Small Angle Grinder Safety

by Doug Kluender
From The Anvil's Horn

Although not a Blacksmith's tool, the small angle grinder (4 to 5 inches in diameter has become an indispensable part of our tool kit. While easy to use, this tool is also very easy to misuse and abuse. This little tool is capable of inflicting some very serious injuries. What follows is a review of some basic safety precautions, along with a discussion of the proper use of some of the more common accessories and abrasives. The small angle grinder has been used for shaping, cutting and finishing a wide variety of materials including metal wood, plastics, ceramics and glass. The following discussion will focus primarily upon metal shaping and finishing applications. Precautions that apply to all power tools

- Avoid accidental starting. Make sure the power switch is turned off before plugging the tool into an electrical outlet.
- Periodically inspect electrical cords. Repair or replace if they are damaged.
- Keep the work area clean and uncluttered.
- Dress properly: Do not wear loose clothing or jewelry. Contain long hair. Keep hair, clothing and jewelry away from moving parts.
- Do not wear gloves when operating rotating equipment. It the work is too hot to handle, cool it. If the work is dirty, clean it. Gloves are easily caught in saw blades, drills and grinders.
- Use appropriate safety gear. Always use ANSI rated protective eyewear with side shields. Hearing protection is also strongly recommended. Respiratory protection may be necessary when using grinders.
- Do not remove guards or disable safety devices. Support and secure the work. Do not hold the work piece with your hands. Use appropriate clamps and fixtures.

Precautions specific to small angle grinders

In addition to the foregoing, there are some precautions unique to the operation of small angle grinders.

- Always use the proper guard with grinding wheels.

This protects the operator from disintegrating grinding wheels. The guard may be removed for certain sanding and wire brush operations; otherwise it should remain in place.

- Inspect grinding and cutoff wheels for damage before use, especially if they have been dropped.
- Always use the side handle. The handle on most grinders can be installed in several positions suited to various operations. It provides a firm grip and control of the machine.
- Accessories must be rated for the operating speed of the grinder. Check the product label to ensure compatibility.
- Know where the sparks are going. Sparks can damage other equipment, cause fires and injure others.

Abrasives and other accessories

- Hard grinding wheels.

Intended for rapid stock removal. Most common are the Type 27 depressed center designs. These wheels should be operated at an angle of 10 to 20 degrees. They are not intended for use as a cutoff wheel.

- Edge cutting wheels

Available in both depressed center and flat designs and thickness ranging from .045 to approximately 1/8 inch. Care must be take to avoid binding the disc in the kerf of the cut.

- Abrasive sanding discs

This is probably the most widely used of all small angle grinder accessories. Discs are available in a large variety of materials and grits, designed for use on all types of materials. They range in cost from a few cents to several dollars each. Abrasive discs usually used with some type of backing pad. Some users stack used or worn out discs in lieu of using a backing pad. These discs are designed to be used with a 10 to 15 degree angle of attack.

- Flap wheels

These are a versatile and widely used alternative to abrasive sanding discs. They are available in both flat and depressed center styles. As with abrasive discs, they are available in a wide variety of materials and grits. They typically last a little longer than abrasive discs and are more expensive. They are also designed for use at a 10 to 20 degree angle. Flap discs with worn edges are useful for smoothing welds made in corners.

- Cup wheels

This accessory is not appropriate for small angle grinders. Although they sometimes may appear to fit, they are not rated for the speed of a small angle grinder.

- Wire wheels

Wire wheels are perhaps the most dangerous and misused accessories available. They are well known for their ability to grab everything nearby. They are equally adept at snaring shirts, shop aprons and flesh. Use only knotted wheels. Crimped type wheels are notorious for launching small diameter missiles. Wire wheels are available in both cup and flat styles.

- Non-woven abrasives

Non-woven abrasives are used primarily for deburring and polishing operations. They consist of a synthetic mesh that has been impregnated with abrasive material. Typically they are specified as a degree of coarseness, (i.e. Fine, medium, coarse rather than by grit. Attachment systems vary by manufacturer and are often not compatible between brands. One of the most versatile is the "hook and loop" system often referred to under the trade name "Velcro", offered by several manufacturers. This system allows for rapid pad changes.

- Other Accessories

There exist a large number of specialized attachments and accessories for small angle grinders. Among them are Chain saw blades, Wood rasps, Diamond impregnated cutting wheels, Buffing pads, and rubber or plastic pin type attachments for polishing or stock removal.

"WRABA Tips and Techniques"
The Weekend Metallurgist

by Don Klesser

This article is a follow-up to the Beaver Creek event in August, where I provided an overview of the metallurgy of hardening steel through quenching.

Hardening requires two steps: heating steel to austenite, and then quenching to obtain martensite. Steel is a combination of iron and a small amount of carbon. At low temperatures (below 13000 F.), in the unhardened state, the carbon and iron atoms form two phases, ferrite and cementite (together they are called pearlite). As steel is heated above 1300°, the iron atoms begin to form austenite, which has the ability to dissolve carbon atoms - like sugar dissolving in iced tea. All steels must transform 100% to austenite before they can be hardened. It is widely, but falsely, believed that austenite has formed when steel loses its' magnetism; that is, when a magnet will no longer stick. Steel begins to form austenite around 1333°, and loses its magnetism around 1430°. However, many steels are not 100% transformed to austenite until they reach 1500° or even 1600°. A reliable, but low cost, method to ensure proper heating temperature is a Tempil® stick. The stick will melt above its 'rated temperature' - and for most steels, 1650° minimum is a good starting point for hardening.

Once austenite is formed, it can be quenched to form martensite. Under normal cooling conditions, the iron and carbon atoms transform back to ferrite and cementite as the temperature falls below 1333°. When steel is cooled rapidly however, carbon atoms don't have time to move out of the austenite solution, and another steel phase is formed called martensite. Martensite is hard and brittle because the carbon atoms act to strengthen its structure. (By adding a heat to martensite, the carbon atoms gain energy, begin to move out of the structure, and form ferrite and cementite again. This softening process is called tempering.)

The phases of steel are summarized below:

Steel condition	Low & medium carbon steels	High carbon steels (>0.60% C)
At 70° (unhardened)	ferrite & pearlite, magnetic	pearlite, magnetic
Heated to 1300°	ferrite & pearlite, magnetic	pearlite, magnetic
Heated to 1350°	ferrite & pearlite, austenite, magnetic	pearlite & austenite, magnetic
Heated to 1450°	ferrite & pearlite, austenite, non-magnetic	austenite, non-magnetic
Heated to 1650°	austenite, non-magnetic	austenite, non-magnetic
Slow cooled to 70°	ferrite & pearlite, magnetic	pearlite, magnetic
Quenched to 700	martensite, magnetic	martensite, magnetic
Semi-quenched to 70°	ferrite, pearlite & martensite, magnetic	pearlite & martensite, magnetic

The maximum hardness of quenched steel is fully dependent on how much carbon is in the steel; higher carbon enables higher hardness. Hardenability, on the other hand, depends on both carbon content and alloy content. Two steels having the same carbon content, but different alloy content will quench to the same maximum hardness. However, the steel with the higher alloy content (chromium, nickel, molybdenum, vanadium, etc.) has better hardenability, or ability to be hardened'. Alloy steels are more hardenable because the alloying atoms slow the movement of the carbon atoms out of austenite during quenching. If sufficient alloy is in the steel, the movement of carbon atoms is so slow that it can be quenched in oil, or even air - these are oil hardening or air hardening steels.

Quenching involves rapid removal of heat. During quenching, only the steel surface is being rapidly cooled as it is in contact with the quenchant - water, or oil, or air. Inside the steel, heat has to move to the surface so that it can be removed in contact with the quenchant. Because this process takes time, the interior of the steel cools more slowly than the surface. The bigger the part, the slower the interior cools.

As a result, martensite may form at the surface of the steel, but the inside cools too slowly, and only ferrite and cementite result. Alloy steels are better able to harden into the center

Low alloy and carbon steels require a very fast quench to remove heat quickly, such as water. As the water contacts the hot steel surface, it is heated and forms steam. The formation of steam draws a lot of heat from the steel. Unfortunately, once the steam is formed, it also forms a vapor barrier around the steel and slows the quench process. To obtain an effective quench, the blacksmith must stir the part during quenching to break the vapor barrier. Violent agitation, obtained by adding water pressure, is even better. If a water supply is available, a simple way to add pressure is to use a water hose or faucet with a pressure nozzle.

There is much interest in the effectiveness of 'superquench' (a solution of water, salt, soap and wetting agents) for improving the hardness of steel during quenching. It is well known that salt does somewhat improve the quenching ability of water (brine), and soap significantly decreases the quenching ability. In order to compare superquench with other available quenches, we heat treated some test pieces during the Beaver Creek demonstration. Later these test pieces were hardness tested with a Rockwell hardness tester.

Two sets of samples, made from a plain carbon (approximately 0.20% carbon) and a low alloy (grade 4140, with 0.40% carbon) steel, were heated in a coal forge. Prior to quenching, the temperature of the bar samples were measured using a 1650° Tempil stick to ensure austenite was formed. The parts were randomly quenched in one of three solutions: water with salt (brine), ice water & salt, or superquench - two sets in each quench. The samples were cut apart, ground slightly with a water cooled knife sharpener (to remove any decarburization), and tested with a calibrated hardness tester in three locations - for a total of 72 hardness readings.

The average hardness results are summarized below:

Steel Type	Quench	Outside Hardness*	Inside Hardness*
plain carbon	water & salt	37.5 Rc	37.2 Rc
plain carbon	ice water & salt	42.0 Rc	36.8 Rc
plain carbon	superquench	18.2 Rc	19.7 Rc
4140 alloy	water & salt	56.2 Rc	52.7 Rc
4140 alloy	ice water & salt	56.2 Rc	50.3 Rc
4140 alloy	superquench	53.7 Rc	52.7 Rc

*Outside is the surface touching quenching solution. The inside hardness is about 1/4" deep on the plain carbon steel, and 3/8" deep on the 4140 steel.

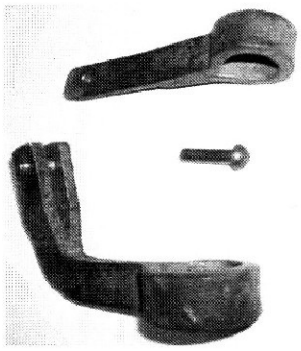
From metallurgy literature, a 0.20% carbon steel (such as hot rolled bar stock), can have a martensite hardness of about 44 to 46 Rc. The ice water was able to get an average hardness of 42.0 Rc (note one of the 6 readings on the two samples was near the maximum of 46 Rc) on the outside surface - this was the best result for the plain carbon steels. The inside surface was about 37 Rc - this is due to marginal hardenability of the plain carbon steel. The superquench did not harden the plain carbon steel at all, having an average hardness of about 18 to 19 Rc (the hardness of ferrite and pearlite).

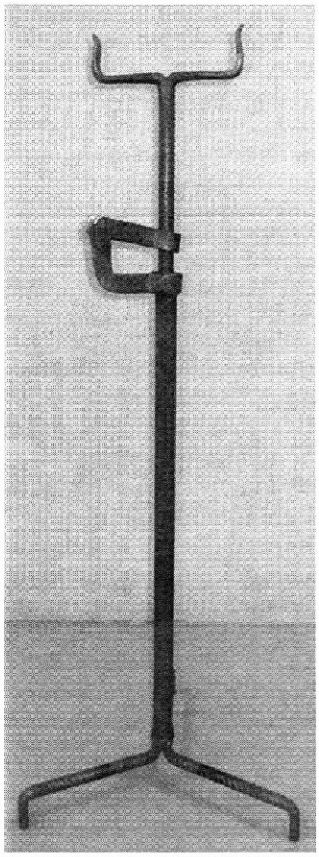
The expected hardness of the 4140 steel is about 56 to 62 Rc (the variation is due to the allowable tolerance on carbon content). All of the quenches were capable of quenching the outside surface of 4140 to near the maximum expected martensite hardness. Inside hardness dropped only a little, indicating that 4140 steel has good hardenability for this size part. From some blacksmithing articles that I have read concerning superquench, it is not recommended for use on alloy steels because of its severity, however, in this test, the results were similar to that of plain water with salt.

Originally published by PAABA

With A Little Help from My Friend

by Bob Selvaggio





List Of Materials
1 piece of 3/4" x 24" round bar;
1 piece of 3/4" x 20" I.D. black iron pipe
3 pieces of 1/2" x 9 1/2" rebar
1 piece of 3/4" x 1/4" x 7 "1/2" flat bar
1 piece of 3/4" x 1/4" x 12" 1/2 "flat bar
1 - 1/4" x 1" round headed rivet .

I wish that I could take credit for this handy little Blacksmith Helper. I received this stand from a fellow that got it out of the Allegheny County Workhouse, which was located in Blawnox, Pa. The workhouse had a blacksmith shop as well as many other shops. When the facility was closed my friend gave me the stand. It is a handy little thing, just right for keeping off to the side and moving it into position when forging long items that need to be supported. Being lightweight, reaching for it, and adjusting the height can be done with one hand while holding onto the material being forged.

The original stand is a mixture of traditional forging and newer arc welding. I decided to keep it that way when reproducing a couple more. The way the support piece moves up and down through the adjusting device, it is locked into place by the downward motion of the top bar.

To make this helper, begin by making the feet. Take the three pieces of 1/2" rebar and forge the ends over. The one end is forged over 1" and the other is forged in the opposite direction at 1-1/2". The three one inch ends will go up into the pipe, of which a small flair is forged. The flair permits the three pieces of rebar to fit. The 3/4" round bar is split back 4" on the one end and forged into the "T". For the adjusting device, I start out with a longer piece of the 3/4" x 1/4" bar so that I can hold onto it without using tongs. The piece that goes around the top of the pipe I measure back 5" and center punch on the edge and measure up from that mark 4" and center punch again. At these two marks, I forge it to a somewhat 45 degree bend and forge it around to match up the marks. I have found 4" to be enough to slip over the pipe. At this point, you should have an eye large enough to fit over the pipe and the remaining materiel should be over lapped onto itself. The piece is then brought up to a welding heat and forge welded about 2" back from the eye. The pieces are welded together just enough to stick , no need to reduce the size down at all. Heat the piece up again past the 2" section and clamp in the vise and put about a 80 degree bend starting at 2" from the eye. This remaining piece should not be welded together and will be opened up later to accept the top piece. Open up between these two pieces so that the top bar will move freely between them. The top piece has a smaller eye, one that should take about 3-1/4" of material for the eye. First forge a taper on the end, measure back about 1" or so, center punch once again on the edge, measure from that mark 3-1/4" center punch again and forge into the eye. This eye needs to be large enough to allow the 3/4" round bar to travel freely; so if it is tight you need to forge a bigger one! This top bar is riveted to the bottom bar, line them up when they are placed in a parallel position to each other and mark for the holes and drill. Tack the feet pieces together, place the pipe over the rebar and weld the pipe to the feet, use a level to get it plumb. Weld the bottom "eye" piece to the top of the pipe, rivet the top "eye" piece to the other and slip the "T" support bar into place.

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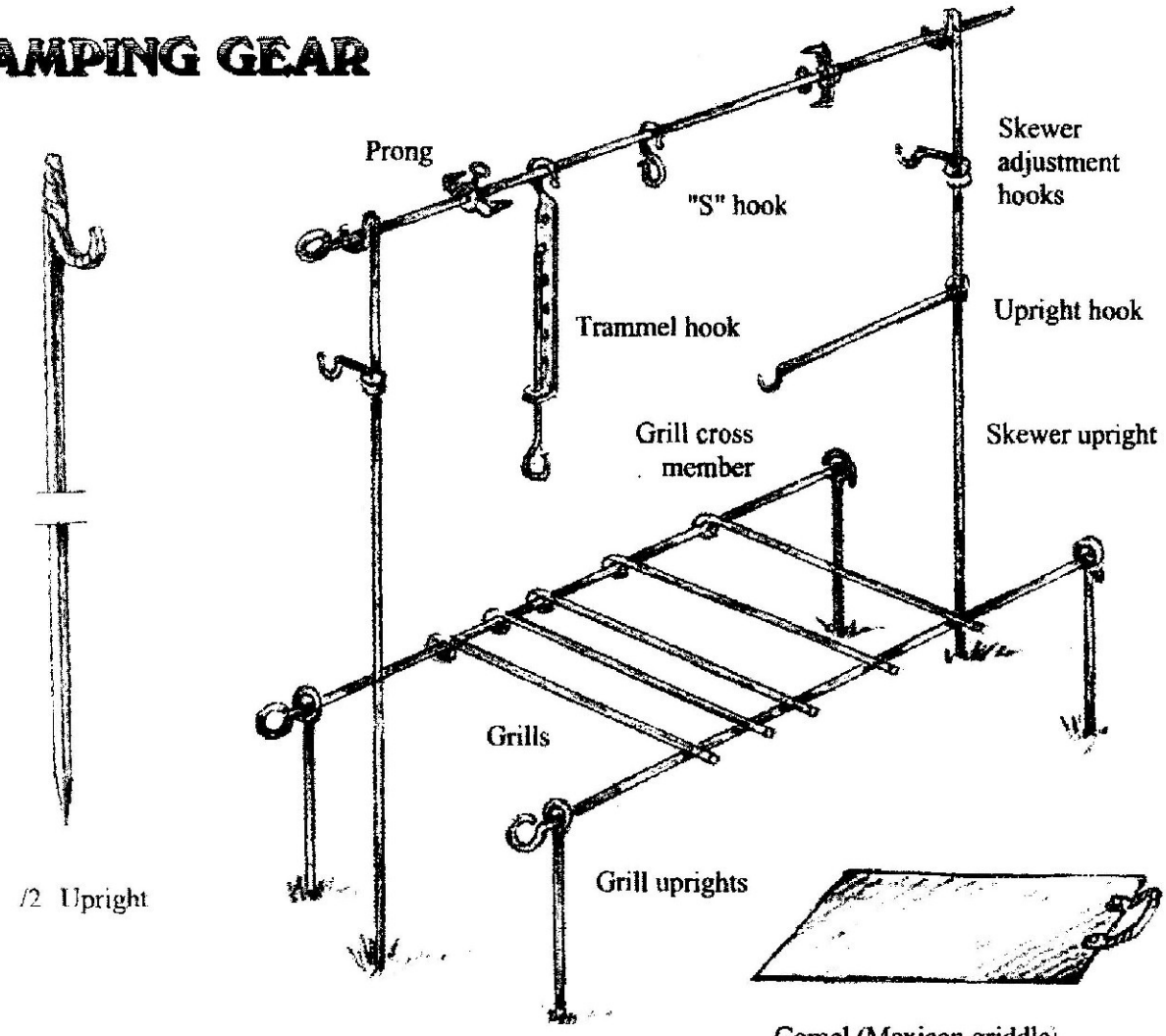
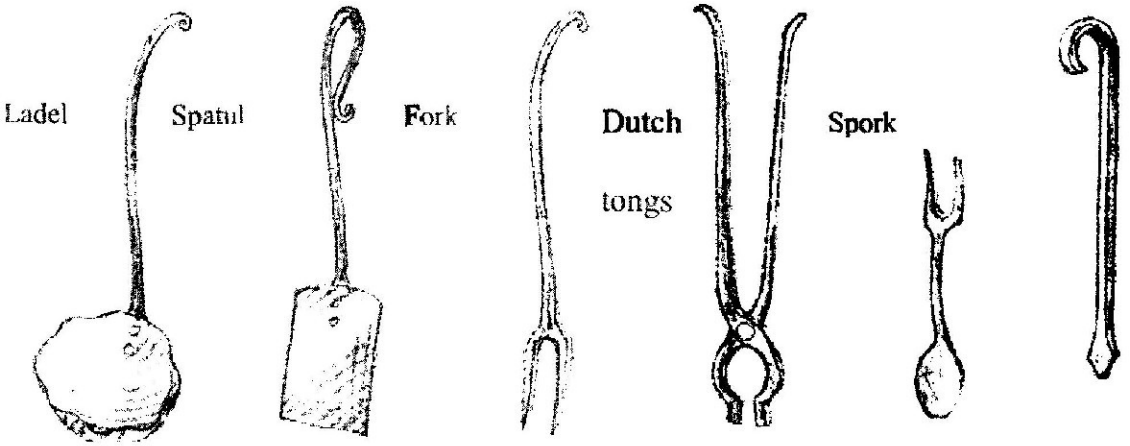
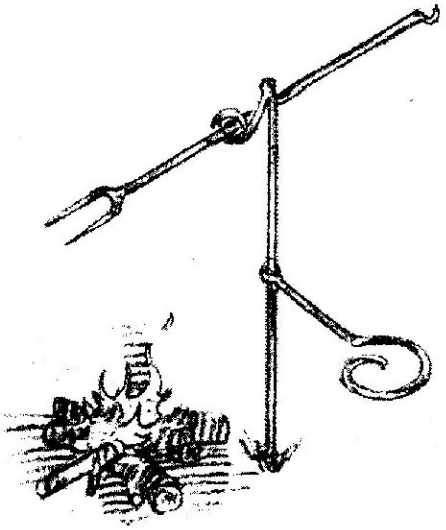
CAMPING GEAR



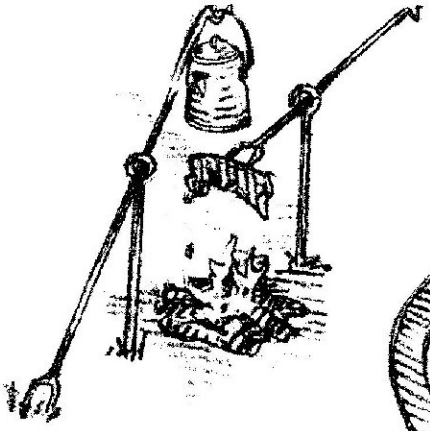


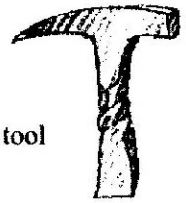
Originally appeared in The Hammer's Blow, Winter 1993/94

Packers small camp kit

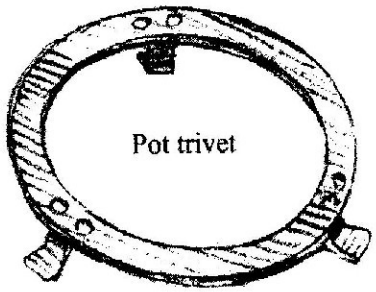


Squirrel cooker



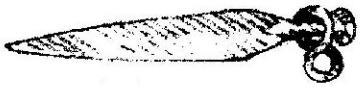


Musket tool

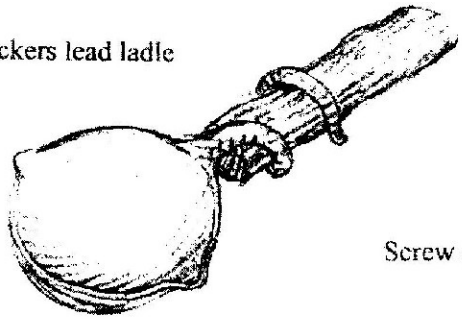


Pot trivet

Cavalry
picket pin



Packers lead ladle



Screw driver

Trammels

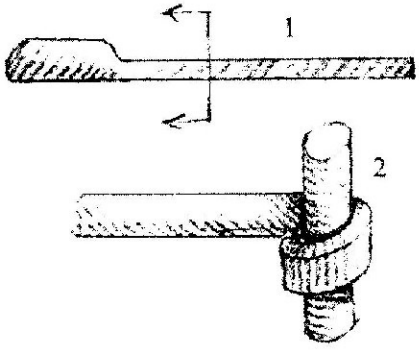
3/16"x 1 1/4"

3/16"x 3/4"

3/16"x 1"

1/4" Round

Making bar locks for skewer adjustment, and upright hooks. Wrap drawn end of hook (1) around ½ upright (2).



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May/June 2002

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We want to encourage all to join us at:

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(631) 265-1564 Ronsforge@aol.com

If any members have a forge at home and work in the evenings or weekends and want to open it up to help a few local guys, let me know, Larry Brown, editor, as we get requests from members who have a hard time traveling to some of the open forge locations.

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The Ashokan campus is located in Olivebridge, N.Y., several miles west of Kingston, N.Y. The meets are held the first weekend in May and in the first weekend in October every year. The main demonstration is in the blacksmith shop and there is a "Hands On" workshop for beginners. A main demonstrator is brought in for each meet, food and bunk-house style lodging are provided as part of the cost of the weekend long meet.

Contact : Tim Neu
to register for hammer-ins
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Membership is from *Jan. 1 — Dec. 31*

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Staten Island, New York 10308
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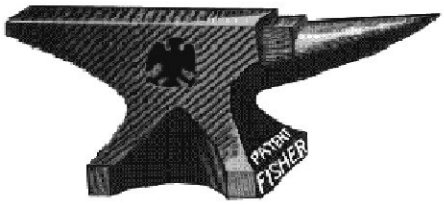
New Jersey Blacksmiths Association



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Volume 12, #1
05/01/07

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