Artillery Models: Design and Construction

By William B. O'Neal

Many of you will recall the fine group of antique artillery miniatures that Bob Rubendunst exhibited at our Chicago meeting in 1966. It was this display that rekindled an earlier interest and excited my initial efforts to construct similar models for my own collection. When, a few months later, my collection of U. S. military long arms was stolen, it seemed possible that a short period of model building would constructively occupy my mind and time while my guns were being recovered. As it turned out, my guns are still missing, and I find myself completely hooked on the subject of miniature artillery and the related history, technical details, and limited collecting of full-scale hardware. Whether or not do-it-yousself projects deserve the time and interest of the American Society of Arms Collectors is perhaps a debatable matter, but I am depending on the well-demonstrated patience and generous interest of our members to give me the courage to address such a subject before you gentlemen here assembled.

The overall objective of my present project is to have representative specimens spanning the entire history of standardized U. S. field artillery, through, at least the early, breechloaders. The scale chosen is 1/10, which offers the convenience of easy conversion of full-scale dimensions, of quite accurate accomodation of scaled screw thread sizes with standard taps and dies, and of conforming with the capacities of machine tools in my space-limited shop.

Foremost among my self-imposed specifications is that the models are to be complete in every detail, whether or not externally visible; and, so far as practicable, to be made of materials and by processes similar to those employed in the prototypes. I have been pleased that dimensions have generally been held within scaled tolerances and that essentially all the details of the prototypes have been duplicated. The other objective has been more elusive, and I am still seeking improved materials and references to pertinent production methods.

The period of 1840 to 1865 has emerged as the starting point, not only because of the attraction of the handsome bronze field guns of that day, so aptly described by Harold Peterson as the "Apex of the Muzzle-loader", but also because original drawings and other design data are much more readily available than for other periods. As a matter of fact, my progress in either direction from this period will depend on finding original manufacturing drawings for the Gribeauval type guns which preceded the "Apex" types and for the breechloaders which followed them.

The primary source of design information for the period of 1840-1865 is "Artillery for the Land Service of the United States" by Brevet Major Alfred Mordecai. While this compendium was not published until 1849, it was the result of orders of 16 April 1839 which established a board consisting of Lt. Col. George Talcott, Maj. R. L. Baker, Capt. Alfred Mordecai, and Capt. Benjamin Huger, for the purpose of "—devising and arranging a uniform system of Artillery, and other supplies of every kind furnished for the military service by the Ordnance Department."

The work accomplished by this board was truly monumental, giving rise to a highly concise document of about 350 pages and 138 magnificently drawn plates, defining the entire spectrum of ordnance stores. The massive background testing, evaluation, and selection of the innumerable details that were standardized and published in the final report no doubt made the ten-year period seem quite short to the participants, most of whom had other simultaneous duties as well. Although original copies of this document are extremely rare, Zerox copies of the text and photo copies of the plates are available from the Smithsonian. These copies are generally excellent, though the plates are filled with minutely drawn dimensions and other symbols, so that I have occasionally found it necessary to use a 50 power microscope to turn certain smudges into useful information.

One quite fascinating insight into the technical mannerisms of the time is illustrated in Figure 1. This is a drawing made in accordance with Mordecai's instructions for defining the curves of the cascable of a 6 pounder gun. Dimensions which are furnished directly are shown in the customary manner, whereas the radii shown in boxes must be determined by the fairly complex descriptive geometry indicated by the broken lines. This practice disappeared in due course, as the drawings of the Model 1857 Light 12 Pounder Gun provide all dimensions directly.

While Mordecai makes available much useful information, it may be of interest to note some of the subjects which he omits. With the notable exception of formers for iron working, construction methods and tools are dealt with only sketchily, resulting in numerous instances of uncertainty as to the intended design. One such case which I have found quite troublesome to understand is the

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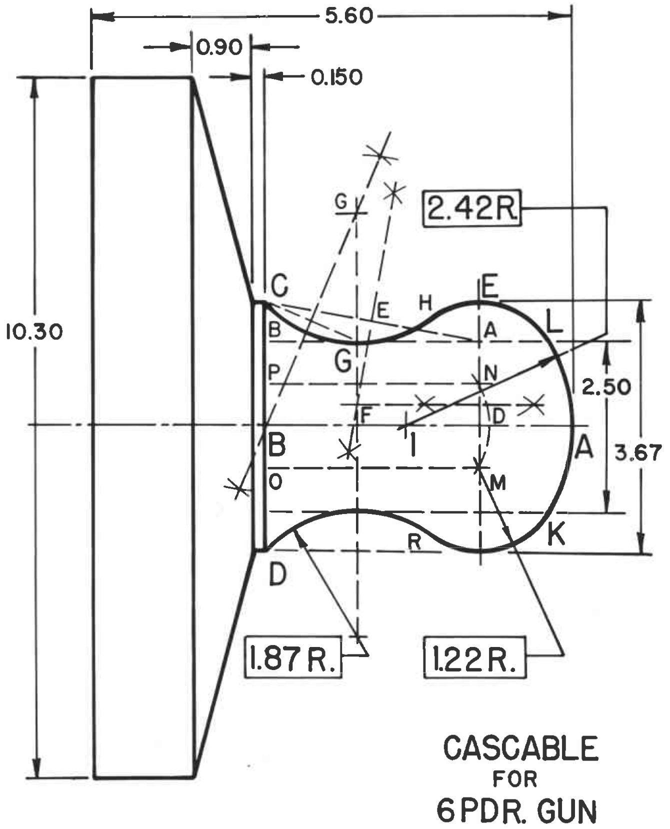

Figure 1
Six Pounder casable showing deviation of radii as described by Mordecai

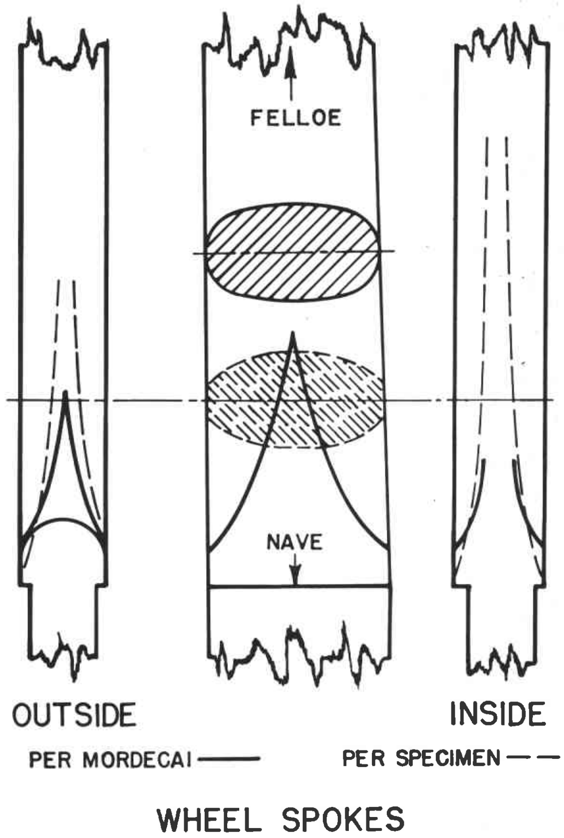

Figure 2
Comparison of specified and measured spoke contours

intended shape of the spokes of the wheels. The drawings show a generally elliptical cross-section, which becomes rectangular at the end which bears against the nave, or hub. In the region of the transition, flats appear on all four faces, the corners of which are shown as convex in the direction of the nave, whereas this geometry should result in two of the faces having corners convex in the direction of the felloes, or rim.

What I believe to be the correct interpretation of the drawing can be seen in Figure 2, which shows a transcript of Mordecai's specifications superimposed on similar views drawn from measurements of an authentic spoke. Although the specimen was evidently hand made, it appears to conform with the drawing insofar as the character of the corner patterns is concerned, but deviates from the drawing if we presume that the elliptical section shown is to be typical throughout the length of the rounded portion. My conclusion is that the section shown is typical in the direction of the felloes, but that in the direction of the nave, modification of the section was customary at the discretion of the artisan. This opinion is derived from the examination of a number of authentic spokes, all of which have embodied the quite graceful corner appearance described, and from discovering that only very minor departure from a true ellipse is necessary to achieve the effect. Further conviction stems from Maj. Mordecai's report of the "Military Commission to Europe 1855-1856" wherein he mentions that spokes were made at Watervliet Arsenal by turning in a machine of the nature of a Blanchard lathe. Such a production method would permit economical achievement of the shape described, whereas production by a machine working on the principle of a shaper would require additional operations to produce the modified section.

I could continue at length with examples wherein the design data available leaves a gap in the knowledge needed for meticulous duplication, and while additional documentary research will fill some of the voids, there really is no substitute for viewing surviving examples of the hardware. This need is particularly evident in connection with fits, finishes, markings, and the numerous unspecified characteristics that were left to the builders' discretion. Unfortunately, it is not easy to find authentic specimens of many of the items of interest. While bronze and iron barrels are familiar sights at the National Military Parks, even they have endured a century or more of erosion and have lost some of the fine detail that certainly would be fun to reproduce in miniature.

As for carriages and accouterments, we are far less well-provided, and I am sure it is safe to say that if any completely original wooden carriages exist, they are certainly kept well-hidden. Nevertheless, at various museums and parks it is possible to view authentic components and thus piece together information and photographs that help fulfill the objectives. The difficulty of finding authentic hardware, particularly the perishable parts, has seriously limited my personal collection and has generated considerable travel to study the material available in museums and other displays. Those at Rock Island Arsenal and at Chicamauga National Military Park have been especially useful to me. The former provides, in particular, an original and nearly complete 12 pounder Model 1841 Gun carriage, along with original irons for several other types, while the latter offers a large and diversified collection of Civil War and earlier barrels.

As in any precision manufacture, the subject of materials is of great importance and some challenge to the builder of miniature artillery. While in most instances the objective is to duplicate the characteristics of the prototype material, it often cannot be done by simply adopting the same material. Even bronze barrels, which might at first glance imply the use of bronze castings meeting Civil War specifications, I have found can be improved by substitution of phosphor bronze bar designated as ASTM B-139 Alloy D (Anaconda 524). According to the 1861 Ordnance Manual, the prototypes were cast of an alloy consisting of 90 parts copper and 10 of tin, allowing for one part more or less of tin, and containing no more than 0.5% of other substances. Phosphor bronze alloy D meets these requirements in all respects, inasmuch as the phosphorus which gives it its name does not exceed 0.25%.

Although it is hard to challenge the desirability of using a cast material, the 90/10 alloy is now available only on special order from a few obliging foundries, although leaded gun-metal as defined by SAE std. 63 misses the early specification essentially only by containing 1-2.5% of lead and a correspondingly reduced amount of copper. I have run a number of comparisons of color and patina of the foregoing materials along with several others which, because of availability, might seem worth considering, even though they depart somewhat from the composition specified for the prototypes. In summary, the appearances of the various alloys vary significantly from the prototype material whenever the copper and tin depart from the 90/10 ratio. Conversely, the phosphor bronze alloy D and the 90/10 cast bronze appear similar in color when freshly cut and remain so for the several months that I have observed my samples, while most of the other alloys depart rapidly from the color of the prototypes as their patinas develop. This characteristic, coupled with its relative hardness and complete absence of porosity has confirmed my choice of phosphor bronze for small barrels.

The major portions of the carriages of the prototypes were constructed of white oak, which has a familiar and very distinctive grain and texture. While the effort may seem futile because all but the most conspicuous characteristics will be hidden by paint, I have attempted to find wood that appears as oak at 1/10 scale. As the ultimate objective in my search, I hope to find an oak tree 3 to 4 inches in diameter that has taken at least one hundred years to reach that size. The only result so far is that the Alabama and Maryland woodlands have suffered some depredations, as I have found no way to predict the growth rate without seeing a partial cross-section. Help from any members in the colder and higher parts of the country would be welcomed, as the areas that I have been able to explore have climates that insure that an oak, if it grows at all, will grow quite rapidly.

Thus, I have again been forced to find a substitute. Presently, hard maple appears to be the best choice, as it is readily availably, reasonably stable, and has enough variety of growth characteristics to permit selection of areas having as many as forty annual rings per inch. This, of course, works out to four per inch full-scale, which is in the right ball park. A somewhat more exotic solution may lie in the use of hop hornbeam, a small tree that can consistently be found with forty rings per inch and with tangential grain patterns that appear similar to small scale oak and are quite beautiful in their own right.

The other material of major importance in the carriages is, of course, the iron. Contemporary records would have us believe that iron was deemed better the less of any other ingredients it contained, but, because application of appropriate finishes obscures any visual characteristics of the iron I have again chosen to deviate from the specified material in favor of type 416 stainless steel. As this material is not available in sheet form, however, there are several parts such as the sponge bucket, implement chain, and trail-plate which are made of type 304 stainless, the latter being of hard temper to avoid distortion from bolting pressure. The type 416 seems to be quite a desirable substitute for the ferrous prototype material, insofar as it is readily machinable, has a color not unlike iron, and is magnetic, while providing assurance that any lack of care of the models will not result in destructive rusting.

While I shall not dwell on the subject of routine machine shop practices, a few other generalities may be worth touching on. First, let me assure you that I did not undertake my project with much knowledge or experience. Thus, I have found a great deal of excitement in acquiring the tools and discovering the skills necessary to perform the wide variety of operations involved. Likewise, it has been most gratifying to encounter the generous help of numerous amateur and professional craftsmen and artillery students whose skills and knowledge they have shared with me. A few pointers that they have offered may be of use to others. Fundamental in any miniature construction is the need to see and to hold the parts being fabricated. The most useful solution to the former problem is the use of magnifying spectacles, of which I find use for two pairs, one of 2½ and the other of 4 power magnification. These two make possible comfortable viewing and adequate working room for most operations, including hand, machine, and light welding. Occasionally, higher power is

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Sponge Bucket

1. Form ends with die from .010 soft 304. Use Isothane and filler to get flat ends. Lubricate lightly.
2. Dress ends and cut to length on mandrel in lathe. Bore top .500
3. Shear side sheet .860 x 2.50. Joggle with die for .060 lap. Approx. .075 overhang in die will provide.
4. Bend sheet to cylinder in press with 3/4 in. mandrel and Isothhane Use $\frac{1}{2}$ in. mandrel at seam.
5. Use alum. filler and assemble ends and cylinder. Silver sold. tack vertical seam.
6. Remove top and filler, sil. sold. tack bottom to cylinder.
7. Layout and drill .025, de-bur with needle and rivet side seam and bottom. Rivets .024 x .045.
8. Assemble float from dogwood turning with .020 rivets. Bend handle to hat section, flatten both ends with 3 tool bits.
9. Check clocking of seam, put float inside with chain attached and rivet top except for ears.
0. Saw and file ears from turning.
1. Assemble bail, chain, and ears. Rivet ears. File heads to even height. Wire brush to break edges.

Notes: 20 rivets reqd. in shell. 18 grip .020, 2 grip .030
Float strap .016 x .050 x .600, 2 rivets .020 x .125
Eye: .100 dia. x .045 thk. .050 hole, shank .032
Turn ball with radius tool, end mill flats
Bail: Turn and file .030 to .050 dia. x .850 long (approx. 1 deg.)
Turn ball .085 dia. with rad tool
Turn opposite taper
File flats on ball to bail dia.
Bend around 3/4 in. mandrel in vise.
Bend ends with RN pliers
Mark and drill .032 for eye
Toggle: Turn .050 x .110 long
Plunge .050 rad. tool to .150 dia.
Mill flats, remove surplus in rotary fixture
File to contour, reduce eye to .040 at edge
Drill .052, csk. 60 deg. to free fit on chain
To assemble bail and eye: Hold eye in Eclipse vise, pein with punch

Figure 3
A sample operation sheet

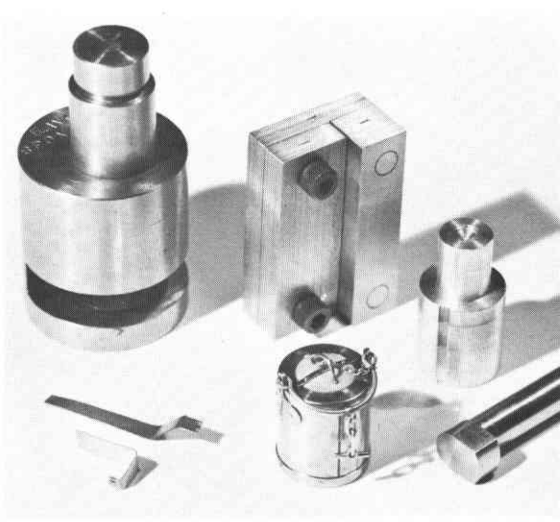


Figure 4
Sponge bucket and tools required

useful, in which cases a 10 power hand magnifier and a laboratory microscope have served me well.

Work holders are usually specialized for each machine and thus involve much variety. One simple device suggested by Bob Rubendunst, however, has been exceptionally useful in connection with a die-filer, belt grinder, and precision tool grinder. It consists of a base plate with adjustable clamp by which either the part itself or other smaller clamps can be accurately positioned. Another surprise to me is the usefulness of collets for the lathe that vary in size only by very small increments. This was achieved by acquiring both metric and English standard items and by occasionally home-making special sizes. For hand operations such as filing, nothing seems to compare with an engraver's block, which can be instantaneously swivelled to any position within a hemisphere.

One other well-known industrial technique that has been quite helpful is the use of simple operation sheets. They first seemed desirable because I couldn't remember from one model to the next how I had done many of the more complex operations, whereas I have found them additionally useful as a reference for pondering improvements that I hope to continue to introduce as I progress. A typical sheet is shown in Figure 3. This example lists most of the important operations in making a 1/10 scale sponge bucket, while Figure 4 shows the finished part and the special tools required. These, from left to right are the end-forming die, the shell joggle die, the shell forming mandrel, and the riveting mandrel. The two small tools in the lower left hand corner are used to insert the pesky little rivets into the pesky little holes, from inside the bucket.

The wheels are perhaps the most challenging components of the entire project, inasmuch as they were the product of highly specialized artisans in full-scale, and as in miniature, their perfection (or the lack of it) has much to do with the quality of the final result. I have previously mentioned the difficulty in understanding the design of the spokes, and, to further belabor the subject of Mordecai's information, there seems to be another mystery with regard to the assembly of the wheel components.

The drawings depict the assembly after completion, showing the tenons on the outer ends of the spokes reaching nearly all the way through the felloes, and showing the dowels deeply inserted in blind holes in each end of the felloes. It would be anticipated that the first assembly operation would be to drive the spokes into the mortises in the nave, to form something of a pin-wheel. So now how does one get the felloes on the tenons and the dowels inserted? In the event that the problem is not apparent, let me explain that the ends of the tenons would appear to be too widely spaced to enter the holes on the inside circumference of the felloes.

The answer lies in the use of a spoke-dog, a vise-like tool that can be tightened around two adjacent spokes until the spacing of the tenons corresponds with the holes in the inner circumference of the felloes. By use of this device it is possible to join the felloes and dowels and then start the spokes into the felloes a pair at a time. According to the eloquent description of this operation by George Sturt in "The Wheelwright's Shop" (Cambridge University Press), after all the parts had been assembled to the stage described, the wheelwright walked around the wheel mounted horizontally on a low stool, tapping each felloe with an axe. Suddenly, all the parts would spring into place with a satisfying thud. I believe that a similar process was employed by the U. S. arsenals, since Mordecai described with interest in his report of the Military Commission to Europe 1855-1856, a British machine in use at Woolwich that was operated by four hydraulic cylinders which forced the parts together. Whether such a machine was later employed in this country is not known to me.

Some of my early experiments in making 1/10 scale wheels are a bit painful to recollect, as I remember seeing several patiently-made spokes reduced to splinters when I tried the spoke-dog trick. The scale effects and dry, brittle material gave rise to greater stiffness and less strength with the result that the tenons on the spokes snapped off the instant the dog was released. While it would no doubt be possible to build a fixture that would permit assembly in the authentic manner, I decided to make the naves in two pieces whereby no distortion of the spokes is required during assembly and the accurate machining of the mortises is greatly facilitated. As the two halves are spigoted together and the joint occurs at the inner edge of the brow band, it is quite secure and inconspicuous. Proper dish is achieved by machining the spokes and mortises at the correct angle and by using a checking fixture which verifies that the rim and nave are assembled in the right relationship. Spokes are made in the lathe, utilizing a home-made milling cutter that shapes the elliptical cross-section in two operations. As pointed out earlier, this procedure results in incorrect sections near the nave. The correct contours are then achieved by careful use of Swiss needle files. Tires are shrunk over the rims at about 250 degrees F., which is low enough to permit removal by careful reheating. A 1/10 scale wheel, complete except for painting and nailing, is shown in Figure 5.

I have frequently been asked why the wheels of artillery carriages are dished, and why the axles are so shaped as to give the wheels a conspicuous tilt. "The Wheelwright's Shop" which I have previously mentioned, provides a general explanation for horse-drawn vehicles, which can be readily adjusted to apply to artillery carriages as follows:

When we visualize a carriage in a rapid turn to the left, we would expect the vehicle to tend to overturn toward the right, resulting in higher loads in the right-hand wheel and reduced loads in the left, as the latter inclines to lift off the ground. Most significant, however, is the side load toward the right which tends to push the hub of the right wheel to the outside. Obviously the circumstances are reversed in a right turn and we can see that there is a threat of failure caused by the loads that consistently push the hubs toward the outside. By building the wheels in the form of a flat cone, concave toward the outside, greater resistance to collapse in that direction is achieved efficiently, since the rims and tires which react the forces thus generated must be quite stiff and heavy for other reasons.

While the dish relieves one problem, it creates another. If the dished wheels were mounted with their rims in a vertical plane, the spokes between the naves and the ground would not be vertical and would tend to move their joints at the nave as the wheels rotate, thereby eventually loosening these critical joints and inviting early failure. By introducing slight bends in the axle, the heavily loaded spokes at the bottom of the wheels are loaded axially, thereby eliminating the side loads which endanger the joints.

Barrel making represents the dessert of miniature artillery construction for me, and of course, the barrel is the reason for being of all the rest of the

Figure 5
A complete wheel

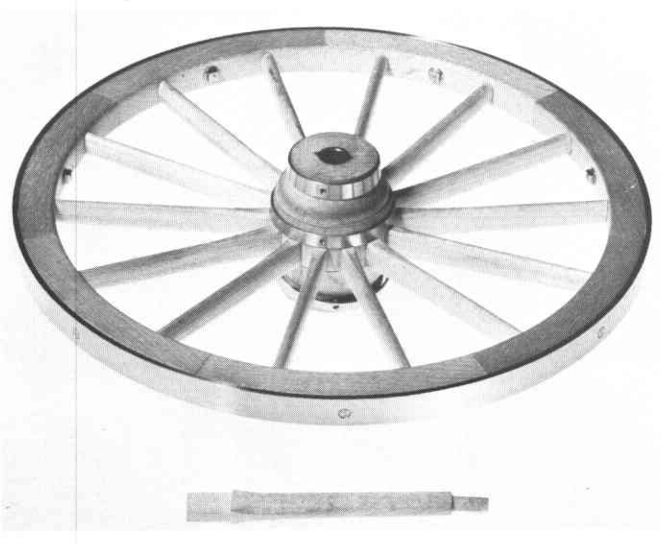
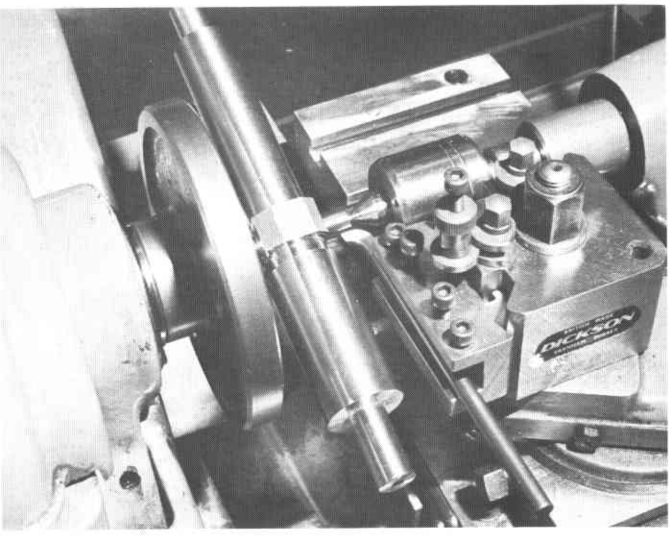


Figure 6
Lathe operations on the barrel



equipment. Several alternative techniques are available to the craftsman, among which are that of working with a detailed casting, or with a cast bar, or with a cold-rolled bar. For reasons that I have previously mentioned, I prefer the last for bronze guns, even though the prototypes were cast close to finished dimensions externally, whereas the bore was drilled and reamed from the solid. The purpose of this seemingly extravagant procedure was to remove the porosity which often occurs near the center of the casting. This problem is best avoided in small scale by machining from bar stock, since the time spent purely in metal removal represents only a small part of the total. The bar is first turned roughly to size, leaving a ring at the position of the trunnions. Boring and chambering is next completed. Then, the trunnion centers are established, taking care that their axis is in the correct relationship to the bore. The barrel is swung end-over-end in the lathe on the trunnion centers, and the trunnions turned to finished diameter. This is the stage shown in Figure 6. The rimbases are likewise turned to finished diameter, but their length at this point can only be that permitted before intersecting the barrel with the lathe tool. The part is now removed from the lathe, and with hacksaw, grinder, and files, the excess metal is removed from between the rimbases. The barrel is then returned to the lathe and the reinforce turned to finished diameter, though only for a short distance on each side of the rimbases, using offset centers to create the taper of the reinforce. The barrel is then set at the angle of the reinforce taper in a dividing head in the lathe and the metal between the rimbases removed with a small end-mill to within about .002" of the finished contour. The remaining metal is then removed by normal operation of the lathe, except in the small area between the rimbases. This residue is somewhat laboriously removed by turning the lathe through partial revolutions by hand. There yet remains the actual intersection of the intersection of the rimbases and reinforce, which is usually somewhat ragged at the extremities of the hand-turned portion. I have found no better alternative than a series of fine Swiss files and rifflers to bring this portion of the barrel to finished contour. A steel ring whose outer diameter is that of the rimbases is pushed over the trunnion and used as a guide in the filing operation.

Contemporary descriptions of the methods of finishing the exterior of bronze barrels would have us believe that rather similar procedures were used on the full-scale products. Mordecai's "Artillery" does not mention the subject, but the Ordnance Manuals specify that the barrels be turned in the lathe, and "dressed" where they cannot be reached with the lathe. Other references, and specimens, indicate that the awkward spots were often dealt with by a specialized planer, but there still remained the problem area requiring hand filing as I have found necessary. Mordecai remarked after his visit to Strasburg Arsenal (France) in 1855 that there, trunnions were finished by chisel and file, as had been done for a hundred years. It would seem that the Space Age could provide a simple answer to this classic problem, and certainly, computer-controlled machines could generate the intersection of a cylinder and a cone, which is the basic geometry in question. Nevertheless, none of the numerous professionals whom I have badgered extensively on this subject have been able to suggest a means by which this intersection might have been generated by the builders of muzzle loading artillery, either past or present.

One of the interesting specialized construction techniques that I have encountered is that of rope making, the primary use of which is for the prolonge, described by Mordecai as being made of 3½ inch (circumference) hemp rope of four strands. He did not define the lay, or direction of twist, nor have I found this specified elsewhere other than that contemporary photographs show a "Z" lay, or right hand twist. Likewise, he did not define the number of threads per yarn. The 1861 Ordnance manual advises us that the best grade of hemp is pearl gray in color, that the number of yarns per strand is from 16 to 25, and that the twist is one-quarter. When this is all reduced to 1/10 scale, it turns out that a reasonable facsimile of the rope thus described can be made of four strands of 26 threads each of #50 Coates and Clark O.N.T. mercerized thread, color #102.

Nowadays, rope is generally made by high speed machines that will produce continuous lengths as long as they are supplied with adequate material. At the time of Mordecai, rope was produced in an establishment known as a ropewalk, the length of which determined the maximum length of rope which could be made without splicing. The ropewalk in its simplest form consists of a set of tracks throughout its length, on which moves a small cart known as the looper. The looper carries a freely-rotating swivel, the forward end of which forms a hook. At one end of the track, the whirls are rigidly mounted. They consist of whatever number of hooks are needed for the maximum number of strands to be handled, all geared together and rotating in the same direction, along with a driving mechanism compatible with the motive power available.

Rope is made by stringing the required number of yarns between the hooks of the whirls and looper. The whirls are then powered, twisting each strand separately. The rope forms in front of the looper, which is braked to induce tension as the cart moves up the track in consequence of the shortening produced by the twisting. When the rope has formed throughout its length, all strands are coupled to one hook of the whirls and rotation continued in the direction of the lay. This operation is performed with the looper heavily braked and its rotating hook blocked, so that the fibers of the several strands are locked into each other. By this means, the stiffness of the rope is increased and the twist rendered permanent.

Figure 7 shows my miniature ropewalk in operation at three stages of forming a length of rope a little under ⅛ in. in diameter. The upper photo, A,

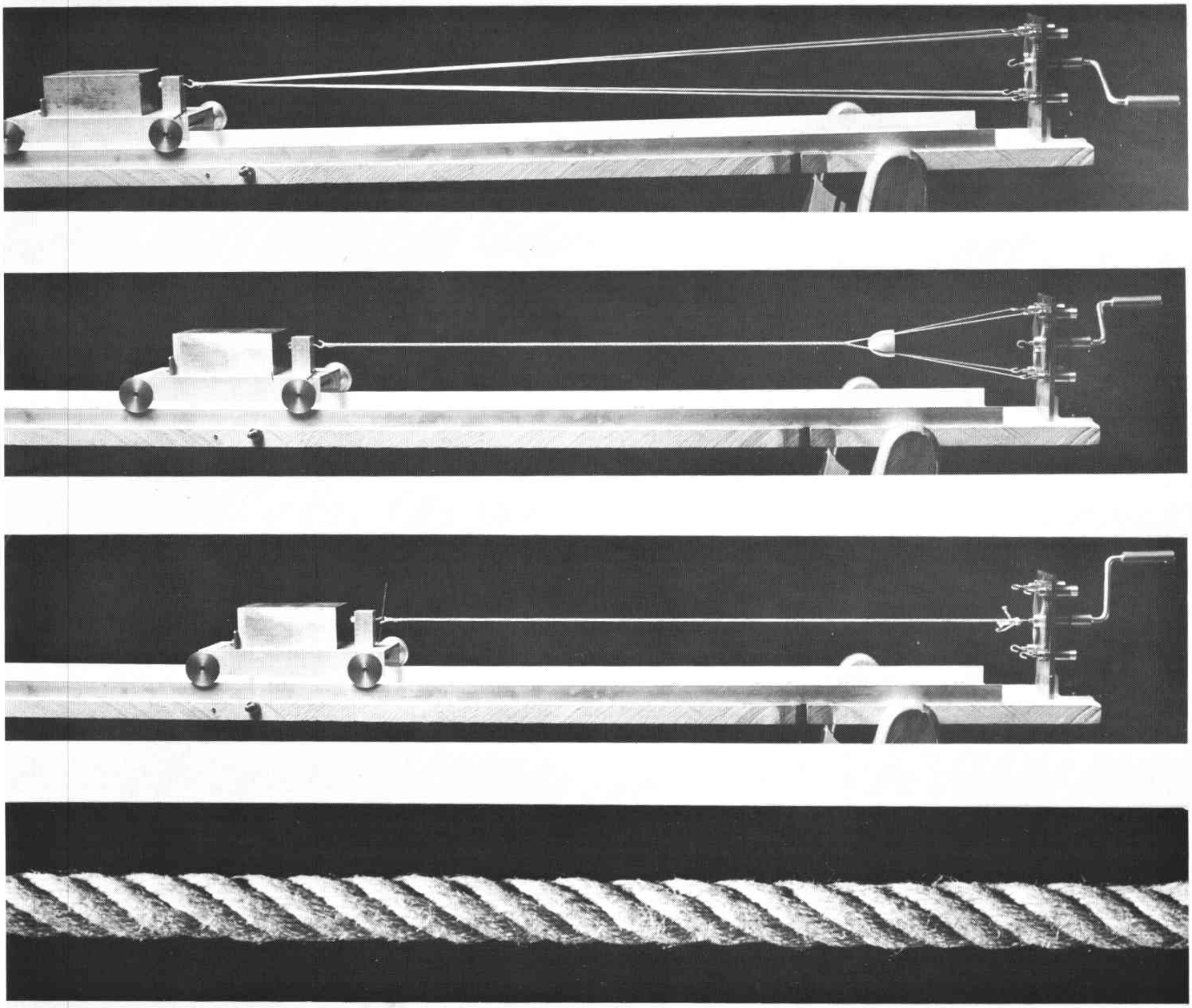

A
B
C
D

Figure 7
A miniature ropewalk for rope 1/10 scale

shows the yarns in place, in the four strands required for the prolonge. B shows the strands twisted and the rope formed throughout most of its length. The device between the strands in this view is the "top" which minimizes snarling, which can be a serious problem if the strands are too tightly twisted. C shows the rope being hardened, by additional twisting and loading of the looper. Although these photos have all shown the tracks in a horizontal position to save space, in practice they are inclined at a fairly steep angle, and some twenty pounds of ballast carried by the looper to provide the necessary uniform tension. Photograph D shows a magnified view of the finished product, which, I think you will agree, does look like a rope.

I could continue at length to elaborate on the construction processes for the remainder of the 500 or so parts that make up a carriage, but time and probably your patience will limit me to showing you photographs of some of them. Figure 8 shows the entire set of parts for a 6 pounder gun carriage, prior to painting, which is done before assembly in spite of the care required to avoid damage to the finish.

Contemporary Ordnance Manuals specify that the iron parts of carriages be painted black, following a priming coat of "lead color". The black paint contained principally lampblack, boiled linseed oil, and a small amount of Japan varnish, which should result in a semi-gloss finish. The wood parts were finished in olive drab, again following a gray primer. The olive drab of the 1840-1880 period had quite a different appearance from the military finish of the present and provides a difficult task for anyone attempting to duplicate it. The formula makes use of yellow ochre, which today can be found in almost any shade from bright yellow to dark brown. Thus, experimenters in this area enjoy much friendly controversy as to what the old paint really looked like. Harold Peterson has performed extensive research on this subject for the National Park Service, and has derived color samples which utilized yellow ochre from Civil War period mines. Thus, his samples are as authentic as we can hope to get. From this point, it might seem simple enough to mix modern paint to match the sample; some subtlety,

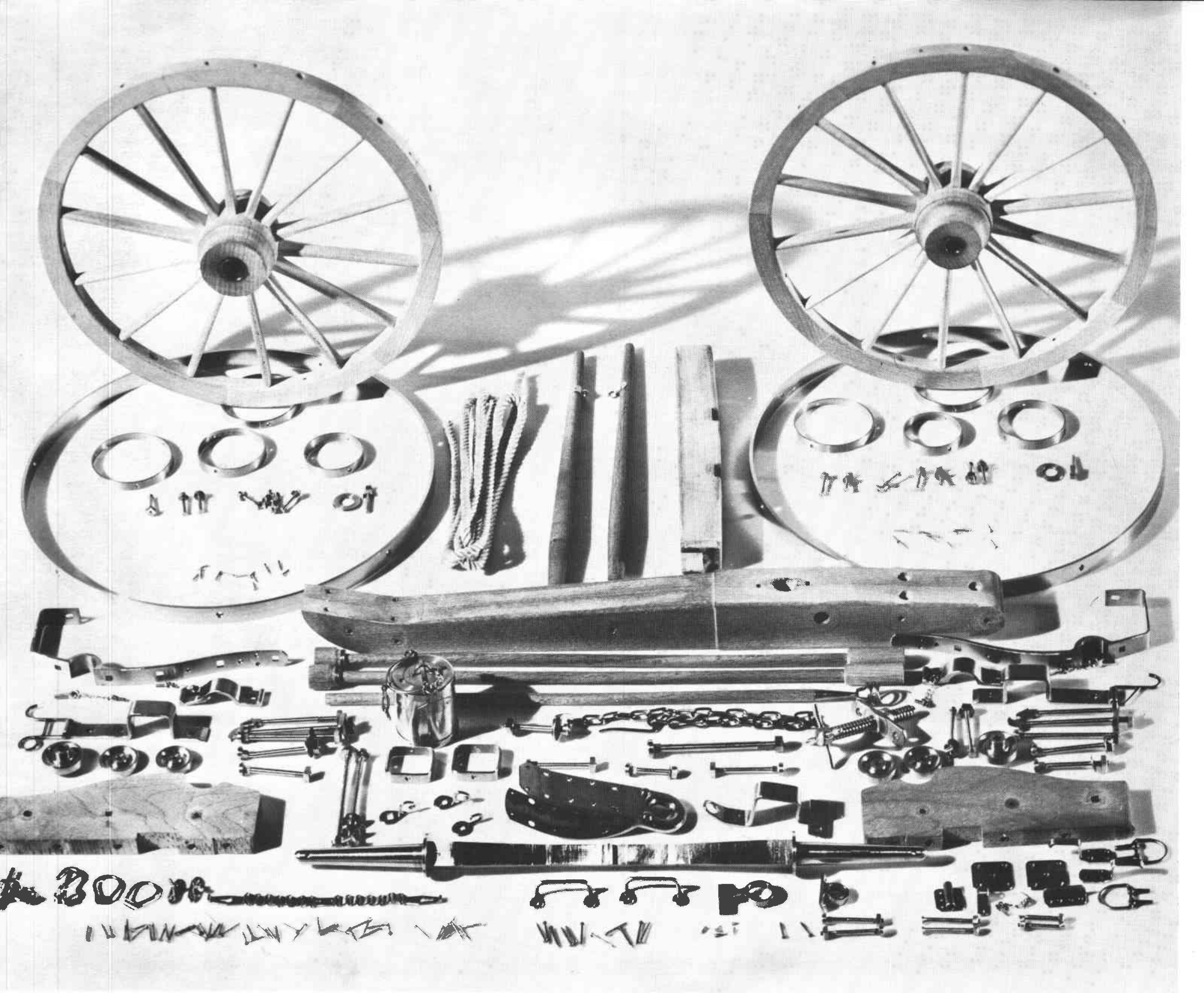


Figure 8
An entire set of parts for a 6 Pounder gun carriage

however, perhaps in lighting, seems to make the match difficult even for experts.

Returning to the models, the metal parts of the carriages are grit-blasted with 100 mesh Pangbornite, as otherwise bonding paint to polished stainless steel can be very difficult. The black paint used is made by Floquil, who describe their product as a "miniature" paint. It is very finely ground and forms a very thin film, which helps to avoid obscuring fine detail. By adding additional vehicle, its gloss can be adjusted from none at all to what I hope is a reasonably correct lustre. The automotive Dulux used on the wood has the opposite problem, the appropriate semi-gloss being achieved by adding flatting compound. The paint is applied with a small spray gun, after straining through a filter made of ladies' nylons.

Markings, like painting, can serve to greatly enhance the interesting features of a model, and certainly provide a demanding task to the amateur. Markings appear on the barrels of most U.S. weapons, and in some cases on the trunnion plates of the carriages. Most of the barrels were marked by stamping, though some appear to have been cut by chisel or graver, and a few may have been chemically etched. Visibility of the finer details on both bronze and iron barrels is frequently impaired by corrosion, and on the latter, by paint, so that convincing evidence of the method employed can be hard to come by.

Of major interest of course is the "U.S." which is normally located on the top centerline near the forward end of the reinforce. These marks are usually stamped in letters about 1 in. high, and while the type faces vary widely between contractors, they are usually quite consistent throughout a contract. The Ames pieces which I have used as prototypes for the models have shown some interesting variations of a minor sort, particularly those of sufficiently low number that would indicate that they were proof specimens. For example, the 12 Pounder Gun, Model 1841, Ser. No. 2 has the "U.S." lightly, but neatly cut, most probably by a chisel, and the surface within the outlines cross-hatched in a diamond pattern. In

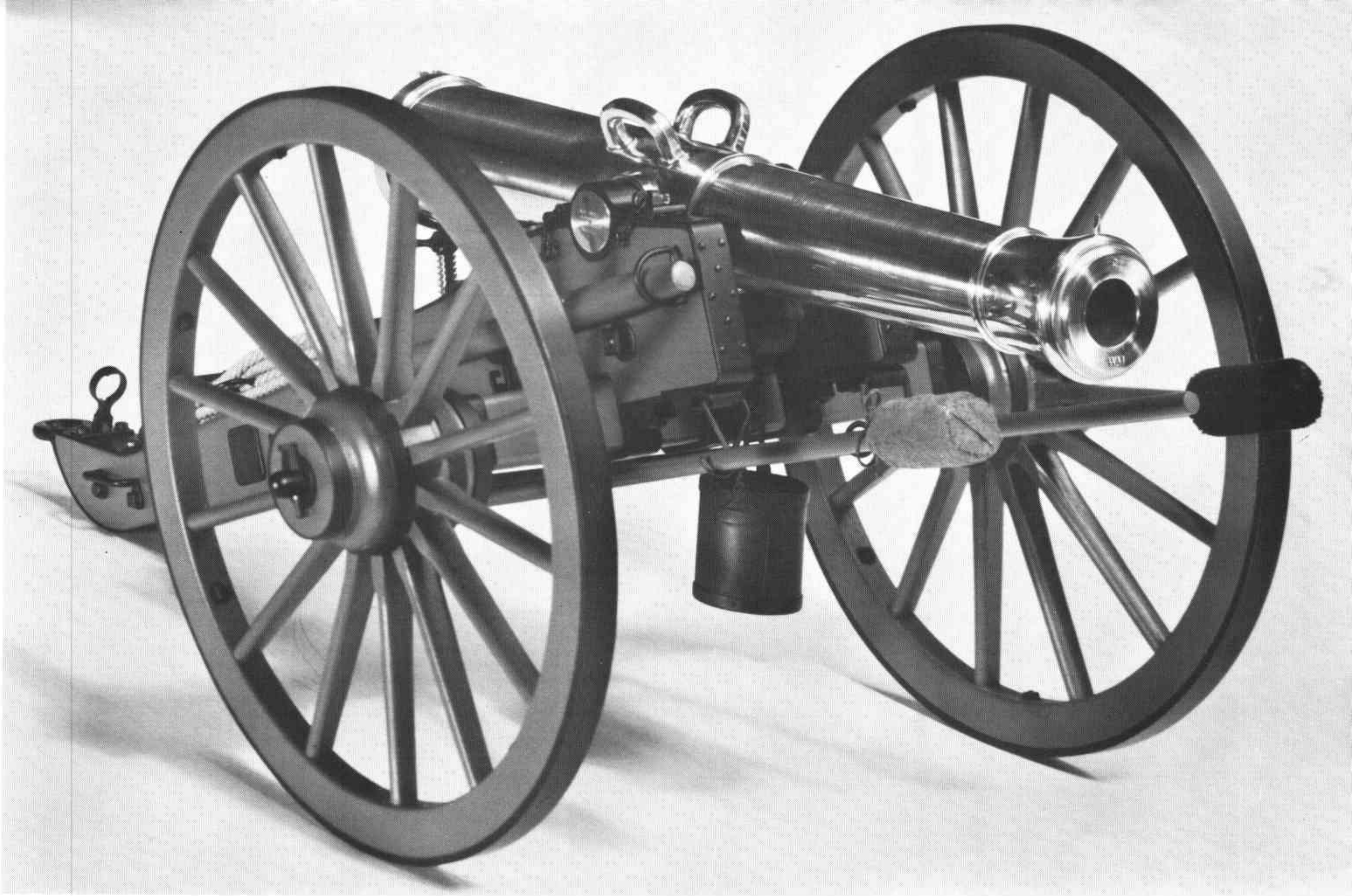
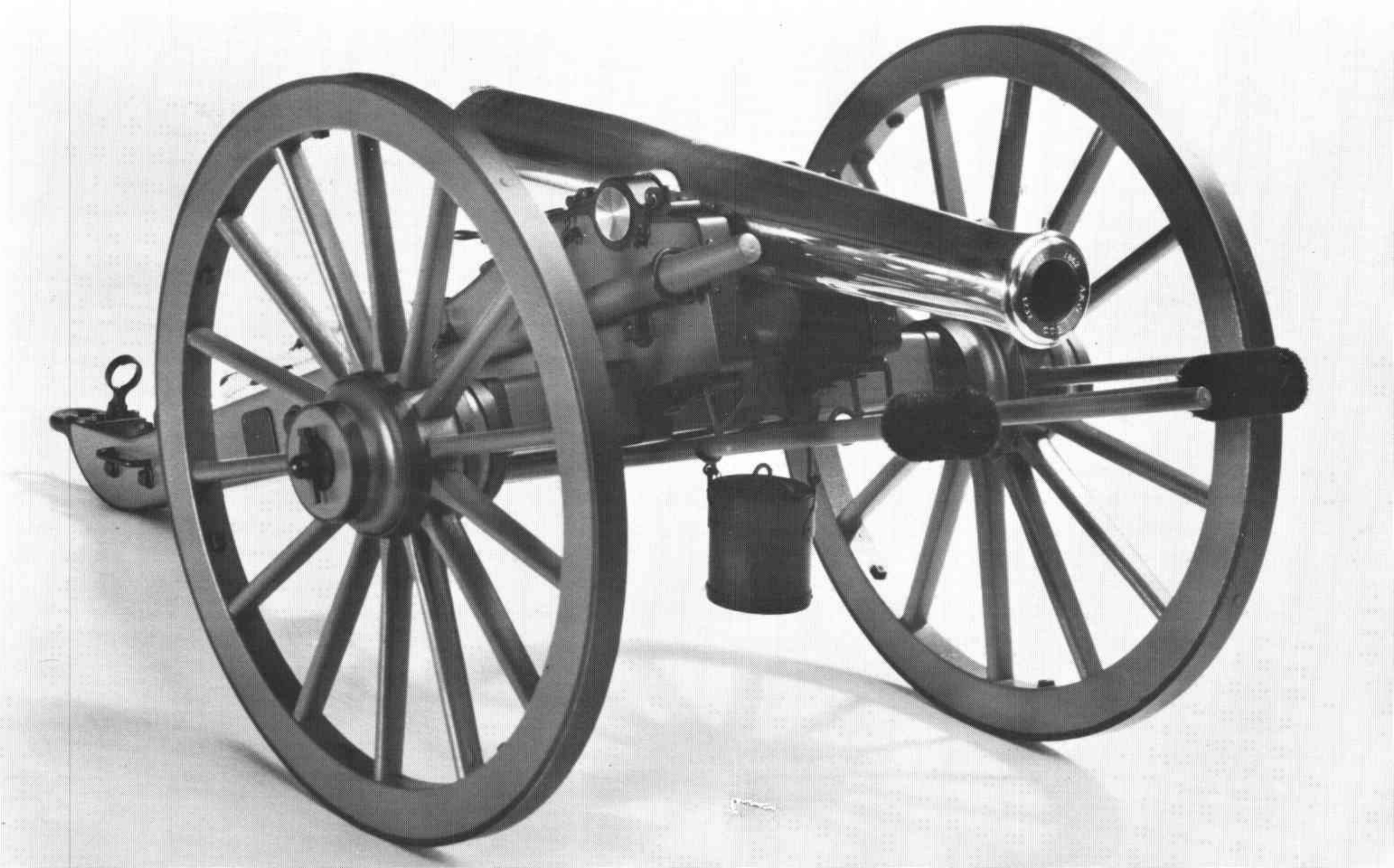


Figure 9
Model of 12 Pounder Gun,
Model 1841

Figure 10
Model of 12 Pounder Gun,
Light, Model 1857



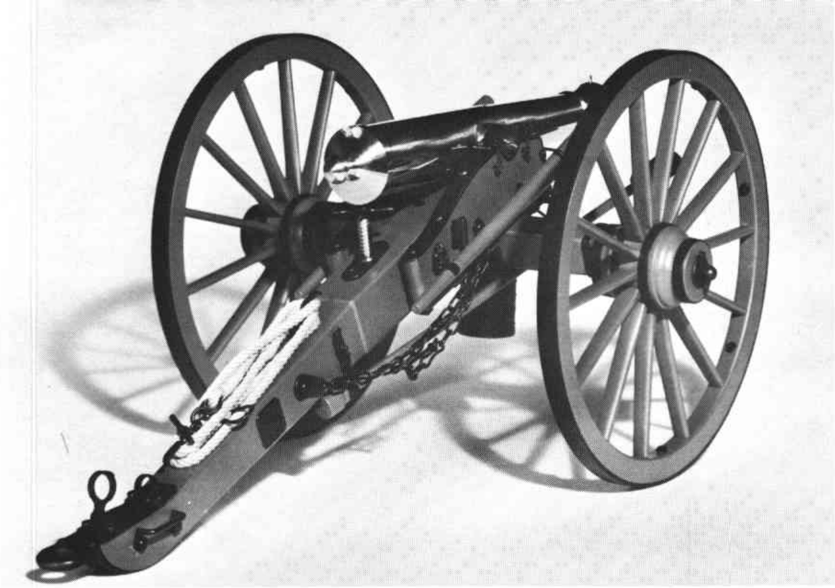


Figure 11
Model of 6 Pounder Gun, Model 1841

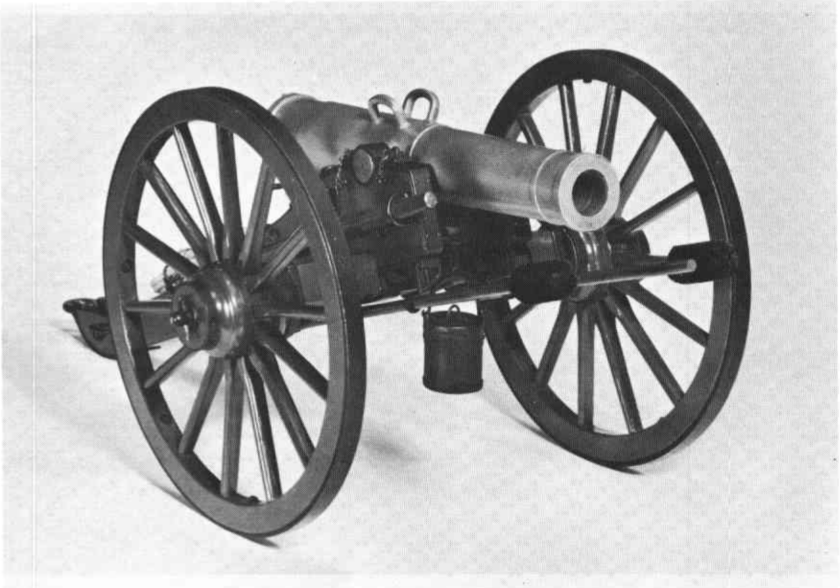


Figure 12
Model of 24 Pounder Howitzer, Model 1844

most instances, the Ames markings are stamped with flat-faced dies. Thus, the obvious way to reproduce these marks in 1/10 scale seems to be with a stamp, unless special conditions would indicate otherwise. To make a stamp, the outline of the characters is picked up from the prototype by a pencil rubbing on rice paper, and then transfered to a piece of thin transparent plastic. With a hand graver, the outline is cut into the plastic on the opposite side, so that the characters are reversed. The engraved plastic is used as a template in an engraving machine set to reduce by a ratio of 10 to one. A piece of tool steel with the end cut to the radius of the barrel at the correct location is laid out with the engraving machine. After some fairly fancy filing, staking, sawing, engraving, and stoning, the reversed characters appear in relief, and after hardening and testing, the stamp is struck with a hammer and a prayer in the proper location on the otherwise finished barrel.

In a few cases, I have been able to apply the foregoing method to the markings on the muzzle face. More frequently, the small size of these characters dictates that the engraving machine be applied directly to the barrel. Even so, the use of a hand cut template, copied from the prototype, permits retention of much of the personality of the original.

In order that you can believe that there is an end to this story somewhere, I should like you to see a few pictures of the finished products. The first of these is the 12 Pounder Gun Model 1841. The prototype is Ames No. 2, dated 1841, and presently located at the National Park Service Laboratories, Springfield, Virginia.

The next is the Light 12 Pounder Gun Model 1857, the well-known Napoleon. Its prototype is Ames No. 55, dated 1862, and located at Chicamauga National Military Park.

Next is the 6 Pounder Gun Model 1841. The prototype is Ames No. 26, dated 1842, and likewise located at Chicamauga.

The next and last, though the first undertaken, is the 24 Pounder Howitzer Model 1844. The prototype is Ames No. 4, dated 1846, and located at the Browning Museum, Rock Island Arsenal.

By now I am sure that many of you would have suggested that the title of my talk should have been "How Crazy Can We Get?" and at times I myself have felt such an inclination, as many of the details of my project have involved an extravagant amount of time. Also, to those who may view the collection of ones own products as the height of egotism, may I offer Ben Franklin's observation that cutting one's own wood warms one twice.