National Park Service

Manual of Instruction for the Safe Use
of Reproduction 18th Century Artillery
in Historic Weapons Demonstrations

TABLE OF CONTENTS

	Page
Part I: Introduction to 18th Century Field Artillery	**4**
Part II: Artillery Nomenclature	**7**
Part III: Artillery Inspection and Maintenance	**16**
Part IV: Artillery Drill	**25**
Part V: Artillery Misfire Procedures	**36**
Part VI: Artillery Laboratory	**42**
Part VII: Artillery Demonstration Critique	**52**
Part VIII: Artillery Competency Exam	**54**
Appendix	
Manual for the 18th Century Swivel Gun	

Bibliography

Cover art:

Continental Artillery Battery (Gun Crew) In Action, Don Troiani, 1975, National Park Service

INTRODUCTION TO MANUAL

This manual sets forth the procedures that must be followed by persons demonstrating 18th century field artillery to the public in areas administered by the National Park Service. It also provides instruction on proper maintenance, inspection and repair procedures. This manual must be used in conjunction with Director's Orders, DO-6, Historic Weapons Demonstration Safety Standards and the Historic Weapons Program Manual.

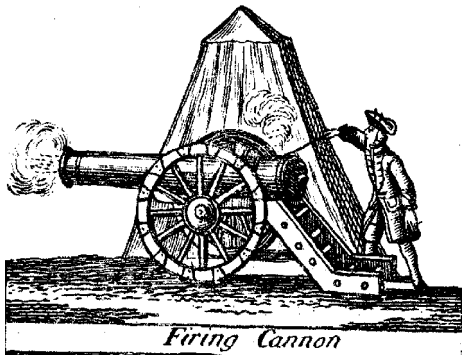
PART I. INTRODUCTION TO 18th CENTURY ARTILLERY

In contemporary times, cannon and other forms of artillery from the War for American Independence are nothing more than quaint, noise-makers. We see them only in demonstrations at historic sites or in the movies and TV. In their day, cannons were the most powerful,
far-reaching weapon which humans controlled. From clumsy beginnings in the 1300's, cannons had become by the 1700's examples of sophisticated technology in terms of manufacture and in performance.

Artillery could destroy walls of cities and fortresses. It could annihilate whole bodies of troops instantly, and at a greater distance than any other weapon. They were complicated and expensive to manufacture, fearsome in their execution, and hazardous to operate.

Cannon firing demonstrations in National Park Service sites are programs understandably very popular with visitors. The noise, smoke and smells provide them with immediate experiences that help them understand the past in a unique and exciting manner. These demonstrations also require a good deal of respect on the part of the participants, not only for the power of the weapons, but also for those who operated the guns, or faced them in battle.

There were three types of artillery pieces in the era of the War for American Independence: cannon, howitzers and mortars. Each had their role, strong points and weaknesses.



Cannon are the most familiar, and most misunderstood. Cannons were long guns which fired solid, non-exploding projectiles. The cannon ball or shot relied on the velocity of the firing and mass of the projectile to smash or batter the target. The projectile would travel in a flat parabola, similar to the path of a pitched baseball.

Cannon fired spherical projectiles, which smashed. Cannon balls were useful against ships and defensive walls. Clusters of smaller cannon balls, called grapeshot, were horribly effective against living targets. An improvement on grape shot, called cannister, was a tin cylinder filled with musket balls. In an emergency, handfuls of broken, scrap iron could be fired. For specialized situations, like fighting against ships, bar and chain shot were developed to wreck masts

Mortars and howitzers were shorter, stubbier guns, which fired exploding projectiles called shells. Shells would be fired at a higher arc than a cannon shot, not unlike an outfielder's throw to home plate. Mortars were used in stationary situations like sieges. They were used to lob shells over walls to harass the defenders. Howitzers were mounted on carriages, similar to those for cannons. They were sometimes found on battlefields, but apparently in more static situations, like defense of a redoubt or prepared position.

Howitzers and mortars usually fired exploding shells, but could also fire solid projectiles like grapeshot. They also could fire light-balls (incendiary shells), smoke balls, stink-balls, message balls and carcasses. The last mentioned were mostly fired from the largest mortars in a siege and were bundles of flammable, explosive and anti personnel materials.

Swivel guns were smaller caliber cannon used in naval actions and static defense (forts, stockades &c.) mostly firing anti personnel ammunition. Intended to be operated by one or two gunners, the National Park Service requires a crew of three.

Mortar battery in action from Memoires d'Artillerie, Peirre Surirey de Saint Remy, 1745

PART II. ARTILLERY NOMENCLATURE

THE GUN

The **bore** is the interior hollow cylinder which receives the charge. In includes all the part bored out. The **muzzle** is the entrance to the bore.

The **breech** is the mass of solid metal between the bottom of the bore and the cascable.

In howitzers, a **chamber** is located at the base of the bore to accept cartridges with reduced charges.

The **cascable** is the projecting part which terminates the piece. It consists of the **knob**, the **neck** and the **fillet**.

The **reinforce** is the thickest part to the body of the gun to offer resistance to the force of the powder and the shock of the projectile.

The **chase** is the conical part of the gun in front of the reinforce.

The **swell of the muzzle** is the large part of the gun in front of the neck; it gives strength to the gun at its termination to prevent the mouth from splitting from the shocks of the projectiles, and facilitates aiming.

The **face** is the front plane terminating the piece.

The **trunnions** are the cylinders at the sides of the gun, which support it on its carriage.

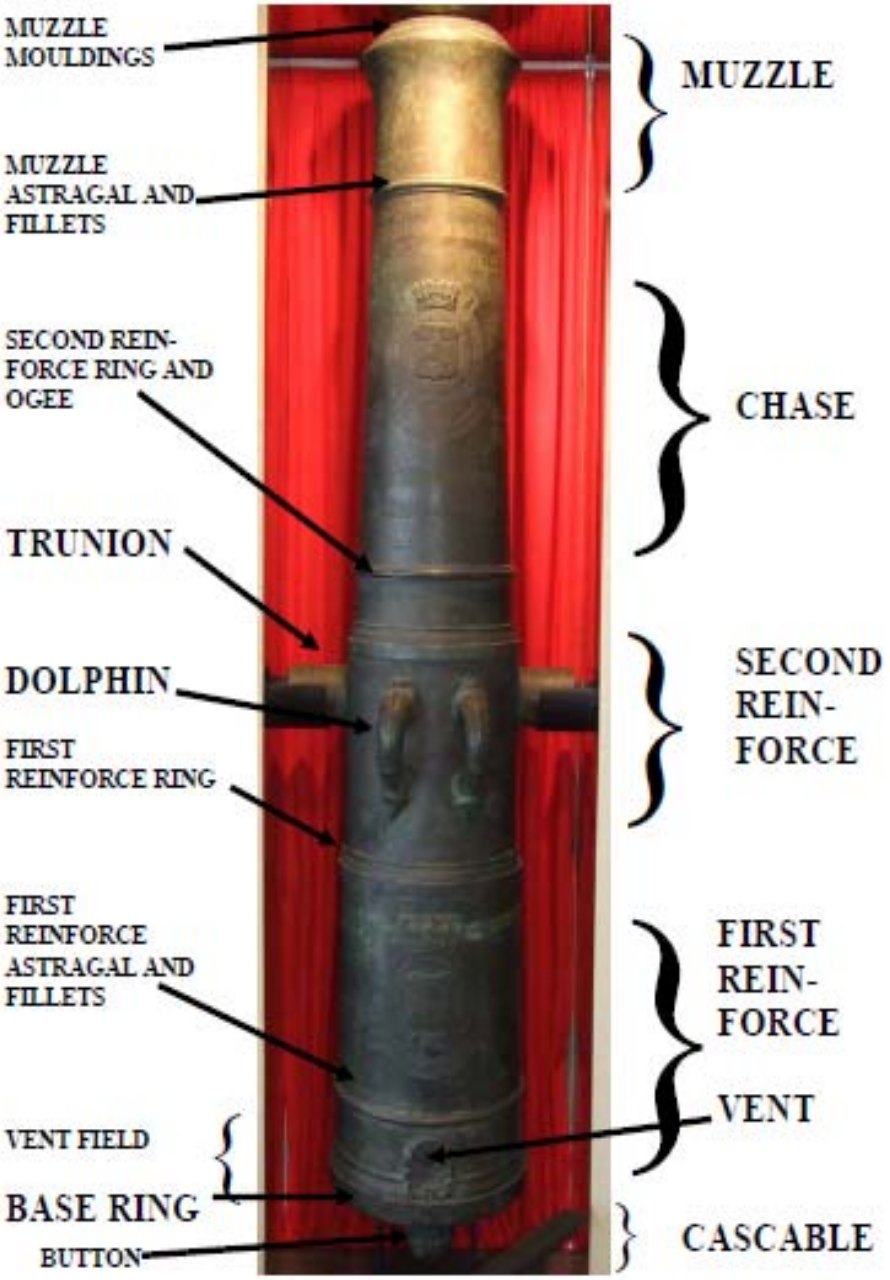
The **rimbases** are the short cylinders uniting the trunnions with the body of the gun.

The **vent** is a cylindrical hole, terminating near the bottom of the bore, through which fire is communicated to the charge. It is bored through a **vent piece** made of wrought copper, which is screwed into the gun.

Markings on guns included the date of manufacture, the serial number, the foundry, the inspector's initials, and the weight.

The Parts of a Gun

Medium 12 Pounder Saratoga NHP



THE CARRIAGE

Carriage parts made of white oak are:

The **cheeks** are two pieces of wood between which the gun rests and serves as the trail.

The **transoms** are wood, in three pieces, joined to the cheeks and serving to connect the two parts of the carriage together. **Breast, Centre and Breech, & Trail.**

The **axle body** covers the axletree.

The **wheels** consist of the **nave**, **spokes** and **fellies, streaks**.

Carriage parts made of iron are:

.

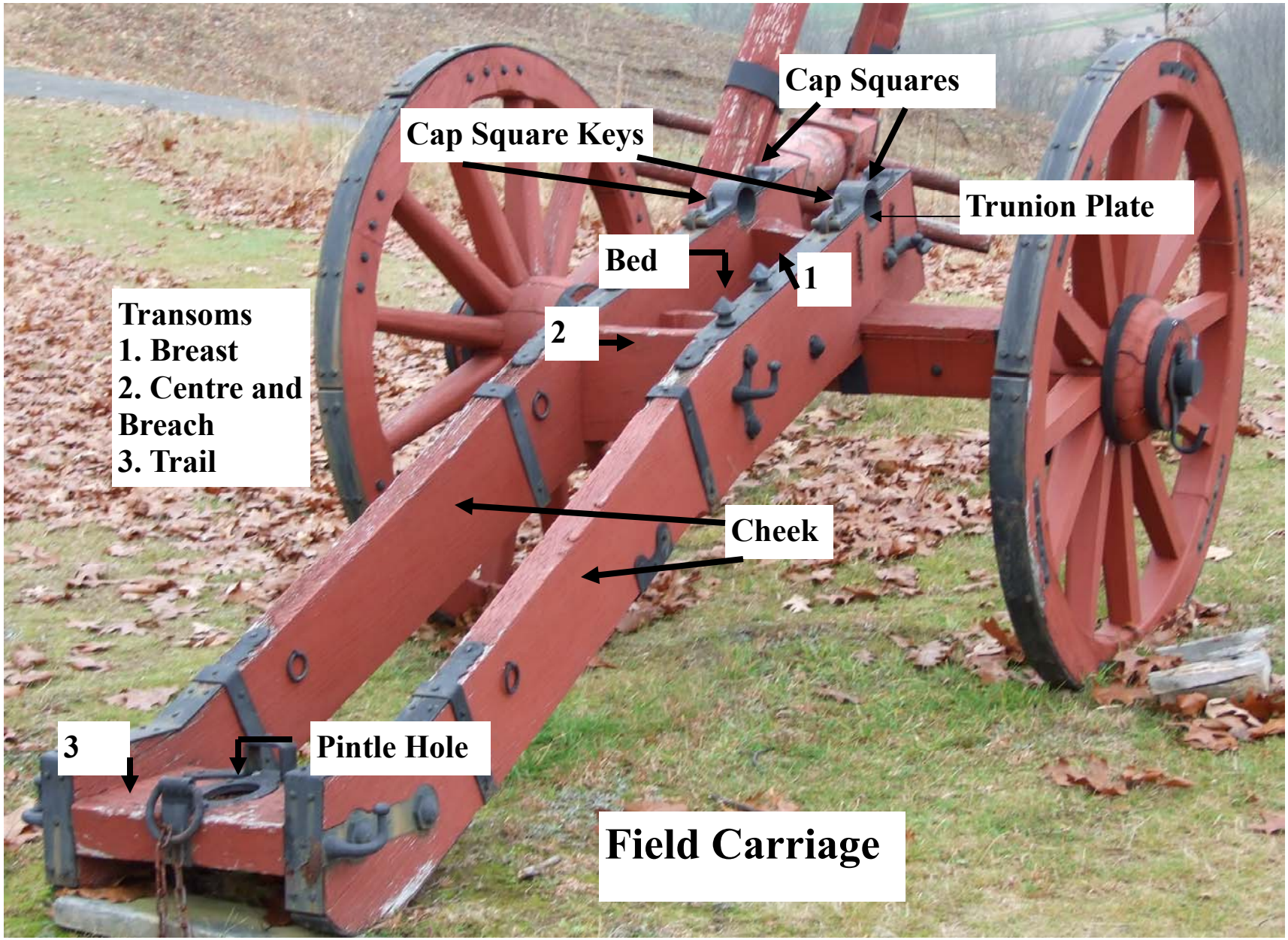
The **trunnion plate** protects the cheeks. The **cap squares** are placed over the trunnions to hold them in place. The are fastened by **chains, pins** and **keys**.

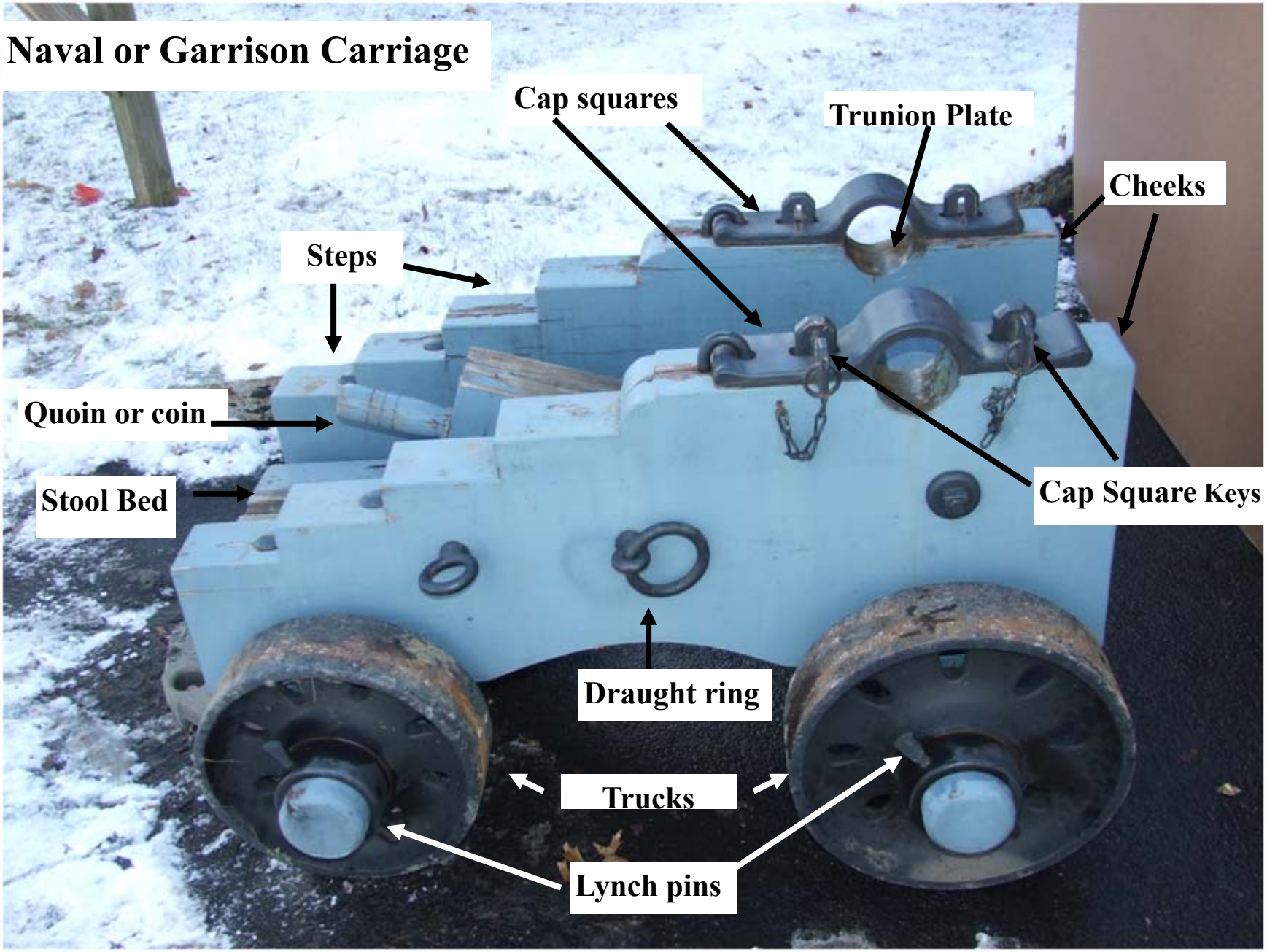
The **whee**l is attached to the **axletree** by means of a **linch pin** and **washer**. The washer prevents the pin from cutting into the nave.

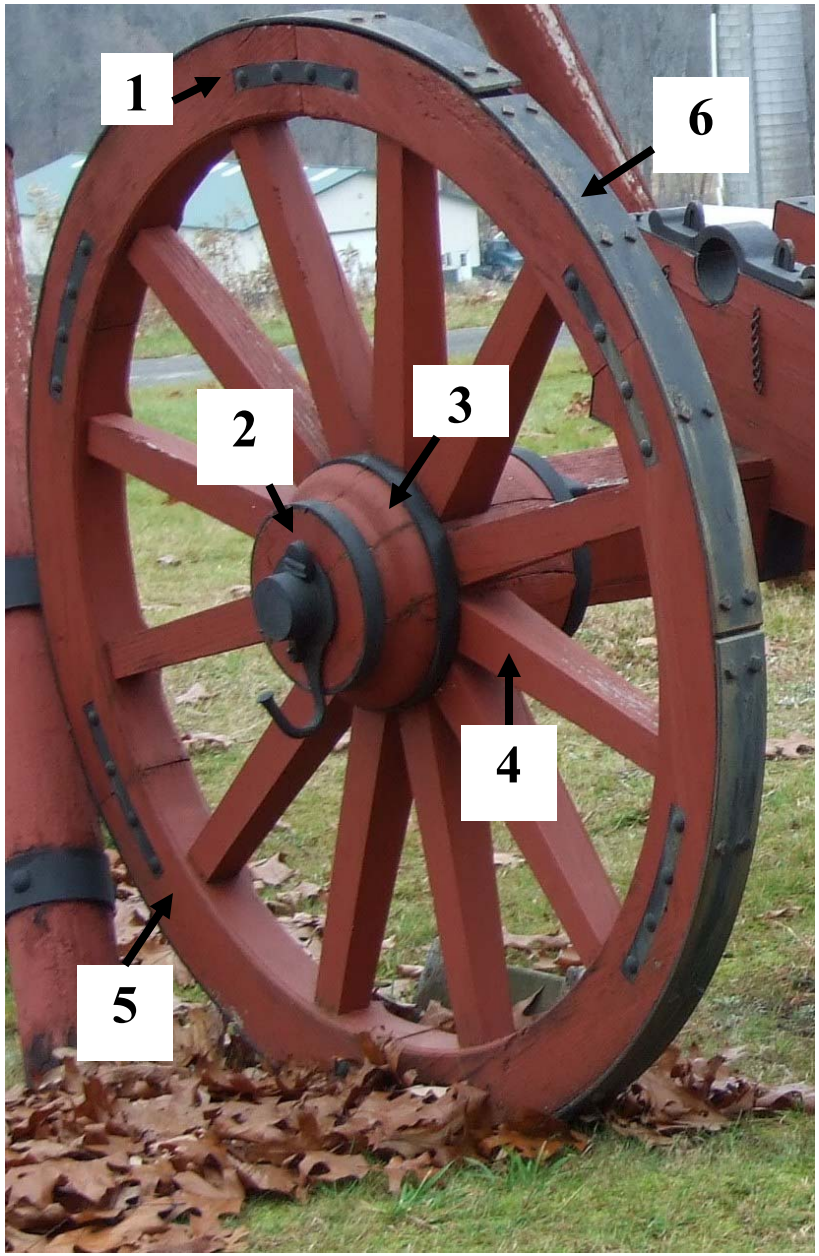
Duledge Plates hold the fellies in place.

The nave is reinforced by the **nave bands**. The wheel is mounted with a **tire**.

On naval and garrison carriages, the **trucks** are iron.


Cap Squares
Cap Square Keys
Trunion Plate
Bed
1
2
Transoms
1. Breast
2. Centre and Breach
3. Trail
Cheek
3
Pintle Hole
Field Carriage


Naval or Garrison Carriage
Cap squares
Trunion Plate
Cheeks
Steps
Quoin or coin
Stool Bed
Cap Square Keys
Draught ring
Trucks
Lynch pins



Parts of the Wheel

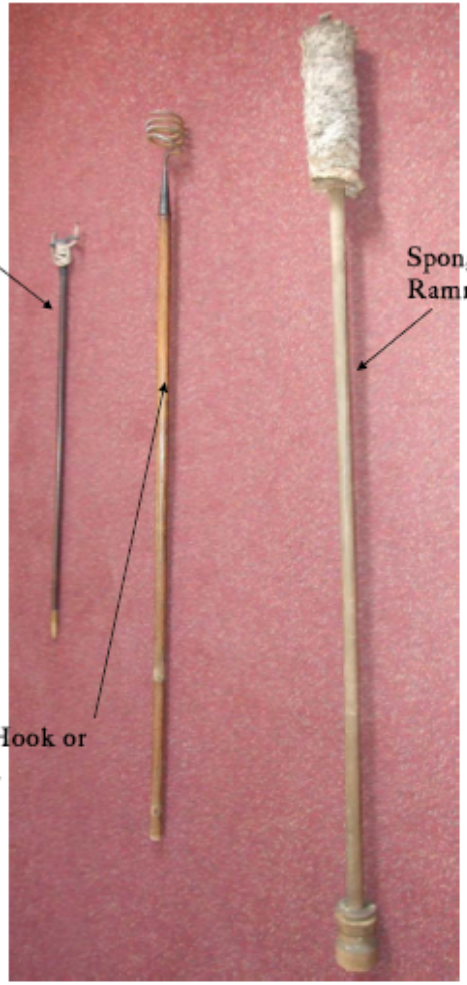
1. Dulledge Plate
2. Lynch Pin
3. Nave
4. Spoke
5. Fellow or fellie
6. Strake

IMPLEMENTS AND EQUIPMENT

The following list of implements and equipment are considered to be the minimum levels for conducting safe demonstrations:

Implement/Equipment	Minimum Recommended No.	Material
Sponge-Runner	1	Stave: Ash or Hardwood Sponge- Sponge Head: Elm, Poplar Rammer-Head: Ash, Elm, &c.
Worm	1	Stave,:Ash or Hardwood
Sponges	Replace as Necessary	Wool Carpet or Sheepskin (Sheepskin preferred)
Sponge Bucket	1	Iron and Wood
Tube Pouch	2	Leather
Thumbstall	2	Leather
Priming Wire	2	Brass
Haversack	1	Leather
Trail-Spike or Tiller	2	Hickory, Oak
Lint Stock	1	Stave, Hardwood

Artillery Implements (1)



IMPLEMENTS

The **sponge rammer** consists of the sponge head, the rammer head, staff and sponge. The staff is made of ash or hardwood, the sponge head is made of elm or poplar and held in place by dowels. The rammer head is made of ash or elm and is held in place by dowels.

The **worm** staff is made of ash or hardwood and is mounted with a worm made of iron.

The **sponge bucket** is made of wood.

The **thumb-stall** is made of leather.

The **priming wire** is made of brass.

The **gunner's haversack** is made of leather.

The **trail handspike** is made of hickory or oak and consists of a ring and staple,
and key made of iron.

Sponge Bucket

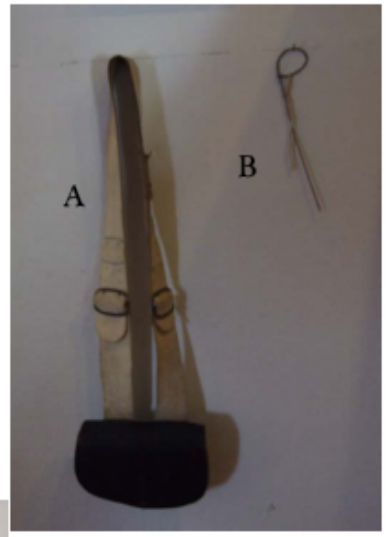
Thumb-stall and Priming Wire

Trail Handspike and Iron Key

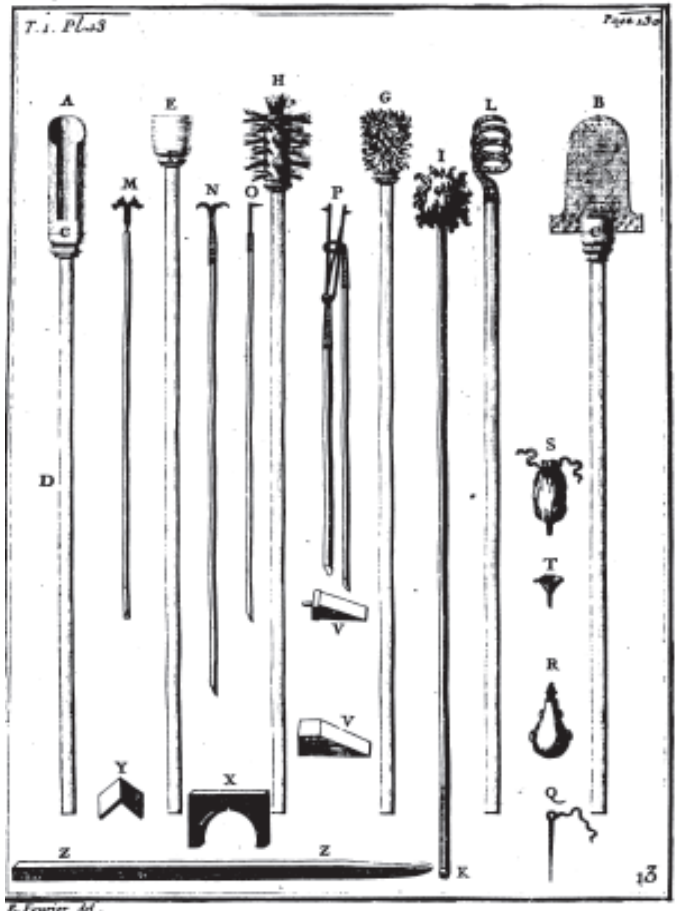
Artillery Implements (2)

Tube Pouch (A)

Pick (B)



Gunner's
Haversack



Artillery Implements from Memoires d'Artillerie
Peirre Surirey de Saint Remy, 1745

Part III-Artillery Inspection and Maintenance

Frequency of Inspections.

The piece should be inspected before demonstrations and after the final cleaning on that particular day. Ordnance in storage should be periodically checked.

Problems Encountered During Inspections.

1. **Overall poor cleaning**: If the piece is not cleaned immediately after use, the residue will harden in the bore, particularly in small voids or pits. This is very dangerous, as, in subsequent firings, this residue can retain a spark or smolder and ignite the cartridge breaks during ramming.

2. **Overall poor maintenance**: Be especially aware of cracks and checks on the cheeks and trail of the carriage since these areas receive the shock of recoil.

The **wheels** are the most critical and important part of the carriage. They should be tight and roll freely and straight. **Spokes** should give a "ring" when tapped with a wooden mallet. Flat sounds indicate the presence of rot. Spokes that jiggle or move when grasped indicate shrinkage of the wood and the manufacturer should be notified for retightening or replacement. The wheels should be rotated frequently to prevent rot of the felloes, especially if the piece is left on the field for appreciable amounts of time. Any wheel that has to be kept wet in order to be tight is unsound, and should be repaired or replaced.

Rot and insect infestation can be detected by looking for blisters in the paint, a softness of the wood, tiny holes bored into the paint and evidence of fungus. Areas where water can be harbored, such as between the spokes on the wheels, the prolong hooks, the lunette and the felloes of the wheels if stored in soft ground or grass especially susceptible to rot.

Inspections (continued)

Wooden implements should be free from serious cracks and splinters. Sponges should be inspected closely for soundness.

The **chest** should be properly made, having non-sparking materials on the inside. All nails are countersunk and the heads puttied over. The lid should fit snugly and be provided with a **lock**. The chest is to be kept locked when not serving ammunition. The chest is clean and free of spilled powder. All equipment and ammunition are neatly and securely stored in the chest.

3. **Enlarged vent**: Bore and vent measurements are taken annually and recorded in the Gun Book. Vents were originally .2" in diameter. A vent in excess of .25" in diameter should not be used as this may cause misfires. On reproduction guns, an extra vent piece should be purchased with the gun.

4. **Condition of the bore**: Injuries to bronze guns is minimal, except for the bending of the trunnions after long service or heavy charges. Internal injuries are caused by the action of the firing of the gun. The *lodgement* if the shot is a compression of the metal on the lower side of the bore, at the seat of the shot, caused by the pressure of the gas in escaping over the top of the shot. There is a corresponding *burr* in front of the lodgement, and the motion thereby given to the shot caused it to strike alternately on the top and bottom of the bore, producing other *enlargements*, generally three in number. *Scratches* in the bore are caused by fragments of a broken shot or the roughness of an imperfect one.

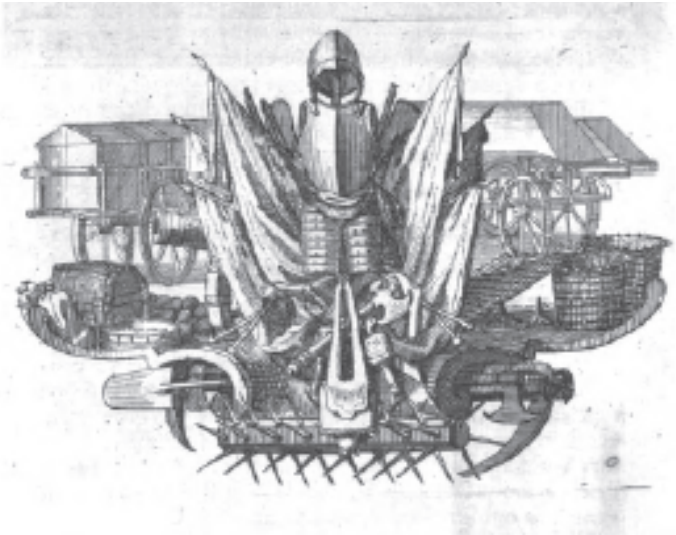
The entrance of the vent should be checked during inspections for corrosion. The bottom of the bore under the vent should be checked for pits caused by the priming wire striking the bottom of the bore during drill.

Iron guns will display the above defects in a less degree than bronze, except for corrosion of the metal. The principle cause of injury in iron guns is from the rusting of the metal. Iron guns that have liners cast in place will have a slight narrowing of the bore at the cascable. Extra care should be taken if firing projectiles to ensure adequate windage as a shot may be fused-welded in the bore.

The following checklist should be used when inspecting individual pieces. Newly purchased ordnance should be inspected using this checklist prior to placing into service.

Recommended tools for inspections include:

--Rawhide mallet
--Craft knife (“X-Acto”) knife, or a pocket knife with a thin blade
--Pocket Mirror or “Mini-Mag” light
--Vent gauge



NATIONAL PARK SERVICE
MUZZLE-LOADING CANNON INSPECTION CHECKLIST

( ) Your overall first impression is favorable.

The Cannon:

( ) Is clean and free of rust or corrosion
( ) No sign of external damage or strain (dents, cracks, etc.)
( ) Inside of the bore is clean and relatively smooth
( ) No internal signs of damage (bulges, lodgments, pits, etc.)
( ) No sign of corrosion damage at breech of the bore
( ) On iron guns with liners, the liner is secure
( ) The vent is clear and of acceptable size, no greater than .25 inches.
( ) No signs of cracks or bending around the trunnions
( ) No signs of weakness at the chaplets on bronze reproduction tubes

The Carriage:

( ) Wheels are tight and free of rot and insect infestation
( ) Body of the carriage is free of rot and insect infestation
( ) No pieces or parts missing, cracked, bent or broken
( ) Wheels move freely
( ) Elevating mechanism or quoin works smoothly and properly
( ) None of the ironwork is coming loose
( ) Tube rotates freely on its trunnions
( ) Cap squares fit snugly and are properly keyed
( ) Lids of side boxes and limber chests fit snugly
( ) Limber chests and side boxes are clean and free of spilled powder
( ) Wood generally free of serious checking and splintering
( ) Wheel hub does not gouge the end of the axletree
( ) Linch pin is not digging into the wheel hub

Equipment:

( ) All necessary equipment is present
( ) Sponge is in good condition and fitted to the bore
( ) Rammer head is secure and free of cracks
( ) Small items in good condition (linstock, thumbstall, buckets, etc.)
( ) Prongs of the worm are sharp and not bent
( ) Haversack is clean and free of spilled powder

( ) The gun book is being kept up to date

EQUIPMENT INSPECTION CHECKLIST

Sponge Rammer:
( ) Sponge head is not loose
( ) Sponge cover is oak-tanned sheep skin or 100% brussels wool carpet
( ) Tacks are copper/brass and are not protruding
( ) Rammer head is not loose
( ) Staff is free of cracks or splintering

Worm:
( ) Prongs are not bent
( ) Worm head is not loose
( ) Staff is free of cracks and splintering

Sponge bucket:
( ) Made of wood and does not leak

Tube pouch:
( ) Leather, flap closes, can be secured and has an inner flap

Thumbstall:
( ) Leather, no extreme wear

Priming wire: ( ) Brass, not bent, long enough to puncture cartridge

Gunner's Haversack:
( ) Leather, flap can be secured

Trail handspike:
( ) Must fit pointing rings snugly and have key

Linstock:
( ) Linstock head is not loose
( ) Handle free of cracks and splinters

Ammunition chest:
( ) Interior is made of non-sparking materials
( ) Nails are countersunk and puttied over
( ) Lid fits snugly and is provided with a lock
( ) Interior is free of loose powder

SPECIAL EQUIPMENT

Quill primers, slow match, sufficient for planned firing demonstration(s) plus possible misfires; misfire kit : a large syringe [60 cc], hose and funnel.

MAINTENANCE

FOLLOWING THE DAY'S DEMONSTRATIONS

The cannon should be cleaned with mild soap (i.e. “Ivory”) and fresh water after the conclusion of the day’s demonstration. The elevation screw should be turned up fully to allow excess water to run out the bore. Excess water should be wiped off the carriage. Fouling should be removed from the vent field with water and a toothbrush. The bore on iron cannons can be lightly oiled after being completely dried with a rag to prevent rust.

The sponge should be washed in soapy water after the day’s demonstration. It should be spun to prevent the knap from matting. The sponge should be allowed to dry in a standing position.

Since powder fouling deteriorates the fibers, sponges should be inspected frequently and replaced as necessary. In no case should a sponge be allowed to deteriorate to the point where there are loose threads and rotting of the material.

The worm should cleaned thoroughly of fouling and dried.

The sponge bucket should be rinsed and turned over to dry.

The priming wire should be wiped clean of fouling.

The ammunition chest is checked to ensure it is clean of any spilled powder.

The day’s entry is made in the Gun Book.

The piece should be kept limbered when on the field, the limber wheels chocked and the lock chain secured. If a piece must be kept in the field, then it should be covered with a tarpaulin to protect it from rain and dew.

LONG TERM MAINTENANCE

For long-term maintenance and preservation, the piece should not be left exposed to the weather. The piece should be kept in an unheated building or other similar structure. Carriages left exposed to the effects of the elements will deteriorate rapidly.

The Gun:

Notations on bore and vent diameters are recorded annually in the Gun Book.

Hardened fouling in the bore can be removed by use of a stove pipe brush of proper diameter attached to a staff. Fouling can also be removed by use of scrubbing patches.

The vent can be cleaned of fouling with a .177 caliber bore brush with a pistol cleaning rod. The vent should be covered while in storage.

Iron guns in storage should be checked from time to time to see that moisture does not collect in the bore.

The Carriage:

In order to preserve the carriage, it should be stored in an unheated building when not in use. If a piece must be kept in the field, then it should be covered with a tarpaulin to protect it from rain and dew.

Some checking of the wood can be expected. Filling of cracks or checks should be done with soft, elastic filler that will allow expansion and contraction of the wood. Hard putty or similar products will sink into the crack and act as a wedge as the wood breathes.

It is recommended that cracks on horizontal surfaces be filled, since they would allow water to soak into the wood, shortening the life of the carriage.
All surfaces (carriage and implements) should be painted as needed.

The elevation screw and the axle should be kept lightly lubricated with common ball bearing grease.

Wheels

Wheels are, perhaps, the most critical and important part of the carriage. They should be tight and roll freely and straight.

The axle is to be greased as necessary, with a heavy lubricating grease.

The spoke should give a musical "ring" when tapped with a wooden mallet. Flat sound indicate the of rot. Spokes that jiggle or move when grasped indicate shrinkage of the wood and the manufacturer should be notified for retightening or replacement.

The wheels should be rotated frequently in order to prevent rot on the felloes, especially if the piece is left in the field for appreciable amounts of time.

Any wheel that has to be kept wet in order to be tight is unsound, and should be repaired or replaced.

Implements and Accoutrements:

Rammer and sponge heads are securely fastened with hardwood dowels, and non sparking metals are used in the construction. During the off-season it is a good idea to soak the sponge head in boiled linseed oil, to minimize deterioration. Paint as necessary.

The sponge bucket should be checked. Sponges should be covered when dried.

Leather accoutrements should be cleaned with saddle soap to remove dirt. Gloves and gauntlets should be kept clean and flexible with saddle soap. Leather accoutrements should be removed from the ammunition chest prior to long-term storage. Dry leather can be restored with neatsfoot oil, Lexol or similar leather preservative.

PART IV. ARTILLERY DRILL

A number of gun drills existed during the 18th century, some of which varied in complexity and safety. The emerging American artillery did not possess a manual for artillery drill or construction. During the American Revolution the Continental artillery relied on the standard 18th century ordnance text by John Muller, A Treatise of Artillery. Muller's work was the only written manual available to the Americans until 1797. Following the American Revolution, William Stevens, a veteran artillerist of the American Revolution, was asked to prepare a manual for the use of the fledgling American artillery, and he quite naturally drew from his personal experience during the war. He published A System for the Discipline of the Artillery of the United States of America, or the Young Artillerist's Pocket Companion. The drill he sets forth is basically a modified form of the British drill--a drill most Americans were familiar with from before the war. This manual is the earliest published American artillery manual known at the time of this writing. A. L. de Tousard, a French volunteer in the American Artillery was requested to write a manual which would be published in 1809. Tousard's three volume work the, American Artillerst Companion, would be considered the standard reference for the War of 1812. Tousard borrowed heavily from Stevens and Muller as well as manuscript notes and information from George Fleming, another Revolutionary War American artillery officer. Tousard includes an American drill used during the American Revolution and is somewhat different from Steven's version, and is attributed to have been provided by Fleming.

All of the above is by way of introduction to the drill and a slight attempt to determine its possible origin.

The manual is specifically for the brass 6 Pdr. Field gun. It is applicable to field pieces of other calibers, however, and may as well serve for smaller guns. It is necessary to alter some of the positions for safety, i.e. move from the inside of the wheels to the outside on shorter guns. Other drill manuals may be used, but the same safety standards must be adhered to in their demonstration as set aside in this manual.

It should also be noted that the following manual is for training purposes. That is to provide drill commands for training purposes. These are not the commands that were used in actual combat. Tousard mentions in his book, "When the gunners and matrosses know and are attentive to their duty, a field piece may be fired sixteen and even eighteen times in a minute without hearing any other noise but the fire and the word charge (load)." Needless to say we are not going to duplicate the combat rate of firing, but it can be a point of interpretation in your program.

For our purposes, we will be using a modified version of the original Stevens drill. The modified drill reduces the number of gunners from sixteen to six, and is written in simplified modern English rather than the frequently ambiguous terms of Mr. Stevens.

Modified Stevens Artillery Drill

Gun Crew Positions:

Front Left (**FL**) handles the worm or wad hook. Required safety equipment: Hearing protection, leather gauntlets.

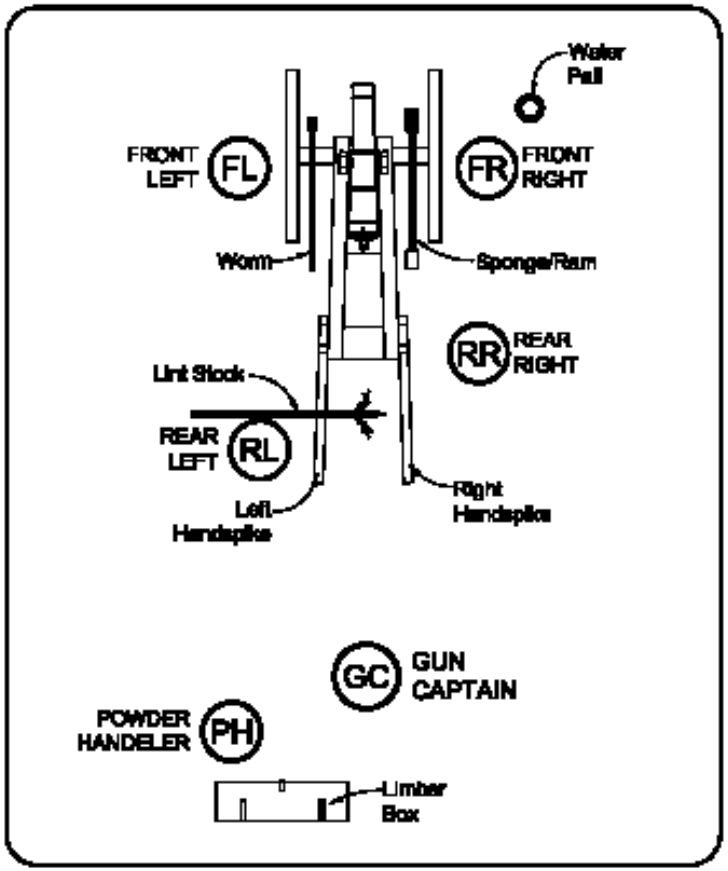
Front Right (**FR**) handles the sponge rammer. Required safety equipment: Hearing protection, leather gauntlets.

Rear Left (**RL**) handles the linstock and is responsible for keeping the end burning throughout the demonstration. Required safety equipment: Hearing protection.

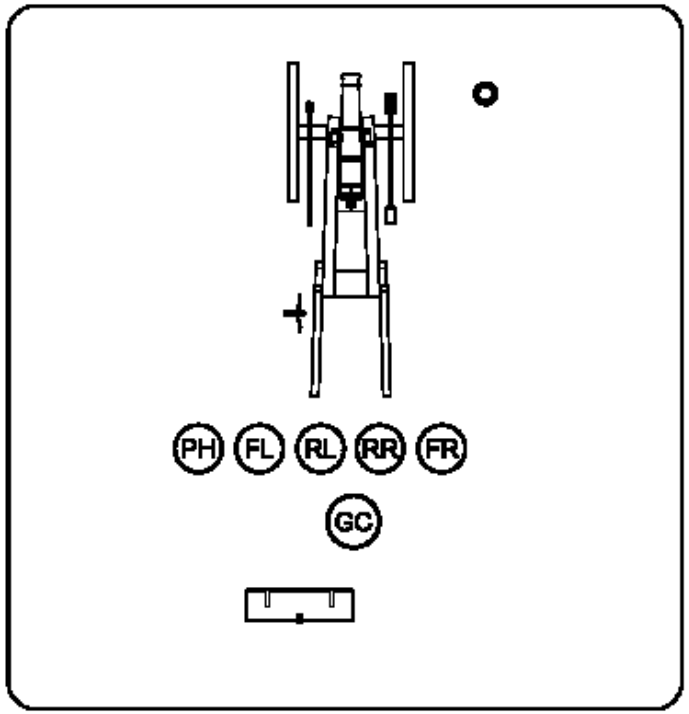
Rear Right (**RR**) handles the priming wire and quills. Required safety equipment: Hearing protection, leather thumb stall worn on left thumb.

Powder Handler (**PH**) carries the cartridge to the gun in the leather haversack and assists in traversing the piece as required. Required safety equipment: Hearing protection.

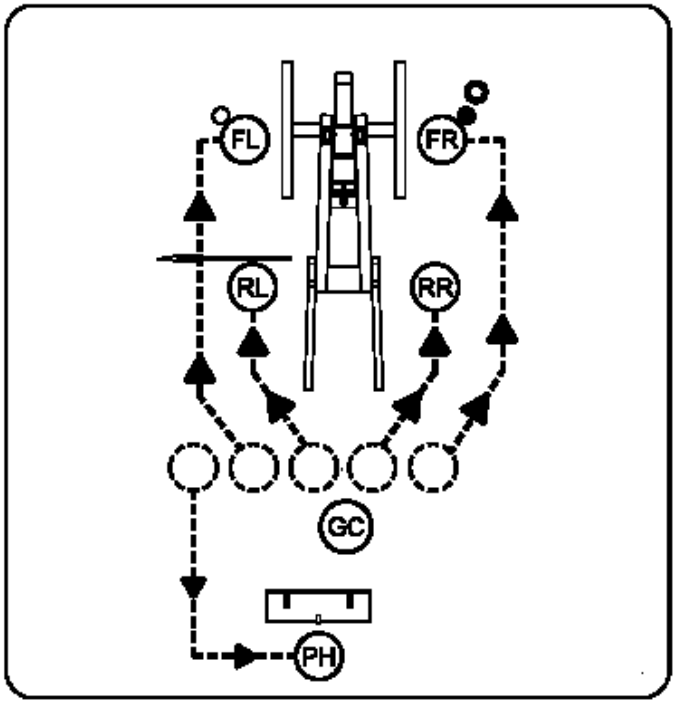
Gun Captain (**GC**) Commands the firing demonstration.



Form at the Rear of the Piece Members of the gun crew standing at their positions perform a "Right about Face" and walk to the rear of the gun. The Powder Handler walks from his post and joins the line at the right.



Man the Piece Gun crew performs a "Right about face" and walk to their positions on the gun. The Powder Handler walks to his post by the ammunition chest. When in position, RR checks that vent is clear with pick, and calls out "clear".



Search Piece (Figure 1)FL inserts the wad hook into the bore, and slides it to the breech. He then turns the shaft of the wad hook to search for any debris from previous shots. After searching, he withdraws it. (If objects or debris are found, a second search is recommended.) (Figure 2) FL hands wad hook to RL, who holds it with his left hand, keeping the linstock in the right.

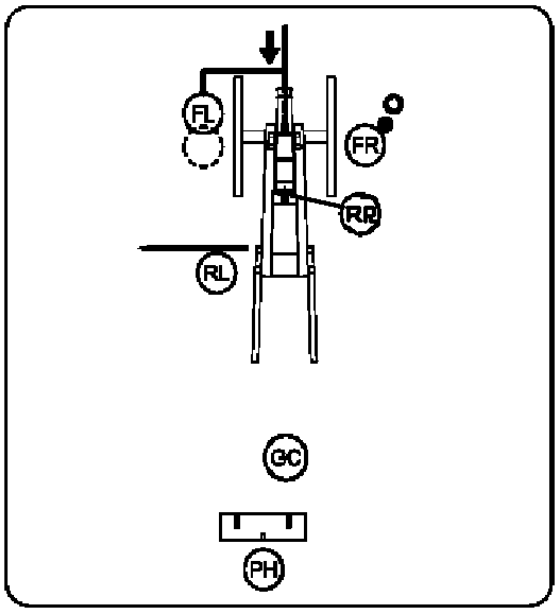


Figure 1

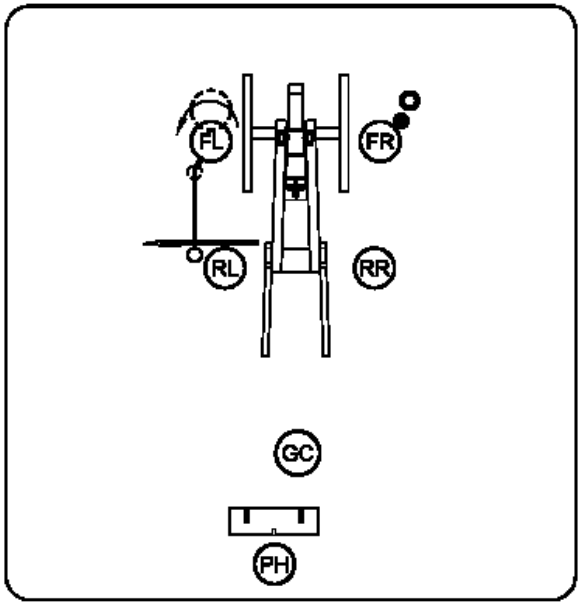
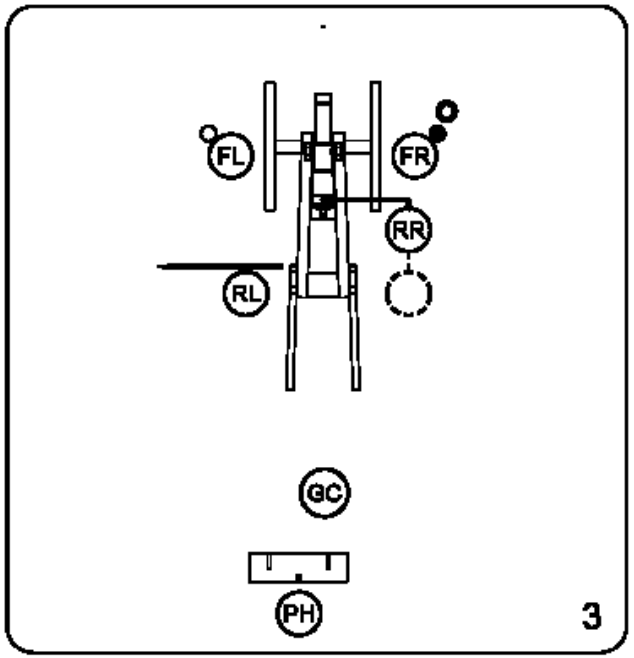
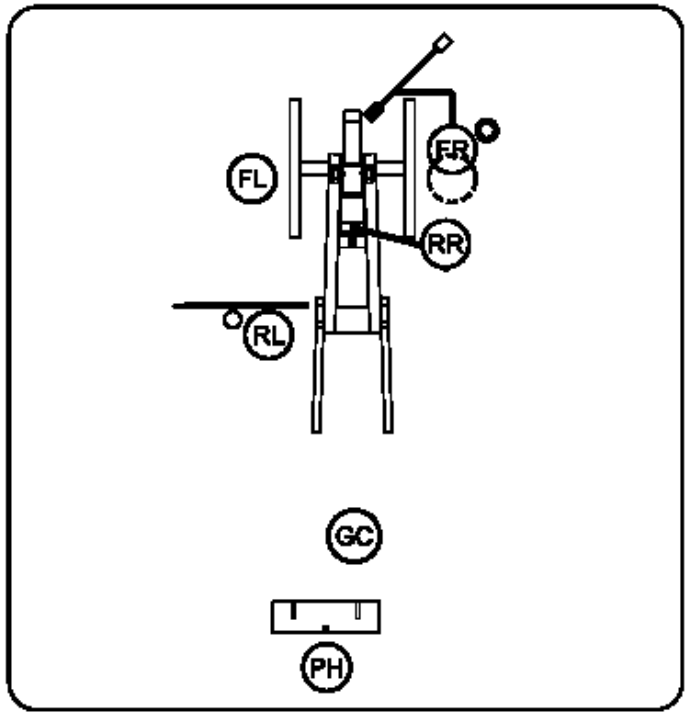


Figure 2

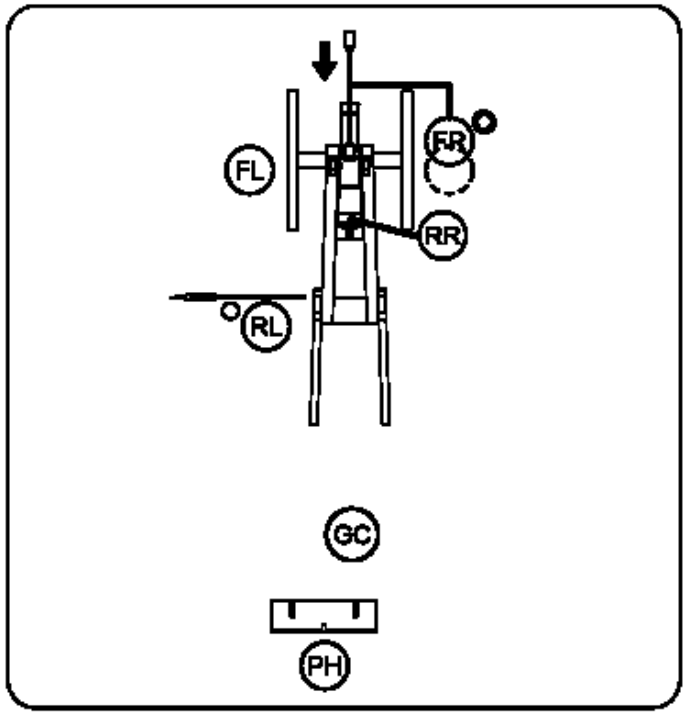
Tend Vent RR covers the vent thoroughly using the thumbstall, standing either “inside” or “outside” the wheel (depending upon the size of the gun).



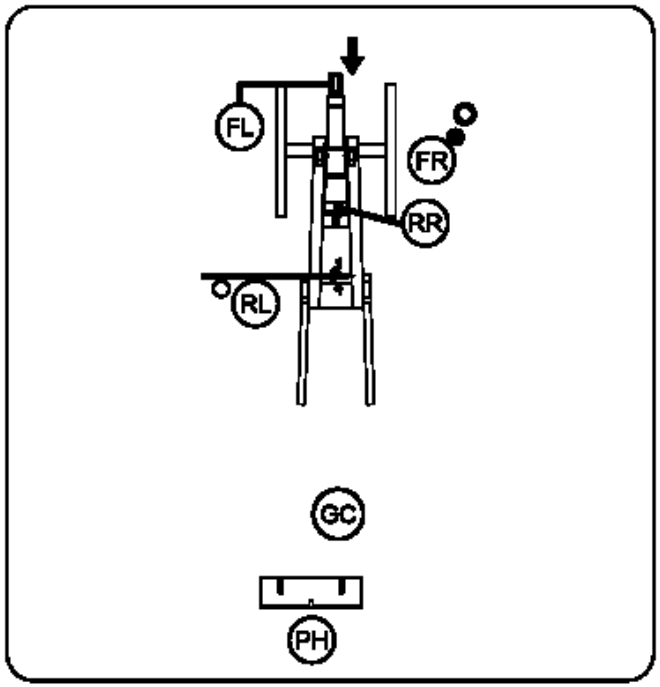
Advance Sponge FR dampens sponge head in bucket and shakes off any excess moisture. (The sponge head should be damp, but not soaking wet.) The sponge is placed against the lower rim of the muzzle of the gun.



Sponge Piece R inserts the sponge into the bore all the way to the breech. He turns the sponge several times. R and RR maintain eye contact as RR maintains the seal over the vent at all times. When the sponge is withdrawn, FR reverses the staff bringing the ram head against the muzzle.

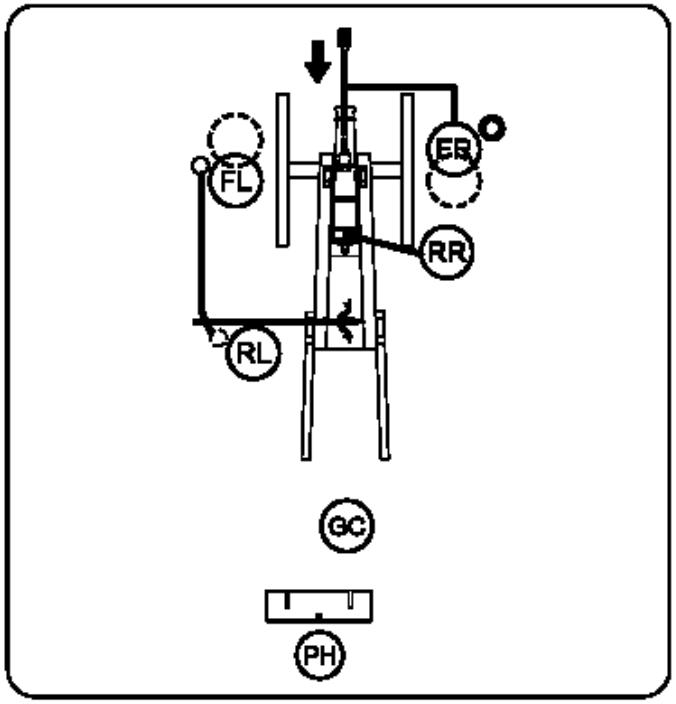


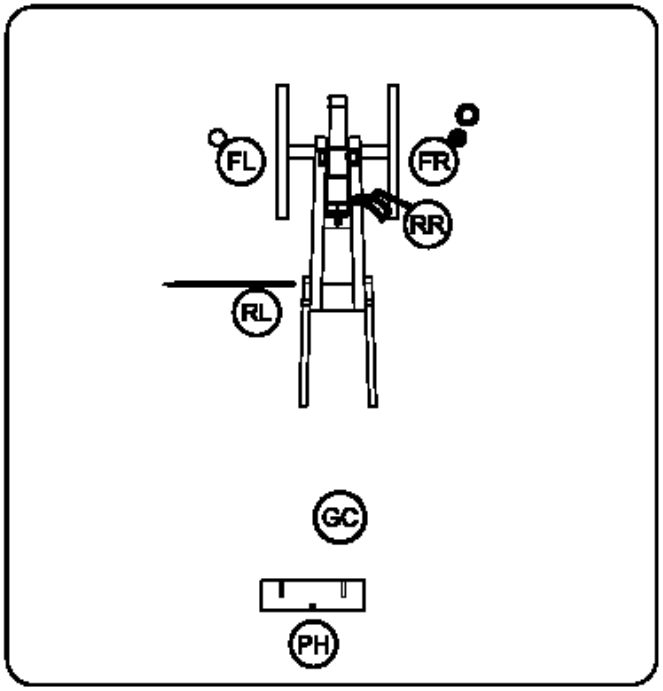
Handle Cartridge PH opens the ammunition chest, removes one cartridge and immediately places it in the leather haversack. The chest is closed.
LR places the head of the linstock the trail of the gun carriage. RF turns to his left to receive the cartridge. PH walks to the left of the gun , halts facing FL and hands him the cartridge. PH walks back to his position by the ammunition chest. FL holds the cartridge with both hands against his body.



Ram Down Cartridge Using the rammer, FR pushes the cartridge to the breech of the gun in a smooth single movement. (The ram staff is held with both hands "palms up" and thumbs along the side of the staff. When ramming, avoid "throwing" the rammer into the bore, or pounding the cartridge.) When the cartridge is seated, FR immediately withdraws the rammer and resumes his position.

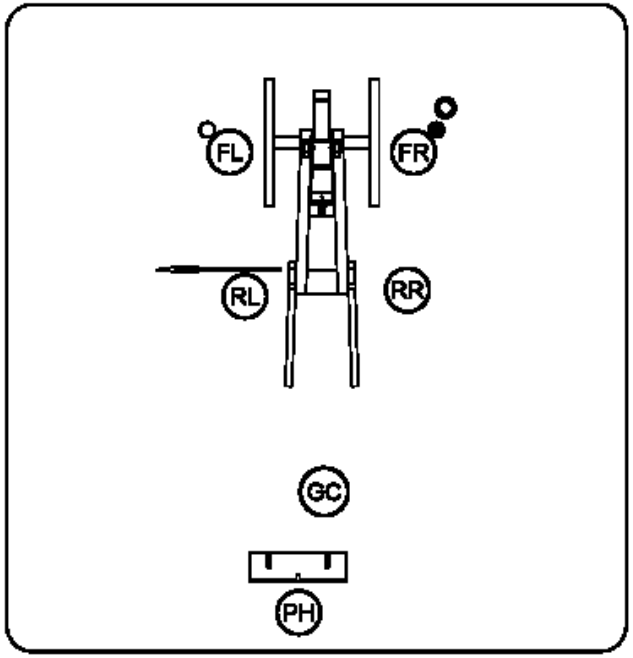
Prime RR withdraws his thumb from the vent. Using the left hand's thumb and forefinger only, take the priming wire (pick) and insert it into the vent hole, letting it drop onto the cartridge. Then still using only thumb and fore finger, push down and break open the cartridge, and the priming wire is removed and placed in its storage location. A quill is selected and placed into the vent again using only thumb and forefinger. RR returns to his original position.

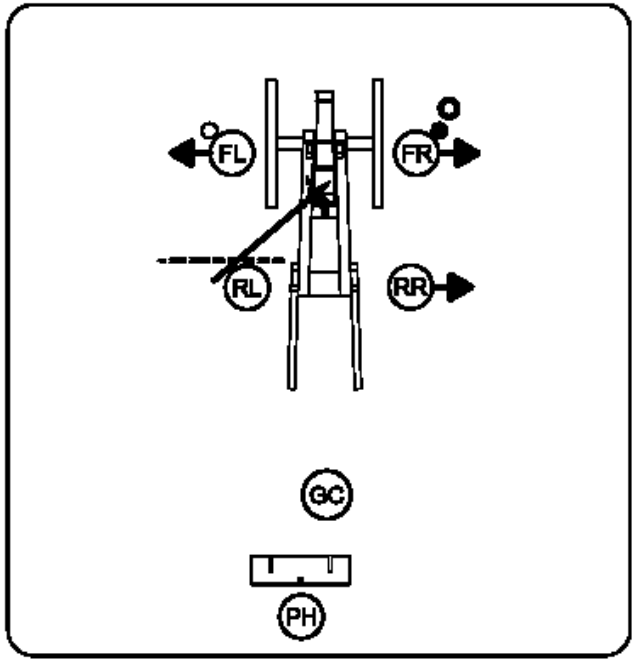




Take Aim GC advances to the breech of the gun and stands to the left of the carriage and does not stand inside the carriage cheeks. PH walks to the handspike at the trail and stands so no part of his body is directly behind the trail or handspike. GC extends his arms and locks elbows and places his palms against the breech of the gun, and aims through his upright thumbs. GC adjusts elevation or depression of barrel, and by tapping upon the cheeks of the carriage indicates to PH which direction the gun must be traversed. PH lifts the trail of the gun with the handspike to traverse it as required. When GC is satisfied with the lie of the gun, he and PH resume their places.

Fire GC makes eye contact with L and either with drawn sword or hand signal, gives a visual command accompanying the verbal command to fire. LR brings the linstock to the vent in a smooth motion from the *breech* toward the *muzzle,* touching the primer quill with the glowing end of the burning match.





Once the gun has fired, the gun captain and crew will secure the piece with the following motions:

Tend Vent

Search Piece

Advance Sponge

Sponge Piece

At this juncture, the gun captain may command "**Secure Piece**" and dismiss the crew.

Rate of fire

Although through drill a crew may feel proficient, it is to be remembered that National Park Service safety guidelines prohibit rapid fire.

The rate of fire permitted under NPS safety guidelines calls for a **<u>ten (10) minute</u>** interval between shots.

Garrison and Naval Gun Drill

The drill for garrison and naval ordnance is essentially the same as for a field piece, except when firing from an embrasure. However, as the gun must be withdrawn from battery to load, several additional points of safety need to be observed.

Teamwork and communication are necessities when moving a gun. Coordination of crewmembers pushing and pulling the gun requires alertness on the part of the crew and gun commander.

Whenever moving a gun in or out of battery, be aware of positions of your feet that they may NOT be run over by the trucks.

In withdrawing a gun, those handling the draught ropes must maintain sufficient tension until the trucks are chocked and front gunners are back in position to continue the drill.

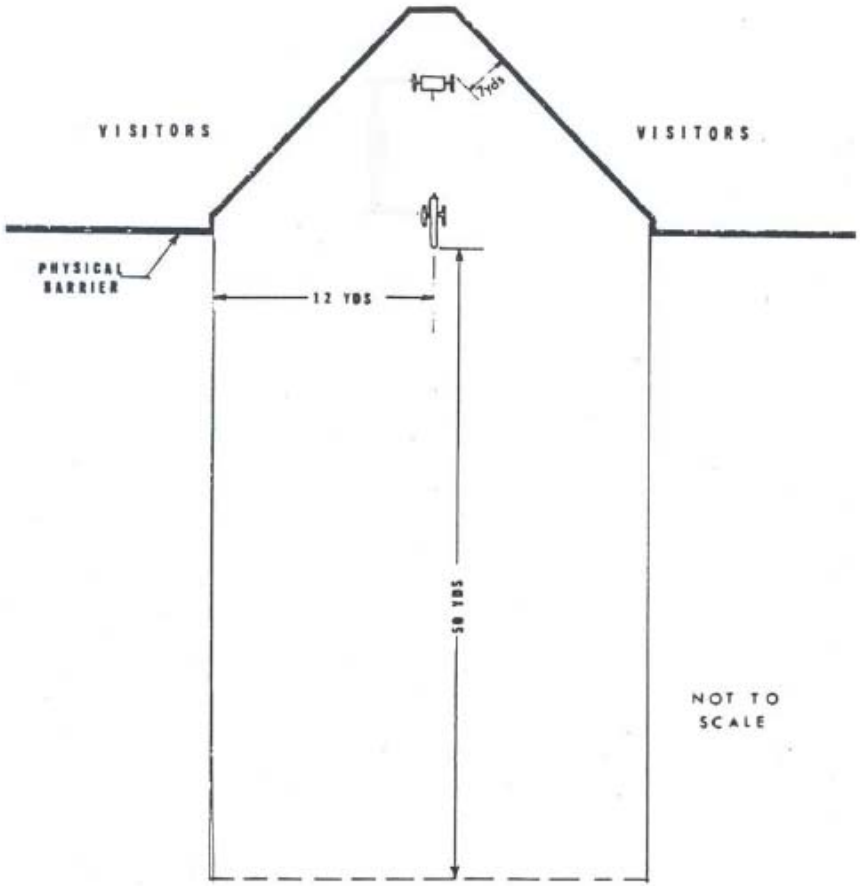
When the cartridge has been opened prior to priming, leave the pick in the touch hole while the gun is returned to battery. The pick holds the cartridge in place and lessens the chance of unseating it.

In returning the gun into battery, gunners handling the ropes should not brake the guns movement until it is almost into the embrasure.

Caution: Garrison guns are somewhat closer to the ground than field pieces. For searching, sponging and charging the piece, bend at the knees and not at the waist to accomplish these tasks.

RANGE REQUIREMENTS

- A physical barrier must separate visitors from the demonstration area.
- Limber must be at least 7 yards away from visitors.
- Gun must be at least 12 yards away from visitors.
- No visitors must be forward of the plane of the muzzle face.
- There must be at least 50 yards of clear area down range.



Part V-Artillery Misfire Procedures

Each park shall develop a written Misfire Plan to address the actions necessary to render the piece safe in the event of a Level I or Level II misfire. The plan must include directions on where and how unfired rounds will be disposed.

TYPES OF MISFIRES

A "Level I Misfire" is defined as a misfire that can be cleared at the demonstration area and the demonstration can continue.

A "Level II Misfire" is a misfire that cannot be cleared at the demonstration area without disrupting the demonstration. Specialized equipment is needed to make the piece safe.

CAUSES OF MISFIRES

Some Causes for Level I Misfires:

- The quill/primer failed to ignite, or incomplete ignition.

Some Causes for Level II Misfires:

- The cartridge was inserted with the extender end first.

- The cartridge tumbled in the bore so that the fire from the primer will not strike the powder charge.

- The cartridge was not seated fully. Once fire has been introduced to the bore, do not re-ram the charge!

- There is excessive foil on the base of the cartridge so that neither the priming wire nor the fire from the primer will strike the powder charge.

- There is an obstruction in the vent, such as the remains of a primer which separated when last fired.

LEVEL I MISFIRES

The duties of the detachment are enumerated below:

Demonstration Interpreter: The interpreter will explain the procedure to the audience and be alert for possible range violations.

Gun Captain: In the case of a misfire, the Gunner immediately calls out "Misfire!" and commands the gun crew to "Stand Fast!."

The gun crew will wait for a minimum of three (3) minutes since the last observed smoke from the piece before taking further action. *This is a longer period than for 19th century artillery using friction primers because quill primers are more likely to cause hang fires a minute or more after the primer is lit.*

When a misfire occurs, the judgment, experience and coolness of the Gun Captain is essential. In some cases, such as smoke coming from the vent, it may be prudent to wait more than three minutes, but in no case shall the waiting time be less than that.

Note: In the event of a smoking vent, the 3-minute count will not begin until no smoke is observed coming from the vent and/or muzzle. If smoke is observed at any time during the 3-minute count, stop and restart the count when the smoke has stopped.

The Gun Captain will be alert during the repriming that all members of the detachment perform their duties safely and correctly.

Note: When firng smaller guns such as the 3-Pounder, the following drill may be modified as needed. For instance, it will likely not be deemed necessary for the FL to move inside the wheels to reprime since he can safely reach over the wheels to perform that procedure without placing themselves behind the gun.

All canonneers not mentioned in the drill below, will remain in their "Take Aim" positions until the Gun Captain determines that sufficient time has elapsed and gives the command:

If the gun captain decides to attempt another priming he will order The Left Front cannoneer (LF) to withdraw any remains of the old priming quill. Using his right hand to brace himself on the wheel, he will loosen the remains of the quill from the vent using the priming wire, and withdraw it with his gloved hand.

LF, using his right hand to brace himself on the wheel, will then will re-pick the vent and re-prime with either a new quill or, if using cartridge, the smallest amount of powder possible.

NOTE: When re-picking the vent, if LF cannot feel the cartridge, he must notify the gun commander, who will cancel any further demonstration. AT NO TIME WILL THE CARTRIDGE BE RAMMED AGAIN ONCE FIRING HAS BEEN ATTEMPTED.

Once re-primed, the gun captain calls out "Take Aim!," and repeats the hand and voice commands to "Fire."

If after three (3) attempts to clear the misfire have failed, the demonstration is over, and the charge must be ejected safely.

NOTE: If the gun commander feels that firing can not clear the misfire, he can stop the demonstration before three attempts. However, three (3) attempts to clear are the limit.

"REPRIME THE PIECE"

Note: Before performing the following procedures, the FL should remove any items that may encumber him or make contact with the gun or carriage such as his canteen.

1. The FL steps inside the wheel to a position near the axle tree with his back to gun.

   The RR steps up to a position even with the axle, facing the gun.

2. The FL removes any remaining primer material protruding from the vent using the middle and index fingers of his left hand (palm up).

3. The RR passes the priming wire to the RF over the top of the wheel.

4. The FL takes the priming wire between his left thumb and forefinger and drops into the vent. He then re-pricks the cartridge, removes the wire and hands it back to the RR.

5.. The RR passes a quill primer to the FL over top of the wheel then returns to his "TAKE AIM" position.

6. The FL places the primer into the vent and then returns to his "TAKE AIM" position making sure to keep his back to the piece while stepping out.

7. Once the FL is in position he calls out, "READY."

8. The Gun Captain gives the command to "FIRE."

The repriming procedure may be tried twice. Once three primers, including the initial demonstration primer, have been expended, the piece should be unloaded using Level II misfire procedures.

LEVEL II MISFIRES

When the piece has failed to fire after three primers have been expended, and the primers are igniting properly, then it is evident that there is a serious problem with the cartridge. In most cases, the cartridge was inserted backwards or the cartridge tumbled in the bore. In these circumstances, the piece will have to be unloaded administratively.

Unloading a piece through the muzzle is a hazardous and delicate procedure. Do not attempt to unload through the muzzle until all evidence of smoke from the muzzle and vent has ceased. Every effort must be made to move as carefully and coolly as possible. Distractions such as visitor kibitzing or razzing must be eliminated by park personnel. It is best to explain the nature of the situation to the visitors and move them away from the demonstration area.

This procedure is administrative and **should not** be performed using a set drill. It is recommended that two experienced people perform the following procedures. The bulk of the detachment should be used to secure the demonstration area and range.

Equipment

The following equipment will be necessary to safely unload the piece from the muzzle.

- Gauntlets
- Priming Wire
- Water Supply
- Bucket(s)
- Two (2) 60 cc veterinary syringes
- Worm
- Sponge Bucket

After waiting at least ten (10) minutes. Two experienced cannoneers will perform the following procedure to unload the piece from the muzzle.

1 One person will step into the FL position for a Level I misfire while the other will bring a bucket of water and the syringes to a position even with the left end of the axle.

On smaller guns like 3-Pounders, both cannoneers may work from outside the wheels.

2 The person inside the wheels will take a full syringe, passed over the top of the wheel and inject the water into the vent. He will repeat the process two more times.

3. The person inside the wheel will insert the priming wire into the vent and re-prick the charge.

4. The person inside the wheel will reach back and genttly turn the elevating screw until the muzzle is fully elevated.

5. The person inside the wheel will continue injecting water into the vent until it overflows. When this happens, he will leave his position in the same mannner as does FL during a Level I misfire.

6. Once the breech is flooded, wait at least five (5) minutes before attempting to remove the cartridge.

7. Fill the entire bore with water using buckets or a hose.

8. One person, wearing the welder's gauntlets will use the worm to remove the round.

9. The cartridge is placed in the sponge bucket and broken up to dissolve the powder.

10. The fouled water is disposed of as prescribed by the written misfire plan and the sponge bucket is re-filled.

11. Depress the muzzle and allow excess water to drain from the bore.

Note: When firng smaller guns such as the 3-Pounder, the following drill may be modified as needed. For instance, it will likely not be deemed necessary to move inside the wheels to reprime since a person can safely reach over the wheels to perform that procedure without placing themselves behind the gun.

PART VI - ARTILLERY LABORATORY

SPONGES

A sponge should be replaced when it: a) does not fit the bore, or b) is frayed and worn.

Materials Needed:

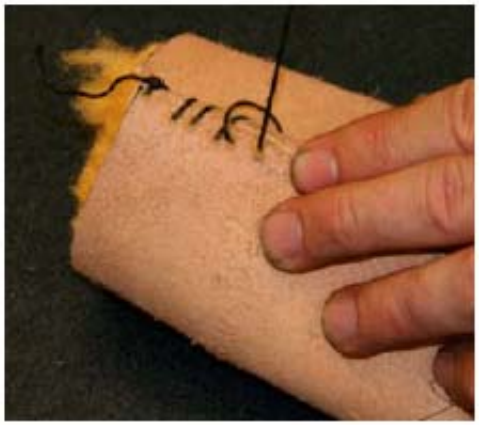
--Vegetable-tanned saddle shearling (fleece)
--Leather for making washers
--Copper or brass nails/tacks, 3/4 inch
--Hammer
--Waxed thread
--Glover's needle, or awl and saddler's needles
--Sponge pattern
--Pen
--Heavy duty scissors

1. Remove the old sponge from the sponge-head. Inspect the sponge head and repair if necessary. It is recommended that you soak the sponge head overnight in linseed oil and allow it to dry before replacing the sponge.

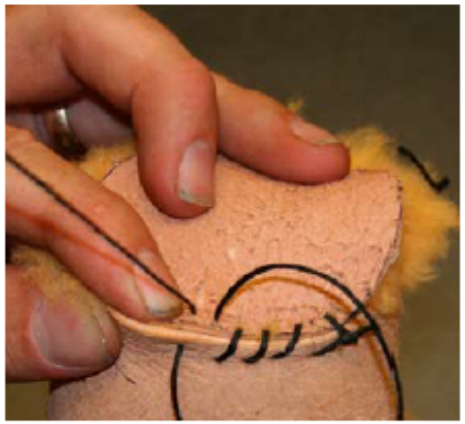
2. Lay the sponge and end patterns on the flesh side of the shearling. Trace the patterns with a pen, making one side and two end pieces. Trace out a washer on a piece of leather using a pattern or an old washer.

3. Cut out the pieces of shearling and leather with heavy-duty scissors.

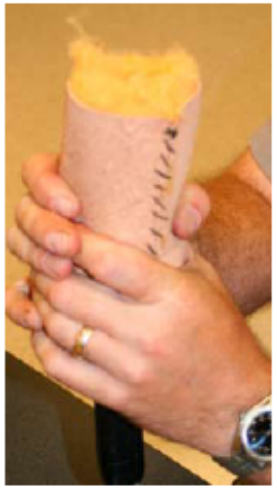
4. Sew the side seam of the sponge body using an overhand stitch. An awl with saddler's needles or glover's needle may be used. The body will form a cylinder with the fleece inside.



5. Sew the end onto the sponge body.



6. Turn the sponge inside out. A large wooden dowel or the handle of a small hammer may be used to help turn the sponge inside out.



7. Place the second shearling end piece on the end of the sponge-head. Slip the sponge over the sponge-head and pull so the sponge fits snugly to the head.

8. Trim excess fleece around the opening so that the sponge can fit snugly around the staff.

9. Slip a leather washer with pre-punched holes around the staff. Drive the nails through the washer holes, through the shearling and into the sponge-head. Also drive one nail into the end of the sponge head.

10. Test the new sponge for proper fit. Trim if necessary.

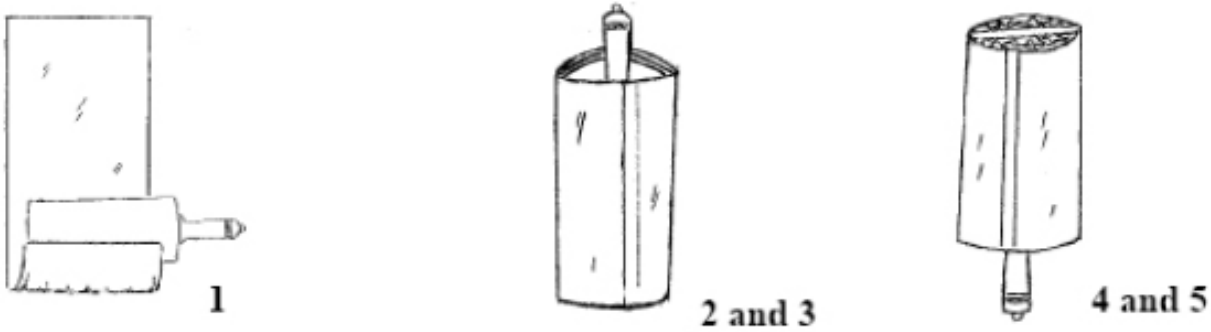
BLANK CARTRIDGES

A cartridge must be long enough to prevent tumbling in the bore, must not allow powder to sift out of the aluminum foil container, and must clearly indicate the end to be inserted first into the bore of the cannon.

The Table of Maximum Loads must be consulted for correct powder charges.

Materials Needed:
--Heavy duty aluminum foil
--Former for caliber of the cannon (tapered to be 1/2 inch smaller than the bore at the large end)
--Damped peat moss or vermiculite
--Powder measure

1. Wrap three layers of heavy-duty aluminum foil around the tapered cartridge former, leaving 2½ to 3 inches of foil to overlap the end of the former.
2. Place a piece of clear tape along the length of the cartridge.
3. Fold the overlapped section of foil over the face of the former, tap the former on a solid surface to crimp and seal the face of the cartridge.
4. Place a piece of clear tape over the face of the cartridge to further seal it.
5. Remove the cartridge former

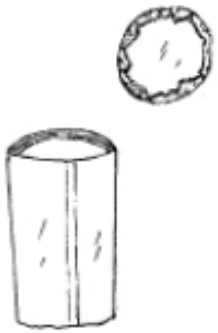


6. Mold an approximately 4½" x 4½" square, double layered, of heavy-duty aluminum foil over the face of the cartridge former. Fold the edges of foil down to form a round disc just slightly smaller than the diameter of the former. Repeat the process so that two discs are available.

6a

6b

7. Insert one of the circular discs into the empty cartridge so that it is flat against and seals the bottom of the cartridge.



7

8. Pour a measured amount of powder into the cartridge casing.

9. Insert the second aluminum foil disc on top of the powder.

8 and 9

10. At a point approximately 2" above the second disc, begin to crimp the aluminum foil in and down over the disk until the powder is completely sealed in the cartridge below the disk. At this point the cartridge should look like an hourglass.

11 Make a wad/cartridge extender by taking a piece of heavy-duty aluminum foil and wadding it into a loose ball.

12. Insert the wad/cartridge extender into the cartridge above the crimped section.

10, 11 and 12

13. Fold the remaining foil over the wad/cartridge extender.

14. Push down, shape, and mold the wad/cartridge extender so that the cartridge has the appearance of a fixed round of ammunition. While the powder section of the cartridge will be in the shape of a cylinder and the wad extender will be spherical, it is still suggested that measures be taken to insure that the powder portion is easily distinguishable from the extender section. Place a red "X" in magic marker or otherwise mark the powder cylinder so that it is readily recognizable.

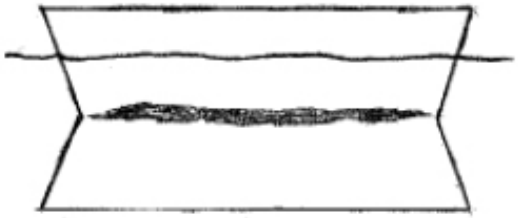
13 and 14

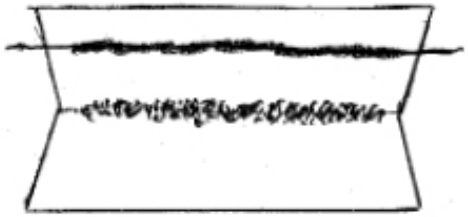
QUILL PRIMERS

The preferred method for making quill primers for artillery will be to use a whole paper soda straw, thin string or dental floss, Elmer's type glue, 1¼" circular gummed labels, and FFg or FFFg powder.

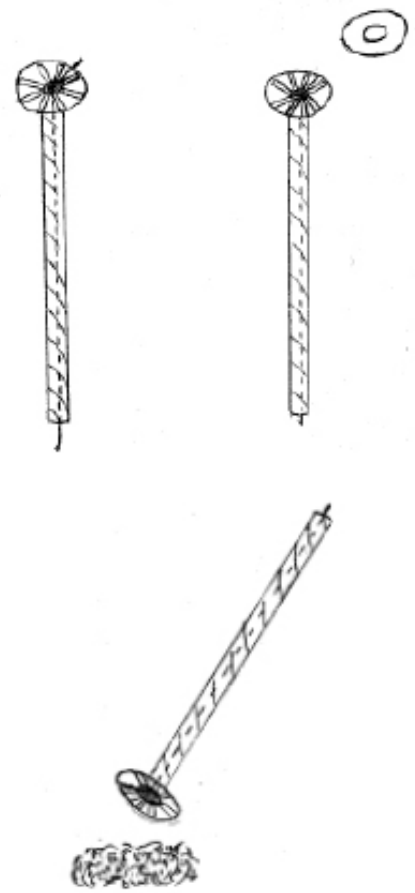
Cut a piece of string slightly longer than the straw approximately eight inches in length), allowing enough space at either end to grip the string between thumbs and forefingers. Dip the string in white glue, making certain that the entire piece of string (excepting those portions being held between thumbs and forefingers) are coated with glue. Once coated, the string will undoubtedly have one or two larger globs of glue adhering to the string, so gently brush the globs against a paper towel or newspaper to remove the excess glue. Immediately immerse the string in powder. Shake off any excess powder and set the string aside to dry.

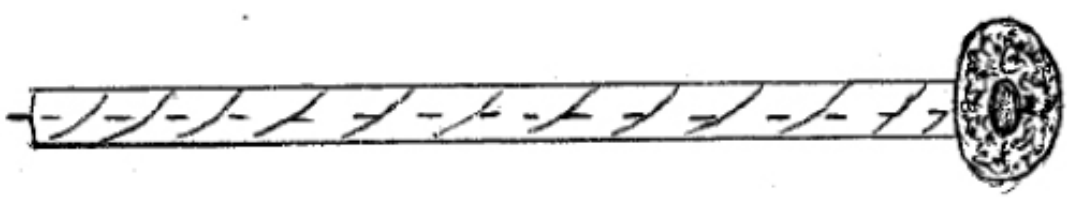
Using a small scissors, segment one end of a paper straw into six or seven sections approximately 1/4-inch to 3/8-inch in length. Peel back the cut portions so that they are perpendicular to the straw fanned out in a propeller shape. Using a hole punch, cut the centers out of two circular gummed labels. Insert the uncut end of the straw through the center of one of the cut circular labels so that the gummed portion of the label sticks to the underside of the propeller cut sections of the straw.





When the powdered string is dry, the string should be threaded through the straw. The end of the string should be cut so that only a very small section extends past the gummed label at the end of the straw. The end of the string should be pressed against and attached to the gummed label. Then the second circular gummed label (the gummed side of the second label is placed against the gummed side of the first label) is placed atop the first gummed label to secure the powdered string and the sectioned portions of the straw (press together firmly but carefully to prevent separation). Excess string should be trimmed off. The top gummed label is then spread with a thin layer of Elmer's glue, insuring not to cover the powdered string or seal the center hole with glue. Dip the top (portion with glue) of the primer into 2F or 3F powder. Set aside to dry.





Manufacturing Slowmatch

Slowmatch is manufactured utilizing 100% cotton rope- ¼", 3/8" or 5/16" being preferable. Clothesline or drapery cord is suitable although finding 100% cotton line id difficult in this day of man-made fibres. Even if the label indicates that the rope is 100% cotton there may be a core of nylon or other synthetic material. If so, the core can be removed by sectioning the rope, gripping the core with pliers or another suitable tool and drawing out the core.

Before making the rope into slow math, the stiffening, or sizing, must be removed. This can be accomplished by stretching the rope outside in an exposed location where it will be exposed to the elements for a period of time or running it through a washing machine for several cycles and allowing it to dry. This method, of course, is quicker.

Once the rope is properly prepared, it should be cut into sections between three to six feet in length, depending upon the particular linstock or other requirements. The rope is then soaked ina supersaturated solution of potassium nitrate in water. Potassium nitrate can usually eb obtained with little difficulty from a chemical supply facility. Using a pot that can hold 2-3 quarts of water, heat the water temperature to slightly above lukewarm. Maintaining the temperature, stir in the potassium nitrate until no more will dissolve (one pound is usually sufficient with two quarts of water. Heat the solution to a simmer and attempt to dissolve more potassium nitrate. Super saturation has been achieved when no more potassium nitrate will dissolve.

After removing the solution from the heat source, immerse the sections of the cotton rope in the supersaturated solution. Periodically, stir the rope around so that all portions of the rope have the opportunity to be impregnated. Make sure that all portions of the rope remain completely immersed. Approximately one to two hours of soaking should prove sufficient, but a little additional time would not hurt.

When the rope has finished soaking, hang the rope up to dry, insuring that any drops that fall from it will not stain anything. When dried, store in a safe place.

National Park Service
Tables of Maximum Loads for Artillery

18th Century

Weapon Type	Caliber	Maximum Blank Charge
Swivel Gun	2- pounder	4 ounces Cg or Fg
"Grasshopper" Bronze	3- pounder	6 ounces Cg or Fg
British Light Gun	6- pounder	12 ounces Cg or Fg
British Field Howitzer	5.8 inch	10 ounces Cg or Fg
Iron Gun	3- pounder	6 ounces Cg or Fg
Iron Gun	4- pounder	8 ounces Cg or Fg
Iron Gun	6- pounder	10 ounces Cg or Fg
Iron Gun	12- pounder	20 ounces Cg or Fg
Howitzer	8 inch	36 ounces Cg or Fg
Howitzer	8.76 inch	16 ounces Cg or Fg
Iron Gun (Armstrong)	9- pounder	16 ounces Cg or Fg
Iron Gun (Armstrong)	18- pounder	32 ounces Cg or Fg
Iron Gun (Armstrong)	24- pounder	36 ounces Cg or Fg

19th Century

Weapon Type	Caliber	Maximum Blank Charge
M1841 Gun	6- Pounder	10 ounces Cg or Fg
M1841 Field Howitzer	12- pounder	10 ounces Cg or Fg
M1841 Mountain Howitzer	12- pounder	8 ounces Cg or Fg
M1857 Gun- Howitzer (Napoleon)	12- Pounder	20 ounces Cg or Fg
Parrott Rifle	2.9 or 3 inch	10 ounces Cg or Fg
Ordnance Rifle	3 inch	10 ounces Cg or Fg
Lyle Line- Throwing Gun		1.5 ounces Cg or Fg

Note: Maximum blank charges for weapons not identified on this chart will not exceed 50% of the service charge for solid shot. For those weapons for which a service charge is unknown, the maximum blank load will not exceed 2.5 ounces of Fg powder for every 1 inch of bore diameter.

PART VII - ARTILLERY DEMONSTRATION CHECKLIST

Before

( ) The gun, limber and implements have been inspected using the Artillery Inspection Checklist.

( ) Ammunition is properly prepared, with only enough for one days demonstrations.

( ) All implements are in their correct place on the piece (not on the ground).

( ) Misfire equipment in place at the firing position.

( ) Required number of demonstration personnel are present to safely fire the piece.

( ) Limber placement is at least seven yards distance from visitors barricade.

( ) Cannon placement is at least twelve yards distance from the visitors barricade and muzzle is forward of all visitors.

( ) Visitors have a good field of vision of the demonstration.

( ) The interpreter has a clear view of all the visitors and downrange area.

( ) The carriage is free to recoil if necessary so it won't buck or break carriage.

( ) There is a fixed barricade between the visitors and the demonstration area.

( ) The wind conditions are not too strong for a safe demonstration.

( ) Conditions are not too dry as to risk a range fire from the muzzle blast.

( ) First Aid kit is available.

( ) Emergency communications are available.

( ) There are no open fires nearby (campfires, brush clearing, etc.).

( ) Final review of misfire drill and accident procedures.

During

( ) The crew is following the approved manual with each person is in their correct position during each portion of the drill.

( ) The sponge is adequately damp, but not soaking wet.

( ) Cannoneer # 1 and Cannoneer # 2 (the two cannoneers who service the muzzle of the piece) are wearing gauntlets.

( ) Gauntlets are not so stiff or heavy as to cause fumbling or other difficulty.

( ) When quill primers are used: linstock and lantern are handled safely.

( ) The sponge head is not allowed to contact the ground at any time during the demonstration (to prevent grass, sand, etc. from sticking to it).

( ) If there is a misfire, is it handled correctly.

<u>After</u>

( ) After firing, the piece was cleared of all cartridge material, washed and dried.

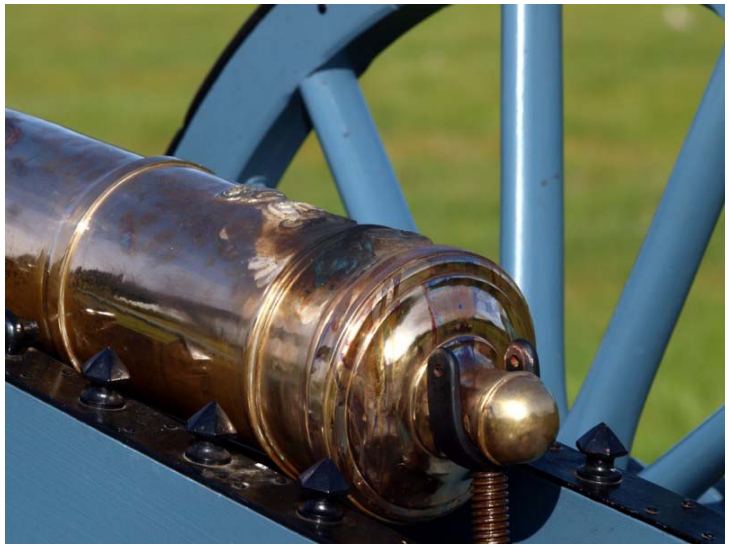
( ) All weapons, explosives and accessory pieces are accounted for.

( ) The field piece and limber are secured and stored properly.

( ) The demonstration area is inspected carefully for smoldering residue.

( ) Sponge head is thoroughly rinsed and dried.

( ) All remaining explosives are returned to storage facility.



A dirty cannon is not a happy cannon.! Be sure to clean up after demonstrations.

PART VIII - ARTILLERY COMPETENCY EXAM

Gun Captain

___ Gives all command clearly and in the proper order
___ Sets himself in a good observation position before issuing the "Ready" command
___ Waits to give the "Cease Firing" command until the sponge has been inserted
___ Demonstrates ability to deal with safety issues as they arise (including misfires)
___ Demonstrates full competence in all other positions

Front Right Cannoneer

___ Advance Spnge (uses proper footwork, proper positioning at the muzzle)
___ ponge (Sponge reaches breach, eyes on the vent)
___ Ram Down Cartridge (proper hand position, eyes downrange)

Misfire

___ Remains in Prime position, eyes down range

Front Left Cannoneer

___ Hands wad hook to RL after searching the piece
___ Handle Cartridge (Holds cartridge against body)
___ Charge With Cartridge (minimizes exposure of hands in front of muzzle)
___ Prime (eyes down range)
___ Fire (Begins "Load" cycle immediately after gun fires)
___ Cease Firing (Returns to "To Your Posts" position)

Misfire

___ Waits for command to re-prime
___ Re-prime (keeps back to muzzle, does not touch wheel)
___ Extracts primer with the left hand palm up then drops it to the ground
___ Takes priming wire from RR over the top of the wheel
___ Drops priming wire into vent then pushes down to re-pierce the charge
___ Properly takes new primer from RR
___ Properly re-places new primer
___ Properly returns to position of Ready

Rear Right Cannoneer

___ Tend Vent (fully covers vent with thumbstall)
___ Remains at the vent until "Prime"
___ Holds priming wire along the shaft with thumb and forefinger when piercing the charge (feels for cartridge)
___ Steps outside wheel as soon as primer is inserted.
___ Fire (Steps in to tend the vent immediately after the piece fires)

Misfire

___ Moves to center wheel on the command to re-prime the piece
___ Hands priming wire and the primer to FL over the top of the wheel
___ Returns to "Take Aim" position after giving FL the primer.

Rear Left Cannoneer

___ Properly tends slowmatch throughout the drill.
___ Search Piece (takes wad hook from FL with left hand)
___ Handle Cartridge (holds head of linstock under the carriage)
___ Prime (withdraws linstock from under carraige)
___ Makes eye contact with GC prior to "Fire" command
___ Fire (smooth motion with linstock)

Misfire

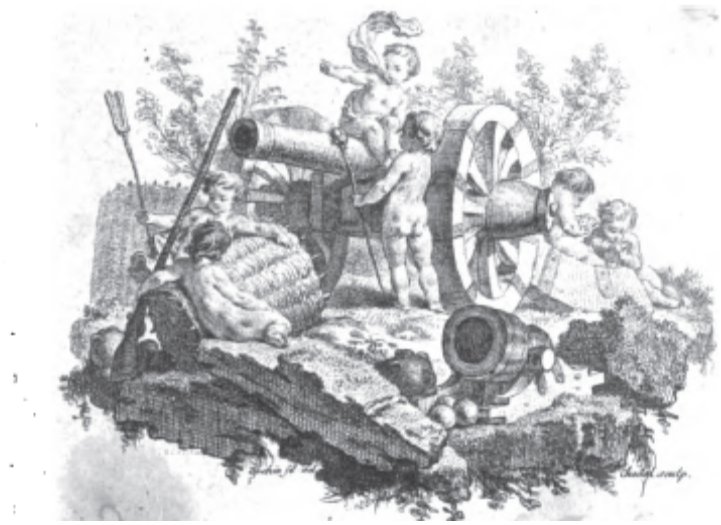
___ Remains in position safely tending the linstock unti "Fire" command is given.

Powder Handler

___ Handle Cartridge (Places cartridge in haversack, brings it to the front of the gun, hands it to FL, and returns to chest)
___ Take Aim (Proper position at handspike or tiller)

Bibliography:

Muller, John, A Treatise on Artillery, London 1779 (reprint Restoration Press, Ottowa

Caruana, Adrian Bernard The light 6-pdr. Battalion gun of 1776 (Historical arms series), 1977

Caruana, Adrian Bernard GRASSHOPPERS AND BUTTERFLIES: The Light 3 Pounders of Pattison and Townshend., 1979