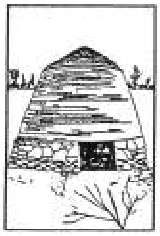


Chapter 5
Historical Overview of Charcoal Making

The Charcoal-Making Process

Whereas iron mining was more or less connected to a blast furnace or bloomery forge, charcoal making was not. The iron industry, not only in Vermont but in neighboring New York and Massachusetts, did in fact consume much of the charcoal made in this state. Much charcoal also found markets in the copper-smelting operations at Strafford and Vershire, in iron and brass foundries that dealt with metals requiring special qualities, and also in glass foundries.

Charcoal was used because it is nearly 100 percent pure carbon and burns hotter than wood. There are other reasons why the ancients chose charcoal over traditional fuels (wood and baked dung, for example), but to understand why, exactly what happens during the smelting process must be understood:

> Combustion is an oxidation process. That is, oxygen must combine with the carbon, hydrogen, and hydrocarbons of which all fuels are made in order for the fuel to burn. In many pyrotechnological processes, such as ceramic production and metallurgy, the atmosphere in which combustion occurs is critical. There are two extremes. We speak of a reducing atmosphere when oxygen is insufficient for complete combustion; we speak of an oxidizing atmosphere when the draft in a furnace is strong enough to provide more air than necessary for the fuel to burn. The excess oxygen will combine with any other suitable substance it finds, for example, the metal being smelted.
>
> Roasting in an open container over a wood fire is an oxidizing process. The aim is to drive off the sulfides or other impurities in the ore and replace them with oxides. However, the problem in smelting is one of reduction. The aim is to *remove* oxygen from [ore]-bearing compounds, not add more. [Closing] the draft would create a reducing atmosphere, but it would also probably lower the furnace temperature below the point where smelting takes place. There is, fortunately, an alternative. Instead of closing the draft, a reducing fuel can be used, and that is precisely where charcoal comes in. Unlike wood, charcoal is composed largely of pure carbon, the other elements having been burned off in the charring process. It produces quantities of carbon monoxide gas when burned and creates an oxygen-starved atmosphere (Horne 1982:7-8).

Exactly when in history charcoal making (also called coaling) started is not known. Charcoal sometimes results from incomplete burning of wood in a fireplace. In reburning it, ancient man might have noticed that the charcoal emitted no smoke and burned hotter—an obvious improvement over burning wood. It was probably trial and error that resulted in the use of charcoal for smelting ores. Feeding charcoal into the primitive forge, early humans knew nothing about chemistry, oxidation, or oxygen-hungry atmospheres.

Even the ash of the charcoal was a desirable element in making iron due to its fluxing qualities. Mineral coal was experimented with and tried in iron furnaces many times through the ages, but it contained too many impurities that adversely affected the quality of the metal reduced in the furnace. Until 1735, when Abraham Darby successfully coked coal in his furnace at Coalbrookdale, England, the iron industry fueled its furnaces and bloomeries with charcoal.

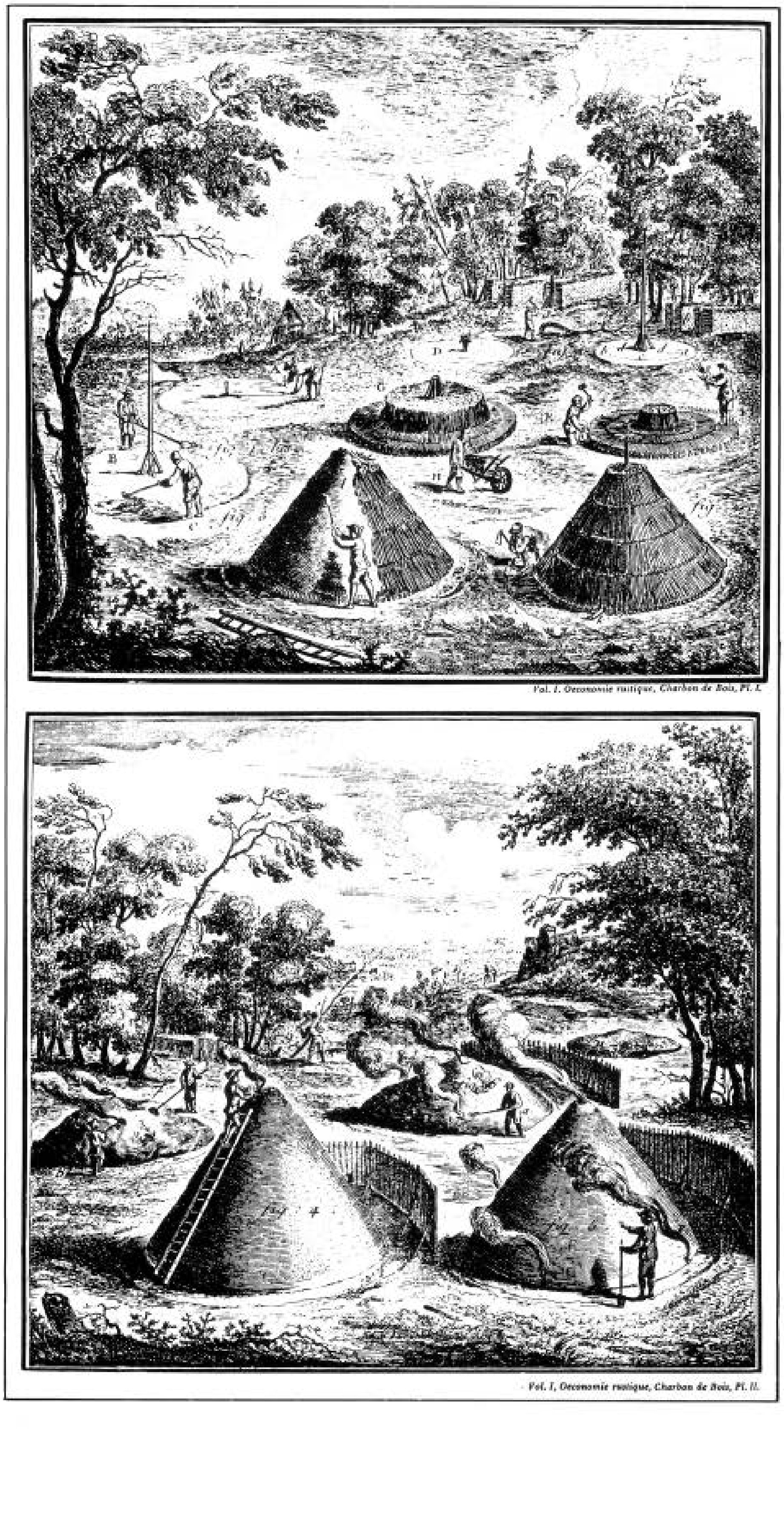
Charcoal making in Vermont descended from a long history of the industry that reaches into ancient time. Charcoal was made by the reduction of timber, and Vermont, like most of New England and New York at the time, abounded in what were once considered to be boundless forests. Charcoal was cheap and easy to make (as long as the forests remained boundless) and being light in weight, large quantities of it could be transported great distances with moderate effort. Since most early ironworks were built next to good running streams, they were also usually situated in or near a good stand of forest. Thus the distance and time was small between chopping trees, charring the wood, and delivering the charcoal to the works in the very early days of the industry.

Only live trees were cut for making charcoal, and they were best cut in winter while the sap was held in the roots. This reduced the amount of pitch that had to be burned off and increased the quality of the charcoal. It also reduced the weight of the logs, lessening the woodchoppers' efforts. In addition to stimulating woodchoppers to work to keep warm, the cold winter snows eased the transportation of heavy loads of wood by animal-drawn sleigh. Leaves, small branches, and sometimes the bark were stripped away, making more efficient use of the space in the kiln for more solid pieces of wood. The wood was cut into exactly 4-foot lengths. Diameter was not considered of much importance except that it be as uniform as possible. Very large pieces were split.

At 17th-century Saugus, Massachusetts, woodchoppers for the ironworks were prisoners brought by England from Scotland for that specific purpose (Clarke 1968:17). During the colonial and post-colonial period, slaves chopped wood at southern ironworks. By the Vermont ironworks era, woodchopping for the charcoal industry provided off-season work for farmers, some of whom periodically harvested stands from their own wood lots. Woodchopping also provided employment for ironworkers who might otherwise be unemployed during winter shutdown periods due to frozen, ice-covered waterwheels.

The price paid per cord for woodcutting varied with place and time. A woodchopper in Vermont was considered making good wages at 25¢ per cord, while the chopper in Missouri thought double that was still poor compensation. Cutting saplings and crooked timber cost somewhat more. Tall timber one to two feet in diameter were more profitable to cut. Hardened wood, maple, sycamore, and knotty timber were more expensive to cut than oak, beech, hickory, and pine. Hillsides were cleared with more difficulty than level ground and demanded higher wages.

A good woodchopper was expected to average three cords



5-1. *Charcoal making in Europe during the mid-1700s. The upper sketch shows the four stages of ground preparation for the mound, then the laying up of the cordwood. Note the collier's cabin and stacks of cordwood in the background. The lower sketch shows the mound in operation with stages of settling and, finally, to the right-center, a mound of charcoal (Diderot 1763: plates 24 and 25; courtesy Dover Publications).*

a day, a cord being a stack of logs 4 feet wide and high by 8 feet long, but a great deal of deception was practiced by the choppers. They cut the wood too short, laid up the wood in crooked and hard-to-measure rows, did not pile the wood tight, or set the cords on hidden rocks and stumps. An acre contained an average of 30 cords of wood and the price of wood in the 1850s was 5¢ to 10¢ a cord (Overman 1850:84-85). Ten years later, at Tyson furnace, good hardwood suitable for making charcoal delivered at the furnace cost $2.00 to $2.25 per cord (*Geological Surveys* 1864:13).

Some woodchoppers were expected to pile the wood in round piles ready for coaling. Wood was stacked on end, each piece being the standard 4 feet long. The pile was tighter at the top than the bottom (the pieces of wood leaned toward the center of the pile as they were stacked), so the measurement of the pile was made at the top. Capen Leonard of Chittenden published a small pamphlet in 1848 which contained a complex formula for calculating how much wood was in a pile: "Multiply together half the diameter and half the circumference, divide the product by 32 (if the wood be four feet in length), and the quotient will be the number of cords" (Leonard 1848:3). A table in the booklet that translated piles of wood with circumferences from 20 to 160 feet into cords of wood made everything much easier for the collier. It took much of the guesswork out of the problem and bypassed the formula. In the table, for a typical 4-foot-high woodpile measuring 30 feet in diameter (94 feet in circumference) the yield was 22 cords.

By the 1850s, special attention to analyzing the results of charring various species of wood resulted in a number of interesting conclusions. Of greatest importance to the ironmaster was the specific gravity of various kinds of wood. Hardwood weighs more than softwood and was preferred by blast furnace operations over softwood. Bloomeries preferred charcoal made from softwood. Since the quality of the iron produced in a blast furnace was limited by the height of the stack (for better draft), this in turn was limited by the crushing resistance of the charcoal. A successful iron production was possible only where the hardest woods were used, resulting in the hardest and heaviest charcoal.

The higher the specific gravity, the more dense the charcoal, and therefore the less tendency for the charcoal to crumble in the blast furnace. Dense charcoal maintained air spaces around itself and allowed for more efficient combustion. Compare the specific gravity of some samples of wood (where water = 1.0000) after the wood had been kiln-dried (Overman 1850:81):

Wood	Specific Gravity
Oak, white or red	0.6630
Sugar maple	0.6137
Beech	0.5788
Birch	0.5699
Poplar	0.4464
Pine, red	0.4205
Pine, white	0.3838

Another interesting evaluation of charcoal is to compare its relative heating ability to other fuels (Overman 1850:136):

One pound of:	Heated this many pounds of water:
Oil, wax	90 to 95
Ether	80
Pure carbon	78
Charcoal	75
Alcohol	67.5
Bituminous coal	60
Kiln-dried wood	36
Air-dried wood	27
Turf	25 to 30

The following, from the Fletcherville furnace near Mineville, New York, across Lake Champlain from Addison, presents weights of charcoal in pounds per bushel (lbs/bu) made from various types of wood (Egleston May 1879:384):

Wood	Lbs/Bu	Wood	Lbs/Bu
Sugar maple	19.0	Hemlock	12.8
Yellow birch	18.8	Poplar	12.3
Beech	17.0	Spruce	11.2
White ash	16.3	Basswood	10.6
Black ash	14.5	White pine	9.8

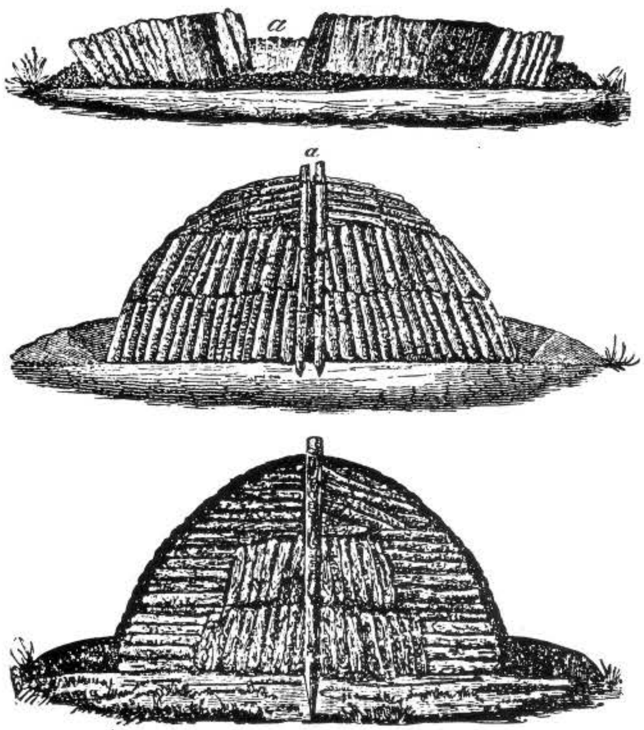
Note the density of the sugar maple charcoal relative to a majority of the other woods. The loss of huge stands of sugar maple in New York, Massachusetts, and Connecticut to the voracious appetites of charcoal-eating blast furnaces virtually wiped out the maple syrup industries in these states.

Charcoal was made by controlled burning of the wood. The burning was not allowed to progress beyond active smoldering, otherwise the entire effort would be consumed in flames. Properly controlled smoldering provided enough heat to burn off all the spirits and pitch in the wood, resulting in nearly 100 percent carbon remaining as charcoal. The uniformity of the charring process also guaranteed the uniformity of the charcoal's quality. Various configurations of wood stacking and techniques of wood burning were tried in the quest for both quality and predictable uniformity. By the post-Civil War period, a more permanent structure called a kiln was used, with a firing and operating procedure that approached an exact science.

Pits and Mounds

In the days before permanent kiln structures, wood was charred in earth-covered mounds. Thomas Egleston, who wrote many papers in the late 19th century on iron manufacture and charcoal making, called the mound types "meilers," a German word for charcoal kilns or piles. In his 19th-century dictionary of manufacturing arts, Andrew Ure described making charcoal in heaps, which he also called "meilers" (Ure 1854:397). Mound types were also called heaps, pits, and kilns. Heaps was synonymous with mound. Pits has been explained by some as an anachronism from the coal-mining industry—from days when coal was mined in pits. Kilns better define the later brick and/or stone structures. Other coal-mining expressions such as collier were carried over to the charcoal industry.

The most likely explanation for "charcoal pits" is based on



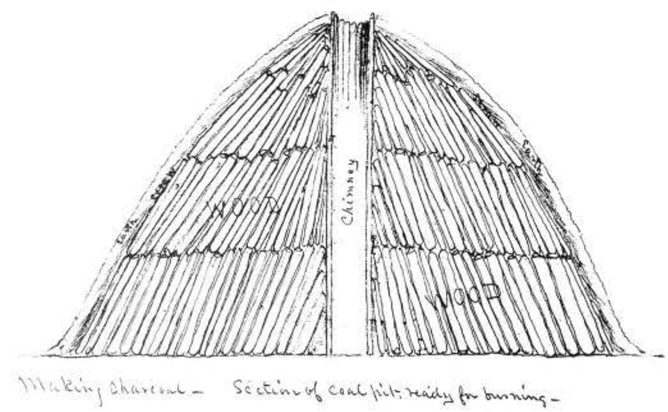
5-2. *A charcoal mound was built by first piling the cordwood vertically around the circumference (top) and continuing in alternate horizontal and vertical layers (bottom). A chimney was formed either by a number of small-diameter logs (center) that created a vertical airspace between them, or by a single large-diameter log placed vertically in the middle (bottom) to be removed later (Overman 1850:104, 105, 107).*

5-3. *A charcoal mound of cordwood ready to be covered with sod (courtesy* Berkshire Eagle, *Pittsfield, Mass.).*

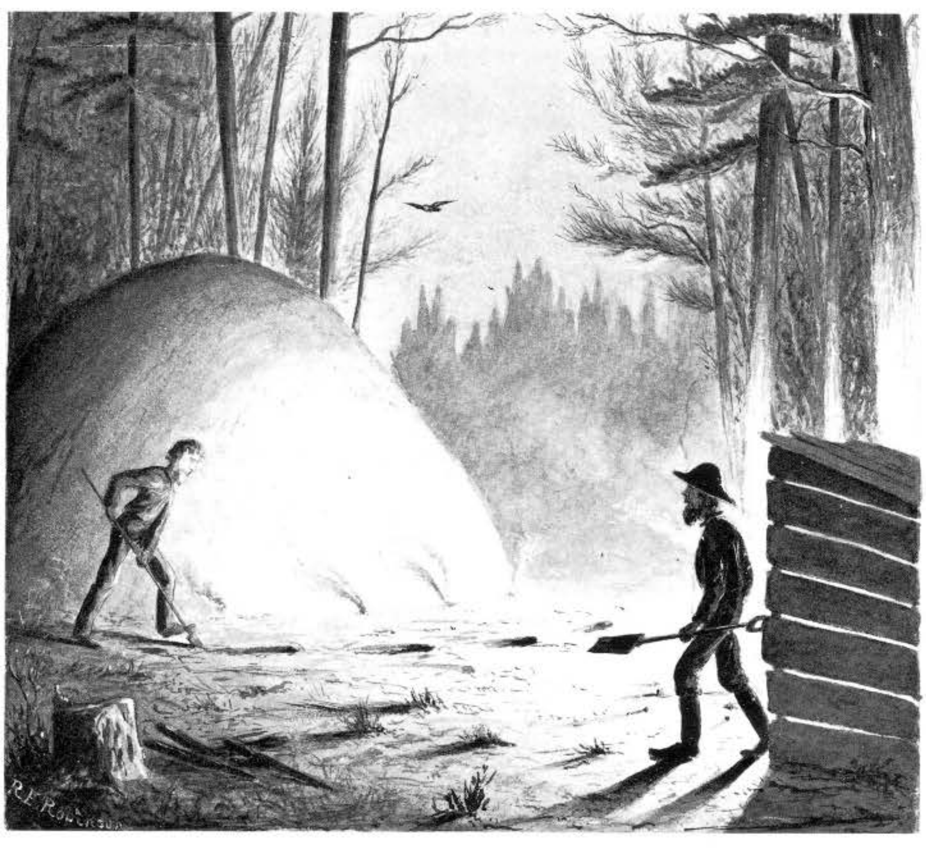
the charcoal-making process employed by the Romans to manufacture charcoal for their forges. Charcoal making in mid-19th-century America differed little from that in use at the time of Pliny in AD 23–79. Historians believe these ancients made charcoal simply by digging a hole in dry ground, filling the hole with wood, setting it afire, and immediately covering it with sod (Overman 1850:104, 109).

The pit method is still used to make charcoal in parts of the Middle East, where the pits are small, bell-shaped, and lined with stone to prevent earth from mixing with the charcoal. The top opening of the pit is the only opening for air. After the wood inside the pit is set afire, this opening is sealed to allow the wood to smolder into charcoal. The typical pit takes one day to dig and line, one day to carbonize, and two days to extinguish and cool the charcoal (Horne 1982:10).

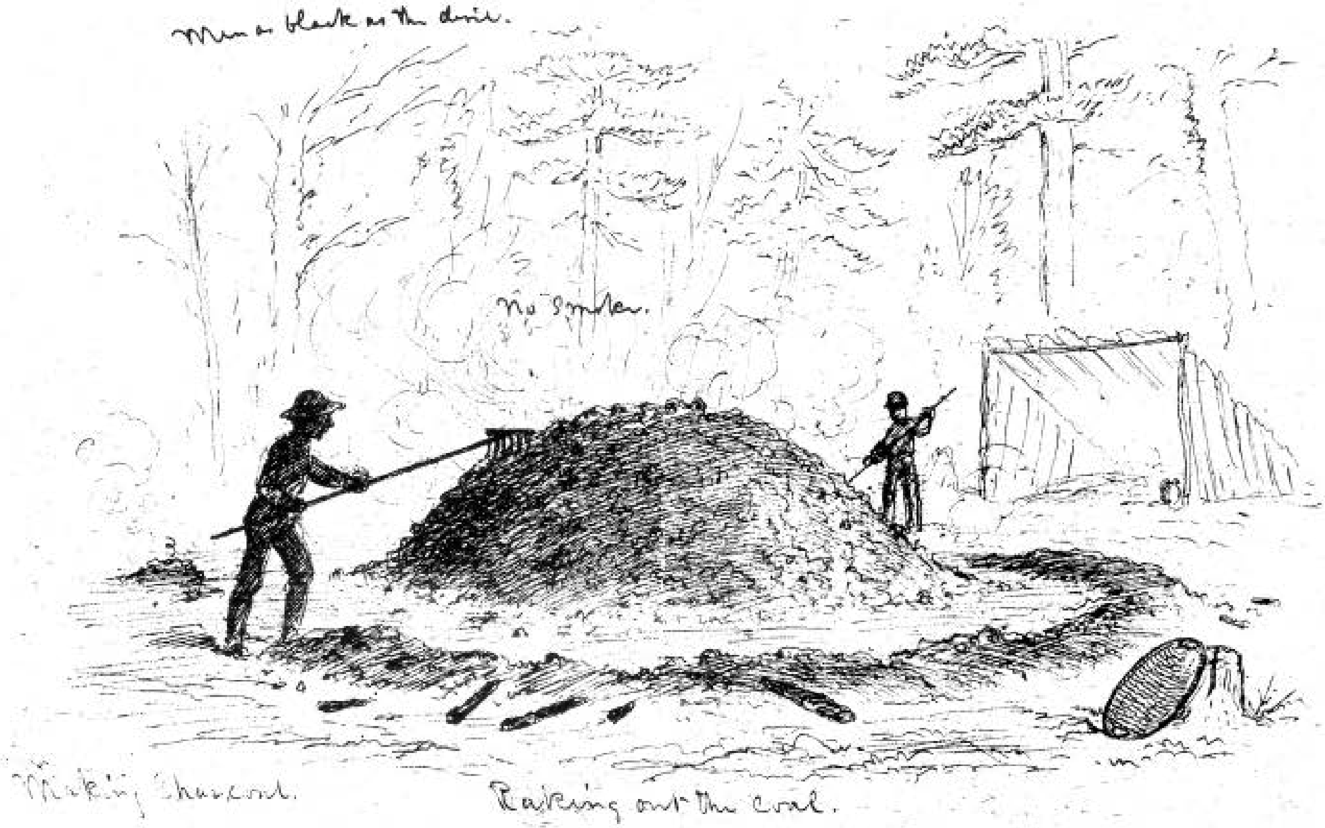
In the charcoal mound, wood was stacked in a 30- to 40-foot-diameter mound, leaving an approximately one-foot-diameter space in the middle to act as a chimney. When stacked, the wood was 10 to 14 feet high at the center. A mound of these dimensions used about 30 cords of wood, the equivalent of an acre woodlot. After all spaces were filled with smaller pieces of wood to make the mound compact, it was covered with a fine layer of charcoal dust, then earth and leaves. A hole was left at the top for the chimney and small 3- to 6-inch-diameter vent holes were opened around the sides, about a foot above the ground. When all was ready, burning ashes and tinder were dropped into the center chimney and the side vents alternately opened and closed as needed to supply a natural draft and draw the burning from the middle of the mound to the sides. It took about a week to char the wood, depending on the type of wood and the skill of the collier.



5-4. *Rowland E. Robinson sketched this cross-section of a mound that was probably in the Ferrisburgh area during the mid-18th century. The center chimney was formed by a narrow circle of tall, straight wood. Cordwood was tightly stacked outward from the chimney and upward to the top of it. The pile was covered with a layer of straw, and finally a layer of earth that was sometimes mixed with coal dust. Comment at bottom reads "Making charcoal—section of coal pit" (courtesy Rokeby Museum, Ferrisburgh).*



5-5. The Charcoal Burners, *by Rowland E. Robinson, from the original drawing (courtesy Rokeby Museum, Ferrisburgh).*



5-6. *This rough sketch by Rowland E. Robinson might have been a preliminary for* The Charcoal Burners, *probably done on-site in or near Ferrisburgh during the mid-19th century. The sketch shows two colliers raking charcoal from a cooled mound. Comment at top left is "Men as black as the devil" from the charcoal dust. The colliers' rakes and carrying baskets (lower right) are non-metal, to avoid unnecessary charcoal breakage (courtesy Rokeby Museum, Ferrisburgh).*

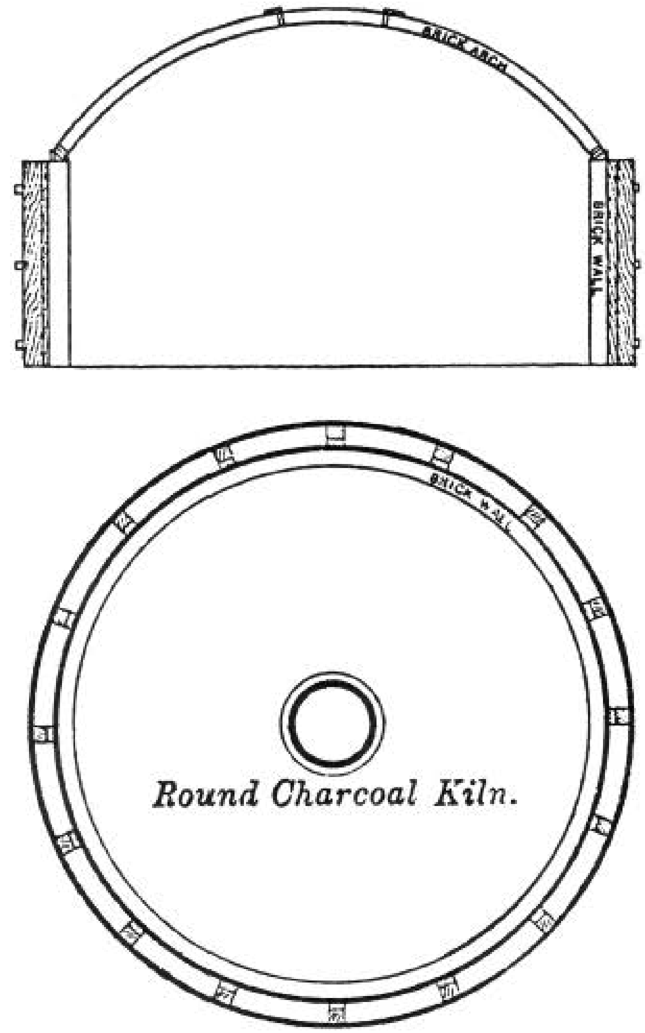
The tenders of these charcoal mounds were called colliers, after English coal miners of the same name. It was the job of the collier to build the mound, stack and cover the wood, correctly ignite the mound, and control the charring. As the wood was reduced to charcoal, the mound contracted and opened holes in the covering. This made for an undesirable job for the collier, that of walking about the top of the smoldering mound, closing the holes, and pushing the earth down by jumping up and down on it while prodding beneath with a long iron rod to settle the coals. Holes in the covering were of the utmost concern to the collier since openings would allow fresh air to enter and burst the charcoal (and himself) into a conflagration. Such activity soon covered the collier with black soot, lending more similarity than name only to his coal-mining cousins.

The charring was complete when the smoke stopped and the shrinking ended. As the earth covering was pulled away, barrels of water were kept handy in case a spark restarted the burning. Only a little water, when used, was needed. The charcoal was still very hot and the water immediately saturated the burning coals with scalding steam trapped within the quickly covered mound. After cooling, the charcoal was carefully shoveled into wagons with wood shovels and rakes to reduce breaking the pieces of charcoal, then taken to the forge. Some teamsters gave the charcoal an extra watering, just to be safe. There is one story of a burning charcoal wagon seen many miles away at night rolling downhill out of control, looking like a comet. Another story describes one hapless New England driver who left a load of charcoal in his wagon for the night. The next morning he found only warped hardware on the blackened ground where his load of charcoal had been the night before (Hubbard 1922:49-50).

The collier's burning season ran from the end of one winter to the start of the next. Charcoal would deteriorate if left to accumulate, so it was made only a few weeks before it was needed at the forge (Bining 1973:64). It took a well-organized and alert collier to master the operation of the number of mounds he had to tend. Should he lose a mound through accidental fire, he was fined the value of the wood. A good collier had to juggle a number of duties, alternately charging and discharging mounds while tending to the vent holes of others. Since the mounds were built 100 or so feet from each other (to give working room and prevent the spread of fires), charcoal tending was difficult (Walker 1966:242). The collier spent the entire charcoal-making season on a mountainside, living in a small hut among his mounds. He kept a small vegetable garden when his day and night duties permitted, and sometimes augmented his diet with small game when he had the chance to check his traps.

5-7. A burning charcoal mound, covered with earth and emitting a wisp of visible smoke, at a 1939 reenactment of the ancient art (courtesy Hagley Museum and Library, Brinton Coll., Wilmington, Del.).

5-8. A charcoal mound site near Adler Brook in Ripton, showing its distinctive raised, circular shape, which is typical of most mound remains found in Vermont.



5-9. Round charcoal kilns were made of vertical brick walls and outside iron binders supported with outside wooden posts. These were most commonly used in the Adirondacks of New York State (Egleston May 1879:386).

The process of making charcoal attracted many visitors, some of whom would beg some choice chunks of charcoal to bring home and drop down their well to "sweeten" the water. It was also a time when many people believed that drinking the most foul-smelling spring water cured any manner of ailments, or that sitting seminude in hot mud did wonders for their skin. So why not hike up to the charcoal mounds, stand downwind in the "purifying" white smoke, and breath deeply the exhilarating benefits of the pyroligneous vapors? Emphysema was a word a century yet to come into common usage, as tar, acetic acid, creosote, and naphtha liberally coated the lung tissues of all who were exposed to the charring fumes.

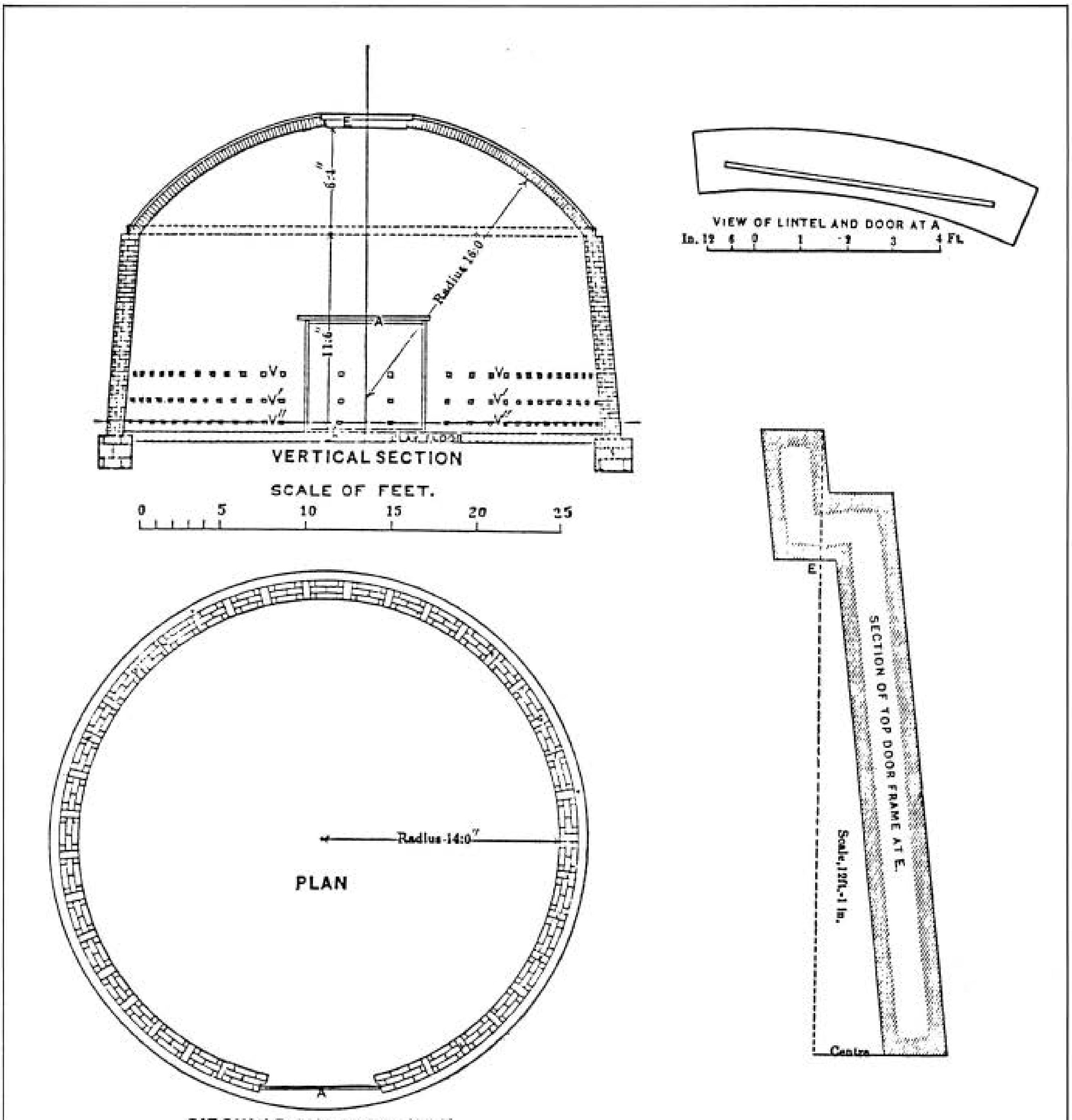
Producing charcoal in earth-covered mounds, however, had a number of drawbacks. Some of these were the amount of time and labor required to produce the charcoal, the difficulty of maintaining complete control of the burning process, and the high amount of dirt that usually mixed with the charcoal from the earth cover. The mound method also produced a weak charcoal, one that crumbled relatively easily in the blast furnace and sometimes choked the blast. By the end of the Civil War, a solution to these problems was the increasing use of more permanent kiln structures.

Charcoal Kilns

Initially, kilns were rectangular or round, and usually of red brick on a stone foundation. Firebrick was sometimes used but was not necessary as long as the red brick was hard enough to resist fire. A typical rectangular kiln in New England measured 40 to 50 feet long, and 12 to 15 feet high and wide. Capacity was 55 to 70 cords of wood, nearly double that of the mound process. The yield of 30 to 35 bushels of charcoal per cord of wood in the mound increased to 45 to 50 bushels in the kiln, a significant jump in efficiency. The rectangular kiln, however, was not as common in New England as in the South. Although some rectangular kilns were found in Vermont, round and conical kilns were the enduring configurations.

A 20- by 30-foot-rectangular charcoal kiln had essentially the same capacity as a 28-foot-diameter kiln of the same height. The rectangular kiln, given its straight lines and right-angle corners, was much easier to construct than the round kiln. Fitting square doors on curved lintels was avoided, and cordwood stacked easier inside the rectangular kiln. Then there was the problem of constructing an arched, corbeled roof atop the round walls. Why, then, were there not many more rectangular than round charcoal kilns? The answer: incomplete combustion took place in the square corners of the rectangular kilns, and this waste more often offset all the benefits of its simpler construction.

Round kilns, also known as round furnaces, were typically 28 to 30 feet in diameter at the base and 12 to 16 feet high at the center. Some were built with vertical walls, others with battered walls. In the battered-wall design, the diameter at the top of the wall was a few feet less than at the base, approaching a conical shape. Round kilns required two to three heavy iron bands around the wall in addition to the usual braces. The few iron bands found in the field varied from 28 to 30 feet inside diameter, indicating the outside diameter of the kiln where it was placed. These heavy iron bands were not carried up the mountain to the kiln construction sites in one piece, but assembled in sections with ½-inch-diameter bolts pushed through pre-holed and preformed joining ends, and attached with 1⅛-inch-square iron nuts (without washers). Small iron bands up to 2 inches wide were single-bolted; 4-inch-wide bands were bolted three at a time in a triangular pattern at joining ends of the bands. These joining ends consisted either of angled and overlapping sections requiring one set of three nuts and bolts, or of butted ends connected together with an iron plate against the outer side of the joint and bolted together with two sets of three nuts and bolts, each set at the ends of the two butted iron bands. The bolts were always placed so that their heads were nearly flush with and on the inside of the joint assembly (bolt head against the kiln wall), and the nut on the outer side of the joint facing away from the kiln wall. In this manner, little



5-10. *The circular charcoal kiln, most commonly found in Vermont, was built with battered brick walls and iron hoops. The battered-wall design was more stable than the straight wall of the round kiln and permitted the construction of a slightly larger-capacity charcoal kiln. Notice the top loading hole; ankle, knee, and waist vents; and vaulted brick roof. The design of a sill plate is at upper right; design at right shows the angular pitch of the top door frame (Egleston May 1879:387).*

5-11. *This charcoal kiln typifies the round brick types that operated in 19th-century Vermont. Probably photographed about 1890 and already showing some decay, this one operated at Fayville, an industrious 1870s–1880s logging community in the northwestern corner of Glastenbury (courtesy Shaftsbury Historical Society).*

mechanical damage was done to the kiln wall and the banding nuts could be tightened from time to time as necessary. These iron bands aided significantly in stabilizing the kiln structures during the heating and cooling cycles of operation.

The kiln had about 300 vents around the lower wall in three rows of 100 vents each. Some kilns had cast-iron vents, others merely holes left by deletion of a brick during construction. The vent hole opening could be closed by inserting a brick lengthwise. The 3- to 5-foot-diameter vent at the top was lined with a cast-iron ring which, together with the heavy doors and cast-iron bands, weighed about 3,000 pounds. It took about 36,000 bricks to build this type of charcoal kiln (Egleston May 1879:388).

The 40 to 50 cords of wood took four or five men one day to load. The kiln was ignited with a long-handled torch at the bottom, in space below the wood that was left by the skids. This was usually done at night so that the progress of the flame could be seen and better controlled. When the kiln was lit, all

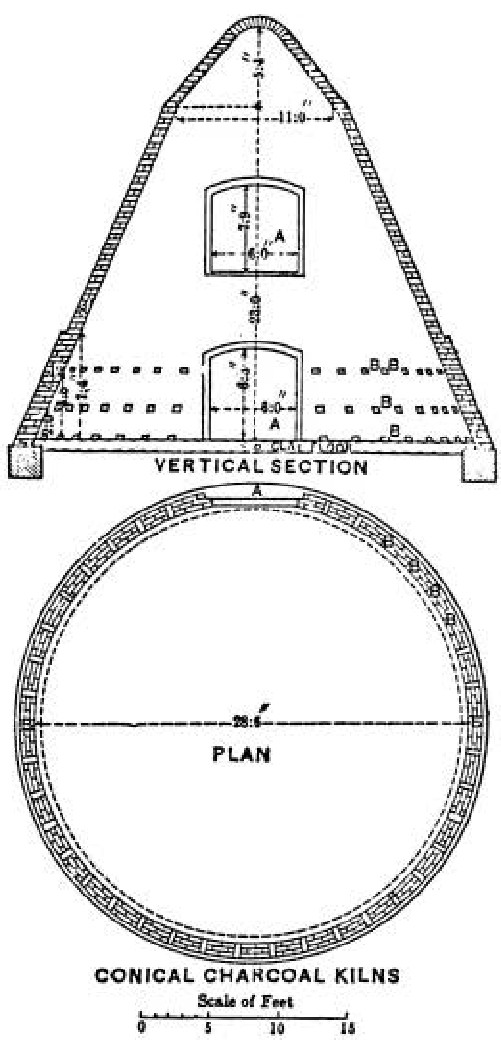
5-12. *Cast-iron kiln vent from a brick-type charcoal kiln site at Ripton.*

5-13. *A heavy iron casting that protected the top loading hole of a brick-type charcoal kiln at Glastenbury just south of "the forks." The casting protected the top inner circle of bricks from burning out prematurely, and also from damage through loading cordwood down into the kiln. The casting was made in one solid piece, with thick, reinforced supporting tabs at every quarter which held it firmly in position. To the right is another casting, upside-down on the ground; both castings have been stolen since this 1982 photo.*

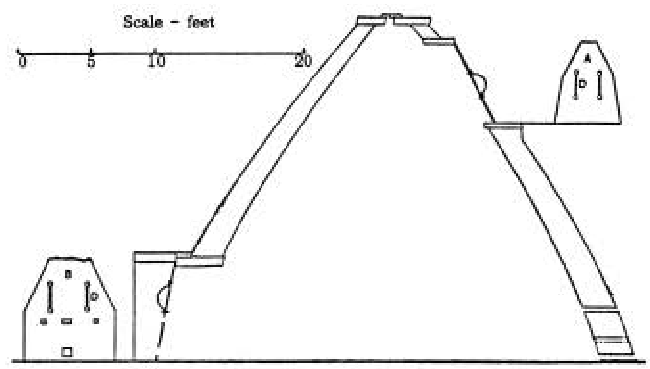
5-14. *One of the better remains of a brick-type charcoal kiln, showing the black pitch still coating the inside wall. This site is near the old Greeley Mill at Mount Tabor.*

side vents were open, but as soon as the wood was burning, the two lower rows of vents were closed. During the first four days, the heavy white smoke coming from the upper vents indicated water being driven from the wood as steam. This was followed by blue smoke, indicating that the kiln was very hot and the charring nearly complete. When the charring was complete, all vents were closed to suffocate the fires, followed by five to six days of cooling. Water was generally no longer used to extinguish the fire and reduce cooling time because the water was found to impair the value of the charcoal for blast furnace use. It took four men one day to unload the kiln. The entire cycle took 10 to 12 days.

Historical records indicate that by the late 1870s, small conical kilns had gradually and generally replaced the larger kilns of other shapes everywhere except in Vermont. Generally 25 to 30 feet in diameter at the base and 25 to 35 feet high, conical kilns were designed for 25 to 45 cords of wood. Some were built into hillsides so that a charging door was near the top; others had a door only at the bottom. Although an overwhelming number of charcoal kilns located in Vermont have been of the round variety, at least one brick-type and numbers of stone-type conical kilns have also been found. Typical of stone-type conical kilns are those atop East Mountain (Bald Mountain), about three miles east of South Shaftsbury near the Shaftsbury-Glastenbury line. They are 30 feet in diameter with walls 2½ feet thick. Wall thickness diminished with height. Kiln doors were ⅜-inch-thick iron sheets measuring 6 feet wide by 5 feet high. The brick-type conical kiln was found in Readsboro. It measured 28 feet across at the base with walls 1 foot thick. It was reported that although it took about 33,000 bricks to build a conical kiln at Plattsburgh, New York, the conical kiln at Readsboro required 40,000 bricks (Egleston May 1879:393). Kilns of a third variant design found at Readsboro, Stamford, and Shaftsbury were built of stone up to about 4 feet high and then brick the rest of the way.



5-15. The most efficient design of a charcoal kiln, with an upper side-loading door replacing the round top-loading hole. This conical charcoal kiln operated at Readsboro in the 1870s to 1880s (Egleston May 1879:391).



5-16. Plan of a conical charcoal kiln at Wassaic, New York, whose top-loading opening is a transitional feature from the circular kiln (Egleston May 1879:390).

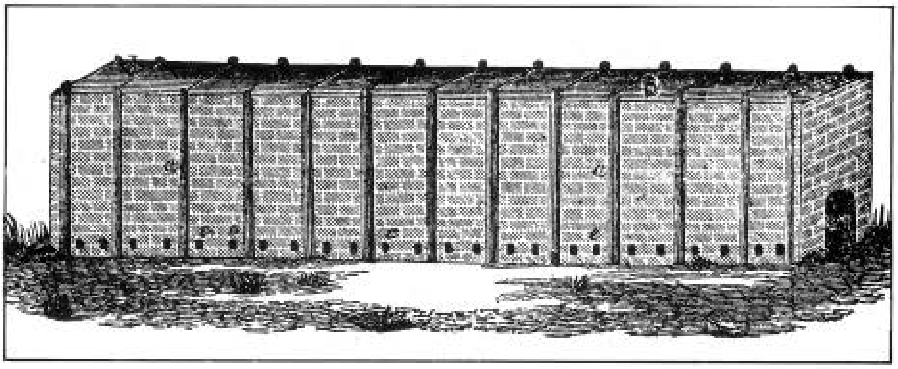
Typical conical kilns held about 35 cords of wood, which took four men 12 hours to load, and the efficient charcoal yield of 50 bushels to a cord was maintained. It was generally conceded by 1880 that the smaller conical kilns holding 25 to 35 cords were the most profitable. They were less expensive to build, more easily charged (loaded) and managed, gave an improved yield, and could be cycled more frequently than any other type of kiln. Some representative costs to charge, burn, and empty a conical kiln per 1,000 bushels of charcoal in 1879 were $7.50 at Plattsburgh (Norton Ironworks), $7.00 on Lake George (near Roger's Rock), and $6.00 in some Vermont localities. Statistics of some typical conical kilns were:

	Charge	Burn	Cool	Discharge
Time (hours)	10	192	72	10
Men per day	6	1	0	4
Horses per day	1	0	0	2

Extrapolation of some of the meager charcoal production data in published histories of Vermont does not indicate a

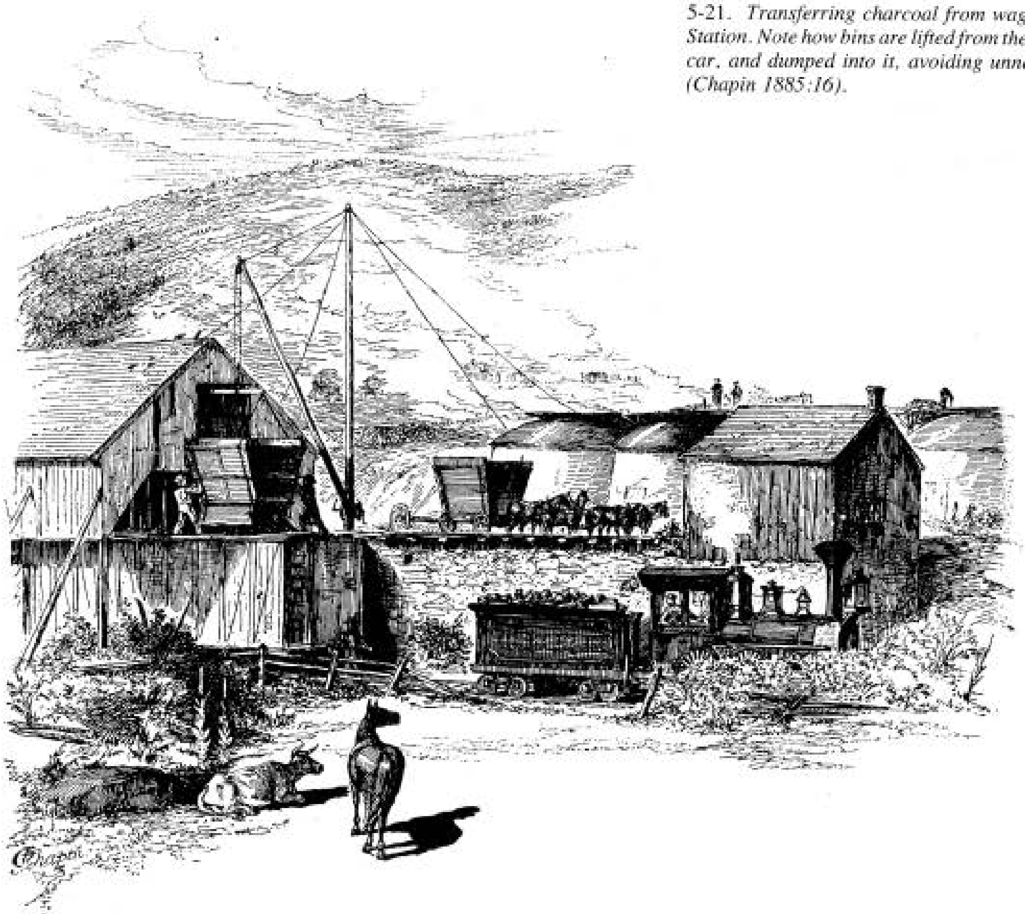
5-17. *Conical charcoal kilns that still stand at Wassaic, New York, which supplied charcoal to ironworks in the Hudson Valley in the 1870s–1880s (courtesy Richard S. Allen).*

5-18. *A side-loading door, similar in configuration to doorways of the standing conical kilns at Wassaic, New York, found near the ruin of one of the Readsboro charcoal kiln sites west of Route 8, indicating this kiln might also have been conical in construction.*

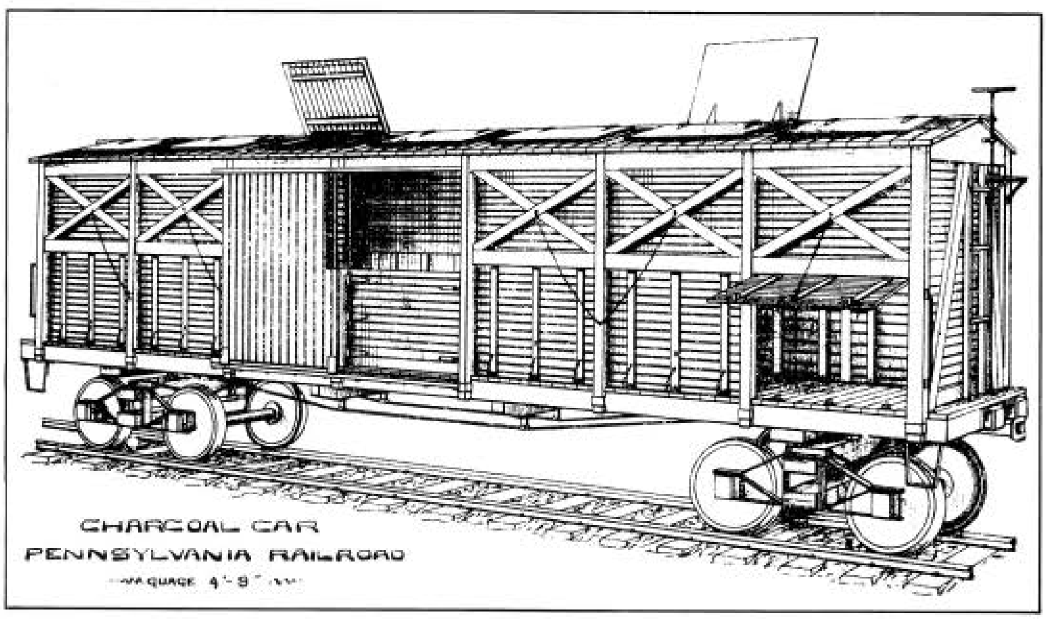


5-19. *A rectangular-type charcoal kiln, made of brick, showing cast-iron external binders and vent holes along the bottom (Overman 1850:110).*

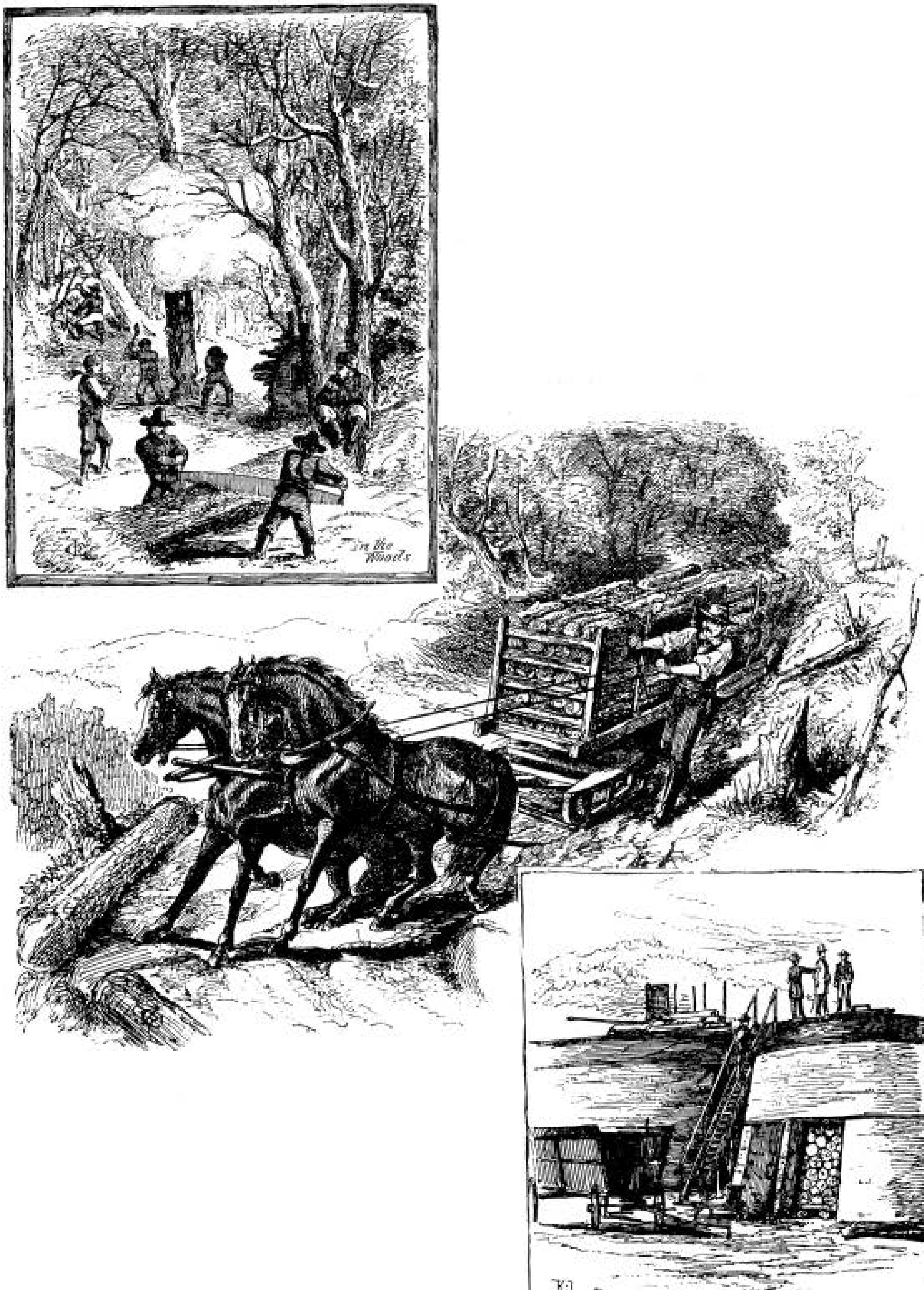
5-20. *Charcoal was transported from the kilns in wagons that could be quickly emptied either by dropping the side panels or sliding out the bottom boards. Since charcoal lost value if broken into small pieces, the teamster shoveled as little as possible (courtesy* Berkshire Eagle, *Pittsfield, Mass.).*



5-21. *Transferring charcoal from wagons to railroad cars at Danby Station. Note how bins are lifted from the wagon, hoisted above the railroad car, and dumped into it, avoiding unnecessary shoveling of the charcoal (Chapin 1885:16).*



5-22. *A typical charcoal railroad car used in Pennsylvania in the 1880s* (Annual Report of . . . Pennsylvania *1894:35ff*).



5-23. *Logging in winter, when the trees contained less sap (top), hauling logs down treacherous trails in Mount Tabor (middle), and "Kiln ready for firing—showing the fore arch." The man with a high hat, standing on top of the kiln, was probably Silas Griffith (Chapin 1885:11).*

5-24. *Vent hole construction (center) in the wall of a stone-type charcoal kiln, north of Old County Road in Stamford. Note the two standard bricks (center) holding up a flat lintel stone. The resultant hole allowed a third brick to be inserted to control the draft.*

5-25. *Griffy doing her part inspecting a charcoal kiln ruin atop Berlin Mountain in New York. Note non-brick-type vent hole construction, although single bricks that controlled draft were found still in place.*

consistency in yield (bushels of charcoal per cord of wood). The Barnum Richardson Company's eight kilns in Winhall produced an average of 2,000 bushels of charcoal per kiln; each kiln cycled 15 times a year. The Bennington & Glastenbury Railroad, Mining, and Manufacturing Company's 18 kilns in Woodford produced 1,600 bushels per year with a yield of 40 bushels per cord. Fourteen of its running kilns produced 28,000 bushels per month. Analysis of this data shows that each kiln cycled about every 24½ days. Using this as a basis, the following yields of some charcoal-making companies in southern Vermont were calculated. Note that the bushels of charcoal per kiln indicates relative size of the kiln:

Company	Average Bushels of Charcoal per: Kiln	Average Bushels of Charcoal per: Cord
Morehouse & White (Woodford)	2,760	25
Barnum Richardson Co. (Winhall)	2,000	40
Bennington & Glastenbury Railroad, Mining, and Manufacturing Co. (Woodford)	1,600	40
Beckley & Adams (Woodford)	1,470	36
Maltby (Peru)	1,000	29
Root & Jones Chemical Works (Bennington)	?	45

Although the Morehouse & White kilns produced the most bushels of charcoal per kiln, the yield of their kilns was relatively low compared to the others.

The Root & Jones Chemical Works at Bennington was a chemical company interested mainly in the distillates in the wood; the charcoal was strictly a by-product of the process and the high charcoal yield indicated an efficient extraction process. The first successful distillation factory in the country was built in 1850 in New York, and principal products of these distillation factories were acetic acid and methanol. After the 1920s these could be made synthetically and the distillation factories disappeared. Factories such as this burned nearly 100,000 cords of wood annually, making about 35,000 tons of charcoal in the process (Simmons 1960:10).

Consumption of charcoal by ironworks varied from operation to operation. As iron production increased, ironworks were forced to look farther each year for quality woodlands from which to draw charcoal. Once stripped of timber, it took 20 years for regrowth to be sufficient for another clearing. A blast furnace making six tons of iron a day consumed 270,000 bushels of charcoal annually. This calculates to 6,750 cords of wood. At the average rate of 30 cords to the acre, access to 225 acres per year was needed (1849 figures). And for a constant supply, therefore, a typical blast furnace required 4,500 acres of woodland to keep up with consumption. (Hodge June 9, 1849:354). Since few ironworks owned such acreage of woodland, proximity to the railroads for delivery of charcoal from outlying areas to augment local charcoal production became important.

In the 1850s ironworks in Vermont were drawing charcoal from an average of 10 to 14 miles away. The expense of hauling charcoal greater distances placed a higher expense on the cost of making and working iron. Works that could not stay competitive closed. When the Barney forges at Swanton closed after 68 years of operation, the expense of charcoal was blamed (Hemenway vol. 1 1867:1022-1023). And by the early 1900s when charcoal was being shipped north to ironworks in Connecticut, New York, and Massachusetts from as far away as North Carolina, blast furnaces and bloomery forges had long since ceased operating in Vermont.

Transition

The charcoal industry in Vermont was a reflection of the iron industry, typically rural in the sense that only a few operations approached organizational efficiency. Most were scattered up and down the high western slopes of the Green Mountains in pocket industries that supported purely local needs. Up to the early 1800s when much of the countryside was still being cleared, farmers were able to lay away substantial amounts of money or credit by making and selling charcoal (Smith 1886:493). The stone- and brick-type kilns made their appearance by the mid-1800s and charcoal making shifted from pin money to industrial profit. Kilns on the eastern side of Lake Champlain competed with those on the western side as the charcoal market put better profit position before local loyalties.

Although mainly distributed among eastern townships in Addison, Rutland, and Bennington counties, early charcoal making was also carried on in a few isolated places to the east and north. And by the late 1880s, the charcoal industry was transformed into just a few highly organized operations. Their efficiencies reflected what was quickly happening to Vermont's "boundless forests."

What became of the charcoal industry in Vermont? Historians have traditionally blamed such things as the scarcity of quality woodlands or the increasing cost of making charcoal for the charcoal-burning blast furnaces for the failure of the charcoal industry. A great area of forest land *was* cut for charcoal; and the price of charcoal *did* rise through the 1880–1900 period. But to understand why the charcoal industry died, one must look at what was happening nationwide to its most profitable customer—the charcoal iron industry.

Up to the 1830s all iron made in the United States was charcoal iron, that is, iron made in furnaces and bloomeries fueled solely with charcoal. Soon after the Civil War, significant numbers of furnaces started burning coke, which was made from coal by a process somewhat similar to that of making charcoal in a kiln. The production of charcoal iron continued to increase, however, reaching peak production of about 710,000 tons in 1890 (Schallenberg 1975:342-343). Hardware produced in the late 19th century required a general-purpose iron, not brittle for pounding tools, sharp-edged for cutting tools, and strong for large tools and castings. Charcoal iron was ideal for all these applications. Charcoal was also so relatively easy to burn that blast furnaces did not require strong blast equipment. There was never a shortage of woodland for making charcoal. The countryside abounded in forest land in the 19th century in spite of lumbering and clearing land for farming. The charcoal iron industry continued on in this country for over a century after it ended in forest-poor England.

Following the Civil War, technological innovation in the coke and charcoal industries increased apace, with innovation in the coke industry keeping well ahead of charcoal. By 1910, the heyday of the beehive coke ovens, there were 100,362

5-26. *An itinerant charcoal burner at his trade at one of the charcoal kilns at North Leverett, Massachusetts, which operated up to 1980.*

individual ovens in the United States according to the Federal Bureau of Mines. By the early 1900s coal barons built tens of thousands of red-bricked ovens right outside the mouths of coal mines. They were "hellish pillars of fire" that burned 24 hours a day, seven days a week, to fuel the booming steel mills. ("Beehive Coke Ovens. . ." *New York Times* Sept. 12, 1982:73).

Innovation in blast furnace technique and design also moved onward as newer furnaces were built higher in order to increase iron production. But as the furnaces grew higher, the charcoal, being brittle and weak, crumbled into small particles in the tall furnace stacks with the weight of additional fuel and iron ore piled above it. Though most charcoal furnaces were kept small and squat, severely limiting their ability to keep pace with the trend of increased iron output, by 1900 some charcoal furnaces managed to reach up to 60 feet in height.

Technological innovation in the iron industry itself also advanced at an increasing rate after the Civil War, and by the 1890s, significant quantities of open-hearth steel were starting to appear on the market. Although still several times more expensive than charcoal iron, products made from open-hearth steel lasted several times longer than those made from charcoal iron. This, coupled with the decreasing cost of making coke, spelled the beginning of the end of the charcoal iron industry, and thus the end of the charcoal-making industry. The total number of 500 charcoal furnaces in the 1860s dropped to half that in the 1880s, to less than 100 in the 1890s, and less than 50 after 1900 (Schallenberg 1975:346).

Inventories of freight cars owned by the Rutland Railroad also reveal what was happening to the charcoal industry in Vermont. In 1905 and 1910 the Rutland owned nine charcoal cars. Two cars were 33 feet long (inside) with 12- and 15-ton capacities; the other seven were 37 feet long with 15-ton capacities. No charcoal cars appear on Rutland inventories after 1910 (Bill Badger letter to author, May 5, 1991).

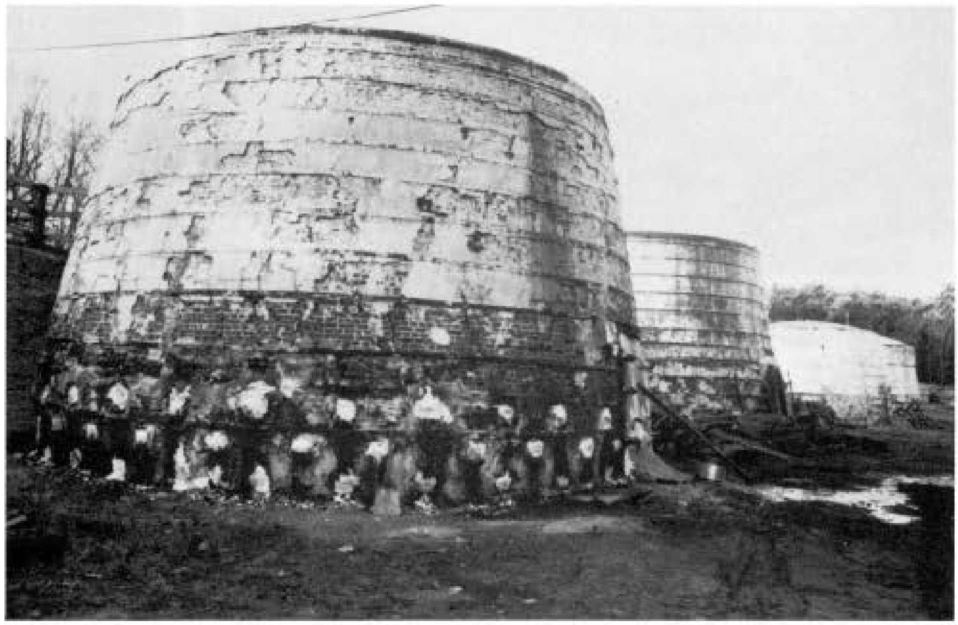
In the 1960s the demand for charcoal for use in backyard grills encouraged a renewed market for the fuel. Charcoal production nationwide was about 200,000 tons in 1950, up to 350,000 tons by 1956, and approached 500,000 tons by the 1960s, nearly equaling turn-of-the-century production figures (Simmons 1960:10). The art of charcoal making had revived in many states, especially in Michigan, Arkansas, Tennessee, and West Virginia.

In an effort to capitalize on this new demand, authorities in New York and New Hampshire who were conscious of forest resources issued many small booklets and bulletins to would-be charcoal burners on how to build efficient kilns from ordinary inexpensive materials and how to make the charcoal. One such kiln was made of sheet metal, forming a miniature beehive-type structure. A variation of this design employed a crane to lower steel kilns over stacks of wood; it then lifted the kiln after the wood had charred. Another kiln that found popular favor was a rectangular unit made of cinder block, designed for one and two cords of wood. During and after World War II many of these cinder-block kilns were built around the country, including the one that was found a few dozen feet off the road to Pikes Falls at Stratton.

Kiln Touring

For the venturesome, there are operating charcoal kilns in New England within a 2-hour drive of Vermont. At Union, Connecticut, about a 15-minute drive south of Old Sturbridge Village, Massachusetts, on and visible from Route 171, the Connecticut Charcoal Company operates seven 30- to 35-foot-diameter brick-type kilns. The originals of these recent-vintage kilns were built in 1939 to take advantage of local forest damage caused by a hurricane the year before. One of the 1939 kilns is still standing and operating. The kilns today burn slab wood, waste from lumbering operations. Charcoal is made by the traditional process, with the most obvious exception being the pollution-control device attached to the kiln. The device looks like a giant vacuum cleaner. Charcoal yield at the kilns is a surprising 45 to 50 bushels per cord of wood, comparable to yields at 19th-century coaling operations for similar-design kilns. Customers for the charcoal are various foundriės in New York, New Jersey, Massachusetts, and Connecticut. The charcoal is also sold to individuals (about $2.00 a bag) who find it aids in starting their coal stoves in winter. The company has established a retail barbecuing market for the "clean coal" (versus so-called "briquette coal," which usually contains large quantities of non-charcoal material and toxic industrial waste).

In Massachusetts, modern charcoal found its way to Boston's better restaurants and steak houses (Woolmington Dec. 1979:80-85, 132-134). At Leverett, charcoal was made at two brick-type kilns until they were closed in 1980 due to air-quality laws. The kilns are about a mile south of the village of North Leverett along Old Coke Kiln Road, an area where charcoal making dates to about 1825. And in the Dubuque State Forest near East Hawley there is a fully standing stone-type conical kiln, which made charcoal from 1872 to about 1900.



5-27. *Charcoal kilns at the Connecticut Charcoal Company in Union, showing vent holes and kiln door plastered shut and whitewashed to contain heat and shut off draft at the end of the burn. The water on the black ground, sticky with pitch, is moisture liberated from the charred wood that seeped through the kiln walls. The walls were hot to the touch and the air carried a pungent naphtha odor.*

5-28. *Tools of the trade at the Connecticut Charcoal Company: charcoal fork, picks, and shovel; a wheelbarrow of whitewash to seal the kiln walls; and a face mask/filter (hanging with the sweater).*