Mortar

By William B. Park Photos by Author

y neighbor to the south accosted me one day.

"Bill," says he, exhibiting a 1" steel ball, slightly rusty, "look what I found in my hand-split shakes."

I knew it was a 1" ball because I had measured it recently, but I said, creatively, "It must have fallen from an airplane."

If it had fallen from a plane, it might have been in his cellar, not in his roof. I have no idea of the terminal velocity of a steel ball falling from 40,000 feet. I neglected to mention this.

He looked at me closely, grumbled a little, and, pocketing my steel ball, stalked away.

I mention this incident in case any of you cannon aficionados are planning to test fire this mortar.

The mortar is a model of a gun I saw on the north bank of the Thames, hard by the Tower of London, where the English display some of their trophies of war. I took photographs and measurements. This gun is not in any scale since I started from the 1" ball, but the proportions are right (Photo 1). Mortars of this type were mounted on the foredeck of a bomb ketch which, under cover of darkness, crept in close under the walls of a harbor fortification. From this vantage point, safe from the guns of the fort which could not be depressed to bear on the little ship, it would lob bombshells up and over the battlements to the confusion of the enemy gun crews. The forestay of the mainmast was a chain, to withstand the heat and blast of the mortar.

Our mortar is all brass, for ease of working, finishing and brazing (Photo 2). Mine was largely made from the contents of the scrap box.

Do not hesitate to change details as long as the proportions are preserved. If the brass bar you have for the barrel happens to be 2-1/2" in diameter, you could choose to use it and increase all dimensions 10%. Without any change in other dimensions, the thickness of the plates for the carriage could be varied by a sixteenth thicker but no thinner.

A characteristic of this mortar is the hemispherical shape of the breech, or butt. Since this is an unusual operation, it is shown as it is set up. A special tool post is mounted on the compound rest. The tool bit is set on center of the workpiece, horizontally and vertically, with the compound set at 0°, or at right angles to the cross slide and parallel to the ways (**Photo 3**). The bit - in this case, the shank of a broken 1/4" high-speed tap - is ground with 0° back and side rake with a 1

small radius point. The front and side clearance is kept at a minimum to prevent digging.

Lock the cross slide. The compound rest is now backed off until the tool is 1-1/8" from the center of the vertical axis of the compound rest. Do not fret about this; you can adjust as the work proceeds.

Now it gets tricky. Loosen the screws that control the swivel of the compound rest until the swivel turns smoothly through an arc as you move it by hand. Swing the swivel to the opposite sides of the bar and adjust by means of the compound screw so that it just clears both corners of the cylindrical workpiece.

Return the swivel to the mid-point, start the lathe, advance the carriage toward the headstock a small amount, and swing the tool by hand to cut the near corner of the work. The far corner will take care of itself. Return the swivel to mid-point. If the lathe is loose in the bearings or the swivel, it might be wise to stop the lathe when returning to take another cut. Do not turn the compound screw during cutting. All cuts are made by moving the carriage toward the work in small increments (Photo 4). It should be locked during each pass.

As **Photo 5** shows, the overhang is large – in fact, in this instance, larger than need be because I did not want to lose an inch of the bar, so I used it full length off the shelf. However, I suggest you keep the overhang to a minimum. The minimum, unfortunately, is large, since the swing of the compound rest must clear the chuck jaws as they whirl past. Check this before vou start.

Some lathes, such as the Logan, on which this mortar was built thirty years ago, have small dials and cranks on the compound rest. This enables the crank end to be swung under the workpiece, and with a little devising, the standard tool post can be used. Since the progress of the tool along the arc is controlled entirely by the pressure of the hand, it may be advantageous to rig some kind of handle for increased leverage. Light cuts and a spindle speed of 500 rpm are the only way to go.

Drill a center in the hemisphere and support the work with the tailstock dead center as you machine the OD between the bands. Cut to length. Leave a sixteenth for finish.

Reverse the piece in the chuck. Protect finished surfaces with masking







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tape. Face off and drill 15/16". Bore to 63/64". Ream to 1". Later, you might want it a few thousandths over if you intend to shoot a steel ball. (This can be accomplished by loading two or three of the reamer grooves on one side with small strips of wood. If you put a ball in a tight bore, you may never get it out.) For now, it may be advantageous to be able to mount it snugly on a mandrel for subsequent operations.

Set it on its face on the vertical milling machine and, with a 5/8" ball-end milling cutter, mill the recess for the trunnion. Or set it on its side and, with a 5/8" end mill, plunge cut the recess. Fasten the trunnion to the barrel by means of a centrally located cross pin or a small recessed fillister brass screw, not larger than 6-32. This will hold the $5/8 \ge 3-1/4$ " round brass firmly in place for reference in drilling the holes for the dolphins and milling the recess for the touchhole cup. It will be invaluable when we come to silver brazing the whole thing together.

Dolphins earned the name from the early ornate design of cannon. The cast-in rings or loops to be used in swaying the guns into place were shaped with eyes, mouth and tails. They were covered with scales, and cast in lively attitudes.

The exact location of the dolphins is not critical, but the holes to receive them must be drilled on a diameter of the barrel and be symmetrical with respect to the trunhion and the axis of the gun. The dolphins are made of 3/16" diameter x 2" brassrod, heated to redness and plunged in a pickle of 10% sulfuric acid. This is dangerous. Protect your face and clothes. I know about inexplicable moth holes in cotton jeans, but Virginia doesn't. The virtue of sulfuric acid is that it does not rust the machinery, and machinery is more important than clothing. Muriatic acid works well, but hydrogen chloride is a water soluble has and pervades the whole shop, and turns all the sacred surfaces brown with rust. In dilute solutions it does not eat cotton. Is there a choice?

Make a bending jig out of a bit of brass or aluminum. A slot is milled in the piece (which could be 1/2 x 1 x 2") 11/16" wide by 9/16" deep. A groove is cut in the long axis to position the 3/16" round piece. This is a temporary die, since only two pieces are to be made. Make a punch out of a piece of $5/16 \ge 1 \ge 6^{\circ}$ cold rolled or equivalent. Break the corners of the end to be used in forming. Setting the die and the workpiece on the arbor press and holding the punch vertically, centered on the slot, push the brass round into shape. The ends of the "U" will be uneven and too long; trim them to size.

An old toolmaker once said to me, "Any damn fool can make one alike. It takes a good man to make two alike!"

The cup for the touchhole is a piece of 1/2" round, shaped as shown while still on the end of a bar, and then cut off.

The gussets are also shaped on the end of a bar on the rotary table for the 1-3/32" radius, and the 5/8" ball end mill used to fit them to the trunnion.

All pieces must be fitted closely.

Easy-Flo silver solder is like glue in that it does not make fillets at the joints. The trunnion is already securely fastened; the gussets are tied in with black stovepipe wire wound around them; the dolphins are a snug fit in the holes; and the touchhole cup can be fastened with two or three silversmith's stitches.

A stitch is made with a graver. Under the piece to be fastened, a stitch is curled up to the location of the edge of the piece previously marked. After two or three chips have been curled, the piece is placed in position and the stitches pressed against the workpiece. Some brass is brittle. If this is the case, a small cape chisel and a light hammer can be used to raise a chip of sorts. After brazing, the stitches are filed off. You will find this trick handy in making nameplates and for many other problems of holding small pieces in place for brazing.

When all the pieces are clean of all oil and dirt by careful washing in solvent and bound together in final form, the entire assembly is painted with a thin paste of fluoride brazing flux to which a few drops of dishwasher detergent has been added to make it wet the piece uniformly. This is to hold down oxidation during heating.

It is wise to preplace thin sheets

of solder between the joints to ensure that enough will be available to float, but you must have a coil of wire solder in hand to touch up all joints. Flux all joints thoroughly.

Place the assembly face down on a firebrick covered with a sheet of asbestos (a dirty word, but I have been using this stuff for many years) or some approved refractory. With a large propane torch, slowly bring the workpiece up to heat (Photo 6).

You will see the preplaced pieces of solder start to melt. Move in deftly with the wire solder to touch up the many joints. Remove the flame and, as soon as



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the solder has solidified, grasp the work with tongs and lower it slowly into a large vessel of acid as above, being twice as careful as before. The brown scale will rub off easily after rinsing well. Do not try to remove remaining flux mechanically – it won't come off. Boiling water in a pan will remove it at once.

Any slight etching by the acid can be polished off; I chose to leave it on because it lends a fine flavor of antiquity.

Now is the time to drill the touchhole. Use number 44 drill – .086".

The carriage, in the main, should follow the drawings. The several pieces can be pinned to hold them in position while brazing as above. The brass pins can be filed flush on cooling, and they will disappear. Two 3/16" holes should be drilled in the baseplate to vent the pressure of brazing.

Do not mill the trunnion seat until after brazing, since the trunnion must bear evenly all the way across. The trunnion seat must be relieved to permit the barrel to swing forward (**Photos 7** and 8).

The holes for the pins of the hold-down straps are also drilled later with the trunnion caps in place. Each strap should be numbered to show position, and the trunnion caps and carriage, also.

The trunnion caps give a distinctive





TRUNNION CAP 2 required





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air to the mortar (**Photo 9**). They are held in place by straps and pins, which suggest the age of the gun. More recent mortars, as used in the Civil War, used threaded bolts and nuts to hold down the caps. Common use of screw threads is a comparatively recent development in the long history of cannons.

The caps are made as a pair. A piece of brass $3/8 \times 1/2 \times 2 \cdot 1/2$ " is soft soldered edge to edge at one end of a similar bar 6" long. This extension serves as a handle for the milling operation. Blue and lay out the two caps face to face. Drill and ream the common hole 5/8". Mount the piece on a 5/8" peg on the table of the vertical mill (Photo 10), and with a 1/4" four-flute mill, mill the outside of the cap by rotating it around the peg by hand (Photos 11 and 12). This is a trap, because the milling cutter will pull the work out of your hand if you attempt to climb mill









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GUSSET 2 required



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TOUCHHOLE CUP double size





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the work. Keep the RPMs up, work against the cut, and take small bites; if in doubt, turn off the machine for the noncutting return stroke. The radius ends of the straps can be made in the same way. These little jobs hardly warrant a rotary table.

The flats to receive the straps are milled. All that is left is filing the raised rounded ends, after the pieces are melted apart, and the excess solder wiped off while still liquid. A filing machine is a modelmaker's dream (**Photo 13**)...how sweet it is!

The trunnion straps are made in the same way as the dolphins. Another bending jig is made, with a 1/4" slot to hold the flat. The punch is now 3/8" thick and the die has a 9/16" opening 3/4" deep.



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The pins are as shown. I brazed the square brass heads on stainless rods, because brass on brass does not slide so smoothly and sometimes galls and seizes, particularly if the pins are taken out and reinserted from time to time when showing off the model. The pins are in sheer if they are properly installed. The straps should be padded if necessary to hold the trunnions firmly.

The carriage is finished a dark brown to contrast with the polished barrel and trunnion caps. Use a chemical dip, the formulation of which is too lengthy for this already too long dissertation. I will be glad to furnish it on request, or if there is enough interest, maybe Joe Rice would print it.





The finished mortar is shown in **Photos 14** and **15**.

Finally, this mortar can be fired, with or without ball, as hinted at the beginning of this article (**Photo 16**). Photographing a cannon at the moment of discharge takes some doing. The small wire that you see above the touchhole leads to the output terminal of a high voltage neon sign transformer, controlled by a foot switch. When the photographer steps on the switch and sees the flash in the pan, he presses the cable release. I tested the setup by firing a small charge inside the shop and the smoke detectors went out of their collective minds. Outside, I got two acceptable pictures out of six.

Mortars of this type were used in the civil War as coast defense weapons. They could drop their explosive shells on the lightly armored decks of ironclads such as the Monitor, and would be deadly against the bomb ketch mentioned earlier. It was important, when loading the spherical bombshells, to point the fuse forward. If it was pointed to the rear, the gun would blow up. They were sometimes mounted on short eight-wheeled flatcars, and when set up on a curved track, would have considerable traverse. This excerpt from Artillery and Ammunition of the Civil War by Warren Ripley gives us an idea of the effectiveness of mortar fire:

"The mortar, fired with 14 pounds of powder, recoiled less than two feet on the car, which moved 10 or 12 feet on the track. The effect of the charge was taken up without damage to the axles...This mortar, whose shell would crush and explode any ordinary field magazine, excited dread among the Confederate gunners, and was effective in inducing their enfilading batteries...to discontinue fire on the right of our line."