

THE BLACK ROCK FOREST

BULLETIN No. 4

HENRY H. TRYON, *Director*

A PORTABLE CHARCOAL KILN

By

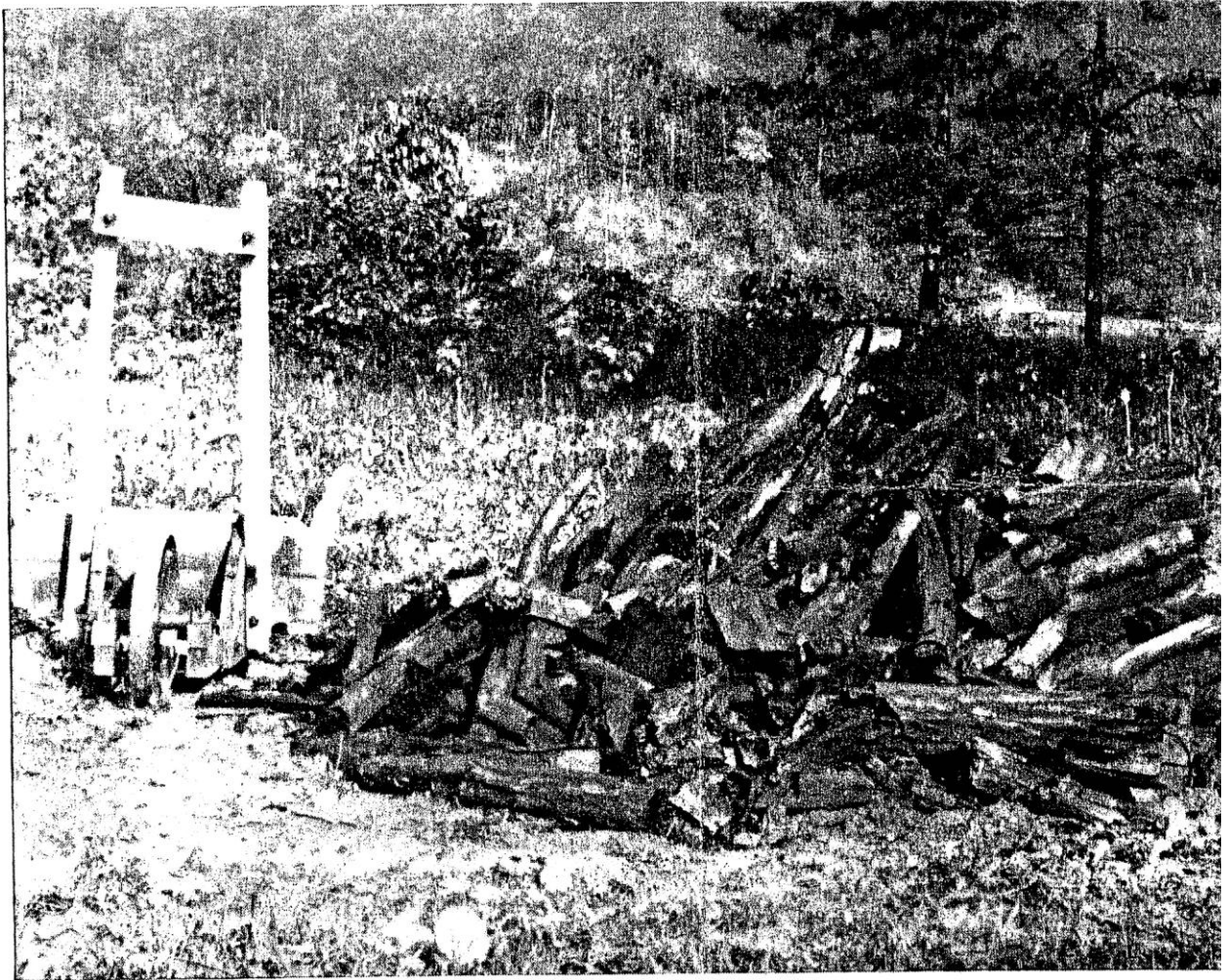
HENRY H. TRYON

With a Foreword by Austin Cary



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1933



A GOOD COOK FROM ONE-HALF CORD OF MIXED HARD WOOD.

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FOREWORD

ONE noteworthy feature of the forestry movement in this country, in just recent years, is the experimental or demonstration forest, a forest, that is to say, run with the primary purpose of developing and illustrating good forest management. This marks a noteworthy advance over the propaganda stage which, inevitably perhaps, was the most prominent feature of the movement at one period, and certainly is a thing needed to at least supplement the work of forest schools. On the other hand, no one probably would maintain that it is the final result aimed at, which is rather the general handling of woodlands for their actual utility, in other words and in most cases for profit.

For one on the sidelines but feeling concern it is interesting indeed to watch the development of such a movement. Questions arise inevitably, this one in particular and with especial force—whether the men so segregated and supplied will see their real opportunity for service and use it right. Would they on one side make their forests pretty, illustrative of abstract principles and of foreign practice, or would they on the other hand get down to the level of the comprehension and need of their countrymen and work out things of a nature and in such form that these could readily adopt them? This seemed to be a fundamental question in the circumstances of the case. To feel it so does not of course imply that one fails to value the precedents and principles just referred to or really keen and effective research which deals with them.

The foregoing understood and presumably agreed to, it is a pleasure to state that as far as material for judgment has come in things seem to be going well on this field of action. We learn that in some cases a forest under manage-

ment has not acted at all as men had supposed it would; one or two tracts have been given up as too hard jobs, either because of refractory nature or hard location; effective operation, cheap lumbering in other words, has become a matter of vital concern; from all around we hear that what can be done with the woods depends on market for the products. All inevitable and wholesome, it would seem; as noted just above the men seem to be adjusting themselves as needed, meeting the demands laid upon them.

Mr. Tryon before entering on his present job had varied experience that must have enabled him to fall into place with more than usual readiness. Since he has been on Black Rock Forest, over and above the regular conduct of its work, a bulletin has been produced yearly. The three preceding were on the forest itself, on the important topic of introducing coniferous trees into the Hudson Highlands, and a highly technical soil study conducted on the forest by men from outside. This fourth bulletin takes a new and unexpected line. Studying on possible sources of additional revenue and noting the quantities of small material that as yet were waste, Mr. Tryon looked up markets for charcoal that were within his reach and then went to studying in a broad and systematic way on how he might take advantage of them. This bulletin embodies the result of his efforts.

Charcoal making at various times and places has been an important industry, and it might again be. A full story of its rise and fall would in fact bring out numerous romances of business. At present in this country this fuel has widely diffused, though seldom extensive, use. This bulletin may suggest to many the possible advantages lying in this field; and the ingenuity displayed in devising equipment suited to charcoal production under conditions that prevail rather widely today seems likely to be of distinct service.

AUSTIN CARY,
U. S. Forest Service.

LOCAL HISTORY OF CHARCOAL MANUFACTURE

EVEN before the Revolutionary War the manufacture of hardwood charcoal was a common thing in the Hudson Highlands, and in the Shawangunk and Catskill Mountains. The open-pit process was the method generally used until about 1875, when the appearance of metal ovens or kilns, designed primarily for the destructive distillation of hardwoods, liberated such quantities of low-priced high-grade charcoal that the operators of open pits were forced to discontinue except where their location afforded an unusually favorable combination of a supply of raw material with a nearby market.

This open-pit process was precisely the one which, used for generations in Continental Europe was, without doubt, imported to the Hudson Highlands by the early settlers. It was a simple method. The wood was piled on end in a conical stack often as high as sixteen feet, and containing from ten to perhaps forty cords of wood. (Plate I) The charge was stacked as closely as possible, with a central "pigpen" shaft or chimney. The cord wood was covered with large sheets of sod or "floats." Sod was generally used for floats, but leaves, grass, moss, or needles were sometimes pressed into service, depending on what material might be most convenient. Next, several inches of screened earth was spread over the pit. Draft holes were made around the periphery at the base. The fire was then kindled at the base of the central chimney, and kept burning from 24 to 48 hours with direct draft through this chimney. As soon as the central portion of the stack itself was well ignited, the chimney was covered tightly with heavy cord wood, floats and earth; six or seven small vent holes were then made with a shovel handle about the upper shoulder of the stack. During charring, constant supervision was

essential. Air-leaks or "explosions," where the earth blanket had burned through, had to be immediately located and plugged with short, green wood and recovered with fresh floats and dirt. The object was to admit the right quantity of air via the draft holes, to insure a slow but steady charring of the stack. This air supply was controlled by the partial or entire plugging of the draft holes. As the charring progressed downward through the stack, the existing vent holes were tightly plugged and a new series opened at a lower level to allow the gases to escape from the uncooked portion. Ordinarily a fifteen-cord charge required about two weeks for complete coaling.

THE BLACK ROCK FOREST PORTABLE KILN

NEARLY all of the preliminary cuttings on the Forest have been weedings, improvement cuttings, or light thinnings, yielding fairly large amounts of wood suitable only for fuel. The market for such wood has steadily declined with the increasing use of coal, oil, gas, or electric stoves, combined with coal-burning furnaces in residences. In order to find an outlet for our surplus low-grade wood, the local charcoal market was investigated. This study revealed that several thousand bushels were sold annually in the nearby towns and cities. Thereupon various types of steel charcoal ovens or kilns were examined, some of these being of French design, some Canadian, and several which were patented in the United States between 1862 and 1907. Only one of these—that evolved by Mr. A. Magnein of Paris—could accurately be classed as portable. Mobility was essential inasmuch as it would probably reduce the hauling costs on the wood—a considerable item in such rough country.

DESIGN AND CONSTRUCTION

In France, where charcoal has been utilized for centuries as fuel and where charcoal making is one of the ancient



PLATE I. OPEN-PIT PROCESS, SHOWING THE STACK NEARLY COVERED WITH THE "FLOATS

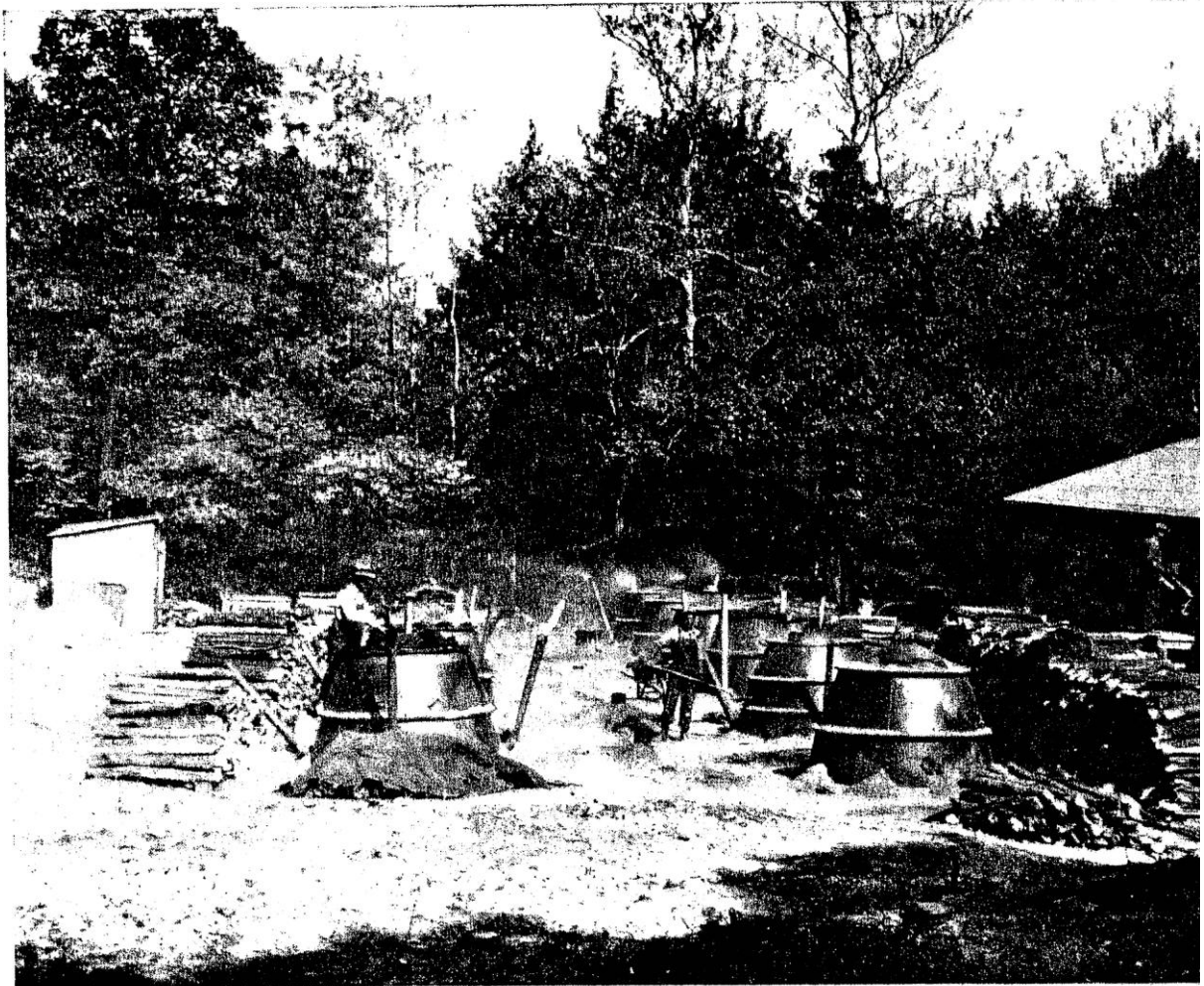
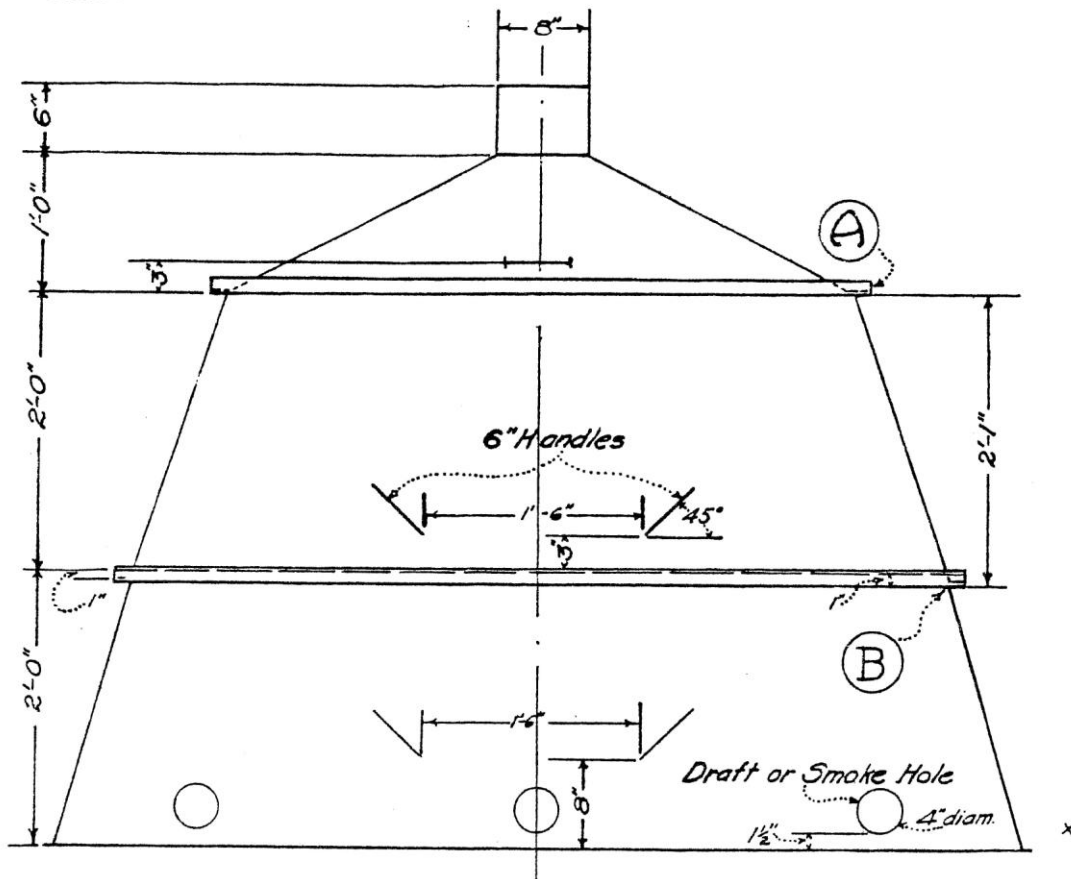


PLATE II. GENERAL VIEW OF 12 KILNS IN OPERATION:—TOOL SHED, WOODRANKS, BRICK COOLING, BEING LOADED AND BURNING, CHARCOAL READY FOR SCREENING, THROUGH WINDOW ONTO SCREEN IN BAGGING SHED.

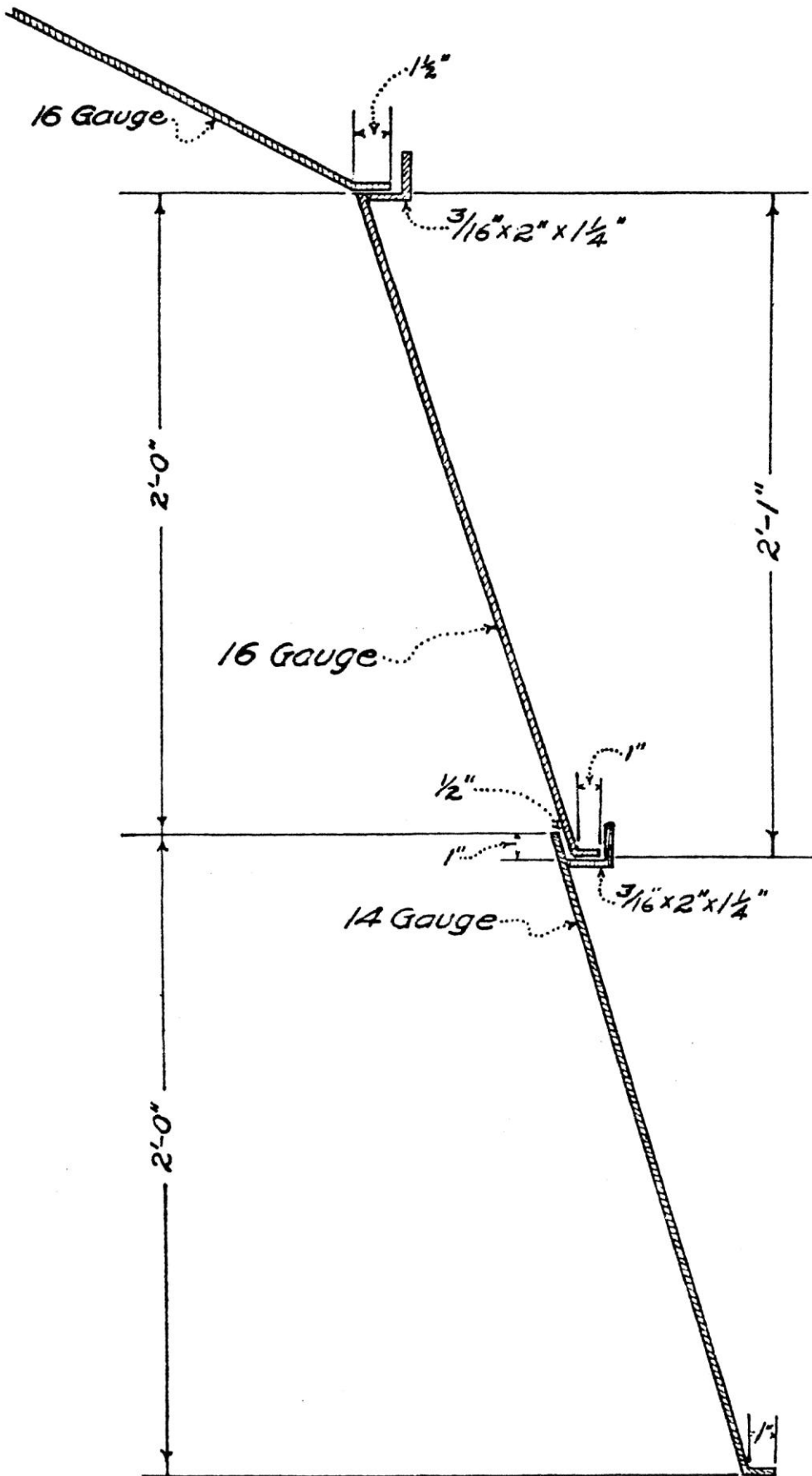
trades, the old open-pit process has been superseded in some measure by the use of light steel ovens of various types. These are made in one, two, or more sections and are usually of small cubic capacity. When more than one section is involved various patterns of air-tight joints have been devised. These foreign kilns bear a general resemblance to the Black Rock Forest model, but the French operating practice differs sharply in two respects which will be discussed later in detail.



TEXT FIGURE I. SIDE VIEW OF BLACK ROCK FOREST KILN.

The Black Rock Forest portable kiln is made of light steel, in two sections, with a coned lid. The bottom section is No. 14-gauge sheet metal, the upper section and the lid are No. 16-gauge. (Text Fig. I-III) This construction was adopted because the lower section has to bear the highest temperatures and also is seldom lifted clear of the ground. The top section and the lid do not have to withstand such

True Section Showing Details at (A) and (B)



TEXT FIGURE II. DETAILED SECTIONAL VIEW OF BLACK ROCK FOREST KILN.



PLATE III. CENTRAL CHIMNEY OF SMALL, 4-FOOT SPLIT CHESTNUT OR OTHER DRY WOOD, POINTED AT ONE END AND SET IN SMALL CIRCLE.

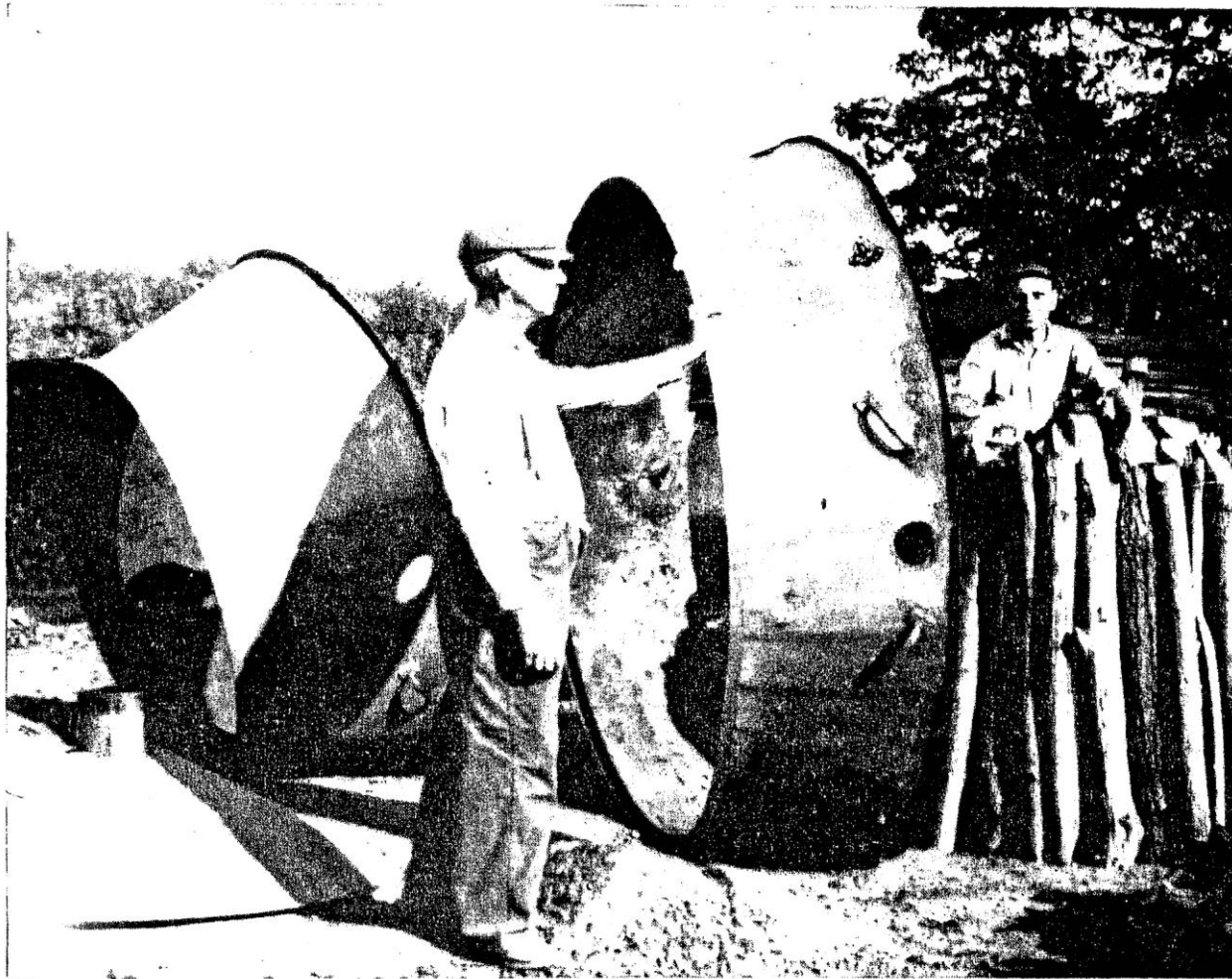
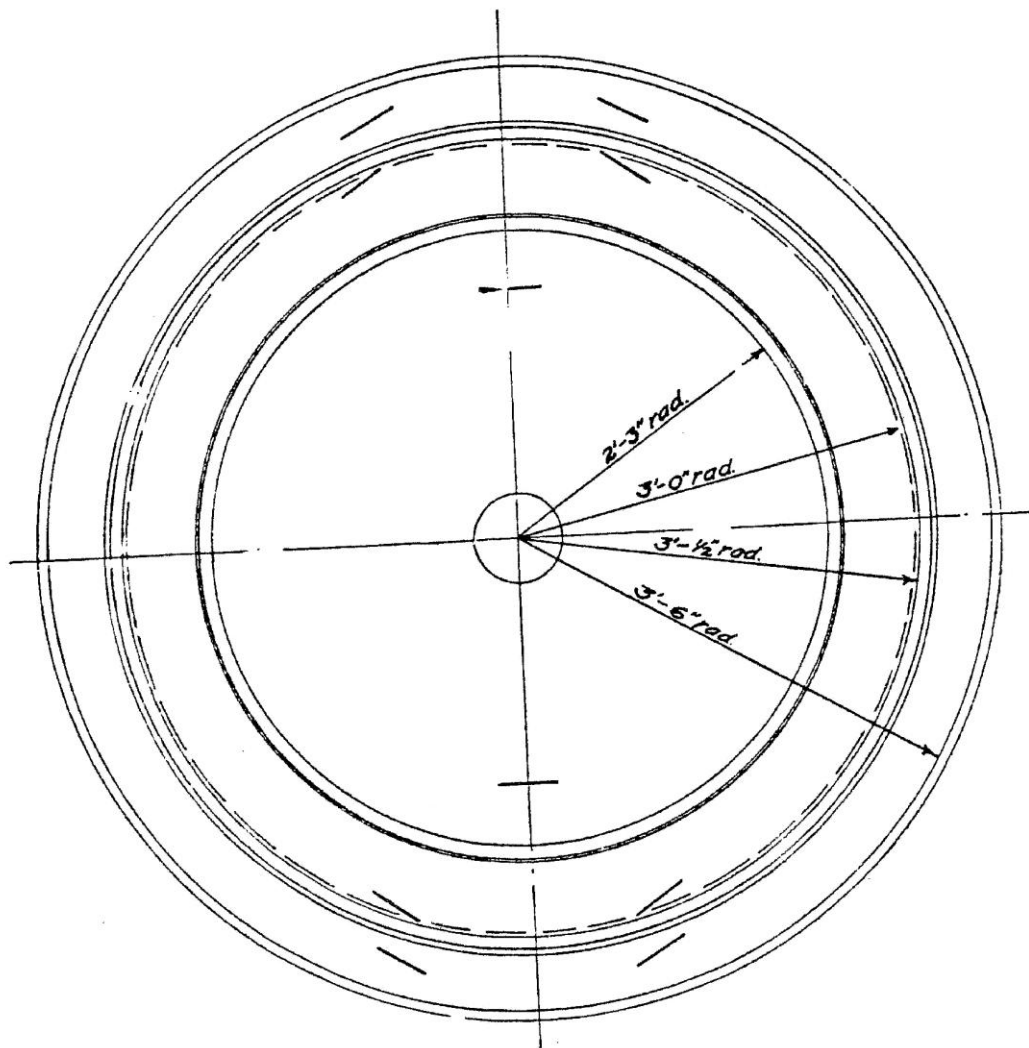


PLATE IV. CHIMNEY AND CHARGE COMPLETED AND BOTTOM SECTION OF KILN READY TO IN PLACE.

heat, and when the kiln is being placed over a charge both of these elements must be lifted at least four feet.

This apparatus follows Mr. Magnein's design more closely than any of the other designs which were scrutinized. The general idea of a sectional, light, stiff, portable steel shell to



TEXT FIGURE III. PLAN VIEW OF BLACK ROCK FOREST KILN.

replace the sod-and-earth blanket of the open-pit process is used; the reversed draft feature has also been incorporated. But the form of the truncated cone has been altered, the cubic capacity is perceptibly larger, the section joints have been re-designed, and both the entering air supply and the escaping hot gases are controlled in different fashion.

When assembled, the two sections form a truncated cone with the lid covering the top opening. The lower section has a one-inch horizontal flange around the lower edge to stiffen the shell. The lid and the lower edge of the upper section are similarly flanged. These flanges fit snugly into gutters welded to the upper side of the section beneath. Both sections and the lid are fitted with good-sized handles. The lid has also a short smoke pipe in the center. (See Plate VII.) A gross capacity of about 100 cubic feet combines the desirable degree of portability with the maximum unit yield. A kiln of this size will hold, on the average, a full half-cord of wood. A larger capacity will produce somewhat more charcoal per cord, but a slight increase in the capacity means a considerable rise in the weight with disproportionately greater difficulty in handling. Eight four-inch holes are cut, equidistant from each other and with their centers about three and one-half inches above the lower flange of the bottom section. Four of these function as air inlets; the rest serve as outlets for the hot gases. Thin covers, made of scrap steel, about eight inches square and slightly curved to fit the kiln shell, are used to regulate the amount of air entering the draft holes. Five-foot lengths of four-inch leader pipe, with a ninety degree elbow at one end, serve as smoke pipes. These elbows are inserted into four of the holes in the bottom section. The upper ends of these pipes are guyed with light iron wire to the smoke pipe in the kiln lid.

OPERATION

An accessible flat, open area of sufficient size to yard the wood, should be selected. Water should be nearby. Although dry wood can be used, green wood will make heavier coal. The wood should not be ranked over five or six feet high. The ranks should be so arranged that a battery of kilns may be operated in regular rotation without mutual interference and with a minimum amount of moving of

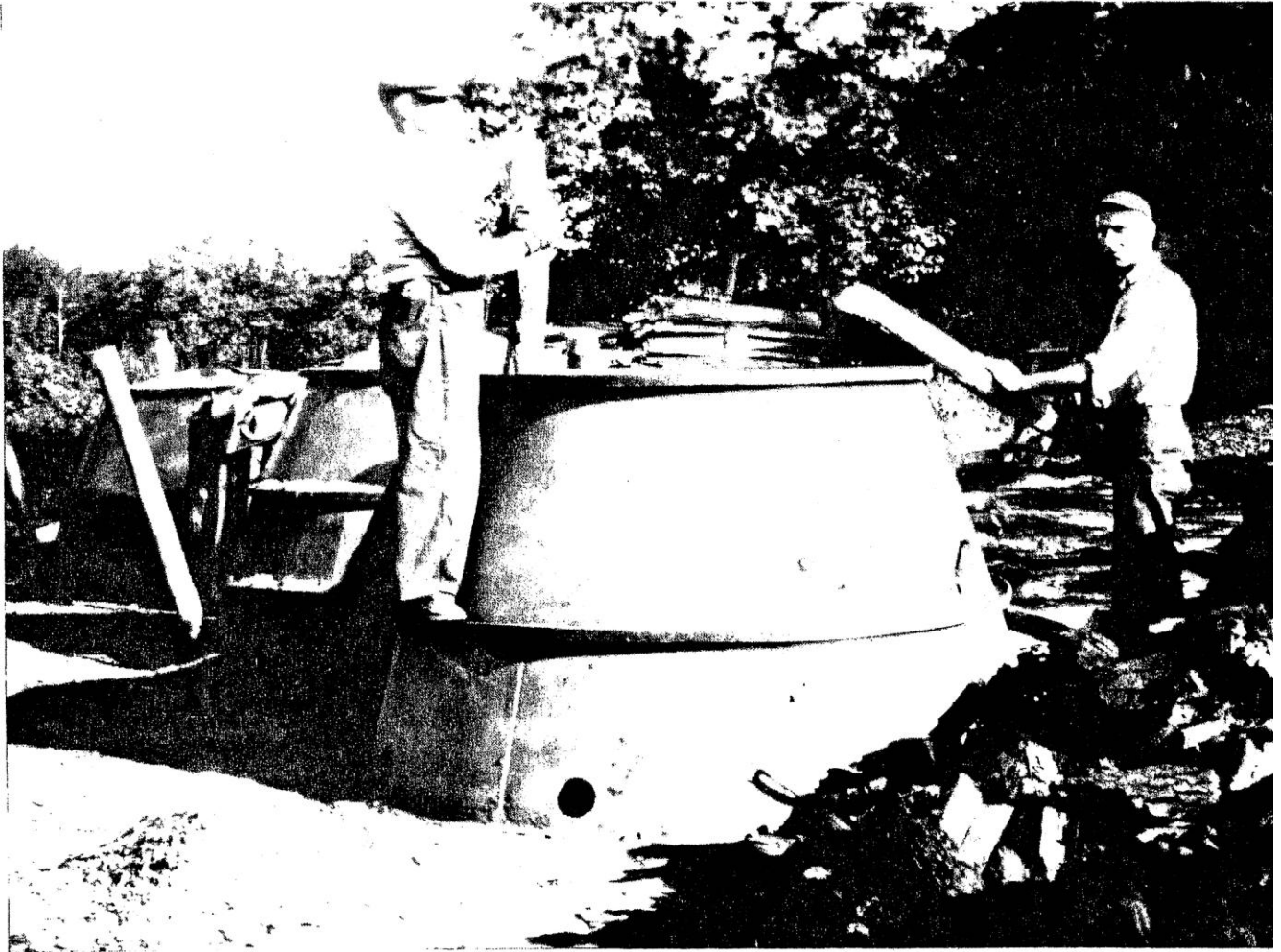


PLATE V. FIRST AND SECOND SECTIONS OF KILN IN PLACE; CREW ADDING THE FEW STI
NECESSARY TO COMPLETE THE CHARGE.

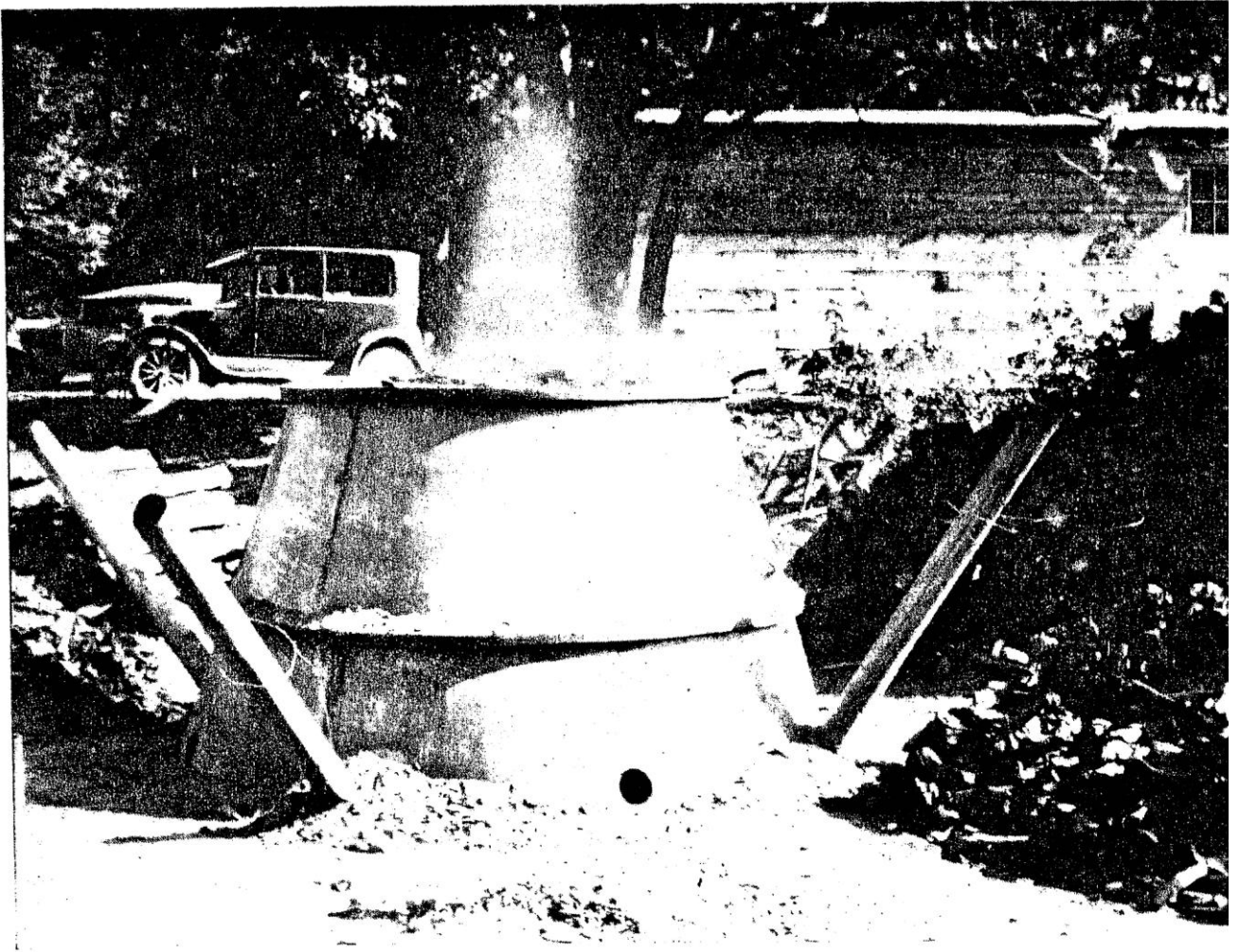


PLATE VI. KILN JUST AFTER IGNITING. BOTTOM EDGE AND LOWER GUTTER HAVE BEEN PACK EARTH AND FLUES SET IN PLACE BUT NOT GUYED.

either kilns or wood. A little advance planning before the wood is ranked will serve to keep the labor costs down.

ACCESSORIES

For a battery of twelve kilns the following accessories will be needed:

2 12-quart buckets	1 toolbox to hold the fore-
2 5-gallon knapsack pumps	going
1 old axe for grubbing	1 chopping block
2 round-pointed shovels	1 wheelbarrow with high
1 grub hoe	sides
2 2½ lb. axes	2 large feed scoops
2 steel rakes	Binder twine
1 pair cutting pliers	A supply of light iron wire;
1 ensilage fork	matches; handsaw; ham-
1 coal scoop	mer; wire nails, staples;
1 stable broom	¾-inch mesh screening;
1 5-gallon kerosene can	surgical masks; hand-
1 1-gallon kerosene can	basins, soap, towels; such
1 wood barrow	record forms as may be
10 pieces waterproof can-	desired
vas, 8' x 10'	

OPERATION IN DETAIL—CHARGING THE KILN

Prepare a level circle approximately eight feet in diameter on the ground. Level off all leaves, twigs, rocks, stumps, and humps. Save any clean dirt. Where the quantity of wood to be coaled is large, a loose brick floor retained by strips of 2" x 3" studding may be laid. Such floors, made 9' x 108' will carry six kilns each. Kilns arranged on such a floor are shown in Plate II.

BUILDING THE CENTRAL CHIMNEY

Use small, four-foot sticks of dry wood split sufficiently to offer plenty of raw edges to the kindling fire. These are sharpened at one end and merely stuck in the ground in a

circle not over eight to ten inches in diameter. (Plate III) This method eliminates all sawing of short kindling and nearly all of the splitting needed for the "pigpen" type of chimney commonly used abroad. We have tested and discarded this practice in favor of the method first described above. The Black Rock Forest method unquestionably saves time but calls for rather careful stacking of the main charge to prevent collapse. Moreover, this practice is not successful unless well-seasoned wood be used. In a series of several hundred runs this type of chimney proved the best. The occasional collapse of a stack during construction will by no means offset the very considerable amount of time gained through the elimination of the sawing and splitting.

The French operating practice frequently includes at this point the laying of a "grille" made by placing several large pieces of wood horizontally and in spoke fashion with the "pigpen" chimney at the hub. This "grille" is then thatched with small limbs or finely split stock and the main charge of wood is piled vertically on the floor thus obtained, resulting in a definite clearance between the ground and the bottom of the stack proper. This feature has also been tested and discarded.

PILING THE MAIN CHARGE

Piling is begun with a double circle of dry wood placed vertically around the chimney. All wood is stacked directly on the ground and as tight together as possible. The sticks should be both selected and placed with care to reduce voids to a minimum. Follow this dry circle with the big wood, working steadily around the stack. The entire charge may fall down if the chimney be not kept as near the center of the stack as possible. Use limb-wood in the outer portions of the stack. Do not build the pile out to the full diameter of the cleared circle; it is best to leave it a trifle undersize and complete it after placing the kiln shell.

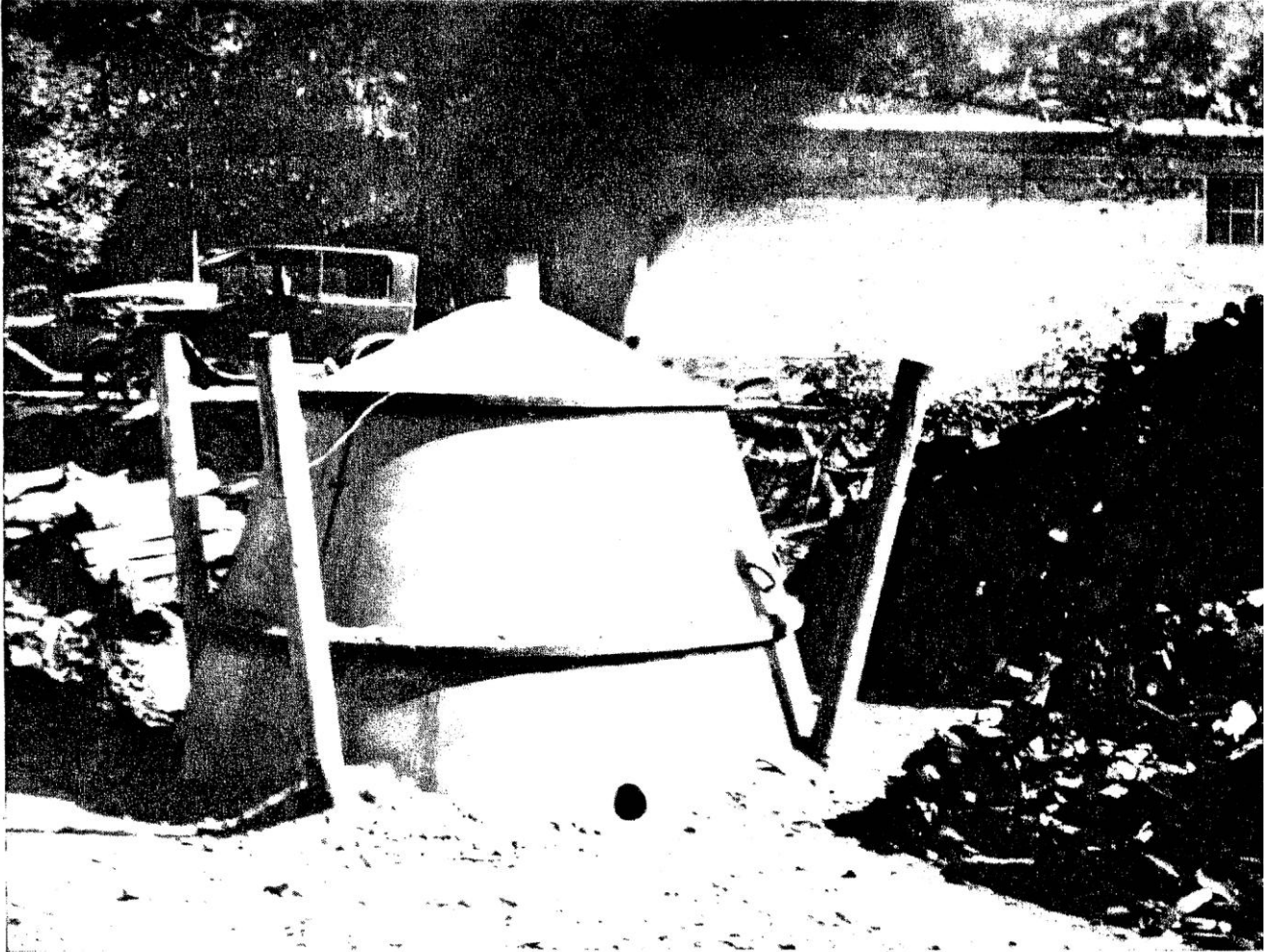


PLATE VII. KILN AFTER IGNITING AND KINDLING SUFFICIENTLY TO PLACE THE LID. LATTER I
BEEN CAPPED AND ALL DRAFTS AND TWO FLUES ARE ADMITTING AIR TO KILN INTERIOR.
HAVE NOW BEEN GUYED TO CENTRAL FLUE. TOP GUTTER BANKED WITH EARTH.

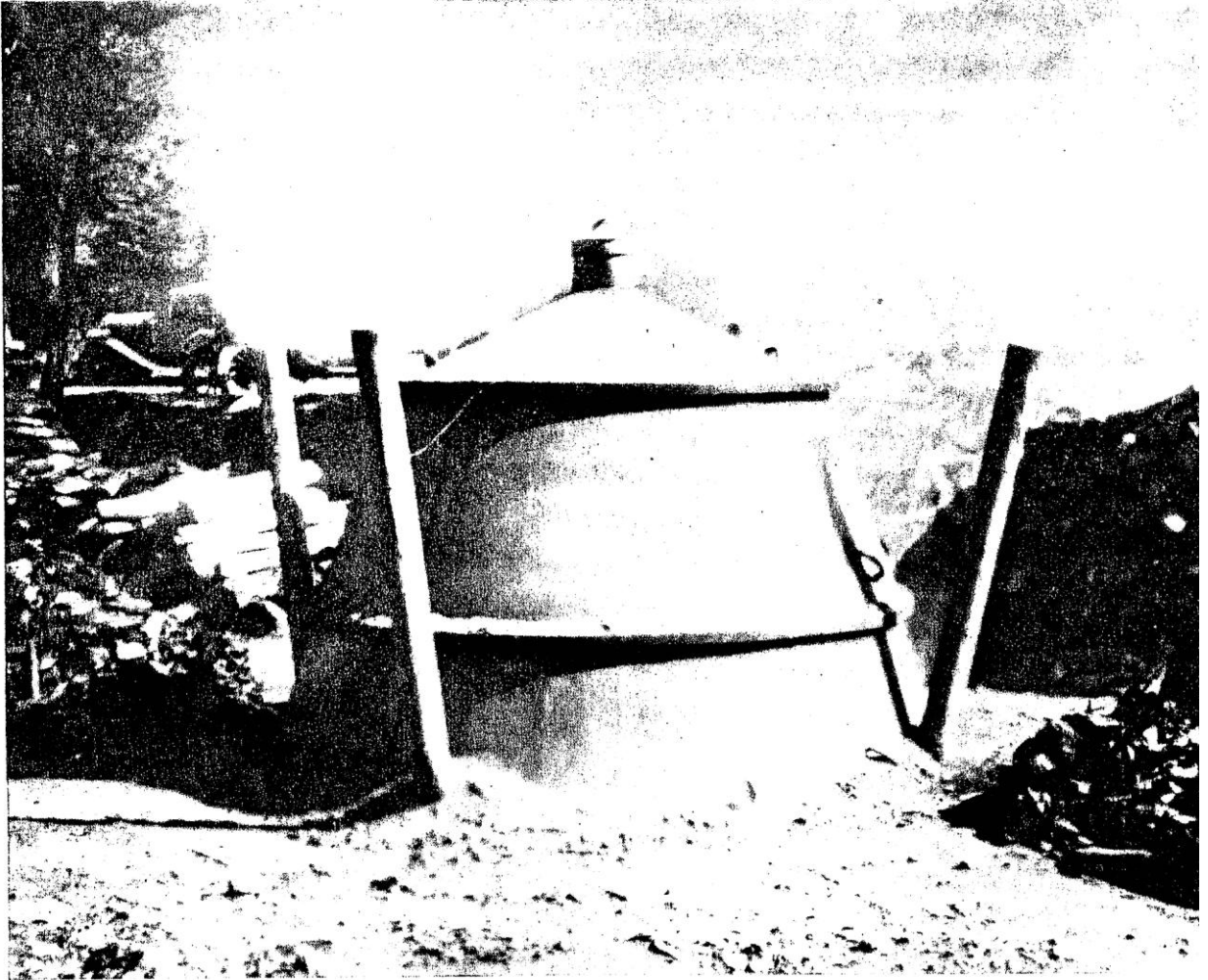


PLATE VIII. KILN WITH CENTRAL FLUE CAPPED, ALL DRAFTS WIDE OPEN AND ALL FL. THE CHARACTERISTIC THICK, GRAYISH-YELLOW SMOKE WHICH STARTS AS SOON AS 1 DRAFT BECOMES OPERATIVE. TOP GUTTER HAS BEEN BANKED WITH EART

PLACING THE OVEN

Drop the lower section over the stack, letting the bottom flange rest flush on the ground or the brick floor. (Plate IV) Have this section level and with the stack chimney at the center. Set the second section on the lower, making sure that the flange of the former seats snugly and completely into the gutter on the top edge of the latter. (Plate V) Add enough wood to fill the kiln tightly. Bank the bottom edge of the kiln and fill the middle gutter with clean earth free from stones. This earth must be tamped thoroughly. Be certain there are no air leaks around the base or at the section joints.

IGNITING CHARGE

Put a few dry chips in the bottom of the central chimney. Pour in a little kerosene, and drop in a lighted match. The fire should begin to draw vigorously. (Plate VI) Fill the chimney up with short, dry wood. Let it pull for perhaps fifteen or twenty minutes. When the smoke and flame from the central flue shows plainly that the chimney is completely ignited, place the lid in place without caulking the top gutter with dirt. It is unwise to caulk the lid flange immediately. Occasionally the lid has to be removed to permit re-kindling. Because of the smoke and heat a short pole is useful in setting the lid in place. Let the kindling proceed with direct draft through the central smoke pipe in the lid for ten or fifteen minutes longer. (Plate VII) When the charge is well ignited, caulk the lid flange with earth. Tamp it well, and set the side flues in place. Guy them to the central flue. They should be placed as nearly vertical as possible with plenty of earth tamped about the base of each. Finally, place the cap on the central flue. The side smoke pipes should promptly give off a good volume of thick, wet, acrid smoke. (Plate VIII) The central flue

may temporarily leak smoke from under the cap, but such leaks are soon plugged by the condensation of the pyro-ligneous acid.

CARE DURING COALING

While these kilns are based on the reversed draft theory, making the air admitted to the interior follow a perceptibly tortuous path before reaching the lateral smoke pipes, it is entirely possible to lose the greater portion of a charge through too hurried cooking. This can arise from allowing too much air to enter the draft holes resulting in active burning of the charge. This makes ashes instead of charcoal. A kiln, therefore, must be watched constantly. At all times the earth on both of the gutters and around the bottom flange and about the lateral pipes must be kept firmly tamped to prevent the entrance of excess air. The best coal, both as to quality and quantity per cord, will be obtained when the charring is done slowly and evenly. One side of the charge should not be permitted to cook faster than the rest. The necessary checking down of the process can be gained by regulating, with the small metal covers, the amount of air admitted to the kiln chamber. (Plate IX) Without exception, the air entering a given draft inlet is about evenly divided between the two adjacent lateral smoke pipes. Practically none goes to any other pipe. Hence, should one portion of the kiln become too hot, the air inlets to that sector should be partially or wholly closed to retard the charring of this portion of the charge.

As each portion of the stack becomes carbonized, a glimmer of light will appear in the corresponding draft hole. That hole should then be promptly covered with a steel cover and banked with earth. If the adjacent portion of the kiln shell is of the same temperature as that near the draft hole, the adjacent smoke pipes should be removed, and the holes covered and banked. This process of closing down the kiln is usually a progressive affair. Rarely do all



PLATE IX. COALING:--A KILN AFTER 22 HOURS COOKING. DRAFT HOLES ARE NEARLY CLOSED BY PLATES. FLUES ARE NOW GIVING OFF ONLY THE LIGHT VAPOR CHARACTERISTIC OF THIS OF THE PROCESS.



PLATE X. COOLING DOWN. ALL SMOKE PIPES REMOVED AND HOLES CLOSED WITH STEEL COVI
CAREFULLY BANKED.

the draft holes "come in" simultaneously. Ordinarily, these glimmers should begin to appear after about twenty-two hours. Occasionally they will show before this, but if the run has been carefully tended, twenty-two to twenty-four hours will serve, although, it appears a slower cook will make better coal.

COOLING

When all the draft holes and smoke holes have been properly covered and tightly caulked with earth, the gutters and the kiln bottom should have a final inspection to insure against any air leaks. (Plate X) The apparatus should be left in this condition for not less than twenty-four hours. Less time than this is dangerous. If only a small spark be left in the charge, the oxygen admitted upon removing the kiln shell will ordinarily be sufficient to start a fire. Once the dry coal is on fire, it can only be extinguished by the copious use of water. This means wet charcoal which is undesirable, as well as the loss of a portion of the charge.

GENERAL HINTS ON OPERATION

The efficient operation of a battery of kilns calls for careful advance planning. The ideal condition is to have the green wood delivered to the kilns simultaneously with cooking, and to have each kiln move only nine feet reciprocally between set-ups. Drawing all the wood to the job before starting cooking may mean clearing of added storage space, and will surely result in ranks uncomfortably high for quick charging of the kilns, in partial drying out of the wood, and in more or less continuous moving of the kilns about the yard as the ranks are consumed. It is far better to establish two semi-permanent bases for each kiln and then feed the green wood to these bases, always keeping a four to six-foot rank available. As to timing the firings, these should be so spaced that the hour for "pulling" the kiln will come at such time as to make it possible promptly to screen, bag, and

store the coal. Wet, or even damp coal is not acceptable as fuel, so, since charcoal is both absorptive and adsorptive, it is unwise to leave it in the open for long. Get it under cover quickly. Knowing the time required for cooking and cooling, it should be simple to plan the firing schedule. For example, when running on a 24-24-hour schedule—*i.e.*, twenty-four hours for cooking and a like period for cooling—plan to fire the ovens the first thing in the morning. This means that forty-eight hours later a batch of ovens will be ready for pulling.

Always have wood stacks prepared to eliminate all possible delay in moving the ovens. Keep these covered with waterproof canvas. Just as soon as a kiln has cooled sufficiently to be opened, it should be pulled down and re-set over a fresh charge. The lid and the lighter top section must, of course, be lifted at least four feet in setting. In moving the heavier bottom section, tip it up on one side, roll it up to the new charge and drop it over the stack into place.

In filling out the charge after the kiln is set, the coned lid makes it possible to utilize the short, unburned ends (the "brands" or "brads"). You will find some of these about the outer edge of every cook. They may be laid horizontally on top of the charge or used as kindling in the central chimney. (Plate XI)

While the ovens are operating, the crew may be employed on numerous jobs such as cleaning up the floors, preparing chimney material or new kiln sites, screening, bagging and storing coal, screening and wheeling in a supply of earth for filling gutters, cleaning the condensed acid from the spare smoke pipes and elbows, cutting twine for bagging, etc.

The first few cooks seemed to indicate that weather conditions played a part in the time necessary for cooking, but a fuller experience disproved this entirely.

Ovens which are not in use may be left out in the open



PLATE XI. CHARGING COMPLETED. "BRADS" IN PLACE AND KILN READY FOR KINDLING

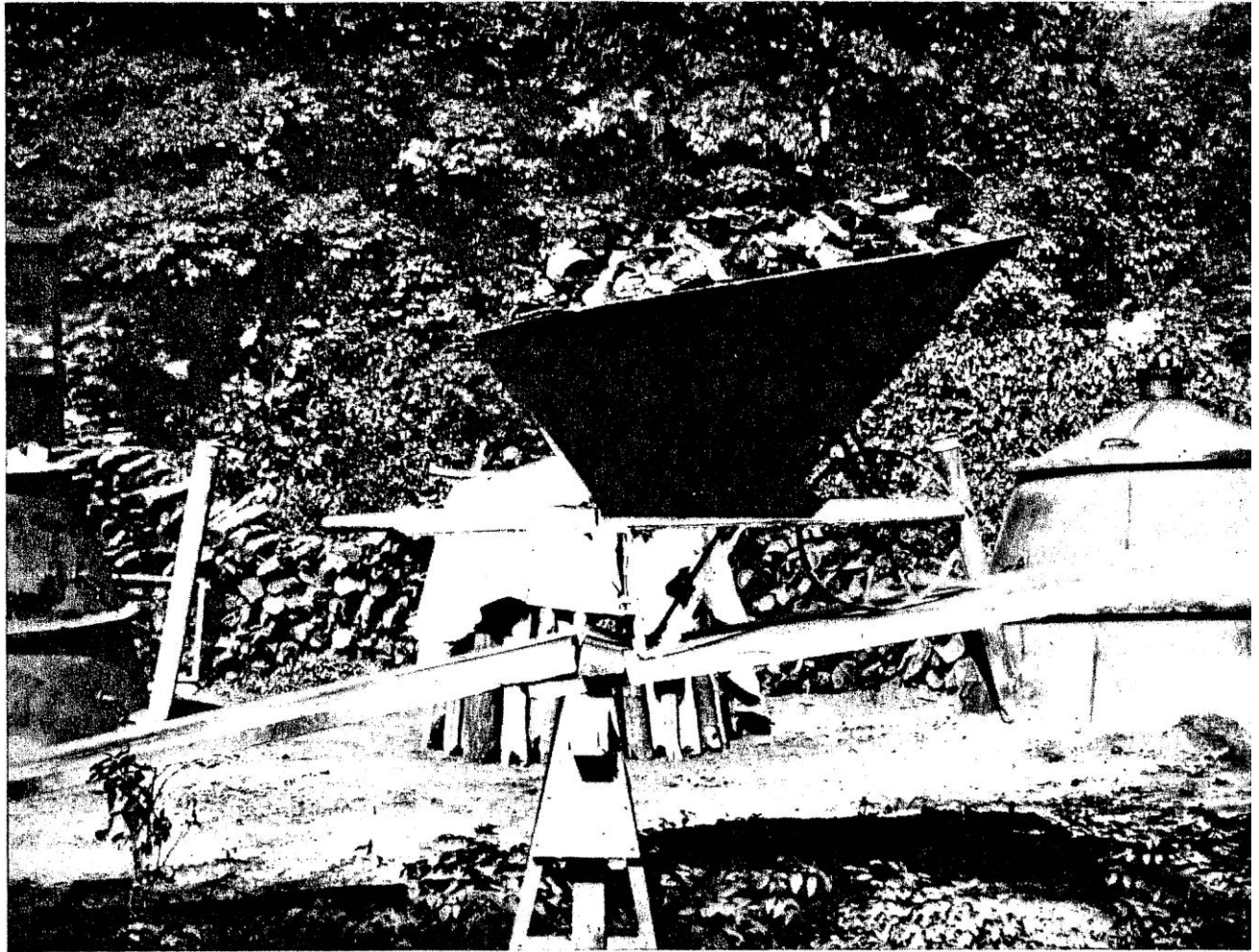


PLATE XII. THE SPECIAL CHARCOAL WHEELBARROW. MADE OF NO. 16-GAUGE STEEL. UPPER END REINFORCED WITH A HALF-ROUND IRON ROD; BOLTED TO ORDINARY WHEELBARROW FRAME.

but they should first be thoroughly scraped down, given a coating of high-grade smokestack paint inside, and set up on peeled skids well off the ground.

THE PRODUCT

MARKETING experience with charcoal has been almost entirely as fuel, chiefly for domestic cookery or tin-smithing or forge work. Grading has not been necessary to any appreciable extent. Buyers of charcoal for the foregoing purposes will insist, however, that it be made entirely from hardwood species, quite free from dust, dirt, leaves or ashes, and that it be dry and screened, usually over a three-quarter inch mesh screen. A smaller mesh permits so much small coal to pass over that the consumer finds the fire packing too tightly and not drawing freely.

SCREENING AND BAGGING

Charcoal is loaded at the oven into a special wheelbarrow (Plate XII), wheeled up a runway, and dumped upon a nine foot screen with a slight slope. The coal is raked down over the screen with the back of an ordinary rake, onto a wooden platform where it is scooped into bags. The special wheelbarrow was made by mounting an unusually large, high-sided body made of 16-gauge steel on an ordinary barrow frame. The runway is built of ordinary plank, wide enough for a man to walk comfortably, with cleats on the two outside treads to insure against slipping. The screen is $\frac{3}{4}$ " mesh, 9' x 3' and with sides not less than 12" high. This should lead down to the bagging platform which should be sufficiently large to accommodate comfortably a good-sized heap of coal, as well as two men and the necessary tools. The minimum workable size for such a platform is about 16' x 10'. It is well to have it somewhat larger for comfort. (Plate XIII) Where the size of the operation warrants, a rough shed should be erected over the platform.

The shed should be large enough both to cover the latter and also to provide some storage space for the bagged coal. Such a shed should, if possible, be so set that trucks may load directly from it with the tailgate at the level of the shed floor.

An ensilage fork is convenient for filling the wheelbarrow. This permits rapid loading, and the tines are sufficiently separated to leave behind much of the dirt, gravel, and ashes. The screen should eliminate the rest. It is not wise to hurry the screening when done by hand. Care must be taken not to rake the coal "over itself"; it must pass over the screen in a thin layer to permit thorough cleaning.

For bagging, where the small, quarter-bushel kraft bags for retail trade are to be filled, a large feed scoop is the best tool. Men engaged in filling such bags should each have a small wooden stand—any small wooden box will serve—about eighteen inches high and ten inches square on the top. This is used as a convenient base on which to tamp the bags to insure that the contents are well shaken down. This shaking is highly essential to getting good measure, as charcoal is lumpy material. The stand should have nailed to its back a vertical slat about 1" x 3" and projecting at least 24" above the top of the stand. A V-shaped notch about 3" deep should be cut out of the top of this slat to hold a supply of binder twine, for tying the bags. A light tin holster, or sheath, might well be tacked to the side of the stand to hold the feed scoop. This prevents dropping, breakage, and battering of the working edge of the scoop. In filling gunny sacks of two bushels or larger capacity, a good tool is the ordinary coal scoop.

If the air in the shed becomes very dusty during screening, have the crew use the common surgical masks. They are no trouble to wear and are easily washed. Prohibit all smoking in or around the shed.

Before buying a supply of bags, consult State regulations covering weights and measures of charcoal containers. Ordinarily a legal quarter bushel of charcoal has a somewhat

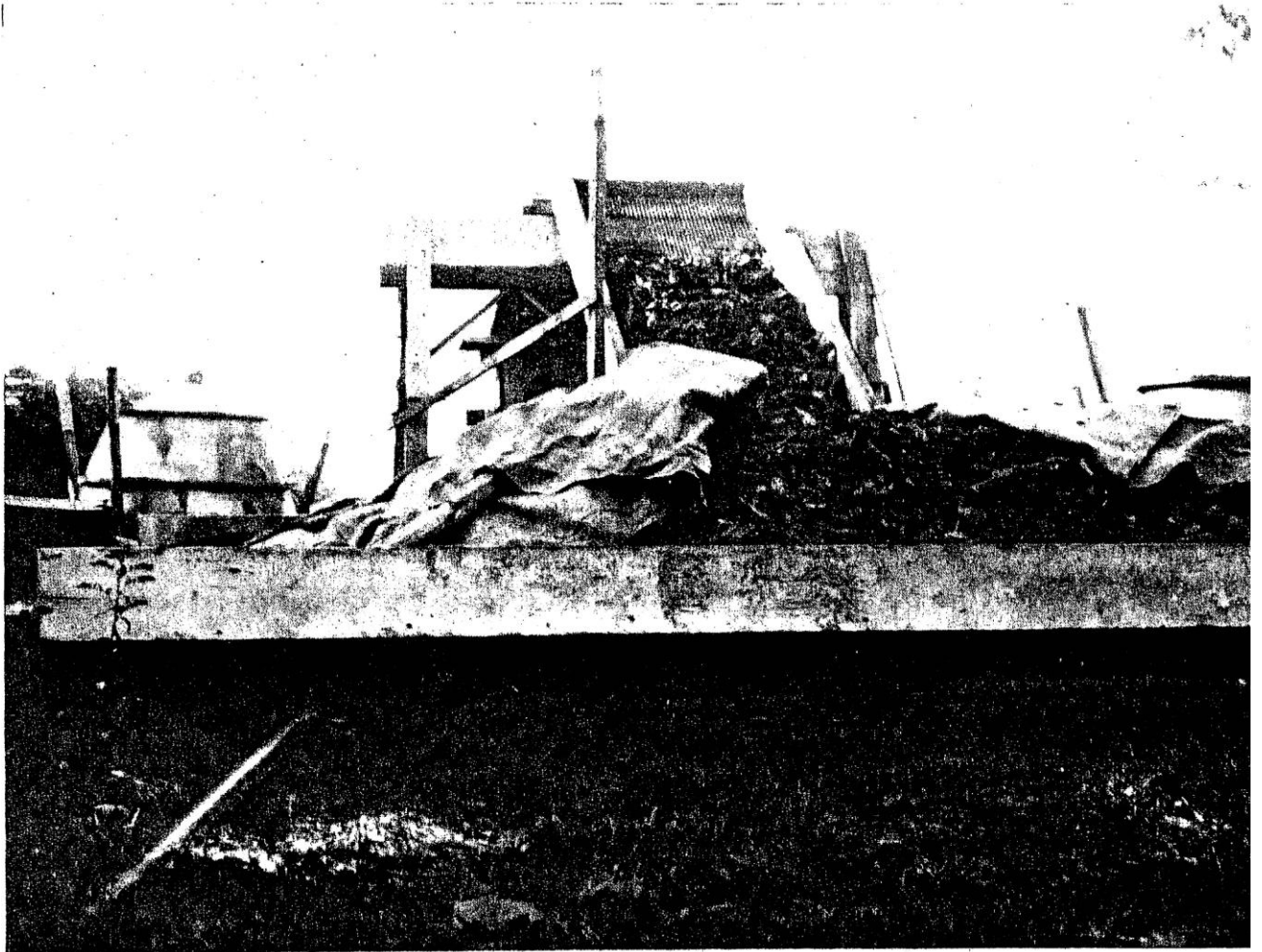


PLATE XIII. BAGGING PLATFORM AND COAL READY FOR BAGGING.

larger volume than exactly 537.5 cubic inches. As a rule the housewife and the retail dealer will expect such containers to show close to five pounds gross weight.

Operating these kilns, especially the bagging, is a dirty job, and a good place to wash, equipped with basins, soap, and towels will be much appreciated.

STORAGE

Charcoal should be stored under cover. Damp coal is not acceptable to the trade. Where the operation is not large, a fair-sized wall tent makes a suitable storage shed. The sacks should not be laid directly on the ground. It is best, if using a tent, to lay a loose board floor several inches above the ground level. As noted above, if the operation be of sufficient size, a light shed may be built to serve for screening, bagging and storage.

The danger of a lurking spark is always present. A shed such as the foregoing should be insured both as to building and contents. In storing bagged coal, avoid packing the bags too snugly together. Make sure that frequent small air spaces are left, for tightly packed coal is susceptible to spontaneous combustion, especially if it be of the smaller sizes or if the bags contain much charcoal dust.

Before shipping on a common carrier, it is wise to examine the Interstate Commerce Commission regulations covering the loading of charcoal. This also applies to trucks which travel on ferries. Regulations require that charcoal be aged for a definite time interval before shipping.

ANALYSIS OF RESULTS

AT THE BLACK ROCK FOREST

FOR purposes of record the first series of cooks was set at 127. This number covers what was in actuality a training period, especially as the unit yields averaged perceptibly higher at the end of the first 100 charges.

(Inexperienced Crew)

Total number of cooks	127
Total yield of charcoal	32,896 lbs.
Average time per cook	24 hours
Average yield per cook	259 lbs. charcoal
Average yield per cord	{ 536 lbs. charcoal 26.8 bu. charcoal

In the second tabulation these figures are omitted, the figures given below showing the results from the balance of the runs (424 cooks), which were made by a crew which could accurately be styled experienced.

(Experienced Crew)

Total number of cooks	424
Total yield of charcoal	138,945 lbs.
Average yield per cook	327.7 lbs.
Average yield per cord	{ 655.4 lbs. 32.7 bushels

(Note—The foregoing cooks were not timed except that we sought to hold to an average interval of 24 hours).

This last figure of 32.7 bushels per cord is about as fair an average as may be expected. In the days when the old open-pit process was flourishing, the common converting factor in this section and in New England was "three cord to the hundred bushel." It is doubtful if the Black Rock Forest kilns will exceed this. Not infrequently cooks with these kilns have yielded as high as nine hundred pounds, or forty-five bushels to the cord, but these can hardly be taken as standard performance.

AT ORLAND, MAINE

During the summer of 1932, fifty-four cooks were made at Orland, Maine, by Mr. W. B. Candage. Twenty-three were done in steel kilns and thirty-one in stationary brick kilns of slightly larger cubic capacity than the standard Black Rock Forest kiln. These had the usual equipment of

draft holes and smoke pipes with a coned steel lid with a central flue. Permanent steps were built into the sides at about half the height to help in loading. This non-movable apparatus appeared to behave somewhat better than the steel kilns, but a longer time was needed to charge and to draw. This series of cooks was made by an inexperienced crew.

The fuel was chiefly limbwood which could not be packed as tightly as is desirable. Both green and dry Alder, White and Yellow Birch, Beech and Hard Maple were used.

Below is a tabulation of the results.

AVERAGE FOR ALL KILNS

<i>Time of free burning, min.</i>	<i>Time of cook, hrs.</i>	<i>Time to cool, hrs.</i>	<i>Yield, bu. ch.</i>	<i>Yield, bu. "brads"</i>
25.4	25.2	31.5	19.1	1.6

COMPARISON OF AVERAGES OF STEEL AND BRICK OVENS

	<i>Time of cook, hrs.</i>	<i>Yield, bu. ch.</i>	<i>Yield, bu. "brads"</i>
Steel kiln	26.9	19.5	2.5
Brick kiln	23.9	18.8	0.7

THE CREW

To operate a battery of twelve kilns for six days will require two men for full time on loading, firing and tending; and two men for three days full time on wheeling, screening, bagging and storing of coal plus such additional time as may be needed for delivery. The first two men (the kiln crew) should pull, load, and fire six ovens every fair day. This totals 144 man-hours. With continuous fair weather such a battery and crew will carbonize approximately eighteen cords of wood in one week.

POSSIBILITIES OF APPLICATION

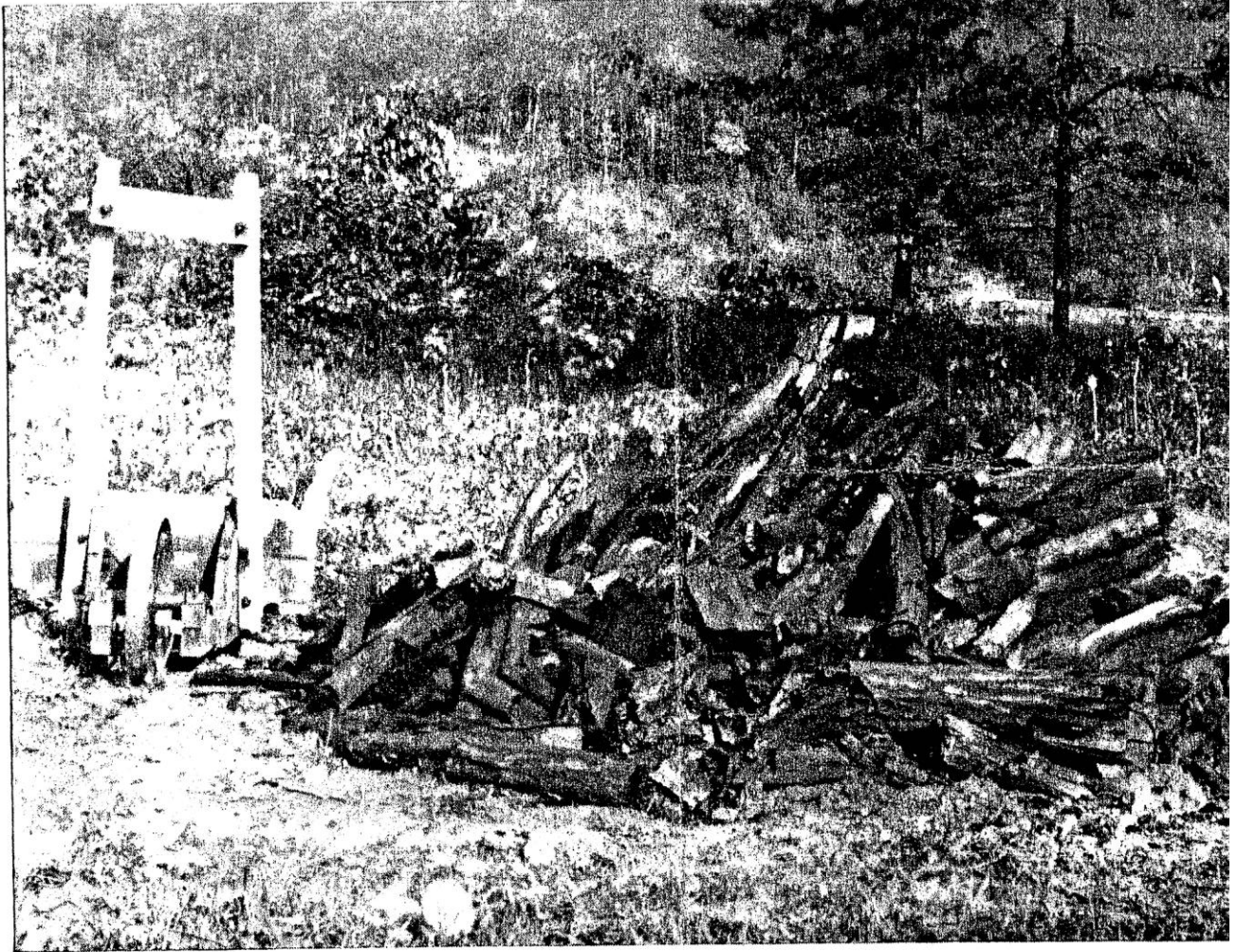
Where there exists competitive delivery of charcoal from hardwood distillation plants, these kilns can only serve as

a not overly expensive outlet for surplus fuelwood. In this section, distillate charcoal rarely exceeds a delivered price of twenty-five cents per bushel, while thirty-two cents represents about the best delivered price so far possible at the Black Rock Forest. In the case of a demonstration forest or research laboratory, where such competition is present, a battery of these kilns may be operated with reasonable propriety, since this form of utilization makes it possible to carry on applied silviculture at no excessive cost and also to leave the woods in much better condition than could be done without this outlet.

Where, however, an operation is favored with a market located beyond reasonable freight haul for distillate charcoal, it is entirely possible to run these kilns at a slight profit and to carry on highly intensive applied silviculture at the same time.

COSTS OF EQUIPMENT

On this Forest, charcoal has not been made during snowy weather. The usual burning season has been from about May 1 to December 1. The life of a kiln is estimated at five such periods. In 1930 one fully-equipped kiln cost in this region about \$115.00. Taking the kiln life at five years, with interest at 5% per annum, and using the yield of 33 bushels to the cord, gives an estimated interest and depreciation and interest charge of 2.04 cents per bushel—a fixed charge of no mean proportions when one considers the sharp competition prevailing in the charcoal market.



A GOOD COOK FROM ONE-HALF CORD OF MIXED HARD WOOD.