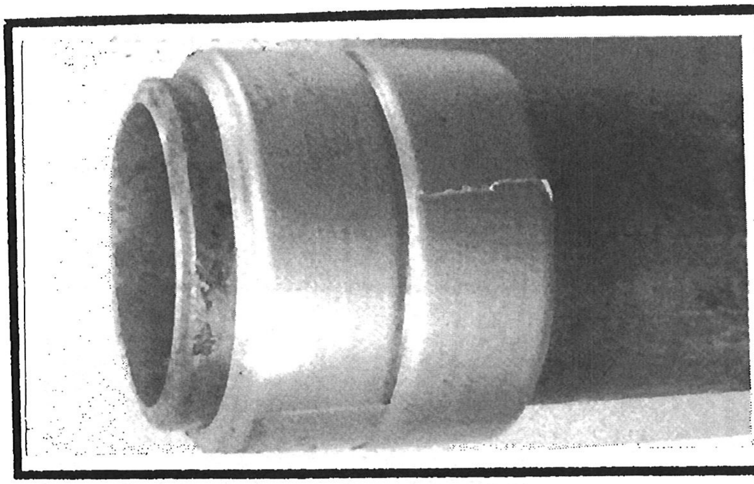


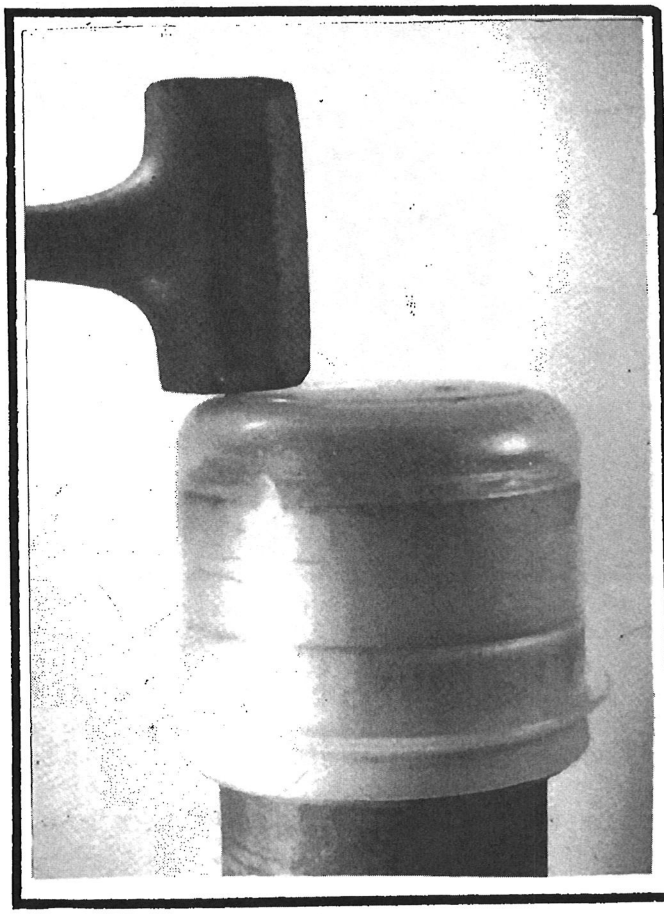
On the following page is shown a photograph of a Rubbermaid plastic bowl, #3882, with it's bottom cut out. The bottom is used in the pressing operation as spacers between the black powder ingots. The bowl with it's bottom cut out is used for Stack Screening. By mounting



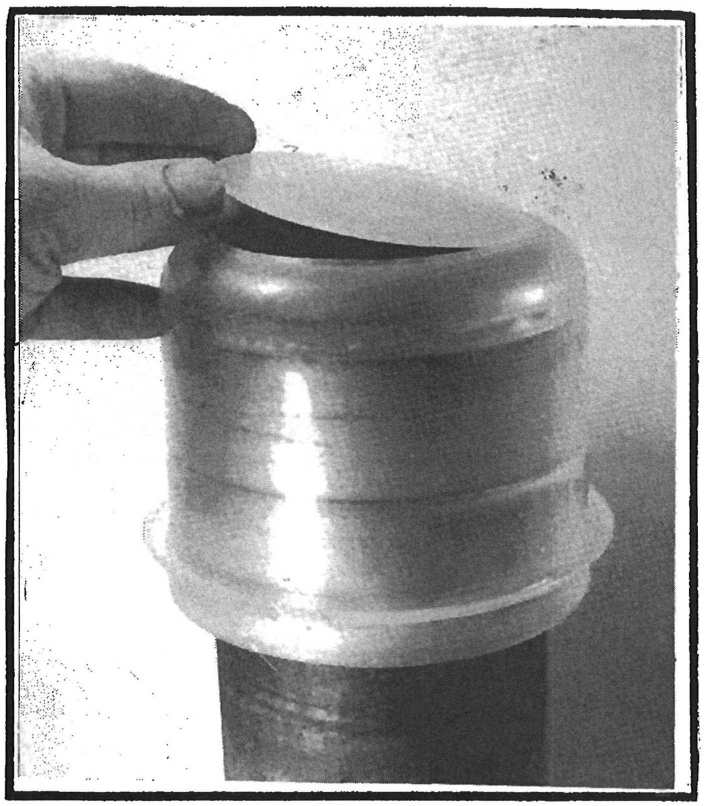
a screen of a known hole size in the bottom, the black powder grains of a certain size will pass and grains of a larger size will stay in the bowl. The bottom of the bowl is cut out with this cutter made out of a piece of steel pipe with an inside diameter of 3 7/8". The duct tape is used as a spacer to center the bowl precisely on the cutting edge, which has been filed on the inside edge, as shown on the following page.

The bottom is cut out by placing the bowl over the cutter shown below and striking with



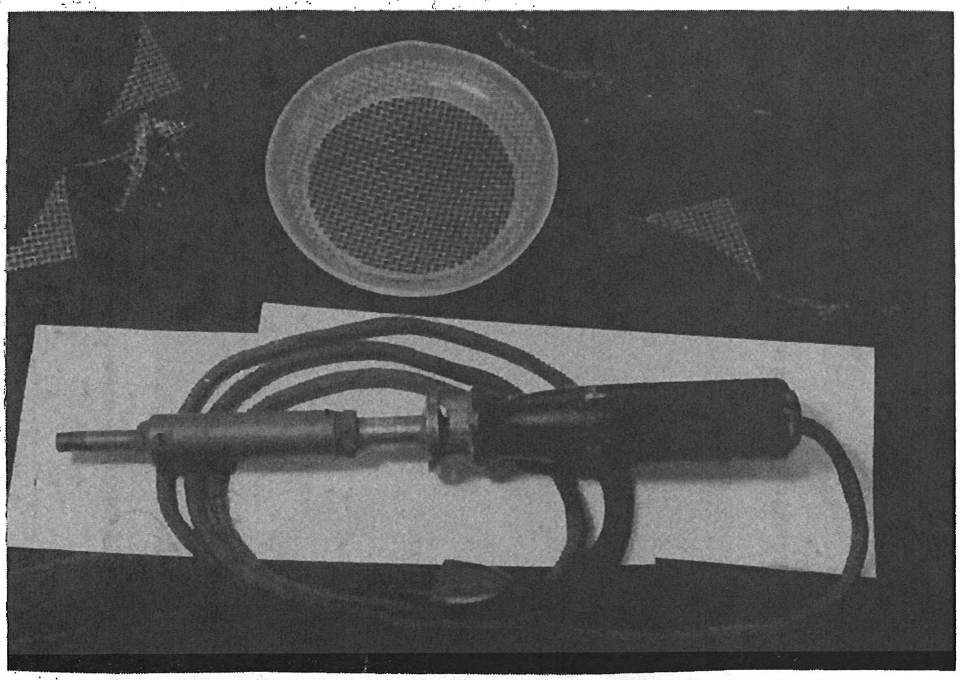


a hard plastic mallet (shown on previous page), where the bowl sets on the cutting edge. Warming the bowl will help soften the plastic so that it is more easily cut. This can be done by running hot tap water into the bowl just before cutting.



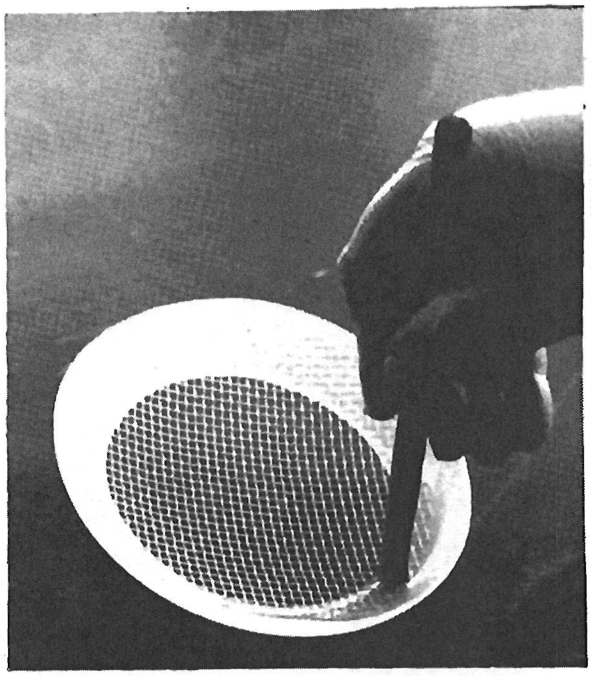
As you can see here, the bottom is cut very precisely with this technique and the bowl bottom is easily removed. You can remove the bowl bottoms of about a dozen bowls in just a few minutes.

Here we have cut out the bottom of the bowl so we can show more detail. The screen has been



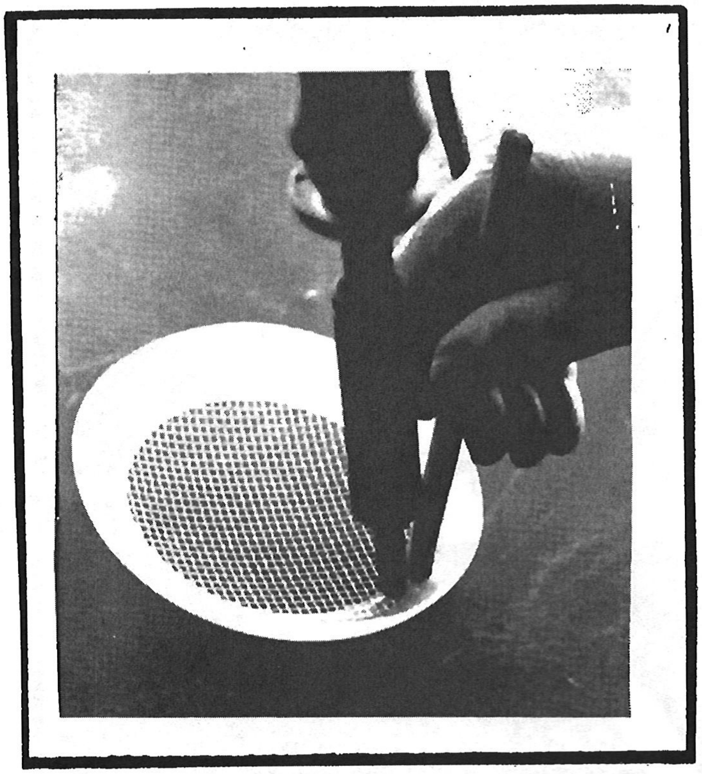
cut to size and placed in the bowl bottom. This soldering iron has a blunt end to transfer the heat more evenly.

The next tool we're going to show you how to make is Stack Screens. These will be made from the bowls that have had their bottoms cut out and the screens that you have obtained.



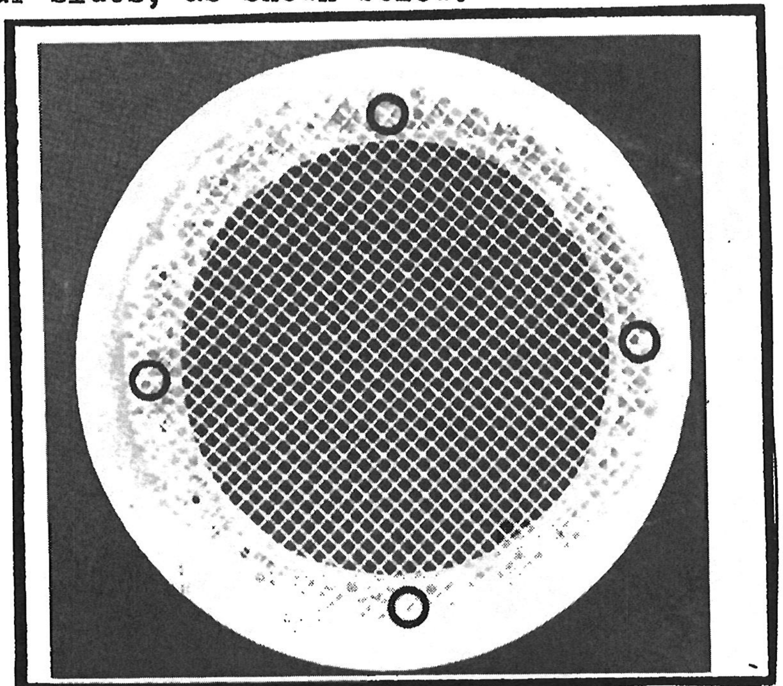
Step 1. Place a screen that is an inch and a half larger than the hole in the inside bottom and center it. Take a wooden dowel and hold it down on one side as shown above. Here we have cut the bowl bottom out in order to show more detail.

Step 2. Place the hot blunt end of a large electric soldering iron directly onto the screen beside the dowel. The heat will transfer through the screen and melt the

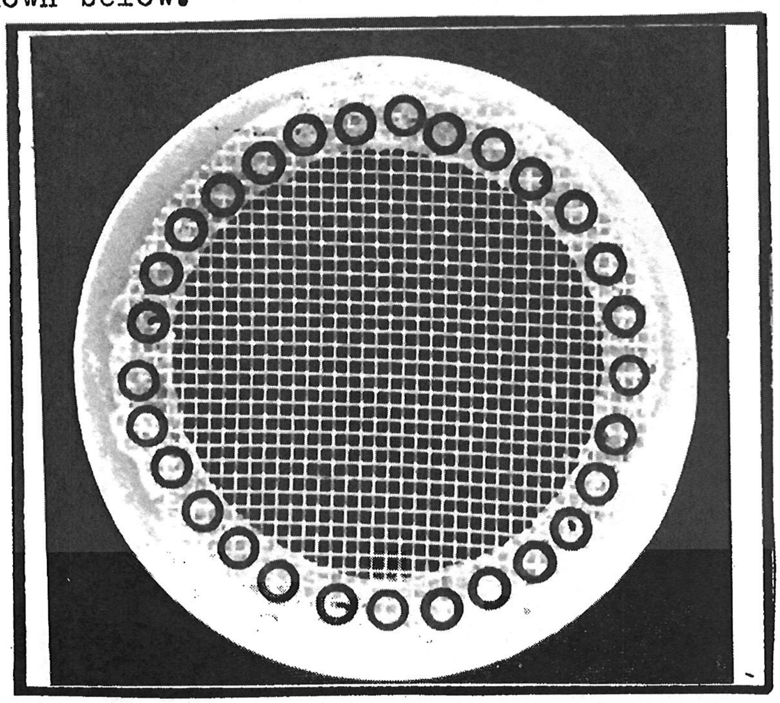


plastic bowl bottom. Remove the soldering iron slowly, while holding the dowel in place. When the plastic cools, it will hold the screen in place.

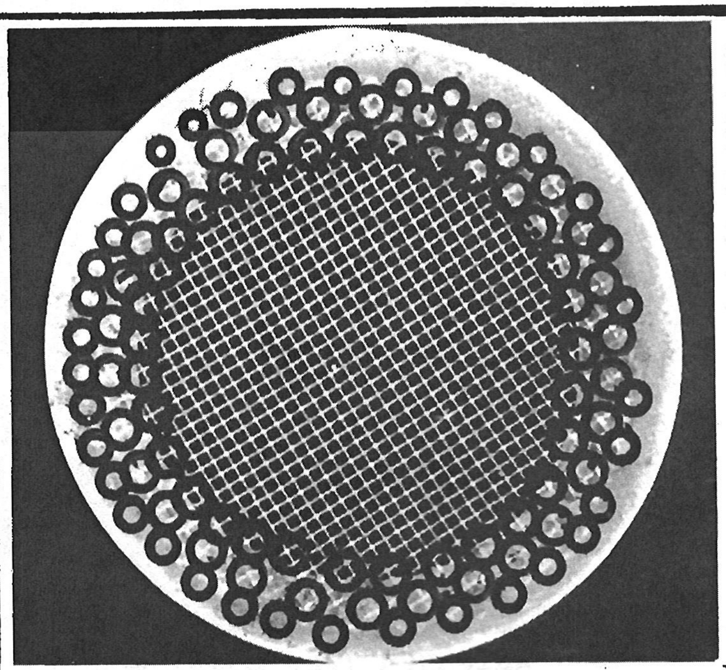
Step 3. Using the same technique, tack down all four sides, as shown below.



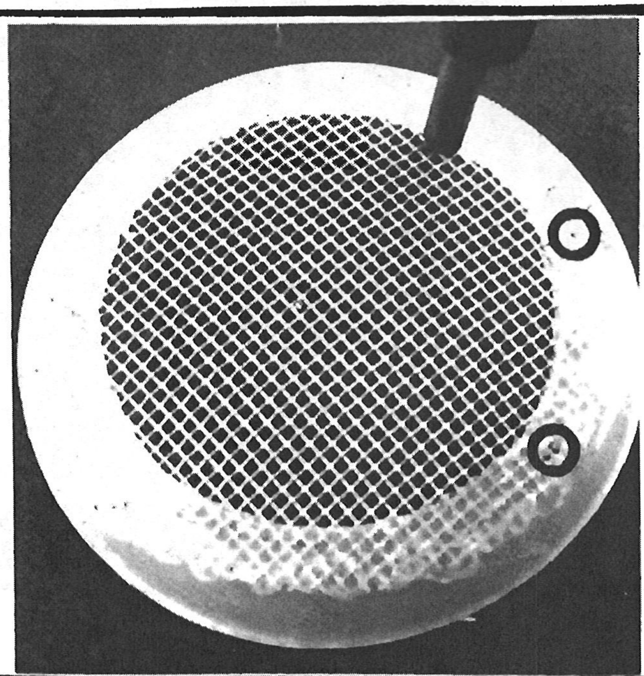
Step 4. Tack in between the first four tacks as shown below.



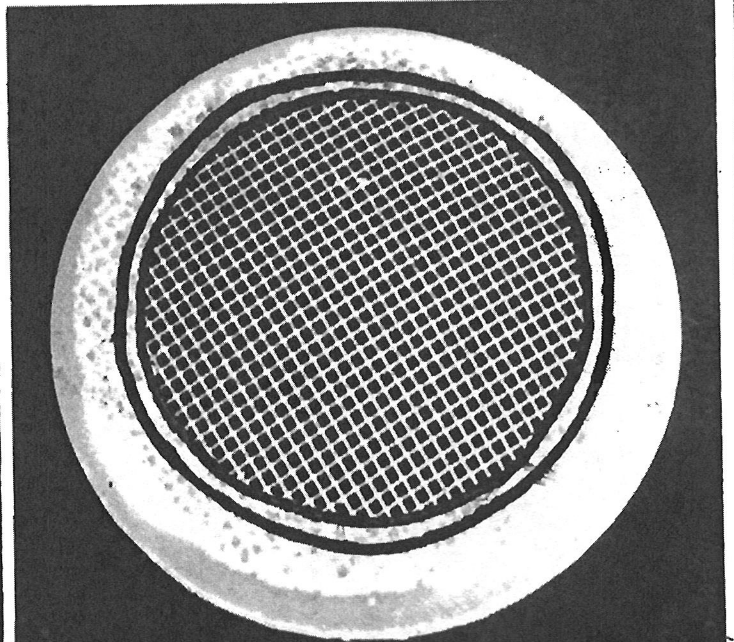
Step 5. Tack down the inside edge and any wire screen ends, as shown below.



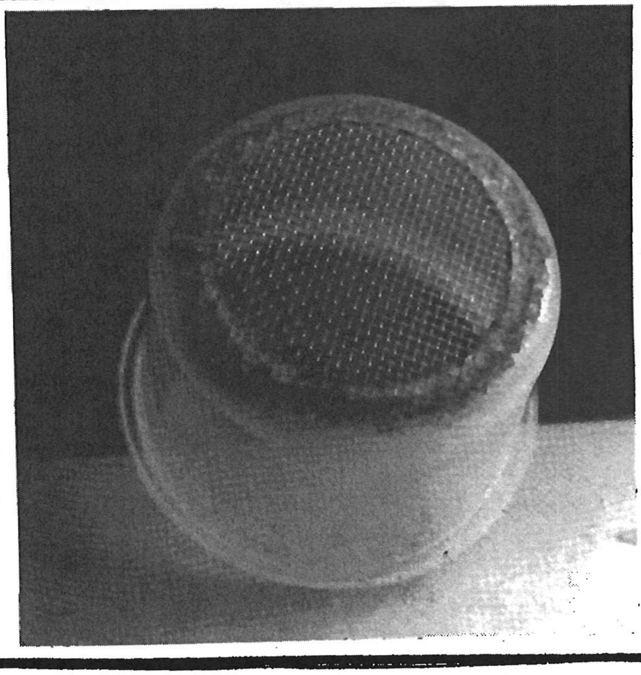
Step 6. Turn the bowl over and rub any holes that might have burned through with the soldering iron to seal them, see below.



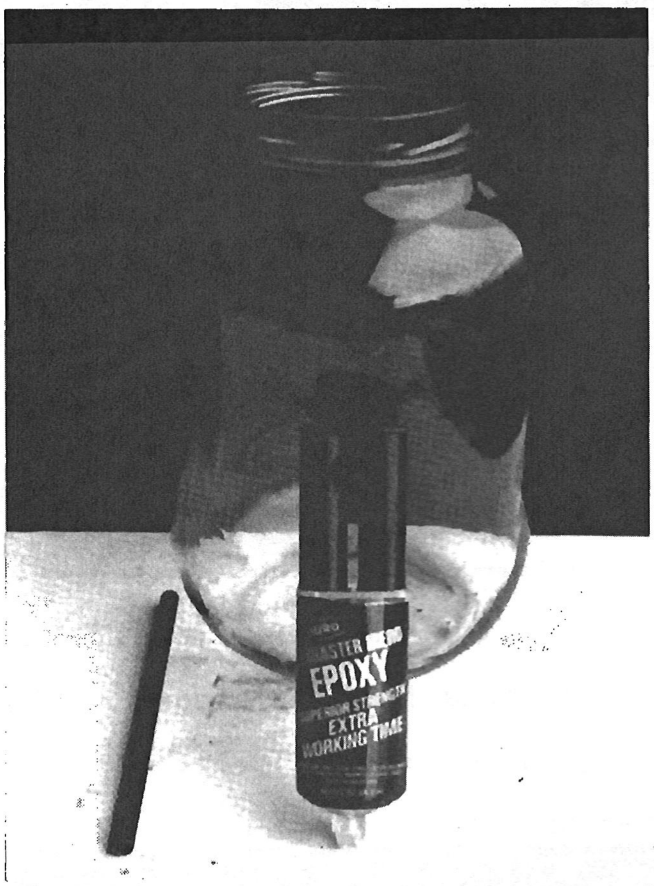
Step 7. Hold the soldering iron as shown in Step 6 and feather in the inside edge as shown below.



Here is a completed bowl mounting ready for use. A dye has been added to show the areas of adhesion.

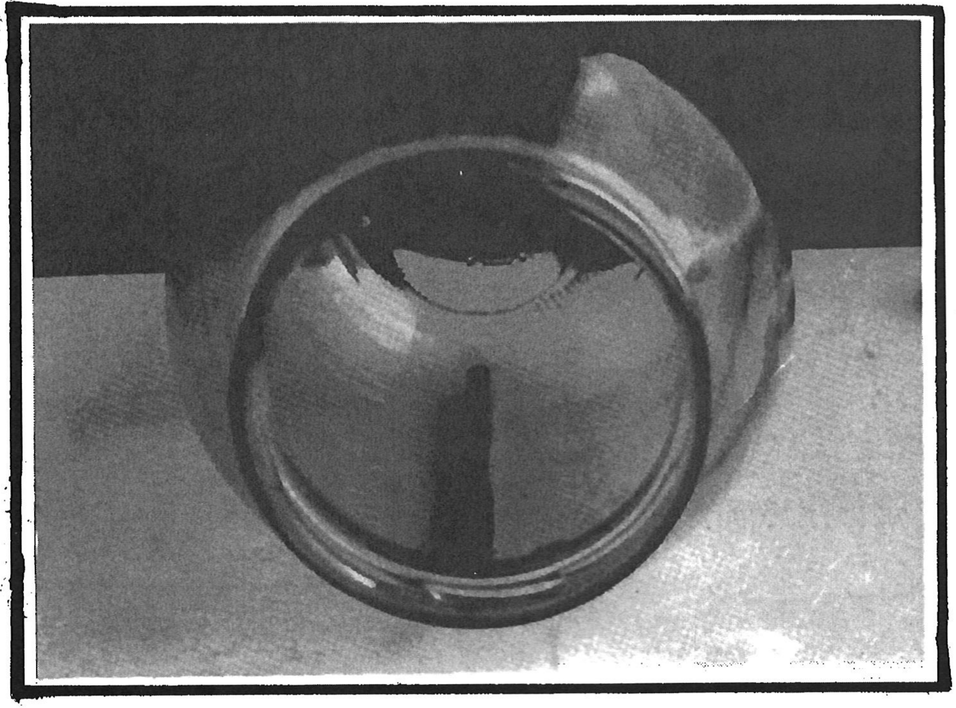


The last tool you will need to make is the Rotary Dryer Drum Jar.

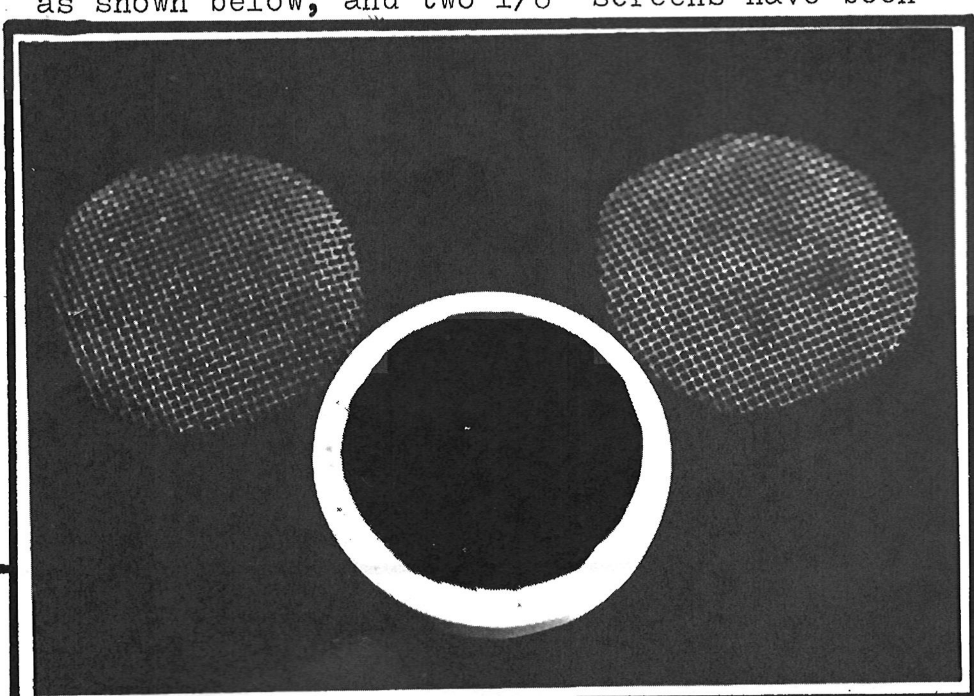


Shown above is a one gallon glass jar and a tube of epoxy glue, along with a fiberglass tube cut to length (from a fiberglass arrow). Wood doweling can also be used.

Here the tube is glued to the inside of the jar to act as a "speed bump" when the jar is



rotated. This will keep the black powder from just sliding around on the inside of the jar. The lid that originally came on the jar is cut as shown below, and two 1/8" screens have been



cut to fit on the inside. Between the two screens, you place one sheet of toilet tissue to act as a filter to let air in and out at the same time retaining the black powder grains.

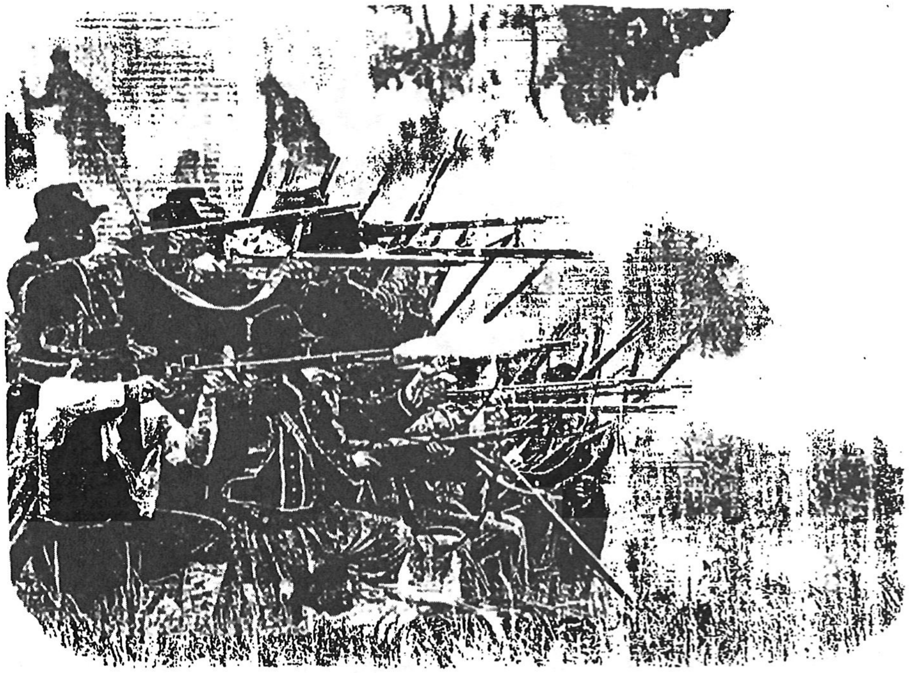
Additional Reading

Explosives in History, the Story of Black Powder, by Wilkinson, Norman B.; Rand McNally Co.; Washington State Library, Olympia, Wa. Call No. 662.26-W65GE.

Supplementary

A better black powder for use in firearms has been made by using brass rollers instead of golf balls. Golf balls have been shown to wear down, adding their plastic material to the black powder mix causing bore fouling. Brass or bronze rollers can be made from round stock, from 1 inch to $1\frac{1}{2}$ inches in diameter, and 2 to 4 inches in length. The number of rollers used should fill the mill about 1/4 to 1/3 full before adding chemicals.

It has also been discovered that the water used by the major U.S. manufacturer of black powder, contains certain bacteria that may over time adversely affect the chemical composition of their product. We now suggest using water that has been filtered through a charcoal bacterial filter.



The Byzantines kept the secret of black powder for a long time, but finally the Moslems learned of it and used black powder against the Christians at the time of the Fifth Crusade. In the Sixth Crusade, the army of St. Louis in Egypt was bombarded with incendiaries, as well as grenades of glass and metal which scattered fire upon bursting.

Guns apparently came into use shortly after the death of Roger Bacon, and a manuscript in the Asiatic Museum in Leningrad probably compiled about 1320, shows tubes for shooting arrows and balls by means of powder. In the library of Christ Church in Oxford, England, there is a manuscript entitled "De officiis regum" written by Walter de Millemete in the year 1325, in which a drawing pictures a man applying a light to the touch-hole of a bottle-shaped gun for firing a dart. On February 11, 1326, the Republic of Venice ordered iron bullets and metal cannon for the defense of its castles and villages, and in 1328 cannon and powder were provided for the protection of the ports of Harfleur and l'Heure against Edward III. Cannons were also used in 1342 against the Moors in the defense of Algeciras and again in 1346 by the English in the battle of Crecey.

When guns began to be used, experiments were carried out for determining the precise composition of the mixture which would produce the best effect. The following are tables of formulas that have been used in the past.

	Saltpeter	Charcoal	Sulfur
8th Century - Marcus Graecus	66.66	22.22	11.11
8th Century - Marcus Graecus	69.22	23.07	7.69
c. 1252, Roger Bacon	37.50	31.25	31.25
1350, Arderne	66.6	22.2	11.1
1560, Whitehorne	50.0	33.3	16.6
1635, British Government	75.0	12.5	12.5
1781, Bishop Watson	75.0	15.0	10.0
England	79.0	18.0	3.0
England	77.4	17.6	5.0
Germany	78.0	19.0	3.0
France	78.0	19.0	3.0

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Randy & Leigh Ellis

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