2 The Legendary Steel of Damascus
   Part two of the definitive study of the mystical metal by Wallace M. Yater.

14 Forging the Chain
   A detailed account of the event that forge-welded a link between the past and the future by Jack Andrews.

22 ABANA Showcase
   Recent ironwork from the members of ABANA.

26 Wrought Metalwork, 4
   The fourth in our printed series by Bernard Heatherly, a master smith from the Yellin shop.

30 Whitaker at Salado — 1982
   The second in a series of articles by George Holliday and Roy Bellows detailing the design, forging and installation of a staircase railing at this Whitaker workshop.

35 Diderot Translation
   The tenth in a series by James L. Kirkland.

36 ABANA Update

38 Letters

42 Coming Events

48 ABANA's Birthday

Cover: Cross-section of a wootz cake that has been polished and etched to reveal the structure magnified 5X (late nineteenth century). Originally from the Royal School of Mines, London, it appeared in Dr. Cyril Stanley Smith's A History of Metallography.
The ANVIL'S RING is the official publication of the Artist-Blacksmiths' Association of North America (ABANA), and is mailed to members on a quarterly basis in Spring, Summer, Fall and Winter. Membership is available to any individual or organization interested in the art of blacksmithing. All editorially related material, such as articles, book reviews, queries, tips, announcement of activities, ads, etc., should be addressed to The Anvil's Ring, P.O. Box 212, Morgantown, W. Virginia 26505.

Matters related only to membership and subscription, including dues, change of address and subscription complaints, should be addressed to Dr. Carl VanArnam, ABANA Sec-Treas., P.O. Box 1191, Gainesville, Florida 32602.

All other inquiries and correspondence should be addressed to Jack Brubaker, ABANA President, RR2 Box 102A, Nashville, Indiana 97448.

Back issues through December 1976 can be obtained from the Florida address for the amount of $8.00 per issue. Membership applications appear elsewhere in this issue. The Anvil's Ring © 1983; the contents of this publication may not be reproduced either in whole or in part without the permission of the editor or the individual contributor. Contributors retain all copyright privileges; the material is copyrighted solely for their protection.

ADVERTISING RATES: Advertising will be accepted under the following rates & conditions:

Ads placed for a full year's run, i.e., for four consecutive issues, will receive a 10% discount. Closing dates for ads will be TWO months before time of issue (e.g., closing date for the Fall issue will be mid-Summer). Issues will be published in Spring, Summer, Fall and Winter. Checks for space must accompany each order payable to "The Artist-Blacksmith's Association of North America." Inquiries regarding advertising may be sent to: THE ANVIL'S RING, P.O. Box 212, Morgantown, W. Virginia 26505.

PLEASE NOTE AD SIZES.

$300  full page ad 7 3/4 x 9 3/4";
160  1/2 page ad (horiz.) 4 1/4 x 7 3/4";
      (vert.) 3 3/4 x 9 3/4";
85  1/4 page ad 3 3/4 x 4 3/4" (vert.);
45  1/8 page ad 2 1/4 x 3 1/4" (horiz.).

A Late Spring

At some point, after having read every article and scanned every photograph at least a dozen times to scrutinize the minutest details, you have no doubt noticed that this issue is numbered as the Summer issue and that you didn’t receive your Spring issue. Searching for an answer to this dilemma, you have no doubt arrived at the one page that gets no more than a fleeting glance as our famished readers devour the rest of the issue: the editor's column.

Lay your fears to rest, your Spring issue was not disintegrated by the Post Office. The Spring issue will be a Special Edition and is currently in production. I won’t divulge its content, but I will promise you a blacksmith’s treasure.
The Legendary Steel of Damascus

Part II

How it was made in the East

The previous discussion of pattern-welded blades, crusaders, Romans, Gauls and bloomery furnaces was an introduction to both the subject and the purpose of this article — the making of the original Damascus steel and the clearing up of the confusion between true Damascus and the pattern-welded variety.
by Wallace M. Yater

Indipendently or possibly even before the bloomery process was discovered in the Middle East, a very different steel making method was developed in the isolated vastness of the Eurasian continent. It took place in India and involved the making of steel sealed in clay crucibles, protected from the difficulty to control atmosphere of the furnace. This steel was known as wootz to English explorers and traders of the 18th and 19th centuries. This name was once attributed to the native Telinga Language, but is now believed to have resulted from the same kind of misunderstanding that led Captain Cook to derive the word kangaroo from the native Australians. A much older, more widely used and perhaps better name is the Persian poulad jaucharder (literally waved steel) from which the Arab term fulad and the Russian bulat were derived. These last three names were well established in reference literature by the end of the 15th century. Marco Polo’s term, ondanieque, is now believed to be derived from the Persian hunadvani meaning Indian steel. The name Damascus steel came from its principal point of trade in Syria. Its adoption in western Europe reflects the degree of isolation and ignorance prevailing at a time when China and India existed only as a hazy notion between fable and unsupportable bits of hearsay.

In truth, India was one of the most important iron and steel making centers of the ancient world and for most of recorded history, the only source of “Damascus” steel. The antiquity, number and volume of old ore workings and slag heaps give ample testimony to this: as do the great iron pillar of Delhi (after which that city was named), the 24 ft. long wrought iron cannon at Nurwur, the massive iron girders at Puri and other very large works dating from around the fourth century A.D. Remarkably, the size and weight of these have only recently been matched by modern industry.

Many writers believe the art of making wootz or bulat to be far older still. Fragments of weapons from the tombs of Wuri-Goan in central India are thought to date from around 500 B.C. Roman historian, Quintus Curtius, mentions a present of 100 talents (about thirty pounds) of steel given to Alexander of Macedon by the Indian King Porus, whose country had been invaded around the year 326 B.C. Such steel had to be special indeed to be a worthy peace offering to the then conqueror of the world and be noteworthy enough to receive attention from the writers of history.

Another remarkable fact about Indian steel is that for possibly as long as 2000 years, it was known and traded throughout the old world, though its true point of manufacture was often unknown. Traders and travelers could freely watch it being made, yet every attempt to duplicate it failed until the advent of modern science in 19th century Europe. However, before the ancient process could become widely understood and properly appreciated, European steel technology began making spectacular advances in the quite different direction of alloy steels. This took attention from the old process, even in India, where it rapidly fell into oblivion as too inefficient. Much later, when curiosity and interest began to revive about those strangely marked old sword blades, people began to appreciate how illusive this old process could be.

This difficulty of duplicating the process is illustrated by a quote from Dr. Voysey’s manuscript in the June 1832 Journal of the Royal Asiatic Society of Bengal, published in Calcutta after he had made repeated visits to Kona Samundram (Corner of the Sea), 12 miles south of Godaveri and 25 miles from Nirmal, and made personal inspections of the process.

The export of the metal to Persia must be profitable, as it is sufficient to bring dealers from that country and to defray the cost and risk of traveling. We found at the village, in 1820; Haji Hosyn, engaged in the speculation; and it must have answered his purpose, as he was here again in 1823, having returned in the interval to Persia and disposed of the venture. He informed us that the place and the process are both familiar to the Persians, and that they have attempted to imitate the latter without success. Besides residing at the village, he bore a personal part in the operation, weighing the proportions of the iron, and testing the toughness of the steel himself.

This profitability in spite of the fact that . . .

The cost of this steel is much enhanced by the exacting of the Jaghirdar (tax collector), who not infrequently appropriates the advance to himself and leaves the purchaser still to incur the whole expense.

In addition to Dr. Voysey, four other writer-travelers give brief glimpses of two different kinds of ancient Indian steel furnaces. Missing information and a few inconsistencies between them necessitated a prolonged investigation that has been the cause of the long delay between parts one and two of this work. Confusion, speculation and the inadvertent interjection of preconceived ideas on the part of many later writers have greatly compounded this problem.

The two best descriptions have been given by Dr. Francis Buchanan, M.D. in his A Journey From Madras through Mysore, Canara and Malabar 1807 and Ananda K. Coomaraswamy in his Medieval Sinhalese Art 1908. These will be quoted here in their entirety with reinforcing or clarifying bits and pieces from the descriptions given by Dr. Benjamin Heyne, M.D. in his Tracts Historical and Statistical on India 1814 and Josiah Marshall Heath’s “On Indian Iron and Steel”, Madras Journal of Literature and Science, Vol. XI 1840 and reappearing in David Mushel’s Papers on Iron and Steel, Practical and Experimental, London, 1840.

After making a very good description of a bloomery furnace and a bloom reheating forge, Dr. Buchanan describes a furnace used for making . . .
Figure 4 The only known drawing of this type of furnace is from Dr. Francis Buchanan's 1807 A Journey from Madras through Mysore, Camara and Malabar. Lettered parts are described in the text. With a little effort, the three-dimensional set up can be constructed "in the minds eye" from this drawing. It is a production facility for firing a number of crucibles at one time and is considered the most accurate existing description of such a steel furnace.

Figure 5 A three-dimensional sketch based on Dr. Buchanan's original drawing with labeling letters enlarged. The dome or arch of crucibles (14 plus one empty) would be completely invisible under a pile of burning charcoal. The empty crucible (n) would occasionally be removed to keep the fireplace (c) filled with burning charcoal. The tuyere (g), fireplace (c) and horizontal ashpit (b) are all below ground level (d). The bellows are shown slightly smaller in scale to give the hearth greater clarity.
draw out when he pleases, and throw fuel into the fire-place. The fuel used is charcoal prepared from any kind of tree that grows in the country, except the Ficus Bengaliensis and the Chloroxylon Dupoda of my manuscripts. The fire-place being filled with charcoal and the arch of crucibles being covered with the same fuel, the bellows are paled for four hours, when the operation is completed.

As for the amount of fuel used, Dr. Buchanan, while visiting a similar furnace near Savana-durga...

They (the dome of crucibles) are covered with two bushels of charcoal, and burned for six hours; a third bushel of charcoal having been added, as the former two were consumed.

Back at his first operation...

A new arch is then constructed, and the work goes on night and day, five sets of fourteen crucibles each being converted into steel. When the crucibles are opened, the steel is found melted into a button, with evident marks on its superior surface of a tendency to crystallization; which shows clearly that it has undergone a complete fusion. It is surrounded by some vitrified matter, proceeding from the impurities of the iron, and probably nearly equal to the quantity of carbon absorbed from the sticks and leaves shut up in the crucibles; for the steel in each crucible is by the workman reckoned to weigh 1½ seer. These buttons, however, are never sold by weight and those that I tried weighed very little more than one seer of 24 rupees. In some crucibles the fusion is not complete, in which case, the steel is of a very inferior quality, and differs but little from common iron.

I might add that intense fire must be maintained both above and below the arch of crucibles in order that the very high temperatures around 2400°F can be maintained long enough to thoroughly melt the iron. This would require that the empty crucible (n) be lifted often to replenish the fuel below, but not so often that frequent disturbances of the fire would cause heat loss. This is no doubt a matter of skill and experience on the part of the workman. It is also possible that a travel weary Dr. Buchanan might have missed a few bushels of charcoal as they went onto the fire.

Ananda Coomaraswamy in his Mediaeval Sinhalese Art, 1908 gives a description of a perhaps more primitive type of steel furnace which had fallen into disuse and was nearly forgotten by his time.

At present the industry survives only near Balangoda, where a certain amount of iron is made as a service rent, and where there still live two very old men who understand the method of conversion into steel. With these two men the latter craft will become a thing entirely of the past. One can hardly help regretting the decay of so ancient and interesting a craft; for comparatively little of the European iron is of the fine quality of Indian.

After describing an ore smelting furnace Mr. Coomaraswamy says:

The manufacture of steel, even as a service rent is quite extinct; but two very old men at Alutnuvara still keep up the tradition, and are able to demonstrate the process when required; with these men a knowledge of the process will be gone, so that a record of
mud walls

six crucibles in charcoal
their methods is of much value. The steel makers are smiths (navandannō) thus of much higher cast than the yamannu from whom they buy the iron required. The process of steel making is more delicate than that above described (iron). The furnace, (photo in Fig. 6 and shown in plan in Fig. 7) is smaller and at the ground level, instead of being raised three feet above the ground; it is a semi-circular hearth filled with charcoal, into which air is conducted from the bellows, which are identical with those of the iron furnace. The hearth is defined by a low clay wall, rising about six inches above the ground. The steel is made in crucibles, each about eight inches long, two inches in diameter, and a quarter of an inch in thickness. Into the crucible is put a piece of iron, with some chips of ranavard (cassia auriculata); in the proportion of 12½ ounces of iron to five ounces of wood in the case examined. The crucible is covered with a lid having smaller holes pierced for the escape of gas; six crucibles, thus prepared are embedded in the charcoal and a fire started. Very soon the gases burn off, and while this goes on the blowing is stopped. Then the blast is kept up continuously, while the tubes are turned about and more charcoal added, the great object being to keep up a constant and even distribution of heat. When the steel is likely to be ready, a hole is opened in the front part of the hearth, so that the blast goes right through the furnace, and the tubes are lifted up one by one in long iron tongs and shaken to see if the steel is quite liquid. Any which are not quite ready are returned to the furnace for a time. The others are laid down to cool and subsequently broken open and the bar of steel removed. The steel is highly crystalline, and is used for the best cutting tools. The bars which weigh from 12 to 15 ounces are worth from 75 cents to a rupee each. A specimen of the steel has been analyzed at the Imperial Institute, London, with the following results:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>99.77%</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.00%</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.07%</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.07%</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.08%</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.02%</td>
</tr>
<tr>
<td>Carbon (combined)</td>
<td>1.97%</td>
</tr>
</tbody>
</table>

The steel is thus very free from sulphur and phosphorus and very high in carbon. It is stated to resemble somewhat the older forms of Sheffield tool steel which, however, seldom contained more than 1.5% of carbon. The high percentage of carbon is characteristic and interesting, for it has been pointed out by Ritter Cecil von Schwarz that “it is well known by every manufacturer of crucible steel how difficult it is to get the exact degree of hardness to suit certain purposes, especially with reference to the steel for cutting blades etc. With the ordinary (European) process endeavor are made to reach the required degree of hardness by selecting such raw materials as on an average have the required contents of carbon in order to correspond with the required hardness as far as possible. The natives of India reached this degree by introducing into their cast steel an excess of carbon, and by taking this excess gradually away afterwards, by means of the slow tempering process, having it thus completely in their power to attain the exact degree of hardness by interrupting this decarburizing process exactly at the proper time in order to cast steel of a quality exactly suitable for the purpose.”

Mr. Schwarz's statements on controlled decarburization are quite correct. However, his description of the process where the molten iron in the crucible is cooled down with the furnace and decarburized at a dull red heat has led generations of scientists as well as craftsmen completely astray. Mr. Schwarz got his description from “some old records” not first hand, even though it was represented as such by later writers repeating it. Mr. Coomaraswamy's two old men didn't cool their crucibles down with any furnace. They took them out, sloshed the molten metal...
Figure 8 The line ABCDEFFG traces the path on the iron-carbon equilibrium diagram taken by a piece of wrought iron as it is converted into a wootz cake. At A the loaded crucible has been brought up to the maximum obtainable temperature of a charcoal fire. After a four to 24 hour (Buchanan gives four, Heyne six, Voysey 24) cementation-melting heat the iron has absorbed enough carbon or carburetted hydrogen gas from the woodchips to melt. At B the smith shakes the crucible with a pair of tongs, detects the sloshing of molten metal and lays the crucible on the ground to cool fast enough to assure the formation of white cast iron instead of gray. At C the crucible is broken off, the cake cleaned and given a protective coating of clay and ore powder. It is then brought back up to D for decarburization as near as possible to the melting point without the danger of actually melting it. After a couple of hours (Heath), 12 to 16 (Voysey), at D it is again cooled rapidly in air, though not excluding the possibility of oil or other media that would not harden the pearlite. It is then checked for hardness at E. If it is still glassy hard, the clay-ore glaze would be renewed and it would be given one to three more high temperature decarburization heats at F until it is found at G sufficiently soft for further working. It is during the last rapid cooling from F to G in the zone of secondary crystallization, S, that the damask forms in a supercooled supersaturated solid solution.

One other comment, if you tried to decarburize this steel at a dull red heat, the reaction would proceed far too slowly to be of any practical value.

As a point of comparison, a white (chilled) cast iron with 3% carbon and 1% silicon is annealed around 1600°F (Guy) to make modern industrial malleable cast iron.
every part of the iron-carbon equilibrium diagram and the very fragmentary real knowledge we have of the ancient Indian process, only one possible way of reconstructing it can be found that satisfies all the requirements. In figure 8 the line ABCDEFF' and G traces the path on the iron-carbon equilibrium diagram of a piece of wrought iron as it is converted into a wootz cake. At A the loaded crucible has been brought up to the maximum obtainable temperature of a charcoal fire. After a four to 24 hour cementation-melting heat (Buchanan gives four, Heyne six and Voysey 24) the iron has absorbed enough carbon to melt. At point B the smith shakes the crucible with a pair of tongs, detects the sloshing of molten metal and lays it on the ground to cool. Heyne even adds:

The crucibles are then removed from the furnace, ranged in rows on moistened mud and water is thrown on them whilst yet hot. The steel is found in conical pieces at the bottom of the crucibles, the form of which it has taken. The upper or broader surface often striated from the centre to the circumference.

The point of this fast cooling being to produce white cast iron instead of gray.

At point C, Mr. Schwarz may be more reliable.

The cakes are carefully cleaned from adhering slag etc. and dipped into a mixture of iron and manganese ore powder with clay water, then dried.

This would glaze the cakes and protect them from the scaling heat of the fire. The unreduced ore would help draw unwanted carbon out of the cakes. At D the coated cake is brought back to as near as the melting point as possible without the risk of actually melting it. It is kept there for several hours (Health) or 12 to 16 hours (Voysey), removed from the furnace and allowed to cool rapidly enough to avoid producing any graphite (a crystalline form of pure carbon found in cast iron), though this becomes less of a threat as decarbonization progresses. At E, the cold chisel or hammer test indicates to the smith that the cake is still too glassy hard to be used. The clay and ore glaze is renewed and the cake is again brought back up to high temperature at F. After a somewhat shorter heat, at the point F', the smith doesn't really know if the cake is ready yet, but he wants to check it in order to find out. He most likely still cools it fast in air, as other methods would have probably attracted the attention of early observers. However, this time at point G, the hammer or even a hard cake dents the cake. He hands it to Haji Hosyn who verifies for himself; a transaction is made, and the cake begins its long journey from India to Persia. Dr. Voysey and J. M. Heath vary from a couple of hours to 16 for the decarbonization heats. With my limited experience with charcoal fires and laborious hand methods, I would speculate that the first heat at D could have been that long (16 hours) and that subsequent ones at F would have been progressively shorter as the smith knew the hardness was getting close.

Now the big stumbling block. If you keep cooling the cake fast (water or oil could have been possibilities as long as they didn't harden or crack it) how can you possibly get any crystalline structures big enough to be visible to the naked eye? Everyone knows you have to have slow cooling, but nature has a surprise. The damask forms fast in a supercooled supersaturated solid solution. However, your first instinct about needing big crystals is not too far off the right track. Truly enormous ones have been growing during all those prolonged, high temperature decarbonization heats. Figure 9 (cover photo) is the cross section of a wootz cake from Dr. Cyril Stanley Smith's A History of Metallography. All those areas covered by parallel squares or triangles

around and laid them on the ground. That tiny mud walled structure would be hard pressed to hold a red heat for ten or 15 minutes! Then, just how did they decarburize it? If you peel away 150 years of guessing, speculation and copying misinformation, you come up with the tiniest fragments that give the meagerest hints as to what any first hand observer saw of this critical part of the process.

Dr. Voysey says that:

The mixture (iron, wood chips and leaves) being put into the crucible, the fire is excited for 24 hours. It is then allowed to subside, and the crucible is taken out and placed on the ground to cool. When quite cold it is opened and a cake of steel of great hardness is found, weighing on an average about a pound and a half. The cake is covered with clay, and annealed in the furnace for 12 to 16 hours. It is then taken out, cooled (no one really tells us how) and repeated a third or fourth time until the metal is rendered sufficiently soft to be worked.

It is Mr. Heath's article in the Madras Journal that provides the definitive clue for the reconstruction of the entire process.

The natives prepare the cakes of steel for being drawn into bars by annealing them for several hours in a charcoal fire, actuated by bellows, the current of air from which is made to play upon the cakes while turned over before it at a heat just short of that sufficient to melt them. It appears from this, that in order to ensure fusion of the contents of the crucibles, it is found necessary to employ a larger dose of carbon than is required to form the hardest steel, and that this excess is afterwards got rid of by annealing the cakes before a current of air at a high heat, the oxygen of the air combining with and carrying off the excess of carbon in gaseous form: without this operation none of the cakes would stand drawing into bars without breaking.

From what we know about the behavior of iron and steel at

Summer 1983
Figure 9 (cover photo) Cross-section of a woolz cake that has been polished and etched to reveal the structure magnified 5X (late nineteenth century). Originally from the Royal School of Mines, London. It appeared in Dr. Cyril Stanley Smith's A History of Metallography.

Dark areas are pearlite that formed first out of supercooled solid solution. This makes grain boundaries very hard to see, especially between grains with nearly parallel orientation. Light areas are cementite (iron carbide) that formed last by carbon that was forced into leftover spaces. Had this cake cooled slowly, wide bands of cementite would appear along the grain boundaries making them appear bright. In such a large grain structure this would present considerable forging difficulties.

Figure 10 A tracing of the more easily made out grain boundaries in the woolz cake. All those areas covered by sets of parallel squares or triangles are single primary crystals. On the left hand side, grains numbered 1, 2 and 3 are especially large and distinct. Number 1 is almost as long as half the width of the cake.

Figure 11 All the different squares and triangles on the woolz cake in Figure 10 represent the same cubic structure cut in different ways. The cubic lattice is parallel to the axes of crystallization of the original parent austinite grain. The cut in (a) is nearly parallel to a face of the cube intersecting only two layers visible as wide shadowy bands; that in (b) produces equilateral triangles with lines equally heavy in all three directions; along an edge (c) produces a prominent series of V's. This structure, when flattened under the hammer, is the "damask."

Item (d) is a filled and sealed crucible ready for the furnace. Small holes in the top relieve gas pressure — Coomaraswamy. A green leaf on top of the wood chips keeps the soft clay top from being pressed into the wood. wrought iron is in rectangular pieces because it has been hammered to drive out most of the slag.

the Anvil's Ring
are single primary crystals or grains. Figure 10 is a tracing of the more easily made out grain boundaries. Grains numbered 1, 2 and 3 are especially large and distinct. Number 1 is almost as large as half the width of the cake.

From figures 9 and 10, can we tell anything about how fast the cake cooled: At high temperature, point F' in figure 8, all the unwanted carbon had been expelled and none was coming in. The iron and carbon were in equilibrium. If you could look at the crystals in this intense white heat you would see no internal details. They would be pure austinite or gamma iron. That diagonal line just below point F' tells you that as the iron cools it wants to get rid of more and more carbon. If the iron or now steel cools slowly, the carbon has time to move out of the crystals and collect along the boundaries between them as cementite (Fe₃C) or iron carbide since this phase is more stable at these high temperatures. This would cause all the grain boundaries traced in figure 10 to show up as wide bright white bands, but they don’t. They’re so dark, only changes in the series of parallel squares and triangles tell you where they are.

On the other hand, if the cake cools fast, the carbon atoms don’t have time to move very far. Something else happens too, at the lower temperature 83% carbon eutectoid phase becomes very stable. It wants to form first and dominate the reaction. It now forms along the grain boundaries making them almost invisible. Since nothing can move very far, it also forms along a series of planes parallel to the axis of the original austinite grain. At the last moment, the unwanted carbon forms cementite in all of the vacant places between these planes, making them visible as parallel triangles and squares in figure 9.

Cementite is extremely hard and brittle. If you put a pea sized crystal of it on the anvil and struck it with the hammer, it would shatter like glass, leaving a dent in both hammer and anvil. It would be better to fast cool and have little bits of it scattered throughout the cake than to slow cool and have large bits accumulate in a smaller number of places like the grain boundaries.

Figure 11 illustrates how the different squares and triangles that appear on the wootz cake in figure 9 are really the same cube cut at different angles. Only those along the edge of the cake want to put sides parallel to it. The rest are randomly orien-

tated. It is these cubes, that when flattened, will form the damask. Only their size will determine if the damask is coarse or very fine. Naturally, if the cooling were very fast, carbon atoms wouldn’t have time to move very far and a very fine damask would be produced.

This method of making steel by the controlled decarburization of white cast iron puts severe limits on the size of the piece that can be made (Buchanan — 9.7 to 14 ounces; Voysey — a pound to a pound and a half). If you got too ambitious and tried to make too big a piece, you couldn’t cool it fast enough. It would become gray iron, frustrating the process. If you made it too small, it would cool too fast. You would need a microscope to see the damask; otherwise, it would be quite good.

There was one feature about the process in which all the old records were surprisingly clear and consistent. The ancient Hindu smith never put bits of charcoal into his crucibles to carburize the steel. He used wood chips and usually a green leaf. Not just any species either, it was always Cassia auriculata wood and a convolvulus or calatropis leaf. About this, Shamsul Ullama Syed Ali Bilgrami says in his “Iron Industry in the Territory of His Highness the Nizam of Hyderabad Deccan,” Journal of the Iron and Steel Institute, Vol. LV, 1899:

Reference has already been made to the Hyderabad steel and the manufacture of the famous Damascus blades from it. Steel is made in the usual way by the carburisation of wrought iron in earthen crucibles. The wood used is a species of cassis, very common in the country, and known as Cassia tora, and the leaves are those of Calatropis Gigantea. The genus calatropis has played an important part in the religious, industrial and political history of the East. One of its species, the famous soma plant, was the chief ingredient from which the well-known exhilarating beverage was made which the priests, both of the Hindus and the Parsees, used so largely in their sacrifices, and under the influences of which they saw things unseen by human eye (hallucinations). A whole book of the Rig-Veda and many hymns of the Zendavesta have been devoted to a description of the virtues of this sacred plant; and so important is the question of its habitat in relation to the early home of the Aryans, that full descriptions of the shrub were furnished to the Algin Boundary Commissions whose labours lay in the region assigned by the early school of German Orientalists to the original settlement of the Indo-Germanic races. The species gigantea, still highly valued for its numerous medicinal properties, has helped to manufacture the renowned Indian steel — the endanique of Marco Polo which supplied many a true blade girded by Asiatic conquerors of yore, and may be said to have overthrown dynasties and established empires.

That this “medicine” may very well have had an effect on the steel is indicated by the following paragraphs from David Mushet’s Papers on Iron and Steel Practical and Experimental:

In the year 1825 Mr. Charles Mackintosh (of raincoat fame) took out a patent for converting iron into steel by exposing it to the action of carburetted hydrogen gas in a closed vessel, at a very high temperature, by which means the process of conversion (cementation) is completed in a few hours, while by the old method, it was the work of from 14 to 20 days.
Now it appears to me that the Indian process combines the principles of both the above described methods (Modern lawyers would use this kind of argument to break Mr. Mackintosh's patent). On elevating the temperature of the crucible containing pure iron, and dry wood, and green leaves, an abundant evolution of carburated hydrogen gas would take place from the vegetable matter, and as its escape would be prevented by the luting (clay seal) at the mouth of the crucible, it would be retained in contact with the iron, which, at a high temperature, appear from Mr. Mackintosh's process to have a much greater affinity for gaseous than for carbon; this would greatly shorten the operation, and probably at a much lower temperature than were the iron in contact with charcoal powder. In no other way can I account for the fact that iron is converted into cast steel by the natives of India, in two hours and a half, with an application of heat, that, in this country, would be considered quite inadequate to produce such an effect; while at Sheffield it requires at least four hours to melt blistered steel in wind-furnaces of the best construction, although the crucibles in which the steel is melted, are at a white heat when the metal is put into them, and in the Indian process, the crucibles are put into the furnace quite cold.

We modern smiths now know that the source of carbon in steel is completely immaterial as long as undesirable impurities are not introduced with it. However, this convenience to the Hindu smith may have been exacting a price. Even in David Mushet's day (circa 1840) Europeans were beginning to lose interest in Indian steel. Maybe they couldn't get their swords as sharp, but when they struck a hard blow to the helmet of the enemy their swords were less likely to break. In other words, the price paid for this easier, faster carburization with the aid of "carburated hydrogen gas" may very well have been the hydrogen embrittlement familiar to arc welders whose rod of choice is low hydrogen D.C.

On getting started

If my explanations have been clear enough, this whole process should not be too very difficult to understand and apply in the shop. If you wish to simulate the various steps of the original process and make reproductions as close as possible to the old, I might be able to offer a few pointers on getting started. Put out of sight and out of mind your pyrometer, coke fire, power hammer and preconceived ideas. You will be working with a(n) new (old) material with very strange properties indeed. About getting good clay, Francis Buchanan says:

Good clay is mixed with an equal quantity of the charcoal that is made from Paddy husks, and having been well moistened with water, is thoroughly mixed, by being trodden under the feet of oxen. It is then picked clean, and made into tanks, which are dried one day in the shade, and the next day in the sun.

In addition to this you will need a few simple hand tools, a lot of most any old wood that can be made into charcoal and any convenient source of wind that is easily controllable. You don't really need to cast an eye on the ox for this though. He'll need his hide to mix the next batch of clay. Most important of all, try to think like an ancient Hindu smith.

Go out and take a good look at your scrap pile. Save plenty of rust. This will make a good ore powder. All those old broken bullet points, pieces of mild steel, long dead automobile parts and other steel of recent manufacture might contain too much silicon. This promotes the conversion of white cast iron into gray by the reaction \( \text{Fe}_2 \text{C} + \text{Si} \rightarrow 2 \text{Fe} + 2 \text{C} \). Graphite, which is just what we want to prevent. Hunt up an old buggy axle, wagon tire or other piece of genuine wrought iron. If you have doubt about a particular piece, break it. A flibber break, almost like broken wood, is the right stuff. Take it to a machine shop, have it cut up into a bunch of coarse shavings and hammer these into a compact mass. This should simulate quite well a piece of poorly consolidated bloomer wrought iron. The ancient smith's problem was to get slag (calcium silicate) out of his iron; with our refined wrought iron we might have to put a little more in. A pebble of limestone road mettle or a bit of pulverized common glass should help flux and protect the iron. Limestone will bubble in acid or turn into a greasy white lump — lime in the fire. References to adding a bit of kank or glassy slag exist, but are unusual. Ancient iron workers almost never appreciated the value of limestone and it is mentioned nowhere in the literature on ancient Indian iron or steel. If you get a little tar in with the road mettle, it will feel right at home with the green leaves and wood chips (any will do) forming "carburated hydrogen gas."

The clay of which the crucible is made is of potential importance. To some extent it will enter into the fluxing reaction and to a lesser degree into the steel itself. Manipulation of these reactions is central to any modern steel-making operation. Most clays are a mixture of silica (\( \text{SiO}_2 \)) and alumina (\( \text{Al}_2 \text{O}_3 \)); smaller amounts of potassium oxide (\( \text{K}_2 \text{O} \)), sodium oxide (\( \text{Na}_2 \text{O} \)) and iron oxide (\( \text{FeO}, \text{Fe}_2 \text{O}_3 \)); and really small amounts of trace elements — among them only metal sulfides and phosphorous pentoxide (\( \text{P}_2 \text{O}_5 \)) are of any possible importance here. Clays are derived from the decomposition or weathering of rocks. Heyne mentions the natives using a clay derived from rotten granite, a rock with typical composition: 72% \( \text{SiO}_2 \), 15% \( \text{Al}_2 \text{O}_3 \), 5% \( \text{K}_2 \text{O} \), 3% \( \text{Na}_2 \text{O} \) and 1% \( \text{FeO} \). This composition is altered somewhat during the weathering process as some components would leach away in rain water faster than others. Tropical climates tend to produce more refractory clays richer in alumina.

Most clays contain plenty of silica. As the molten metal slowly erodes its container, there would be a tendency for the reaction \( \text{SiO}_2 + 2\text{C} \rightarrow 2\text{CO} + \text{Si} \) (alloy silicon) to slowly occur. We can retard this by adding limestone, which will tend to draw the silica into the slag, an indefinite glassy mixture of calcium and silicon oxides. However, our crucibles are going to be in contact with molten metal for such a short time, problems of this kind are unlikely. This should be kept in mind any time concern develops over "clay troubles", especially the kind where the crucible would erode from the inside and the metal seem contaminated.

In parts of India where clays are not available, mention is made of the natives "blurring" a red loam by mixing it with water, allowing the heavier particles to settle, pouring off the clay water and allowing the clay to settle. They then pour off the silt water which takes most of the organic matter with it.

The most important parts of this process are the temperatures of the various heats, their duration and the rate of cooling or quenching of the steel. To start a series of experiments in the right ball park I would recommend a 4 to 6 hour cementation-melting heat. That seems to be the most widely agreed upon length. About 2400°F or 1350°C is the upper limit of a sustained charcoal fire. Peaks of 2550°F or 1400°C would occur as new fuel is added and heats up. See Rao et al. where these temperatures are determined from firing products in the clay. Cool the cakes in the air for a starter. This would allow cake size to precisely control
the cooling rate. Next, try faster methods (oil or water) or slower (cooling in wood ash). Too slow and you will find cementite along the grain boundaries with no regular internal secondary crystalline structure (damask); too fast and the cakes may harden or crack. Only Heyne says anything about splashing water on hot crucibles, and his may have been larger than normal. Most important, any unusual or elaborate measures or apparatus to control cooling would most likely have attracted the attention of such observant workers as Heath and Voysey.

The duration of decarburization heats is much less critical. The same hydrogen mobility that brought carbon into the iron will bring it back out again before the heat decomposes the cementite into graphite. Any excessive duration of heat here would simply result in larger grain growth at equilibrium. Perhaps most important of all, when struggling to master a new process, a certain amount of endurance is needed in the face of frustration. Remember too, that primitive people had to struggle hard to scratch out the meagerest existence. They did everything in the fastest, easiest way they knew how.

There is one other problem. Nowhere in the literature did I find a description of the forge or furnace used to decarburize the steel. It could very well have escaped notice in the guise of primitive simplicity. It may have resembled nothing more than the simple hole in the ground forge (see figure 2 of Part I of this article in the Spring 1982 issue of the Anvil's Ring) with some type of clay bonnet or hood over it to help hold in the heat. This is more a problem in historical reconstruction than any kind of block to technique or shop procedures. With millions of books cataloged in various libraries, the most exhausting search can be but a scratch on the surface.

If you actually succeed in nursing a cake through all the steps on the iron-carbon diagram in figure 8, don't do anything further to it. Polish and etch portions of it to examine the structure and determine the relation between damask size and cooling rate. It is like no other kind of steel and has plenty of surprises which we will examine in detail in Part III, "Forging the Blade, Pattern Development and Heat Treatment".

One further comment

What I have tried to supply here is at best a rough guide, a skeleton of the process. Things are heated a couple of hours to a half a day, cooled fast or slow. Everyone who has learned to forge weld or heat treat tools knows there is a lot of latitude within each of these descriptions. One usually messes up a number of pieces before he learns to succeed with some measure of reliability and even then cannot live with the certainty that he can do it right every time.

In other words, a lot of experimentation is needed. What clay has to be treated in what way to make a crucible that won't fail apart in the fire or crack and leak? What mixture of clay and ore glaze won't fall off the cakes during decarburization? Exactly how fast does a particular size damask form on cooling? Modern theory and technique permit certain shortcuts and product improvements, but these too must be worked out experimentally.

By publishing my research I hope to inspire my fellow smiths to experiment, independently or in groups, in the actual making of wootz steel. One man could spend years on such experimentation (only possible with corporate research grants), but by working together we would have a grass roots research team that could shorten the time considerably. After all, isn't that what ABANA is really about? I look forward to reading the results of such trials efforts in future issues of the Anvil's Ring.

In acknowledgement of

A number of people have been instrumental in helping me with this project. I wish to thank Martha Goodway of the Conservation-Analytical Laboratory, Smithsonian Institution for our discussions of metallurgy both ancient and modern, and for reviewing this manuscript; Karen Presloc at the Conservation Laboratory for helping to locate all sorts of obscure and rare publications; Thorid Clark for help with some German translation; and Dr. Cyril Stanley Smith for providing a vital key, the original photograph of the wootz cake in figure 9.

As for our three year search, nowhere does the English literature describe a complete identifiable process. What bits and pieces that are here shown to fit together become more confused and obscured with the passage of time. However, in addition to the writings already discussed many of the following will provide an interesting history of the European encounter with this very strange, beautiful and enigmatic material.

References and Additional Reading


Buchanan, Dr. Francis. A Journey From Madras Through Mysore, Canara and Malabar. 1807.


Heyne, Benjamin, M.D., F.L.S. Tracts: Historical and Statistical on India. 1814.


Voysey, Dr. "Description of the Native Manufacture of Steel in Southern India." Journal of the Royal Asiatic Society, 1832, p. 245.


Summer 1983
Forging the Chain

photos and text by Jack Andrews
The First Yellin Memorial Workshop was held in Yellin’s Arch Street shop from March 6 through March 18, 1983. It was a workshop devoted to the Yellin tradition, one which would teach the processes and attitudes that he used in his shop. It was led by Francis Whitaker, who was returning to the shop after having left in 1923 for work in Germany with Schramm. So it was also a memorial to Francis, who summed up the whole workshop experience as “gemütliche stimmung.” (good feeling)

The idea for this type of workshop developed in conversations with Francis over the years. When a grant became available to develop this type of activity I immediately called Francis to see if he would lead the project. His response was a quick joyful yes and he rearranged his busy demonstration schedule. The time of the workshop was selected to coincide with the opening of the Yellin show. The important aspect of the workshop was that it was to be based on the design and making of a major piece. Enough had been done in demonstrations of the fundamentals of blacksmithing. Now was the time to move on to advanced problems of fabrication and organization.

The workshop was sponsored by Harvey Yellin, who most graciously allowed the use of the shop; the Philadelphia College of Art, who handled the registration and mailings; and the Samuel Yellin Foundation, who received a grant of $2500.00 to fund the workshop. There were 12 participants in the workshop from around the country which were selected from over 60 applicants. Fred Crist and I made the final selection of participants with suggestions from Francis. Fred was responsible for making things accessible in the shop and helping with the tooling as well as working on the project. The regular workmen in the shop under Lou Baccanero’s direction were also of great help.

The Yellin shop had only two working forges, so others had to be set up; at the same time equipment was being organized, the project itself was being planned. The size and scope of the project had to be considered for a two week project. It was decided to do a replacement for the gate in the Yellin Museum (which was to travel in the show) when it was found out that it was built in 1923 — the year that Francis worked in the shop.

Francis and Portia arrived in Philadelphia, Thursday; Francis wanted to get as well prepared as possible. Time was devoted to the layout of the gate, organization of the shop, ordering materials and forging test pieces. The smiths arrived at the shop on Sunday for the orientation. Final adjustments were made for setting up the shop as they brought in their personal equipment.

1. The gate made at the first Yellin Memorial Workshop, March, 1983 as seen at the Yellin show in Philadelphia. The open panel is for the lock, to be made at a future workshop.
2. Francis discussing some problems of fabrication around the layout table; nothing would be assumed.
3. Tom Joyce’s drawing for the repoussé panel.
4. Glenn Gilmore forging tenons with the Nazel hammer.

Summer 1983
Portia Whitaker stayed for most of the first week, but had to return to Aspen. Her comments and impressions about the activities which she wrote on her return home, follow.

It is 1983. It was Monday. It was March 7. A heavy fog was everywhere. As we left the Andrews home, Betty waved us a concerned goodbye. It would be an hour's drive. You could see the tension in Francis. Though he and Jack Andrews had been planning — planning — Friday, Saturday, and Sunday. Their entire time and minds were consumed with "The Gate." Many letters and drawings had gone between them in the mail before this.

Friday, Saturday and Sunday they had sketched pictures — drawn and redrawn the whole, the parts. They were ready.

Eleven of the young advanced smiths had checked in on Sunday. They'd had many discussions, and their work was laid out: who would build the frame — who would do which of the inner portions. They were excited. You could almost see the adrenaline flowing in each of them.

The "Log Book" was with us as we drove through the fog. This book would hold the records of many of the daily details as the work progressed.

The 5520 Arch Street Studio seemed so far away. But, since it was early, the traffic was light. Jack is a good driver, and well acquainted with the area, so, we traveled many short cuts, and though Francis and I were completely lost, we had faith in Jack.

The fog grew heavier. It was damp, cold and there seemed no let up of rain.

The outer gate of the forge was unlocked. A ring of the bell brought Fred Crist to let us in.

My little projects I had brought along to keep me busy were insignificant compared to THE PROJECT — about to begin.

Inside, it was as if the whole sky had lit up. The forges were bright. The hammers were making music on the anvils.

But, the brightest light of all was in the eyes of Francis. He was serious, though a fleeting smile crossed his face as those he was depending upon would perform well. He knew. There was no doubt.
He had trained too many of them. He knew their strength, their desire. The fire was in them, too! Tom Joyce would arrive soon, the last one, the twelfth. Francis would assign him the job of the art work that would be the space for repoussé. He was beaming.

Bob Bergman, with a great smile had set to work doing the inner designs of the quatrefoils. Those are the flower petals, or leaflets that have converging arcs.

Gary Gilmore was steady, willing and glowing in the light of his fire. His assurance was there. You could almost hear him saying: “I can do it — I can’t wait to do it!” as he also tackled the quatrefoils.

Terry Carson and Daryl Nelson were measuring and remeasuring the framework that would house the gate.

Terry might be saying, “let’s go!”

Daryl would be saying, “Slow — easy now — recheck that.”

They would be starting on the hinges after the oval-topped gate framework was complete.

John Lupton and Corky Storer were making circles of round iron that would house the quatrefoil designs. John would be giving his spark of thrill over it all to anyone near him.

Corky would stop to take a photograph now and then. You could almost hear him saying, “This is wonderful — we need a record of it.” But the picture taking didn’t deter his work on the rings.

John and Corky would also help fit the quatrefoils into their circles.

Jim Batson and Glenn Gilmore were making rosettes and button-head rivets that would hold the circles and designs and all of the intersections together.

Jim’s enthusiasm was catching for everyone near him. He was almost a wild man, his energy was going so fast. He was so happy. His wife, Barbara made herself tiny as she perched on a box behind the forge to watch — she was so proud of him.

Glenn just kept a serious pace, almost perpetual motion, a laugh here and there, though. He was happy to be near Francois.

Jeffrey Funk was building his fire quickly. His quiet, serious face said: “Let’s work. I’m ready.”

He had started on the iron collars that would be bent around the various iron pieces to hold them together.

Nol Putnam would be smiling and moving quickly. He was ready, his motions strong. He was making the cross bars and vertical bars along with Peter. Peter Happny, boyish yet serious, tried to move slowly, but the pent-up energy was showing. He was proud.

In secret, I understand that Jim Batson has an unusual touch to add to the gate — let’s hope.

And then, the best news is that a small piece of Samuel Yellin’s work will be incorporated in the gate — Harvey Yellin has agreed to it!

The beards and mustaches gave them all the look of a “motley” crew. One wouldn’t realize that there was an artist in the whole bunch. One wouldn’t know they were “Dirty Old Blacksmiths”!

Francis was clean shaven, as was Harvey Yellin, who watched as the work progressed. They were the staid gentlemen.

Jack Andrews knew every phase of the work. He had planned so long. A dream was coming true.

He knew that Samuel Yellin would be happy, too.

The inspiration for all of them left a spirit here — maybe that is what they all felt.

But, Francis was everywhere. He nodded approval here — gave a helping hand there — explaining the detail of a technique for this or that. He radiated. It was catching. You could see it in his whole countenance. Even if he didn’t say it, you heard it: “This is Great! I’ve been waiting for this!”

No fog could darken those forge fires!

Portia’s observations capture the spirit and the feeling that was a part of the workshop. The manner and process of how the work took place was distinctly Francis’. During the orientation period he established the different jobs and assigned smiths to the tasks, so there was no time lost in getting started. The overall assembly procedure was established so there was no misunderstanding of the steps in the whole project. In his notes of the workshop, he listed under Advanced Planning the
following steps:
1. Scale and full sized drawings (quatrefoils for example).
2. Complete and accurate measurements.
3. Full size layout on 16 gauge sheet so that it can be moved from the work table.
4. Develop vertical and horizontal layout stick locating all spacing, intersections, holes, hinges, lock, etc.
5. Make master frame into which all elements fit.
6. Make test pieces of various elements, quatrefoils, scrolls, collars, and decorative treatment of material.

He summed it up by saying, "Using these methods will avoid time lost in errors. All pieces were made and drilled or fitted using the master layout sticks and master frame. There was no cut and try. The parts fell into place like a jigsaw puzzle."

On some of the aspects of technique he said, "When shaping scrolls or quatrefoils, make a chalk drawing of the correct shape to use when fitting the other pieces... Bend collars to exact size, on a block with sharp corners that have been case hardened. Drive the material into the collar cold, if the collar springs open, heat the lower corner and squeeze together with tongs. Heat end from halfway mark on material being collared to white heat. Fold quickly with cross pieon using sliding blows... When forging a shape that will later be flattened or widened, like a leaf, draw a chalk image of the piece before flattening. Forge succeeding pieces to the same unflattened shape."

Some of the comments from the participants were: "Check the material for straightness after cutting... Instead of splitting the material, double back and forge weld thereby permitting making the quatrefoil out of one piece... Always check forged pieces for twist. Two or three short pieces placed on the bars allow accurate sighting for location and degree of twist... For the corner weld of the frame, cut the material short by 1/6 of the width. (1/2 for a 1/2 width) Cut the end on a 45° angle at the center line of the material. Upset the bevel and the sharp corner to the end, scar so that the scarfs face each other. Tack weld together and fire weld the corner...""

These comments and many others were recorded in the journal which was to be kept current on a regular basis after each task was completed. A most demanding task to do with all the work to be done, but a reasonable record was kept. Most of the major tasks and problems were entered in the log; it is unfortunate that all of the drawings are not clear and clean enough for reproduction, but the sketches do show the major steps of the project and some, the unique aspects of them.

During the first week of the workshop things progressed well; master fixtures were built, test forgings and tools were constructed, and the parts and pieces of the gate were being made. But everyone was a little anxious because some time had been lost with the normal amount of mistakes and the lower efficiency of the crew. On Friday 11, it was decided by all that a Saturday work day would be needed; so there was a half day on Saturday.

Back on the job during the next week saw the efficiency of the crew pick up dramatically with all aspects of the job beginning to fit together as Francis had envisioned the "jigsaw puzzle". By the middle of the week assembly was well along, and the final quatrefoils were being finished. Francis was now emphasising the visual effects of the quatrefoils saying, "Keep the central area of the quatrefoil with the same visual weight, but vary the decorative effect." Final finishing was being done on each piece prior to its being put into place for assembly.

It was now apparent that the gate would be finished ahead of schedule and another task was taken up by several of the smiths. The task of bringing up from the basement many of the old Yellin tools that had been in storage for years. Not only did the tools see daylight, but on Friday morning after all of the details had been finished on the gate, these tools were used again. It was fantastic seeing these tools forming iron like they had many years ago. This work in the shop concluded on this joyous note and was carried on to the lunch to celebrate the hanging of the gate. In typical Yellin tradition, a warm and joyous party was held to conclude another job.

During the lunches everyone told how they started in blacksmithing and why they wanted to be part of this first. All of the comments cannot be included, however, Jim Batson's statement about how he feels, as a contemporary blacksmith, expresses much of what was said. His statement was:

In America, Philadelphia is the ornamental ironwork mecca to the artist-blacksmith. He must come to Philadelphia at least once in his lifetime. First, he must see the Christ Church gates and the Congress Hall balcony made by S. Wheeler in the 1790's. Then he must see the Packard Building gates built in the 1920's by Samuel Yellin. He must feel the texture of the iron pieces at the Yellin Museum, and tread the shop floor where Yellin's white-spattered shoes once trod.

Above all, he should fire the forge, sense the heat, see the glow of the iron, feel the movement of metal between hammer and anvil... in the same surroundings where Yellin wielded his mighty hammer.

He must visualize the heritage of the past. Contemplate that fine thread of lineage, back to old Philadelphia during Wheeler's time and back even further, to the Old World where Yellin was trained. He must understand that this fine thread has transcended centuries of smiths. That it grew strong during the time of Notre Dame. That its strength diminished during the Dark Ages, fragile as a hair; regaining vigor in the era of England's construction of Hampton Court and St. Paul's Church. Happily, that strength continued to the New World, and was seen to be thriving during Wheeler's time, and later, in Samuel Yellin's time. Today, however — in America — the fine art is threatened. And there is danger that it may be lost forever. If there is to be a revival in America it is largely due to one man. One man who worked in Samuel Yellin's shop sixty years ago. A man who knew at the age of sixteen that he was going to become an armsmith. Studying the Old World traditions under a Kunstschmiede Meister, the past...
was linked with the future in this young man — Francis Whitaker. The Samuel Yellin Memorial Workshop will allow a dozen smiths the opportunity to share that tradition. To work with a truly gifted teacher like Whitaker and so indirectly, share the great Yellin's genius. The Workshop gives these smiths the opportunity to leave a hammer mark — perfect or imperfect — upon a piece of ironwork designed by Francis Whitaker, so they will be part of history in the making.

I would like to be part of that workshop. I would like to be part of that workshop so that I can help to keep the traditions alive. So that children in the centuries ahead, when visiting the Samuel Yellin Museum will look upon the ironwork and be familiar with the blacksmith's role. That is my commitment.

Jim's statement was made about why he wanted to be part of the first workshop and be a link to the past. He and all of the members of the workshop formed links of the chain that was made at this time: on the top cross member of the gate, just below the semicircular panel, the motto selected by the group reads, "Forging the Chain."

To continue to forge this chain we are developing the process to establish these workshops on a regular basis. This is being developed at the Philadelphia College of Art and will be organized through the Continuing Studies Program, Fred Osborne, Director. It will continue to be held at the Yellin Forge with the help of Harvey Yellin, Fred Crist and myself. The Yellin Foundation will continue to support this program as part of its objectives in the continuance of the Yellin tradition.

The workshops will vary in scope, size and task. They will cover the entire range of work done by the artist-blacksmith in terms of design, process and technique. The next workshop will be held from the 17th to the 21st of October, 1983 to make the lock for the gate made at the first workshop. This will be a shorter and smaller workshop limited to 6 participants with focus on locks and hardware; but the group will still be limited to experienced smiths. Those wishing to apply may send for an application from the Continuing Studies Program, Philadelphia College of Art, Broad and Spruce Streets, Philadelphia, PA 19102.

The Samuel Yellin Retrospective Show

The installation of the Samuel Yellin Retrospective Show on a main floor of the Great Hall of the Philadelphia College of Art. The show closes on the 27th of May, 1983 and then travels under the auspices of the Gallery Association of New York state to the following locations:


Albany Institute of History of Art, N.Y. Jan. - Feb., 1984

Oglebay Institute Museum, Wheeling, W.V. Spring, 1984

The Hyde Collection, Glenn Falls, N.Y. July - Aug., 1984

After these shows the exhibit will be scheduled at the Flint Institute of Arts in Flint, Michigan; the National Ornamental Metal Museum in Memphis, Tennessee; and other sites in the country.
1. Mirror by Bill Fiorini of LeCrescent, Minnesota. Forged steel and Damascus. 5⅛" x 10"

2. "Breakaway," coffee table by Stephen Wooldridge of Sheridan, Indiana. Forged and fabricated from ⅛" thick type 304 stainless steel sheet, polished to a mirror finish. The top of the table is plate glass. (⅞" x 32" x 45")

3. Miniature suit of armour by Thomas Latané of Annandale, Minnesota. "It stands 5¾" tall and is made of 62 steel plates ranging from 18 gauge to heavy tinned can metal. The plates fasten or hinge to one another with 153 rivets made from model building nails and 15 buckled leather straps. The armour on the calves; thighs; chest; and back pieces do not unbuckle or hinge open, but all the joints are as mobile as those on a large suit. The chain mail showing on the upper arms and crotch is made of over 1400 wire links, assembled by my wife in the common one to four link pattern. Not copied from any specific full size suit, features were taken from 16th century styles of armour."
4. "Montgolfière; Précurseur" by Steve O'Ri Curtis of Savigneux, France. No. 1 of a series of eight sculptures commemorating the bicentennial of the beginning of the conquest of air and space by the brothers Montgolfier's hot air balloon, Annonay, France 1783. The base is forged of steel plate; the rocket is turned stainless steel; the balloon and basket of copper and brass.

5. Swing chair by Stuart Hill of Suffolk, England. The top and bottom frames are each from one piece; stoved epoxy finish; and specially woven upholstery.

6. Detail of swing chair showing "Claydon clamp" joints and one piece frame construction.

7. Firetool handles by Pete Minier of Morgantown, WV. Forged steel.

8. Fireplace furniture by Bob LaRison of Ridgeway, Colorado. Mild steel collared and riveted. "The shovel is brass which really sets off nicely with the iron."
1. Cemetery gate by Bob Patrick of Bethel, Missouri. "The gate is 12 ft. wide and is held together solely by mortise and tenon and collared joints. All 106 swaged collars were put on hot. Design to installation was four weeks." (Photo by Stanley Patrick)

2. Detail of cemetery gate.


6. "Cascade" sculpture by Ivan Bailey of Atlanta, Georgia. Forged steel eight feet tall.

7. Grille — separation by Václav Jaros of Prague, Czechoslovakia. Forged steel. 3m x 2m.

8. Window grille by Angelo Garro of Toronto, Ontario.


10. Fence by Terry Clark of Hampton Court, England.
Wrought Metalwork, 4

By Bernard Heatherley

Having seen how the three main structural processes in wrought ironwork relate to certain problems let us, before dealing with further problems, examine other metals more closely to find whether the nature of each will permit similar methods or whether a different treatment must be substituted. Iron, we find, is the only metal submitting to all known processes in making decorative metalwork. Closely related to it is monel metal. This alloy of iron with nickel, copper, etc., is sometimes preferred because of its greater resistance to corrosion. To allow any metal to corrode so far as to weaken its structure or change its form is to subject it to neglect that few other materials suffer. The results of such carelessness and disregard of property are deserved because the necessary amount of preventive care is so slight and its returns so gratifying and cumulative. Rarely is iron allowed to go so far as actual disintegration, however, but the appearance of rust (surface oxidation rather than corrosion) is quickly objected to. There seems to be an unwillingness to deal with iron oxidation, al-
though no more effort is entailed than with other metals — any of which are subject to oxidation or some change of surface due to atmospheric conditions. When finishes are considered we shall see how to turn this oxidation to good account. The often expressed wonder that some modern ironwork rusts quickly while work centuries old withstands Nature's disintegrating forces is answered by the fact that the old iron is purer and denser than that produced commercially today. The protracted heating and hammering necessary for the medieval smith to obtain the requisite sizes of material seems to have been more effective in producing these qualities than are modern mill methods. But the power of heating and hammering remains with us and their proper application greatly increases the resistance of available iron. To treat thus all parts of the material takes time and uses fuel — which is one reason why the real craftsman must ask a greater price for his work than the man who uses commercial bars and employs neither heat nor hammer except at points where the attachment of parts or the making of forms demands it. The failure to heat and hammer permits the "scale" present on the surface of most stock iron to remain — objectional in appearance and a fertile field for rust. Until fairly recently most wrought "ironwork" has been made of soft steel. For interior work of many designs there is no objection to this, and a higher polish is possible with this material than with pure iron. For exterior work, however, it is not completely satisfactory. Steel is notorious for quick corrosion when exposed to the elements and, where decorative ironwork is concerned, the carbon makes iron into steel must be considered an impurity, reducing corrosion resistance and ductility. The effects of good heating and hammering, nevertheless, are proportionately the same with soft steel as with iron.

The purest iron now available is Swedish iron of which there are several grades — not all perfect. Of all irons, the best Swedish is most resistive to corrosion and greatest ductility in working. Fortunately, domestic manufacturers are now looking into the possibilities of producing a pure iron and an American iron is now to be had which approaches the qualities of that from Sweden. Refined and Double Refined irons are domestic products which, while very resistive to corrosion, lack ductility. For designs not calling for free or elaborate forging they are very satisfactory. The ratio of cost of material to the cost of the finished work is controlled by a project's degree of elaboration. In simple work the price of material must be considered more seriously than in elaborate work when it is so far exceeded by labor costs as often to be negligible. Of the irons mentioned, soft steel is cheapest, the domestic irons next higher in cost, and Swedish iron the most expensive.

Work done in monel metal is necessarily more costly than ironwork for several reasons. The cost of material is much higher and labor costs increase because the metal is much harder than iron and takes longer to work. Owing to a certain brittleness it will not submit to the same liberties at the forge as iron will — another time-consuming element. Also, the use of charcoal fuel for the best results adds to the expense. While greater effort will bring this metal to do many of the things iron can do, its economical use requires designs to be kept simple and made to conform with its particular traits of character. It must not be assumed that one design may be carried out alternately in iron or monel metal. It can, however, be forged artistically and is capable of receiving a very beautiful finish. For exterior work where local conditions or a client's attitude makes it desirable to take extreme measures against corrosion and where genuinely wrought work is desired, monel metal may be recommended. The necessity for care and treatment of oxidation must, of course, be remembered.

The stainless steels and so-called "forging" bronzes are subject to various limitations when worked by hand. Typical of most of them is a hard brittleness which prevents the attainment of freely forged forms or results in very forced effects. Their working consumes much time and their cost as material is high. In cases where they forge well enough they are apt to leave behind in the fire their non-corrosive properties — thus nullifying the main reason for their use. None are capable of being welded under the hammer or presenting a really fine natural finish. For such limited effects as the combination of standard members will give, such materials are satisfactory but work of this sort hardly requires the services of a craftsman. The natures of bronze, stainless steel, or aluminum demand that they be regarded mainly as casting materials if fine, logical results are sought. They also lend themselves to extrusion, rolling and similar types of mechanical handling, but cannot be regarded as forging metals. Hammering and forging are especially antagonistic to the nature of any aluminum yet produced. The slightest knowledge of this metal's reactions to heat and the hammer will show that such pieces as have been "forged" — with obvious hammermarks, wide flaring scroll ends, split ornament, welded collars, etc. — are absurdly strained and false. In some cases, the necessarily mechanical methods of fabrication have been hidden or disguised and the "hand-wrought" effect superficially applied after the work has been done. I have not found it possible to bring aluminum to a red heat at the forge. It has crumbled or melted before reaching that point. A degree of plasticity may be gained by slight heating but, since there is no glow to indicate the temperature reached, overheating is very easy when a blow of the hammer crumbles the metal to dust. Aluminum obviously, then, should not be treated with heat and the hammer, but should be worked. Cold — the lathe, hacksaw, shaper, file, and mechanical welder being its natural tools and a "cut and fit" or carpentering technique its natural treatment. When cold it may be twisted, bent, and, in a slight degree, beaten thinner; much hammering, however, brings hard brittleness. Riveting and collaring may be done cold in the material when of light sizes. Good work may be "wrought" in aluminum if its limitations are recognized, but it is unfair to demand of it things alien to its nature, especially as, treated in the proper manner, it responds very kindly with effects as beautiful as cast leadwork.

The foregoing considerations of these non-forgeable metals are limited to solid stock, their possibilities as sheet metal being much less restricted. All of them may, in this form, receive some easy and natural hand wrought expression. Most sheet work is done cold and ornamental panels, complete doors, and similar work, with designs formed, repoussé, or incised may be carried out in sheets built up on wood or metal cores. Also, such work as lanterns, trays, rainwater heads, lock boxes, etc., may well be made of these metals in sheets. Brass and copper, capable of fine casting, of drawing and extrusion, are well enough known for their beautiful possibilities as sheet metal and nobody would think of trying to forge them. In modelling these materials a combination of ductility and thinness permit a wide range of handling. In the case of sheet tin and zinc; however, which in the past have received some very lovely treatments, ductility is lacking and attempts to model them are not very successful. The cutting and fitting together of carefully developed areas is the correct way to
SOME COMPARATIVE INTERPRETATIONS OF DESIGN IN IRON & MONEL METAL

Doors & other work of this type may be carried out in sheets of forgeable or non-forgeable metals.

SOME CHARACTERISTIC TREATMENTS OF METALS IN SHEETS

- In heavy work, two hammers of different sizes are used. If the work were left rough evidence of the use of both would be apparent.
- In welding a collar to a spindle, the use of swages tends to eliminate evidence of the use of the hammer.
- After certain welds, in straightening work, the flatter is the last tool in contact with the metal.
- The use of fuller in making 'necks', etc., renders illogical the appearance of hammermarks in such places.
- The rawhide or wood mallet is used in adjusting finished work to avoid marking it.

THE LOGIC OF HAMMERMARKS.

- Correct use of ball peen.
- A typical false hammering.
- Hammer marks in illegal places.
- Another false hammering.
handle these materials with riveting and soldering doing the structural work and piercings and ribbings (the latter greatly increasing the strength) as logical decoration. The nature of lead makes its sheet form quite adaptable to wrought handling. Thus we see that most of the metals in architectural use can be wrought by hand in the sense that “wrought” means “worked.” But we should be very careful how we employ the term “forged” which, in its accepted sense, means “heated in the fire and formed while hot with the hammer.”

The fact that work formed with the hammer is bound to bear some imprint of this tool has, unfortunately, led to much abuse, misunderstanding, ugliness, and dishonesty in modern metal work. The subject of hammermarks should have been disposed of long ago, but continuing tendencies show that the craftsman’s beliefs in the matter cannot be too frequently stated. The good smith makes his work as smooth as possible within the reasonable use of his natural tools, and regards as poor work that which is covered with rough hammermarks. Old work seldom shows further use of the hammer than the delightful texture its proper employment imparts — indicating that more rather than less hammering has taken place in bringing the work to a fine finish. Yet there seems to lie rooted in human minds the belief that obvious hammermarks guarantee a piece to be handmade and therefore “artistic.” This false belief has been capitalized in a number of ways and we are surrounded by work made in a purely mechanical and commercial way, covered by objectionable great hammermarks or absurdly small ones made by hammers that obviously contributed nothing to the forming of the work. Often cast work is introduced into these pieces and incongruously hammered. Almost unbelievably, pieces have been made, hammered cruelly and used as patterns for cast reproductions — an hermaphroditic confusion as insulting to the fine art of casting as to forging. The only possible inference would be that the perpetrators of such practices are entirely devoid of ethical sense in trying to represent cheap machine made work as hand work — to command a higher price — were it not for the fact that an occasional architect or educator calls for such practices. Within the last two years the ironwork on a certain Government project was specified to include cast parts, hammered to “match” the rest of the work. The specifying architect probably would not tolerate such immorality in a faker of antiques or in a quack doctor. False hammermarks are easily recognized. Frequently the ball peen of the hammer is used on large areas, making silly little pockmarks, whereas its proper use is restricted to confined or curved surfaces. If the flat of the hammer is falsely used the marks are apt to be exaggerated and the hammer not brought down squarely in the manner of a good smith. Since the saving of time and fuel necessary for proper hammering is attractive to the faker he does his hammering cold, leaving marks distinguishable from those done hot. While improper hammering seldom covers the whole surface of the work, it usually finds its way into some places where the hammer would not logically be the last tool used. Unnatural hammermarks have been defended on the grounds that they give “texture” to metalwork. This merely places metals in the nightmare of false and affected textures which building is suffering. Something might be said for the attitude if the natural texture of a material were insupportable; but with metals there can hardly be a finer texture, by any criterion, than that coming from its intrinsic qualities brought out by the proper use of the proper tools.

This article is the fourth of a series on the subject of wrought metalwork, written by a man who is particularly well qualified by training and experience to discuss for architects the matters pertaining to the metal crafts. He was born at London, England, and trained there first in furniture design and later in architecture. He came to the United States in 1921 and thereafter spent two and a half years under Samuel Yellin. He then engaged in architectural work in Philadelphia, Rochester, N. Y., and Utica, N.Y. He is a member of the A.I.A. and a registered architect in the State of New York. Late in 1931 Mr. Heatherley rejoined Mr. Yellin’s organization and spent about fifteen months in charge of his shop. He is now a metal craftsman in his own name.

Reprinted from the November 1933 Pencil Points, courtesy of Reinhold Publishing.
This is the second of a series of articles describing the Francis Whitaker workshop held October 17-21, 1982 at Salado, Texas. During this workshop the participants, who ranged from novice to experienced smiths, were taught the planning, forging and installation of a staircase railing.

This series is the result of the cooperative efforts of Roy Bellows, Fredricksburg, Texas, who provided the sketches; Byron Wehner, Waller, Texas, who provided extensive notes; and George Holliday, Tomball, Texas, who wrote the text.
FABRICATION OF STAIR BALUSTERS

BALUSTER LAYOUT AND FOOT FABRICATION

Three pieces of 1" square stock were cut 50" long (3" for the scroll, 35¾" for the baluster height, 3" for the distance from the bottom of the pattern board to the top of the tread (H dimension, Figure 1) and 8¾" for penetration into the support hole]. Francis marked the balusters accordingly, Figure 7 (Suggestion 1). Francis shouldered the scroll end of the baluster using a large top fuller and a striker, Figure 9(a) (Suggestion 2). The scroll end was drawn on the 50# Little Giant power hammer so the finished piece was 9/16" thick, 1" wide and about 4¾" long, Figure 9(b) (Suggestion 3). Both the top and the sides were drawn under the power hammer.

A fast taper was formed at the end of the drawn section (last 1-1½"). A tight scroll was turned downward toward the straight side of the baluster, Figure 9(c). The scroll end was cooled in water to protect the scroll and the "foot" was turned away from the shoulder, Figure 9(d). The shoulder was shaped by upsetting the corner with the hammer. The bar was held across the anvil; the shoulder was formed by striking the corner alternately horizontally and vertically, Figure 10. The slope of the "foot" was checked using the Bevel Gage and corrected as necessary. Duplicate scrolls, "feet" and shoulders were made on the three balusters. The top baluster foot was formed at right angle to the baluster because the railing was parallel to the top landing, Figure 8.

The class agreed that the three hollow balusters should be different shapes: diagonal, round and square. Three different tools are needed to punch a hole, Figure 11:

- Slot punch — used to cut through the metal.
- Opening punch — used to open the cut to accept the drift punch.
- Drift punch — used to shape and size the hole.

Figure 9. Scroll end of baluster worked to ⅜" thick using a fuller and power hammer. Sides of drawn end must be worked to maintain width at 1". The end is tapered for about 1-½" and a closed scroll turn. The "foot" is turned away from the shoulder.

Figure 10. Forming shoulder of "foot." Hammer alternately from top and end, as shown.
1. Layout Marks
   Francis recommends use of marks to differentiate break or bend, shear or cut and center punch as follows:
   ✶ diamond with vertical line through corners = break or bend
   ✲ S with vertical line through center = shear or cut
   ☾ circle with vertical line through center = center punch

2. Striker’s Handling of the Sledge Hammer
   The striker must place sledge hammer blows accurately. This can be accomplished by having the striker stand opposite the smith. The striker holds the sledge hammer with the right hand about midway up the handle. The left hand is near the handle end away from the head (Figure S-1). The position should be reversed for left handed strikers. The hammer is held above the striker’s head and brought down by pulling downward with both arms. The striker cannot take a test blow, since this breaks the striker’s rhythm and may knock the striking tool out of position. The striker uses his hammer in the same manner as the smith uses his hammer. The right hand guides the hammer while the left hand adds power, stabilizes and maintains a level blow.

3. Determining Drawn Length
   The volume of metal remains constant before and after drawing. We start with 1” stock 3” long. The volume of metal is 3 cu. in. (1” × 1” × 3” = 3 cu. in.). The drawn end will be ⅝” × 1” or 5/8 cu. in. per inch of length (⅝” × 1” × 1” = 5/8 cu. in. per inch). The length of drawn stock is 4.8” (3 cu. in. divided by 5/8 cu. in. per inch = 4.8”).

4. Sharp Pointed Poker
   Francis recommends using a poker having a sharp point so the center punch mark can be located with the poker while the workplace is in the fire.

5. Chain Link Tongs
   Chain link tongs can be used to advantage to hold hot punches, Figure S-2. The punch is secured by slipping a chain link or two over the tong handles, Figure S-3. This suggestion is particularly useful when handling short length punches. Short length punches are easier to use than long punches because they can be held steadier. Additionally, an asymmetric drift or punch can be held in any desired position using tongs.

6. Hot Cutting Material
   Hot cutting on a cutoff hardy is dangerous if the last cut results in the piece flying through the air. The piece to be cut should be heated bright yellow. Each side and corner should be marked in turn by light blows. Then the cut is made with heavy blows. However, the last blow should leave a thin section, which can be twisted-off using tongs. This prevents having the cutoff piece fly from the hardy striking someone or something with disastrous results or damaging the hot cut or hardy.
The slot is cut 40% longer than the diameter of the finished round hole. Cut the slot 75% longer than the side of the finished square or diagonal hole. Two slot punches were available; ¾" and 1". These were satisfactory for ¾" round and square holes, respectively. No diagonal drift punch was available at Salado. Accordingly, Francis made a ½" drift punch (Appendix B).

A hole is punched in a piece of stock using a hot punch driven through the material from two sides at the appropriate location. This is done by placing a center punch mark at the location of the center of the hole. The area of the hole is heated to a bright yellow in the forge. The punch mark should be up in the fire so the mark can be located easily (Suggestion 4). Several methods are available for securing a straight punched hole through the stock. First, drill a small pilot hole through the stock at the center of the proposed hole. Second, punch from two sides aligning the slot by eye. Francis prefers to punch using the “by eye” approach. He punches from one side about ½ through the stock and then punches from the other side. The first punch indentation shows as a dark line in the stock.

The slot punch is placed so the center of the curved cutting edge, Figure 11, is on the center punch mark. The first blows, generally delivered by a striker, are light. Then, fresh coal is placed in the cut and the slot cut deeper. The fresh coal keeps the punch from sticking in the material. The process is repeated, i.e., punching and applying coal, until the slot is about ¾ through the stock. The slot is then started from the other side by placing the slot punch over the darkened area caused by the cooling from the punch while punching from the other side. Again, the first blows are light. Do not bury the ends of the slot punch until the cut from the two sides are aligned. This is best done by turning the workpiece on its side while the slot punch is held in the second slot, Figure 12. The alignment can be corrected by moving the punch axially until alignment is correct. The slot punch then is driven through the stock. Again, fresh coal is used as a lubricant. The punch must be cooled periodically to avoid drawing the temper from the tool. Francis suggests using chain link tongs to hold a short punch (Suggestion 5). However, he prefers a slot punch on a handle, if available.

The opening punch, Figure 11, is driven part way through the slot. The slot

![Figure 11. Hot punches used for forming holes in balusters. Note the center of the drift punch may be upset to the final hole size.](image)

![Figure 12. Aligning slots cut from two sides of a workpiece.](image)
punch hole is opened farther to receive the final punch by holding the piece vertically while hitting the end down on the anvil, Figure 13. The bar should be rotated as it is hit downward to hold the piece straight. Finally, the drift punch, Figure 11, is driven through the hole while holding the bar flat on the anvil over the pritchel hole or hardy hole.

The three hole shapes are formed identically. Care must be exercised to open the hole by hitting downward, Fig. 13, so use of the opening and drift punches will not thin the side walls of the hole. Additionally, the diagonal square hole will need shaping using the hammer and anvil, Figure 14.

The first of the three punch marked balusters, Figure 7, was placed in the fire for punching. Francis had everything ready. The punch marks were facing up; he had the sharp poker point to find the marks; the slot punch was in the chain link tongs; the chain link secured the tong handles; and the striker was at the ready. Francis pulled the bar from the fire and slotted it at the top punch mark of the top twist! Needless to say, the class agreed to modify the baluster design. This is why the balusters as built have punched holes at different levels on each baluster, Figure 8, rather than a punched hole at the center of each baluster as designed, Figure 7. The result is an improved design caused by serendipity. Francis says "a blacksmith is a man who works with tools and imagination." Imagination won this time!

(The next part in this series deals with fabricating the stair rail, connecting the rail and balusters and installing the completed assembly.)

![Figure 13. Opening a slot cut by striking the anvil with the workpiece end. Long pieces may be upset by hammering on the end of the piece. In either case, the bar must be rotated frequently to keep it straight.](image)

![Figure 14. Shaping the diamond hole after drift punching.](image)

**APPENDIX B**

**SQUARE DRIFT PUNCH**

Make the drift punch the same size as the material to go through the finished hole if a drive or shrink fit is desired. Clearance is provided, if desired, by upsetting the center of the drift punch, Figure 11. A square drift punch for square holes made on the diagonal is forged by flattening the corners of the stock to form a long tapered flat-ended tool having the long transverse axis aligned with the tool corners, Figure B-1. Drift punches can be made from low carbon steel which is quenched. Do not quench the striking end. Low carbon steel drift punches are very serviceable. Generally, short drifts are easier to use than long drifts, since they do not wobble as much.

Francis took special care when hot cutting the material for the drift punch (Suggestion 6).

![Figure B-1. Square drift punch for forming a square hole on the diagonal.](image)
Diderot Translation
tenth in a series
by James L. Kirkland

The September 1980 issue of the Anvil’s Ring was comprised of a collection of Blacksmith plates from the Encyclopédie of Diderot and d’Alembert. To aid your understanding of the prints, James L. Kirkland is providing translations of the French text for each plate. Here is the translation for the thirteenth plate in our collection augmented by Mr. Kirkland’s well-researched notes.

Translation
Serrurerie, Large Works, Embossed Ornaments

Fig. 1. Embossed sepals of a flower.
2. The same cut and prepared to be embossed.
3. Flower, embossed.
4. & 5. Pieces of the flower cut out.
6. The same flower cut out.
7. Piece for the middle of the flower cut out.
8. Leaf
9. The same leaf cut out.
11. Agraphe
12. Piece of the agraphe.
13. The same agraphe cut out.
14. Scribe for tracing designs. AA, the points.
15. & 16. Nails serving to attach the ornaments on the lead block, to chisel (emboss) them. AA, the heads. BB, the points.
17. Lead block for chiselling the embossings.
18. 19, 20, 21, 22, 23, 24, 25, 26, 27, 28. & 29. Little embossing chisels of different forms. AA, etc. the heads.
(The shape of each bit is shown below the shanks.)

Notes
In this plate four separate ornaments are being produced: figure 1, the calyx; figure 3, the flower; figure 8, the leaf; and figure 11, the agraphe.
In figures 1 through 13, the totally shaded figures represent the flat sheet iron with the design cut out, ready to be embossed. The partially shaded figures represent the “raised” or “embossed” workpiece as it appears when finished.
Except for the calyx, (which is made from a single piece, fig. 2), these are composite decorations made from several pieces riveted together as follows:
flower, fig. 3 — made from pieces 4, 5, 6 and 7
leaf, fig. 8 — made from pieces 9 and 10
agraphe, fig. 11 — made from pieces 12 and 13

Figure 11, Agraphe. This term generally means “a hook or clasp.” The agraphe is often used at the junction of scrolls and other curved members. Several examples may be seen in plates 9, 11 and 12 (the decorative ironwork illustrations) in the Anvil’s Ring series. In architecture the term denotes the decoration of keystones of arches etc. in a design similar to that used for ironwork. In clothing, armor etc. the term denotes “hook and eye.”

Figure 17, Tas. The lead tas or tasseau was intended for use with embossing chisels working from the backside of the workpiece. “Tas” is a general term which means (in blacksmithing terminology) a small anvil, backing block, dolly block etc. usually not in the shape of the conventional anvil with biackern. However, this form of tas was made of steel or was steel-faced and was often designed similar to a bottom swage and could produce a desired shape, but more often simply flat. This type of tas could be mounted by driving the shank into a block of wood, as the conventional anvil is, in the hardie hole of the anvil or in a “stake plate.”
The tas appears in many of the early French crafts and often was not mounted but served as a “hand anvil.” For example, the “layetier” or boxmaker used the tas in one hand to back up or “buck” rivets while the other hand wielded the hammer. Thus, the tas was extremely useful in installing locks, hinges and other hardware on cumbersome pieces of work such as large chests.

Figures 18 through 30: Duhamel Du Monceau in his book “Art du Serrurier,” (Paris, 1767) describes these tools as “mattoirs” or “little bars of steel which have at one end different shapes and which, in place of a cutting edge, are cut on their end like a file; they serve to emboss tole on the lead block.”

This plate illustrates the tools and techniques for producing work like that shown on the front cover of the September 1980 Anvil’s Ring. At the top of this cover illustration, a shop is shown which is apparently devoted solely to making decorative ironwork. At the right a workman is embossing a crown on tole using (continued on page 47)
Election Results

Jack Brubaker ........................................ 315
Dorothy Stiegler ................................. 281
Carl Van Arnam ............................ 268
Bill Fiorini .................................. 254
Richard Wattenmaker ................. 229
John Dittmeier* ............................ 167
Stan Strickland ...................... 165
Jay Kidwell .............................. 160
Dave Thompson ....................... 100
Dale Wedig .............................. 90
Jim Garrett ......................... 48

*Appointed by the board to fill the vacancy created by the resignation of board member Dimitri Gerakaris.

I would like to make two apologies, first to Carol Sekowski, whose nominations were lost in the mail crossing the border to Canada and second to all those members who wanted to vote and didn't because they received their ballot too close to (or even after) the deadline. I extended the deadline until May 14, and even though I could not spread the word, many more ballots did come in to raise the total to 427, the largest return we have had to date. The mailing problems were nationwide and did not affect or penalize any specific region. The returns showed a good geographic spread even before the original deadline. This year's election was difficult to manage due to problems securing mailing labels, date changes and wrong addresses. For the future we are working on an annual schedule for elections so that everyone will be aware of the time frame well in advance. It is also planned to mail ballots first class. There will be announcements in the future Anvil's Ring setting out the deadlines for nominations etc. I also expect to streamline the system to make the process less time consuming. As to Carol Sekowski's problem, we will use the telephone to communicate across the border, using the mail as a back-up. More on all this later in the year.

All in all, this has been the most successful ABANA election, judging by the number of votes received. I would like to thank the other people who also worked on the nominations: Floyd Daniel, Georgia; Norman Larson, California; Lloyd Johnston, Ontario; and David Thompson, Oregon.

Finally, thanks to those who did take the time to vote.

Jonathan Nedbor
RD 1, Box 234
High Falls, NY 12440

Executive Committee

Jack Brubaker, President
John Dittmeier, 1st Vice-President
David Court, 2nd Vice-President
Carl Van Arnam, Secretary-Treasurer
Richard Wattenmaker, Member-at-Large

Board of Directors

Jack Brubaker — RR 2 Box 102A, Nashville, Indiana 47448
David Court — Bay Hill Road, Northfield, New Hampshire 03276
John Dittmeier — 6 West Vernon Street, Smyrna, Delaware 19977
Jim English — N70 W 6340 Bridge Rd., Cedarburg, Wisconsin 53012
Bill Fiorini — 15030 Highway 16, LaCrescent, Minnesota 55947
Jim Fleming — Route 1 Box 784, Bonanza, Oregon 97623
Bill Gichner — Box 8, Bethany Beach, Delaware 19930
Joe Humble — 5029 Montcrest Drive, Chattanooga, Tennessee 37416
Pete Minier — P.O. Box 212, Morgantown, West Virginia 26505
Oscar A. (Bud) Oggier — Box 75, Cushing, Maine 04453
Dorothy Stiegler — 4642 180th Way SW, Rochester, Washington 98579
Carl Van Arnam — P.O. Box 1191, Gainesville, Florida 32602
Jim Wallace — P.O. Box 13222, Memphis, Tennessee 38113
Richard J. Wattenmaker — Flint Institute of Arts, 1120 E. Kearsley Street, Flint, Michigan 48503
Brett Wilds — 2810 Central Drive, Fort Wayne, Indiana 46806

ABANA BUDGET
September 1, 1982-August 31, 1983

INCOME
Dues $45,000.00
Convention 5,000.00
Sale of back issues of The Anvil's Ring 3,500.00
Dividend income, Merrill Lynch Ready Assets 2,000.00
Contributions 500.00
Interest Income 100.00
TOTAL $56,600.00

EXPENSES
Advertising 500.00
Postage 850.00
Office Supplies 600.00
Secretarial 2,500.00
Telephone 600.00
Fees 400.00
Anvil's Ring 35,000.00
Convention 5,000.00
President's Expense 750.00
Insurance 1,000.00
Board Expense 2,000.00
Slide Library 2,700.00
Miscellaneous 100.00
Depreciation 60.00
TOTAL $52,660.00
SURPLUS +2,000.00

$54,060.00
Brent Kington Receives Alex Bealer Award, 1983

L. Brent Kington, Professor of Art at Southern Illinois University, Carbondale, Illinois, is the 1983 recipient of the Alex Bealer Award. The Alex Bealer Award is periodically presented by the ABANA Board of Directors to the person selected as having contributed the most to assist the growth of blacksmithing. Besides developing a significant blacksmithing art program at SIU in Carbondale, Brent Kington persuaded Alex Bealer to have a blacksmith conference at Lumpkin, Georgia. He helped organize and promote two conferences there, serving as program director for one of them. In 1976 he organized and promoted the "Iron 76" show and ABANA conference at SIU, as well as an NEA-sponsored blacksmithing seminar. Exhibitor of many one-man iron shows, recipient of design awards, he opened the way for the credibility of blacksmithing to receive NEA grants and fellowships. He has participated in panel discussions, demonstrated and lectured on iron and art throughout the United States, promoting the development of blacksmithing facilities at Penland School of Craft and the Appalachian Center for Crafts. In 1978 he spoke on ironwork as art at the opening ceremony of the American section of the Vatican Art Museum. His students represent a large share of the work exhibited at major juried art shows of iron.

Robert Owings, Chairman
Alex Bealer Award Committee
615 Second St.
Petaluma, CA 94952

School-Demonstrator List

A list of institutions and individuals who offer instruction of any sort in blacksmithing can be obtained (or added to) by contacting:

Dorothy Stiegler
4642 180th Way SW
Rochester, WA 98579

The 1984 ABANA Conference

Plans for the 1984 ABANA Conference at St. Norbert College, De Pere, Wisconsin are running on schedule. The conference dates are June 28th, 29th, 30th and July 1st, 1984. Please mark your next year's calendar now. To offer your services in putting on this fine event, contact:

Jim English, Chairman
1984 ABANA Conference
N70 W6340 Bridge Rd.
Cedarburg, WI 53012

ABANA Slide Library

Susan Showalter took over the responsibilities of running the ABANA Slide Library on January 1, 1983, replacing her husband, Jack Brubaker. Susan's experience includes business management, organizing and fund raising. At present a grant proposal has been submitted to The Indiana Arts Commission to produce, publish and distribute a new, updated catalog and directory.

Under Susan's direction the library is expanding. Slide acquisitions (which are not yet cataloged and edited into presentation sets) include: African Weapons, Ironwork in England and France, Damascus, Ripley Conference Demonstrations, Metallurgy '80 Exhibition, 1982 ABANA Exhibition, Ironwork in U.S. Cities, Sorber Collection of Early American Ironwork, Alfred Haberman, Yellin, etc. Expected to be ready by this fall, their availability will be advertised in the Anvil's Ring.

Books on blacksmithing will also become a future part of the Library. Presently, the library is trying to contact any members who have a complete set of the Anvil's Ring and would like to donate them.

Remember, all orders to the ABANA Slide Library must be accompanied by check or money order to the amount of purchase or rental.

Susan Showalter, Director
The ABANA Slide Library
RR2 Box 102A
Nashville, IN 47448

Editor's Apology

In the Winter 1983 issue (Volume 10 Number 4) of the Anvil's Ring, I neglected to thank Metalsmith, the fine publication of the Guild of Metalsmiths and its editor, Mournane Hubler, for providing the transcript of the tape-recorded interview used in the article "Francis Whitaker: a personal interview."

Coming Next Issue . . .

The return of the "3 Blacksmiths."
Basic Blacksmithing #2 by James Fleming
The blacksmiths of Balangas by Rob Whitehurst
Manufacturing wrought iron by the team of Wheeler, Tyson and Washington
Pouring babbit bearings in your tripod hammer by Ward Brinegar
Hand-held air hammers by Russ Swider
A forum on design
And a lot more.

Summer 1983
On Draft

Though I've had a forge etc. for over ten years I'm still much a babe-in-the-woods, for smithing is a hobby which I practice when I can find time. In the near future I'm building a better forge in a permanent building, but I'm still uncertain as to which style of firepot and/or tuyere is best: the sidedraft or the updraft.

My present forge is the so-called portable rivet heating forge with a hand cranked blower. This updraft forge gets hot enough, but the fire is small and round shaped and I have difficulty heating long sections of iron to make scrolls. (It takes several heats to make a scroll.) The British seem to favor the side tuyere and most American equipment seems to favor the updraft.

Could someone knowledgeable about both styles report on their findings or several people give various opinions? Which style gives less buildup or problems with clinkers? I'd certainly like to see some discussion of the matter in a future issue of the Anvil's Ring.

Paul Bohne
8120 La Senda Road
Alta Loma, Calif. 91701

The Life of a Craftsman

I am writing to describe my experiences as a self-employed craftsman. The romantic image isn't as great as the reality at times, and this is addressed to those who want to give up a nine to five job and “drop out.”

First there is the insecurity of income — for me it is a feast or famine. I can deal with this; my ex-wife couldn’t. Insurance is a second problem — the expense of having it or the worry of not. I have workers compensation, liability and car insurance but no health insurance.

Having to do all parts of business — sales, production, maintenance and book work make self-employment more than hammering. The business part takes as much time as production and don’t earn any income. The lack of traditional apprenticeships makes learning the trade and the business contacts a much longer ordeal. It is slow going. I figure five years to learn the work, five years to develop the business, five years to learn how to make a profit and another five years to become a master. Being self-motivated can be the hardest part of all. Too much freedom can be hard to control.

On the plus side, the freedom of choice, what to make; how to make it; when to work; and the fact of the more you produce the more you earn, is to me worth more than any salary. You can hang in there during hard times — no boss to fire you. You can do for yourself to save money, fix almost anything and escape inflation.

Your hobby can be your job. You can be one person 24 hours a day. Your passage through this life is permanently recorded — most blacksmith work will be here for 100 years at least. You remember the time spent on a piece. How much computer tape will give its creator the satisfaction of leaving a mark on the world?

For me it has been worth all the insecurities; I have survived for 13 years. For others, a steady paycheck and a more controlled work environment is happiness with craft work as an avocation. My conclusions are that money is not the reward for an independent craftsman; there is more pay for the soul than for the wallet.

Bob Bergman
Blanchardville, Wisconsin

Communiqué Savignéux — 1983

Ever since I left California to move to France five years ago, the Anvil’s Ring has been my lifeline to the United States. I really miss the easy sharing of each other’s discoveries as I experienced through the California Blacksmith’s Association. The Anvil’s Ring has been a valiant substitute and I count on it tremendously for inspiration and encouragement.

I thought it time for me to offer a contribution of my own to your efforts in the form of some pictures, a cross section of my work, in hopes that they might at least elicit some good criticism.

I also welcome a widening of my horizons with new contacts and take this opportunity to make an open invitation to any ABANA member happening through this part of the world. This is just north of Lyon, in the Département of Ain.

Might I add a request for an article possibly entitled: “All one needs to know about gas forges?” I have an urgent need to know.

Steve O'R. Curtis
Route de Juvis
Savignéux
01480 Jassans-Riottier
France
Tel. (74) 00.73.63

Long Live the Ring

The Anvil’s Ring has brought blacksmithing into the 20th century. It might be the single best meeting ground for contemporary smiths. It is the only American source for high quality photo and art work in our craft. I look to it for inspiration, and to keep up with “what’s going on.”

Please keep up the good work and standards of quality. The image of American ironwork is in the hands of ABANA and the Anvil’s Ring. To compromise would be a serious mistake.

Russ Swider
Rowe, New Mexico 87562
Southern Ohio Forge & Anvil

The SOFA Blacksmith School is in its second year and progressing nicely. Each class consists of eight students who meet at the Studebaker Frontier Homestead Blacksmith Shop for four hours one night each week. This course in basic blacksmithing runs for nine weeks with all material and tools furnished.

Larry Wood, Bob Zeiler and Richard Franklin are instructors for the two classes that meet here each week from 6 to 10 p.m. At present, two students are driving 70 miles each way to this class.
Emmert Studebaker
6555 South State, Rt. 202
Tipp City, Ohio 45371

Holderness School

For the past two years Holderness School has had a Blacksmithing Program taught by David H. Little, a member of ABANA. It has been a successful program and interest among the student body is increasing. As a result David would like to secure some additional tools in order to expose the students to some modern techniques. The cost of these items will be about $2000.

I am contacting ABANA to inquire if there are any foundations, manufacturers, or other interested parties who make contributions of either specific items or monetary grants for blacksmith materials. Since these items are not budgeted for this year we hope we can find some outside source for funding.

Any help you can give regarding this matter will be greatly appreciated.
David R. Sharrits
Holderness School
Plymouth, New Hampshire 03264

Friends of Yellin

Just a short note to let you know that we are still active, though somewhat slower than we wish. The funds we have received are being used for continuing development of programs and restoration.

We are planning some things for the summer and fall, some activities which will involve your physical being. As soon as I have some concrete details, I will let you know.

Again, thanks for your continuing donations. They are most gratefully accepted. (Make checks payable to the Yellin Foundation.)
Frederic A. Crist
802 Collegeville Rd.
Phoenixville, Pa. 19460

Wrought Iron

I don’t know if you can still get wrought iron in the United States. If not, your people may be interested to know that I can supply iron bar and plate in most sizes, for around £700 per ton plus delivery.

This stuff is very rewarding to forge, being softer under high heat and far easier to fire weld than mild steel. Of course, it’s ideal for restoration work on old wrought iron and for new work it lasts better outdoors. For what it’s worth, some of this iron is being rolled at a steam driven mill.

I don’t doubt that if there’s enough interest to send a decent quantity, freight can be arranged at a reasonable price.
Chris Topp
Carlton Hustwaite, Thirsk
North Yorkshire, England

What’s wrong with this picture?

It seems to me that the blacksmith hits the anvil twice between the striker’s blow, not very safe hammer signals. From “Blacksmiths Hammering on Anvil” Animal Locomotion, 1887 by Eadweard Muybridge. Submitted by Lotte Cherin of Malibu, California.
For the past six months this "tree" has been growing and taking shape in the North Canaan, New Hampshire design studio and forge of Dimitri Gerakaris, a nationally known artist in metal. The tree is being readied for transplanting to Concord around the end of the year.

"It's not everyday I design myself up a tree," said Mr. Gerakaris in a recent interview at his hand-built, post and beam forge amidst the Moose Mountains, "but in this case the physical and philosophical setting called for just such a solution." The gateway needed to span forty feet between two 19th century brick buildings and be high enough to permit fire engines to drive beneath it. This produced an asymmetrical double arched design, the support column for which lines up with a row of trees leading into the pedestrian plaza area. From this evolved the concept of a "tree gateway" whose branches spread to form the two arched openings of the gateway. With the historical fact in mind that the first columns used in architecture were actual tree trunks, Mr. Gerakaris has been willing, in his words, to forge ahead in defiance of Joyce Kilmer's famous sentiments that "only God can make a tree."
MOULIN DE LA CHEVROTIÈRE

Project History

The project “a school in a mill” was born in the mid-seventies. An important group of citizens of Deschambault (Portneuf county) agreed that the beautiful “Moulin de la Chevrotière” (the present school buildings), threatening to collapse under the weight of time, had to be saved and that the most intelligent use of these buildings would be their accommodating a school devoted to a revival of some traditional construction related trades.

Thanks to substantial funds from the Ministère des Affaires Culturelles du Québec, the restoration of the two old mills (1766 and 1802) went on through a three year period. So did the implantation of the following programs:

- Traditional framing and carpentry
- Blacksmithing
- Stone cutting/masonry
- Cabinet making

The blacksmithing and carpentry programs are under way for the second year, while cabinet making is planned for Feb. ’83 and masonry for the Fall of ’84.

Our main goal, briefly stated, is the survival of the above mentioned trades through the training of competent crafts people. In a longer term, a true revival of the market for quality workmanship and artistry in the same fields.

The Blacksmithing Course

The welder, mechanic and machinist having taken over the traditional smith’s role, our approach to blacksmithing is the artist’s rather than merely the technician’s. The program is designed for beginners, and so far most applicants are so. Ten months of training might not be sufficient to make master smiths out of good willed novices, but we think it should be good enough for a fresh start. We are thinking about some advanced follow-up training for our graduates and for others (workshops, trips, guest smiths, etc.).

Our course is one of 40 weeks of 30 hours (1,200 hours), under way since October 12, ’82 and until July 22, ’83. The shop is equipped with eight forges and anvils for eight students, not to mention a teacher who’s been in the country for 8 years and in the trade for 20, and who’s eager to share his energy, skill and passion for ironwork.

The course contents:

- Safety
- Heating techniques
- Basic forging techniques
- Related techniques
- Technical drawing and sketching
- The making of functional hardware
- The restoration of old hardware
- The making of tools, jigs
- Heat treatments of steel
- Coppersmithing
- Creative thought processes
- Decorative and sculptural ironwork
- The design of marketable concepts
- History of the trade, present and future of the craft
- The management of a professional Smith’s shop
- Whatever else will evolve out of it all.

What Next?

Besides being a school, the Moulin de la Chevrotière could also be a significant tool of research and promotion of our purposes. Therefore, a basic step for us is to become part of the existing networks and to throw in our share of energy. Our first concern of course is the health of the trade within our own country, so we are proceeding to touch base with other Canadian smiths, an effort that has already been made among them.

We wish to thank ABANA and all its members for being instrumental in keeping alive the goals of our motivation, notably through the publication of the magnificent Anvil’s Ring.

François Choquette
program director

Daniel Gouffé
maître forgeron
compagnon du devoir du tour de France

teacher

Louis Barrette
apprentice smith
ABANA member


Coming Events

1983

**Turley Forge**... Regular blacksmithing classes are scheduled for February 7–March 18, March 28–May 6, May 16–June 24, September 19–October 28 and November 7–December 16. For application, write to: Turley Forge, Route 10, Box 88C, Sante Fe, New Mexico 87501.

June

... An exhibition of forged ironwork is being planned in Houston for next June. Gallery Space is being provided by Dave Folkman of Little Egypt Enterprises.

If you would like to present one or two pieces, please send slides of your work. There is no entry fee, although you will be responsible for shipping costs. If you would like to sell your piece, please indicate the price along with the other information. Size will be limited to passage through a normal doorway. Entries will be juried to accommodate space. Complete details will be sent to all who submit slides. The exhibition is open to all members of ABANA and BABA. Send your slides or photos to:

Michael Moore  
The Whistling Forge  
811 Oxford  
Houston, Texas 77007

Dave Folkman  
Little Egypt Enterprises  
1401 W. Gray  
Houston, Texas 77019

1-August 5... "Forging Ahead: Indiana Blacksmithing 1983" an exhibition of contemporary ironwork presented by the Indiana Blacksmithing Association at the Indiana State Museum, 202 North Alabama Street, Indianapolis, Indiana.

1-August 10... "Hinge, Hasp and Knob" an exhibition of door hardware including historical pieces from private collections and contemporary forge work by American artist-blacksmiths at the National Ornamental Metal Museum, 374 West California, Memphis, TN 38106. (901) 774-6380.

11-July 9... "Table Ware" at the Vermont State Craft Center at Frog Hollow, Middlebury, VT. Open to current or former Vermont residents. Eligible objects related to the occasion of dining in any media. Jurors: Fran and Priscilla Merritt. Cash and merit awards. Slides (maximum 3 per entry) due May 7. For Entry forms write: "Table Ware," Vermont State Craft Center at Frog Hollow, Middlebury, VT 05753.

11-July 11... "From Iron Age to Space Age" an eclectic gathering of colored space age and traditional metals of varying precious qualities will be shown. Techniques used will range from the traditional Japanese layering, mokume-gane, to electrified space age metals. It presents a full spectrum of work being done today. At the Craft Alliance Gallery, 6640 Delmar Blvd., St. Louis, Missouri.

12-24... Jim Wallace teaches "Blacksmithing: Design Elements in Forged Steel" at the Haystack Mountain School of Crafts. The workshop will concentrate on metal fabrication techniques. Mixed media will be stressed utilizing materials found in the school's environment. Along with basic techniques, design and concept will be discussed. Haystack Mountain School of Crafts, Deer Isle, Maine 04627.

13-17... Richard Mafong teaches Japanese repoussé and chiselwork at the Appalachian Center for Crafts. Processes in making the Japanese tools for repoussé and chasing. Appalachian Center for Crafts, Rt. 3 Box 347 A-1 Smithville, TN 37166. (615) 597-6801.

13-17... Rober Coogan teaches knife making at the Appalachian Center for Crafts. Will primarily examine the stock method of knife making, with a critical look at the design and function of a knife and its production technique. Appalachian Center for Crafts, Rt. 3 Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

17-September 4... "Towards a New Iron Age" an international exhibition of contemporary ironworks, organized by the Victoria and Albert Museum, London. At the American Craft Museum I, 44 West 53 Street, New York City.

20-24... Daryl Meier teaches pattern-welded steel (Damascus) at the Appalachian Center for Crafts. An introductory workshop in the basics of Damascus steel. Lectures and demonstrations will provide participants information which they will use for hands-on set up and welding of Damascus. Appalachian Center for Crafts, Rt. 3 Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

21-26... ACC Craft Fair at Rhinebeck, New York, sponsored by American Craft Enterprises, Inc., a subsidiary of the American Craft Council. This craft fair annually attracts over 4,500 wholesale buyers and 50,000 visitors. It records sales upwards of $5,000,000. Exhibition space is sought after by 2,500 craftspeople because of this event's...
outstanding quality. Application deadline is January 7, 1983. Applications are accepted in all craft media from craftpersons living anywhere in the United States. Five slides must be submitted with official application packet and $20.00 screening fee. Contact American Craft Enterprises, Inc., P.O. Box 10, New Paltz, New York 12561.

26-July 15 ... Douglas E. Wilson teaches “Blacksmiting: Process, Form and Relationship” at the Haystack Mountain School of Crafts. The workshop will explore the relationships of process and the development of form. Emphasis on direct forging technique, forge welding, design and careful craftsmanship. Haystack Mountain School of Crafts Deer Isle, Maine 04627.

26-July 15 ... Carol Kumata teaches metalsmithing at the Haystack Mountain School of Crafts. The workshop will concentrate on metals fabrication techniques. Mixed media will be stressed utilizing materials found in the school’s environment. Along with basic techniques, design and concept will be discussed. Haystack Mountain School of Crafts, Deer Isle, Maine 04627.

27-July 1 ... Phil Baldwin teaches blacksmithing at the Arrowmont School of Arts and Crafts, P.O. Box 567, Gatlinburg, TN 37738.

27-July 1 ... Frank Turley teaches handtools for the smithy at the Appalachian Center for Crafts. Students will make their own hand-hammer and tongs. Other blacksmithing tools will be produced as time permits. Heat treatment of tool steels will also be covered. Hands-on demonstrations and lectures for beginning to intermediate participants. Appalachian Center for Crafts, Rt. 3 Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

July

2&3, 9&10 ... The seventh Annual American Crafts Festival at Lincoln Center in New York City. This year we are expecting an attendance of 150,000 visitors. Participating craft artisans have earned an average estimated $3,000-$5,000 per weekend in the two-weekend event. Contact: Brenda Brigham, American Concern for Artistry and Craftsmanship, P.O. Box 221, Uptown Station, Hoboken, New Jersey 07030.

3-16 ... Ira DeKoven teaches Approaches to Architectural Ironwork at the John C. Campbell Folk School, Rt. 1, Brasstown, NC 28902. (704) 837-2775.

4-8 ... Jim Wallace teaches blacksmithing at the Appalachian Center for Crafts. An introduction to all basic forging operations and an exploration in combining simple procedures for producing complex objects. Beginning to intermediate students. Appalachian Center for Crafts, Rt. 3, Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

4-15 ... Charlie Fuller teaches blacksmithing at the Arrowmont School of Arts and Crafts, P.O. Box 567, Gatlinburg, TN 37738.

11-15 ... Barry Wheeler teaches beginning blacksmithing at the Crafts Center, Cedar Lakes. A hands-on experience for students to develop the basic skills and techniques for forging bar and sheet metal. Fire maintenance, metalurgy, heat treatment and toolmaking will be covered with special emphasis on setting up a shop. Crafts Center, Cedar Lakes Conference Center, Ripley, WV 25271.

17-30 ... Robert Timberlake teaches intermediate blacksmithing at the John C. Campbell Folk School, Rt. 1, Brasstown, NC 28902. (704) 837-2775.

18-19 ... Andrew Lins, Conservator for Decorative Arts, Philadelphia Museum of Art teaches an introduction to metals conservation. A survey of the basic properties of the metals and conservation techniques used in decorative arts and sculpture. Common alloys of copper, tin, lead, iron and silver are discussed, with some consideration given to zinc and aluminum alloys. Special emphasis is placed on the preventive measures which can be taken to preserve metals. How to recognize structural or corrosion problems that require conservation treatment is also stressed. Campbell Center Box 66, Mt. Carroll, IL 61053.

18-22 ... Ivan Bailey teaches blacksmithing at the Appalachian Center for Crafts. Will cover basic forging techniques, including leaves and fire welding. Specialized techniques such as steel carving, inlaying of precious metal, sheet forming hollow bird forms and enameling on iron will be included. Beginning to advanced. Appalachian Center for Crafts, Rt. 3, Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

IRON AGE ANTIQUES
WE BUY, SELL AND TRADE
Hand & Power forging Tools of all kinds — some new, mostly used ... wood stoves ... old books ... old tools ... primitives in wood and metal ... old trade pictures
ANVILS ARE OUR SPECIALTY
Call or write: BILL GICHNER
IRON AGE ANTIQUES
Ocean View, Dela. 19970
(302) 539-5344 or (302) 539-6274

Summer 1983
18-22... Richard Prillaman teaches repoussé and chasing at the Appalachian Center for Crafts. Functional processes involving repoussé, flat-chasing, tool construction, embossing and punching metal surfaces. Individual expression and special interests of participants will be considered. Appalachian Center for Crafts, Rt. 3, Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

21-22... E. C. Pfeffer teaches characteristics and care of antique ironwork at the Campbell Center for Historic Preservation Studies. This workshop will give an overview of historical blacksmithing: its tools, techniques, and designs, with emphasis on forged ironwork and its preservation and reconstruction. Included will be traditional methods of joinery, methods of preserving and caring for forged and cast ironwork (interior and exterior), and examples of and demonstrations using traditional smithing tools. Special attention will be given to examples and types of early American wrought iron and the role of the blacksmith in the development of early American life. The two evening sessions will be available for students to make some forged iron pieces using a coal-fired forge, hammer, anvil and other traditional blacksmithing tools. Campbell Center, Box 66, Mt. Carroll, IL 61053.

22-24... ACC Craft Fair at Newport, Rhode Island, sponsored by the American Craft Enterprises, Inc., a subsidiary of the American Craft Council. The first Annual Fair at Newport attracted over 9,000 visitors. It is offered as an alternative to craftsmen specifically interested in exhibiting and selling their work to the retail buying public. Application deadline is January 7, 1983. Applications are accepted in all craft media from craftspersons living anywhere in the United States. Contact American Craft Enterprises Inc., P.O. Box 10, New Paltz, New York 12561. Five slides must be submitted with official application packet and $10.00 screening fee.

25-29... Randy McDaniel teaches fantasy and nature forms in wrought iron at the Appalachian Center for Crafts. Hot forging of dragons, unicorns, flowers, leaves and the like by hammering, steel carving, chasing, inlaying, repoussé, forge welding, forge brazing and other advanced techniques. Intermediate to advanced. Appalachian Center for Crafts, Rt. 3, Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

25... August 5... Hiroko Pitkanowski teaches metalworking at the Arrowmont School of Arts and Crafts, P.O. Box 567, Gatlinburg, TN 37738.

---

**ABANA LIBRARY RENTAL FEE SCHEDULE**

**MAY, 1982**

**SLIDE SETS:**
- BLACKSMITHING TODAY $15.00
- ARCHITECTURAL IRONWORK $15.00
- ALFRED SCHMIDT $15.00
- FRANCIS WHITAKER $25.00
- METALSMITHING '80 $15.00
- SID BIRT, KNIFEMAKER $15.00
- JACK BRUBAKER $15.00

**16mm FILMS**
- THE MAKING OF WROUGHT IRON (Yellin) $15.00
- BLACKSMITH WORKSHOP $25.00
- IVAN BAILEY $10.00
- FIRE AND FANTASY $25.00

**VIDEO TAPES**
- SAMURAI SWORD $10.00
- MAKING STONE CUTTING TOOLS $10.00
- IVAN BAILEY $20.00
- FIRE AND FANTASY $20.00

All fees from ABANA Library rentals are used to help cover expenses in copying, maintaining and expanding the rental library.

The ABANA Library depends on donations of slides, films, and tapes to expand its collection. It is from this collection that slide sets are produced. All blacksmiths are invited to contribute slides of their ironwork, historical ironwork, tools, jigs and processes. If you have or know of any material which is of historical or educational value to ABANA members please contact:

Jack Brubaker
ABANA Library
RR2, Box 102A
Nashville, IN 47448
Phone 812-888-7630

All donations are tax deductible.
Slide donations should include identification of producer, dimensions, materials used and date made.

---

the Anvil’s Ring
August

1... Deadline for application to the Fourth Annual Fair of Traditional Crafts held November 5-6 at Old Sturbridge Village. Craftpersons who demonstrate a process or create a product typical of 19th century New England are invited to apply. Demonstration is required. Contact: Frank G. White, Old Sturbridge Village, Sturbridge, MA 01560. (617) 347-3362.

1-5... Bruce LePage teaches new directions in forging for furniture at the Appalachian Center for Crafts. Furniture design and construction using the muzzleloading gun making techniques of forging, wood carving, inlay and engraving. Techniques used to make a stool, involving forging the base, carving the seat, inlay and engraving of brass or silver will be demonstrated. Students will design and create their own pieces. Appalachian Center for Crafts, Rt. 3, Box 347 A-1, Smithville, TN 37166. (615) 597-6801.

7... September 18... "Tools of the Woodworker" an exhibition of personally designed and made tools, benches, equipment and machinery for the use of the wood craftsman. This exhibition seeks to document the development of the toolmaker's art relative to the skills of the modern woodworker. Historical tools from several collections will be combined with the contemporary selected work to provide a wide view of the tools used by cabinetmakers, boat builders, coopers, millwrights, wheelwrights and lumberjacks which will shed special light on the skills of the "toolmaker". Brookfield Craft Center Inc, P.O. Box 122, Brookfield, CT 06804.

8-12... Alf Ward teaches knife and tool making at Brookfield Craft Center, P.O. Box 122, Brookfield, CT 06804. (203) 775-4526.

11-14... "The 8th Annual Craft Fair at San Francisco." The craft fair at San Francisco, sponsored by American Craft Enterprises, Inc., a subsidiary of the American Craft Council, annually attracts over 1,700 wholesale buyers and over 20,000 visitors. It recorded sales of almost $1,500,000 in 1982. Quality craftsmanship is assured as a result of the unique selection procedure used to jury the work submitted by hundreds of artists from across the nation. The fair will be held at Fort Mason Center, San Francisco, CA. Application deadline is March 10, 1983. Five slides must be submitted with the official application packet and a $10 screening fee. Applications are accepted in all craft media from craftpersons living anywhere in the United States. Contact: American Craft Enterprises, Inc., P.O. Box 10, New Paltz, NY 12561. (914) 255-0039.

14-20... Glenn Gilmore teaches pattern welded steel (decorative Damascus) at the John C. Campbell Folk School, Rt. 1, Brasstown, NC 28902. (704) 837-2775.

27... "Second Annual Ingram Hammerfest" with much Merriment and hammering at several forges. Over 45 blacksmiths participated in 1982. Contact: R. Ross, Guadalupe Forge, Box 816, Ingram, TX 78025. (512) 367-4433.
September

1. . . . Deadline for application to the Eighth Annual Herkimer County Arts and Crafts Fair sponsored by the Herkimer County College Foundation, Inc. for the benefit of student scholarships. Attendance last year was over 14,000 due to efforts to promote the original work of creative artists and craftspeople. Contact: Grace McLaughlin, HCCC, Reservior Road, Herkimer, NY 13350.

3-6 . . . Francis Whitaker teaches a workshop at the Cedar Creek Forge. Contact Jim English, N70 W6340 Bridge Road, Cedarburg, Wis. 53012.

4-17 . . . Advanced 18th Century Ironwork is taught by Mark Bokenkamp (first week) and Peter Ross (second week) at the John C. Campbell Folk School, Rt. 1, Brasstown, NC 28902. (704) 837-2775.

10 . . . Slide entries due for “The Figure: New Form, New Function” a National juried exhibition sponsored by Arrowmont School of Arts and Crafts. The focus of this exhibition is to explore a variety of concepts as related to the figure and to project new forms and functions in any two or three dimensional media. Contact: The Arrowmont School, Box 567, Gatlinburg, TN 37738.

10-11 . . . Early American Wrought Iron Conference hosted by the Delaware Agricultural Museum. Its third annual weekend of demonstrations, films, lectures, tool swap and hands-on practice for novices. Registration can be by mail or at the door. Please write DE AG Museum, 866 N. DuPont Hwy., Dover, DE 19901 or call 302-734-1618.

16 . . . October 14 . . . “Blacksmithing: German and American,” an exhibition of 28 blacksmiths (14 German and 14 American) jointly sponsored by the Goethe Institute Munich, the Goethe Institut of the United States and Canada, ABANA and the Southern Arts Federation will be at The Public Library of Cincinnati and Hamilton City, 800 Vine Street, Cincinnati, Ohio 45202.

24-25 . . . Ninth Annual Croton Craft Fair sponsored by the Croton Lions Club and the Westchester County Dept. of Parks. A professional-level show, interested participants are urged to contact: Monya Brown, 33 Lexington Dr., Croton on Hudson, NY 10520.

“Towards a New Iron Age” . . . an international retrospective of 20th Century ironwork initiated by the Victoria and Albert Museum in London, is scheduled to appear at the following museums: University Museum and Art Galleries, Southern Illinois University, Carbondale, Illinois January 15—February 27; Mint Museum, Charlotte, North Carolina March 27—May 22; American Craft Museum, New York, New York June 11—September 25. For additional information on the exhibit, contact James Wallace, Director, or Judy Coomber, Assistant to the Director, National Ornamental Metal Museum, 374 West California, Memphis, TN 38106. Tel: 901-774-6380.

October

1 . . . Deadline for application to the American Craft Council fair at the Baltimore Convention Center February 15-19, 1984. The ACC Craft Fair At Baltimore (formerly called Wintermarket), now in its eighth year, is sponsored by American Craft Enterprises, Inc., a subsidiary of the American Craft Council. The ACC Craft Fair At Baltimore annually attracts over 3,000 wholesale buyers, and 30,000 visitors. It records sales upwards of $3,500,000. Exhibition space is sought after by over 1,400 craftsperson because of this event’s outstanding quality, which is a result of its unique selection procedure. Contact: American Craft Enterprises, Inc. P.O. Box 10, New Paltz, NY 12561. (914) 255-0039.

15 . . . Deadline for application to the American Craft Council fair at the Dallas Market Center. The ACC Craft Fair At Dallas, April 4-8, 1984 is now in its fifth year and is sponsored by American Craft Enterprises, Inc., the marketing subsidiary of the American Craft Council. This event was designed to meet the marketing needs of professional craftsperson living in mid-America. American Craft Enterprises, Inc. also sponsors the prestigious ACC Craft Fair At Rhinebeck, NY; Baltimore, MD; Newport, RI; and San Francisco, CA. Contact: American Craft Enterprises, Inc., P.O. Box 10, New Paltz, NY 12561. (914) 255-0039.

November

6-19 . . . Francis Whitaker teaches advanced blacksmithing at the John C. Campbell Folk School, Rt. 1, Brasstown, NC 28902. (704) 837-2775.

December . . . “Blacksmithing: German and American,” an exhibition of 28 blacksmiths (14 German and 14 American) jointly sponsored by the Goethe Institute Munich, the Goethe-Instituts in the United States and Canada, ABA-NA and the Southern Arts Federation will be at Goethe Institute Atlanta for German-American Week. Exact location will be forthcoming.

(continued from page 35)

as a tas the end-grain of a section of tree-trunk. The workman on the left appears to be shaping a piece of tole on some type of anvil gripped in the vise. The other two workmen are assembling components.

The bottom of the plate shows the components of the decoration and the assembled decoration. The scale at the bottom is four feet which indicates that this piece of work was about eight feet wide.


Blacksmithing and Decorative Iron Books

1. A Historical Guide to Wagon Hardware and Blacksmith Supplies, Spilve, $11.95
2. Antique Iron, Shafter, $24.95
3. Antique Ironwork, LeCoq, $47.50
4. Art Nouveau Decorative Ironwork, Meyer, $3.95
5. Art Nouveau Ironwork Illustrated, Voit, (German text), $20.50
6. Blacksmithing, Daven, $7.95
7. Blacksmith’s Manual Illustrated, LeCoq, $6.95
8. Blacksmith’s' and Farriers' Tools at Shelby Museum, Smith & Pressman, $9.95
9. Catalog of Drawings for Wrought Ironwork, CoSPA, $14.00
10. Colonial and Early American Lighting, Hoyland, $4.50
11. Decorative and Sculptural Ironwork, Macht, $8.95
12. Decorative Antique Ironwork, d’Altons, $11.95
13. Decorative Ironwork, CoSPA, $8.75
14. Designs of Contemporary Decorative Iron Work, Vol. II (German text), $17.95
15. Diderot Pictorial Encyclopedia of Trades and Industry, Vol. 1, (Diderot), $20.00
17. Direct Metal Sculpture, Macht & Scalet, $12.95
18. Domestic Fabricated Iron Objects, LeCoq, $55.00
19. Early American Wrought Iron, Spilve, $19.95
20. Edge of the Anvil, Andrews, $19.95
21. Metals for the Engineering Craftsman, CoSPA, $8.75
22. Methods of the Art-Blacksmith, Voit, (German and French text), $15.95
23. Gates and Grilles, Schmied, (German text), $14.95
24. Practical Blacksmithing, Richardson, $7.95
25. Practical Projects for the Blacksmith, Tucker, $12.95
26. Professional Smithing, Shafter, $19.95
27. Southwestern Colonial Ironwork, Simmons & Taylor, $14.95
28. Staircases and Railings, d’Altons & Klauser, (German text), $18.95
29. Step-by-Step Knitting Tools, Matz, $16.95
30. The Art of the Blacksmith (Revised), Reidel, $19.95
31. The Art of the Wheelwright, Daven, $2.95
32. The Art of Wrought Metalwork for House and Garden, Schmier, $49.95
33. The Artis-Blacksmith Otto Schmied, Schmier, (German text), $99.50
34. The Blacksmith and His Art, Hay, $12.50
35. The Blacksmith’s Craft, CoSPA, $8.75
36. The Blacksmith’s Source Book: An Annotated Bibliography, Fleming, $18.95
37. The Making of Tools, Weigros, $6.95
38. The Modern Blacksmith, Weigros, $6.95
39. The Recycling, Use and Repair of Tools, Weigros, $6.95
40. The Shaping of Steel, Kuhn, (German text), $39.50
41. The Practical Handbook of Blacksmithing and Metalworking, Blandford, $12.95
42. The Work Methods and Tools of the Art-Blacksmith, Schmier, $39.50
43. To Draw, Upset, and Weld, Ullanden, $7.95
44. Wrought Iron, Kuhn, $17.95
45. Wrought Iron, Spilve, $39.50
46. Wrought Ironwork, CoSPA, $8.75
47. Wrought Ironwork for House and Garden, Batszoch, (German text), $29.95

California residents add 6% sales tax; Add $1.95 for the first book plus 45c for each additional book to cover postage and handling; Money Back Guarantee — full refund when returned postage paid within 10 days. Prices are subject to change without notice; Send check or money order to: Norman A. Larson, 5426 Hwy. 248, Lompoc, Ca. 93436

$8.00 per issue to ABANA members ($10.00 to non-members)

Send to: Carl Van Arnam, Sec.-Treas.
ABANA
P.O. Box 1191
Gainesville, Fla. 32602

(check or money order must accompany all orders for amount of purchase)
ABANA's Beginnings at Westville

by Matthew Moye

Matthew Moye, Director of Westville Historic Handicrafts, Inc., who participated in this "first," has been kind enough to provide us with this excerpt from his publication, The Westville Mirror. Westville is an historic community located in Lumpkin, Georgia.

In what seemed like an appropriate gesture, Westville invited the Artist-Blacksmiths' Association of North America (ABANA) to hold its tenth anniversary convention here in the village where it was born. Came the reply: "ABANA's grown too big for Westville now. Your Village wouldn't be able to hold us all." The youthful arrogance of that statement is truly a compliment to Westville. It affirms that we did our job well.

In fact, ABANA has grown from an initial membership of those 20 blacksmiths, who together wrought out ABANA over Westville's forges in March of 1973, to over 2000 members today. There are regional affiliations as well, each bringing more and more people together for the pleasure of blacksmithing.

ABANA's quarterly journal, the Anvil's Ring, which began immediately after the 1973 Westville conference as a photocopy newsletter, has now evolved into a fullblown slick magazine. Each 48-page issue is packed with photos and illustrations and contains history, correspondence, translations, book reviews, biographies, techniques, interviews, editorials, and much, much ironwork design. The Board of Directors has recently established the Alex W. Bealer Award to be presented periodically to the person who has "contributed the most to assist the growth of blacksmithing."

So, if the Village isn't big enough to hold the ABANA membership anymore, then Westville, now the absentee parent, can still commemorate the organization by providing a little insight on just how ABANA was conceived.

First of all, why Westville? The Village of Westville, "Where It's Always 1850," exists to provide a proper setting for the historic handicrafts demonstrated in and around its buildings. The State of Georgia in 1966 granted Westville a charter to caretake and interpret these handicrafts, which had started dying out about 1860 because of the advent of specialized mechanization.

Blacksmithing, of course, is one of these handicrafts. Alarmed at the critical shortage of its practitioners, Dr. Joseph B. Mahan, Jr., then-director of Westville, in 1972 contacted Alex Bealer, author of the 1969 classic blacksmithing bible, "The Art of Blacksmithing." Dr. Mahan suggested a blacksmithing conference. Bealer, an advertising executive in Atlanta, was familiar through his book research with the major remaining blacksmiths in the country. He also knew that a 1970 academic workshop on the subject at Southern Illinois University (organized by Dr. L. Brent Kingston) had been very successful. Bealer reasoned that a similar conference, emphasizing demonstrations by the participants, might be just as successful.

Mr. Bealer soon compiled a list of 150 names, and invitations went out. A remarkable 50 acceptances came back, some having heard about the conference third-hand only days before the convention. The conventioners came from 14 states across the country. 19 were Georgians, but ten came from Pennsylvania, and five from Illinois. Several travelled 3,000 miles to come.

The first day of the two-day event was March 16, 1973. Following are the topics:
1) Introduction — Alex Bealer; 2) "Making tools and tempering steel" — E.W. Homé (third generation blacksmith), Atlanta; 3) "Modern design in iron" — L. Brent Kingston (first modern academician to popularize blacksmithing), Makanda, IL; 4) "Making Damascus steel" — Ivan Bailey (academically trained in the fine arts, studied blacksmithing in West Germany, now offering blacksmithing apprenticeships), Savannah; and 5) "Traditional design in iron" — John Allgood (native Georgian, master blacksmith at Colonial Williamsburg since 1949), Williamsburg, VA.

The second day was left open for the participants to demonstrate. They obviously did more, because March 17, 1973 was ABANA's birthday. 19 of the participants chipped in five dollars to become charter members. They are pictured and named in the accompanying photo taken that day in front of Westville's blacksmith shop. Alex Bealer was elected president and Dimitri Gerakaris was elected Secretary.

Gerakaris is still active and recently retired as editor of the Anvil's Ring. George Cobb, then Westville's blacksmith, was the only local charter member.

According to a news release issued that day by Westville, the purposes of the new organization would be to provide communications among the country's blacksmiths, to foster training facilities and to act as a communications network between blacksmiths and the consuming public.
Study blacksmithing at nation's only Folk School. Beginning, intermediate and advanced courses year-round. Architectural workshops with Francis Whitaker (May 8-14) and Ira DeKoven (July 3-16). Eighteenth Century Ironwork with Mark Bokemken and Peter Ross (Sept. 4-17). Many others. Brochure: Campbell Folk School, Brasstown, N.C. 28902. (704) 837-2775.

For Sale: Missouri Art and Craft Fairs 1983 is now ready for distribution from Craft Alliance. The $2.00 pocket sized calendar provides basic information about nearly 100 upcoming fairs throughout the state, where artists display and sell their finest original and handcrafted work. Send $2.00 and a self-addressed, stamped envelope to Craft Alliance Education Center, 6640 Dalmar Blvd., University City, MO 63130.

For Sale: Two 25 lb. Little Giant trip hammers in excellent condition. One 50 lb. like new with no motor. Maurice V. LePage, Rt. 2 Box 3, Waverly, MN 55390.


For Sale: 75 lb. (No. 3) Beaudry trip hammer with extra dies, $850. Ken Wilson, 1524 W. 166th Place, Homewood, IL 60430. (312) 957-1711.


For Sale: 50 lb. Moloch powder hammer complete with 2 hp motor and plain face dies, extra spring and in excellent shape. $3000. Ray Nager, 5712 West Sligh Ave., Tampa, FL. (813) 886-4603.

For Sale: 50 lb. Little Giant in good running shape. Contact Jack Andrews, 1482 Maple Avenue, Paoli, PA 19301.

For Sale: Coal (0.4% Sulfur, coke button-8) Price depends on quantity and shipping. Excellent (light) 100 lb. Little Giant with 3 hp single phase motor, pattern, extra dies. Could deliver to ABANA 1984 Conference or points in between. Air compressors and other hammers available. Also a 9" Niagara hand shearpunch (weighs about 500 lb.). Contact Russ Swider, Box 111, Rowe, NM 87562.

Announcement: People interested in a 5 day Don Hawley, power hammer workshop concentrating on power hammer tools, their making and use, tool steel, and of course power hammer safety contact Russ Swider, Box 111, Rowe, NM 87562. Approximate price is $250 for 5 days, limited to 15 participants. Dates will be set when response is analyzed. Site at By Hammer and Hand forge.

Apprenticeship: Programs in architectural ironwork. By Hammer and Hand has the best equipped shop in the Southwest for handling traditional and contemporary forgework. Write with pertinent background information for details and dates. Russ Swider, Box 111, Rowe, NM 87562.
The more you know about metallurgy the better your metalwork.

Heat Treatment of Steel
In this updated course that covers practical heat treating of carbon, alloy, stainless and tool steels, there is emphasis on process applications — including valuable information on atmosphere control, quenching and temperature control and the type of equipment that is proper for different types of heat treating operations. You also examine difficult heat treating procedures, such as carburizing, carburitriding and nitriding. There is also detailed coverage on quenching medium and equipment to help you increase your understanding of hardening of steel.


Making, Shaping, Finishing and Heat Treating of Steel for the Non-Metallurgist.
This course is designed to provide technical instruction in an easy to understand manner for the non-metallurgist. Much emphasis is placed on pig iron and how it is refined into various compositions of steel. Modern processing is emphasized throughout the course. Basic fundamentals of heat treating are presented in easy to learn language. The course concludes with an overview of cleaning and finishing operations for steel sheet, strip, rod, etc., such as cold rolling and drawing, plus surface treatments.

Specific areas to be covered: Raw Materials for Steelmaking □ The Coking Operation □ Blast Furnace Process □ Open Hearth Operation □ Electric Steelmaking Processes □ Pneumatic Processes for Steelmaking □ The Ingots State, Continuous Casting and Degassing □ Soaking Pits and Primary Mills □ Rolling Sections and Bar Products □ Flat Rolled Steel Products □ Forging Theory and Practice □ Press Forging and Other Forming Methods □ Iron and Steel Founding □ Heat Treatment of Steel □ Finishing Operations


Fill out and mail this registration form today!

Course Requested _____________________________

Total Amount _______ Check Enclosed

☐ Please send detailed information on all 27 home learning courses of special interest to me.

☐ I would like information on all ASM learning formats, such as seminars and intensive courses.

Name _____________________________ SS *

Address ____________________________________________

City/State/Zip ____________

Phone (__________) _____________ ASM member *

Charge:

☐ VISA ☐ MasterCard

☐ American Express

Card No. _____________________________

Expires _____________________________

Mail To:
American Society for Metals
Metals Park, OH 44073, Or
call (216) 338-5151, ext. 600
for further information