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OREGON MUST LOOK AHEAD

Hundreds of thousands of acres of good but profitless stump lands in our state already await reclamation for agriculture.

Twenty-one million acres of standing timber remain, and we are just entering the great cutting era.

What shall we do? How can we begin replacing this huge wealth resource before it is exhausted and leaves us impoverished?

Can the best of this stump land be changed to profitable farms and thus bring enduring wealth to Oregon?

This is one of our most difficult problems in land economics, and as yet it is a problem unsolved.

Can we produce a convincing, practical, commercially successful solution to this problem, that will bring genuine aid and guidance to the settler on the stump lands, or must we wait for slow and costly natural economic evolution to work this problem out for us at the expense of generations of settlers?

This bulletin describes a new method of land clearing to which the Oregon Experiment Station has given years of study and on which it has reached conviction.

It is a simple, logical, practical method. It cuts the cost of clearing big stump land in two.

What shall we do with it. Can we establish it?

Simple and practical as it is, yet it is new. Many at first will fail to use it correctly and successfully. It will take effort and patience and persistence to put it in use. New methods in agriculture, no matter how sound and good, take years to become established.

County agricultural agents and College Extension Service can do much. Owners of timber and logged-off land, bankers, chambers of commerce, and development bodies can do more. Put this method to the commercial test, and in a few years we may have it permanently established and in use.
Stump Land Reclamation in Oregon
A New Method of Clearing the Big Stump Land

By
H. D. SCUDDER

THE STUMP LAND PROBLEM

FOREWORD

Free lands for new homesteads in the West are gone. While there are millions of acres of public land and grant land still untaken, there remain few claims of sufficient value to justify their cost in money, time, labor, and social and economic isolation.

The seeker after new land must turn in future largely to those areas still unclaimed from desert, swamp, and forest. In these lie our richest remaining land resources. With the advance of settlement in search for further agricultural domain, the reclamation of these lands has assumed a commanding position in land economics.

Reclamation of our arid and swamp lands through irrigation and drainage has progressed to successful establishment in fact as well as in public confidence. Reclamation of stump land, in an organized way, has hardly been touched upon. Yet here lies our greatest remaining field for reclamation work. The extent and importance of this field has not been realized by the general public. Further and more careful exploration of its possibilities must perhaps precede any extensive reclamation of this land. A brief comparison, however, is indicative both of the great future interest we may come to take in this land resource and of the magnitude of the problem it presents.

CLASSES OF RECLAIMABLE LAND IN UNITED STATES

<table>
<thead>
<tr>
<th>State</th>
<th>Acres</th>
<th>State</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>6,135,000</td>
<td>Alabama</td>
<td>14,785,000</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>2,608,000</td>
<td>Mississippi</td>
<td>8,263,000</td>
</tr>
<tr>
<td>Vermont</td>
<td>2,070,000</td>
<td>Louisiana</td>
<td>13,877,000</td>
</tr>
<tr>
<td>New York</td>
<td>5,997,000</td>
<td>Texas</td>
<td>12,986,000</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>5,297,000</td>
<td>Arkansas</td>
<td>13,890,000</td>
</tr>
<tr>
<td>New Jersey</td>
<td>1,615,000</td>
<td>Missouri</td>
<td>8,990,000</td>
</tr>
<tr>
<td>Maryland</td>
<td>1,348,000</td>
<td>Michigan</td>
<td>11,668,000</td>
</tr>
<tr>
<td>West Virginia</td>
<td>4,634,000</td>
<td>Wisconsin</td>
<td>15,246,000</td>
</tr>
<tr>
<td>Virginia</td>
<td>9,929,000</td>
<td>Minnesota</td>
<td>14,022,000</td>
</tr>
<tr>
<td>Kentucky</td>
<td>3,222,000</td>
<td>Montana</td>
<td>674,000</td>
</tr>
<tr>
<td>Tennessee</td>
<td>7,853,000</td>
<td>Idaho</td>
<td>676,000</td>
</tr>
<tr>
<td>North Carolina</td>
<td>12,745,000</td>
<td>Washington</td>
<td>3,320,000</td>
</tr>
<tr>
<td>South Carolina</td>
<td>8,994,000</td>
<td>Oregon</td>
<td>3,537,000</td>
</tr>
<tr>
<td>Georgia</td>
<td>20,141,000</td>
<td>California</td>
<td>3,031,000</td>
</tr>
<tr>
<td>Florida</td>
<td>10,109,000</td>
<td>(Minor areas omitted)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>228,509,000</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Of these vast areas, the portion valuable for agriculture and worth reclaiming has not as yet been determined. A primary step in national land economics, that it is none too early to take, is an inventory and classification of these lands as to their value and best utilization. While it is true that a large portion of the cut-over land is more valuable for reforestation than for agriculture, it is likewise true that an enormous area of potential farm land now in stumps, far in excess of any other class of reclaimable land, awaits practicable agencies for reclamation.

STUMP LAND PROBLEM IN PACIFIC COAST STATES

In Oregon, the Northwest and Pacific Coast states generally, the stump-land problem, though already of great interest and importance in many localities, is as yet in its early stages. Statements in a recent publication* on our forest resources make this clear. "The great pine forests of New England and the Lake states are practically cut out. * * * The New England region now ships in about thirty percent of the lumber it consumes. The Lake states region * * * consumes the equivalent of 70 percent of the total it cuts, leaving only 30 percent for export. The southern pine region * * * is already past the peak of its production * * * and within ten years will probably cease to export. The Pacific Coast region alone contains more than one-half the remaining saw timber in the United States." An increasing concentration in timber manufacturing in the Pacific Coast region is not only indicated but already begun.

STUMP LANDS IN OREGON

In Oregon alone is found one-fifth of the standing timber of the United States. According to the authority just quoted Oregon has a total of 18,750,000 acres of mature timber, and 2,500,000 acres of second growth, or a total of 21,250,000 acres of land in timber. Of this, it is estimated that 10,000,000 acres in Western Oregon and 5,000,000 acres in Eastern Oregon is distinctly forest land; that is, of more value for reforestation when cut than for agriculture. This leaves approximately 6,250,000 acres, or 30 percent of our present timbered land of possible value for agriculture when cut.

In addition, as shown below, there is estimated to be at this time in Oregon 2,668,000 acres of burnt-over and logged-off land, of which 830,000 acres, or 31 percent, is estimated to be of value for agriculture. The rate of cutting in Oregon at the present time is estimated at approximately 100,000 acres per year.

*Dean George W. Peavy, O. A. C. School of Forestry in Bulletin No. 2, Oregon State Board of Forestry.
In brief, we have in Oregon, though no accurate classification has been made, possibly 5,000,000 acres of agricultural land now in timber and 1,000,000 acres of agricultural land already in stumps, and we are cutting yearly at an increasing rate. While much of this area may not be of sufficient agricultural value to justify clearing, yet if even 10 percent of our total timbered and wooded area is good agricultural land, the reclamation of our stump land is one of the biggest and most challenging of problems in Oregon’s future development.

Much of this land is of high value for agriculture. Some of it is not excelled in richness by any now in cultivation. Some is chiefly valuable for grazing. The larger share of it comes under the favorable climatic conditions of Western Oregon, requiring neither drainage nor irrigation. Considerable areas of it are close to highways and railroads and markets. Have we feasible methods of reclaiming this land at a cost within its market value when cleared?

*State Forester F. A. Elliott, Oregon State Board of Forestry.

In the adjoining state of Washington a recent estimate places the total area of logged-off land at 4,600,000 acres, of which 2,214,000 acres is considered agricultural land. British Columbia, on the north, and California, on the south, have further great areas of valuable stump land of similar character to that in Oregon.
In the pine region of the northern states, as well as in the southern pine belt—the two areas in which at present are found the largest acreage of stump land valuable for agriculture (Table, page 5) the use of powder and puller combined has proved a fairly feasible method of land clearing, and some progress in clearing and settlement of stump land is being made, particularly in areas stimulated by organized community effort.

But powder and puller in Oregon and the Northwest, while most valuable supplementary agencies, are economically not sufficient for the task. The reason for this is the great size of the stumps of the Northwest land. The average stump on typical stump land in the Northwest has twice the size of top and roots as that of the timber regions of either the northern or the southern states. While clearing with powder and puller costs in these regions from $20 to $90 per acre, here it costs from $40 to $350 per acre, with $200 per acre a fairly representative figure for typical logged-off land.

**THE BIG STUMP THE REAL PROBLEM IN NORTHWEST**

The big stump is the real problem in clearing the logged-off land in the Northwest and the Coast region. With ordinary methods of clearing, the cost per foot of diameter of stump increases with the increase of the diameter of the stump. The “big fellow,” running from two feet to eight feet or more in diameter, and standing thirty or more to the acre, cannot be removed economically with methods now used. In other words, the cost of clearing big-stump land with present methods is usually greater than the present market value of the land when cleared, or of land of similar quality already cleared. Because of this, land-clearing in the Northwest is making little or no progress, while the area of stump land is steadily increasing at a rate that is yearly making the economic problem more acute.

The small stumps, up to fifteen inches in diameter, or the next class, up to twenty-four inches in diameter, are a lesser problem, as they can be economically removed with horse- or engine-operated puller, or with the addition of a little powder to crack or loosen and shake the dirt in preparation for the puller. It is the big stump that is prohibitive in cost of clearing.

**OLD METHODS OF CLEARING**

Little advance in improved agencies for land clearing has been made since the invention of the stump puller and the development of stumping powder. A discussion of the scores of methods, devices, and theories for clearing the Pacific Northwest stump land, that have been tested or advanced during the last twenty years by various men who have given this subject thought, would serve to indicate how difficult and important this problem is, but otherwise would be of little value, for it would lead to but one conclusion—that we have not yet found a method that is feasible. The proof of this lies along every highway and by-way, skirting our rail
lines for miles, standing at the very doorways of our cities and towns—in the thousands of acres of fertile, attractive, close-in agricultural lands that lie profitless in stumps.

Fig. 1. Rich land but idle and profitless and a burden to the taxpayer. Twenty miles from Portland on the Columbia Highway.

Fig. 2. Clover crop just across the pavement from the land shown in Fig. 1. Market value of this land $300 per acre or better.

Hundreds of active minds have tackled this interesting problem. Some of the methods advanced have had outstanding features of value. Some have been wildly impractical in conception. But all have had faults that, when tested against the giant tombstones of our forests, have proved them unfit. Powder and puller and fire alone have emerged and remained
as our sole substantial weapons, and even these, as heretofore used, have proved inadequate against the big stump—too dear in toll of labor, patience, and cash.

A NEW METHOD

Fifteen years of study and observation of land-clearing methods, the last seven devoted particularly to the study and trial of the stump burner herein described, have convinced the Oregon Experiment Station that there is a cheaper, simpler, and more practical method of clearing big-stump land than any heretofore in use. While our findings on this method in many details, no doubt, are not final, and while much corroborative and development work remains to be done, yet it seems safe to say that in this new method a definite step forward in land clearing has been made.

Let it be stated at once that this new process does not eliminate labor, hardship, and cost in removing the big stump, nor is it 100 percent efficient on all big stumps. Nature has used her utmost art and patience in the intricate entanglement of the many-fanged root mass of the tree with the earth, to rear and hold aloft the giant plant. When man attacks with equal art and a fragment of her patience and labor, he may approach her perfection, but cannot hope to equal it. The power of powder and puller has proved economically inadequate to the task, but the old art of fire in a new development gives promise of success.

That this new method does materially reduce the cost of clearing big stump lands and brings them within the possibility of economic use, that it greatly reduces the hard labor of land clearing, that it is simple and extremely practical, requires little cash outlay, fits extraordinarily well into the labor program of the farmer and settler who has the land clearing work to do, and that it gets successful results on a large percentage of the big stumps under actual conditions in which they are found, will not be denied by any who have given the method a fair trial.

To an Oregon farmer, Mr. S. F. Zysset, is due the credit for the invention of a simple but seemingly perfect appliance for the effective use of fire in destroying the big stump. The necessity of finding a cheaper and easier method than powder and puller for the big stumps on his own land was the mother of his invention.

On the completion of his device, Mr. Zysset brought it to the attention of the Oregon Experiment Station. The Experiment Station had already come to the conclusion, from an extensive study of the old char-pitting method, that the use of fire was the most promising field of study and at once became interested in the possibilities of the new appliance. Beginning in 1915, the Experiment Station has made a study of the Zysset stump burner, extending over a period of seven years, during which the development of the best methods of use of the burner on the different types and kinds of stumps and stump land and the time and cost studies necessary to indicate its economic feasibility, have been made.

In brief, it may be said that out of more than a score of devices and methods for land clearing investigated by the Experiment Station, this one alone has emerged convincingly practical, and outstanding in reduction of labor and cost of clearing.
OVERCOMES FAULTS OF OLD CHAR-PITTING METHOD

The new method may be best described as a modified char-pitting process. The old char-pitting method, sometimes called "coal-pitting," first used in Oregon some thirty years ago and extensively tested and developed both in Oregon and Washington, had one great virtue and one great fault.

Fig. 3. The business end of a Douglas fir, a lateral rooted species. It is the massive root system of the big stump that makes land clearing costly.

Fig. 4. Pine root crown below ground level. Pine, oak, and ash are usually tap-rooted and hence more easily burned out.

Its virtue was that, properly used, it would not only consume and destroy the big stump itself, but also the larger share of its roots to a point below plow depth. The big problem in land clearing is not getting rid of
the bole or crown of the stump alone, but rather making away with the great root fangs and secondary roots extending out in all directions from the stump in the surface soil and within reach of the plow (Figs. 3 and 4). It is in clearing away the roots that the excessive cost and labor of land clearing are chiefly involved. No land clearing method that does not successfully and economically handle the root system that lies above plow depth, can be considered satisfactory. The old char-pitting method solved this feature of land clearing with marked success.

The great fault of the old char-pitting method, however, was the difficulty experienced in getting the stumps successfully afire. While the experienced char-pitter was successful with a high proportion of the stumps fired, the beginner usually lost four fires out of every five tried, and would give up the method in disgust, considering it a failure. It was a failure for the man who did not learn how to use it, and its use was difficult to teach.

A second fault of this method was that the stump was set on fire on the outside first and burned from the outside, in toward the heart, thus cutting off the central fire from the roots when the bank dropped in; hence in many cases not all the roots were burned out.

After years of effort on the part of the experiment stations in both Oregon and Washington in developing its use, the old char-pitting method has been very largely abandoned for the faults just described.

PART I. THE NEW STUMP BURNER METHOD

The new method herein discussed, by means of a simple appliance called the stump burner, first, insures the easy and thorough firing of the stump, and second, burning from the interior of the stump outward, permits far more effective burning out of the root system than did the old char-pitting method. Thus it retains the chief virtue of the old char-pitting process and overcomes its greatest faults. Any school boy who can start a fire in the kitchen stove can successfully set a stump afire with this new appliance.

The burner method is exceedingly simple and may be roughly described in a few words. By means of the burner parts (furnace, hood, draft pipes, and chimney) it is possible with ease, first, to burn a hole through the base of the stump and then convert the stump itself into a stove, and then with its own draft, chimney, and fuel, develop a fire in the stump interior so intense as to insure its combustion and the firing of the roots. When this is done the stump is banked in with earth and the crown and roots are burned out below plow depth as a char-pit. Detailed description of the procedure follows.

THE BURNER OUTFIT

A burner unit consists of the following: a furnace, two hoods, a long draft pipe, two short draft pipes, and several lengths of ordinary six-inch stove pipe. The only equipment required in using the process is a shovel, an ax, an iron furnace hook, an iron punching rod, and a wooden cleaning rod.
The furnace and two hoods are very thick walled, heavily reinforced iron castings, weighing combined about two hundred pounds. Each is open on the bottom and at the rear end and each has a shoulder on top for attaching the stove pipe. The furnace has a small draft door in the front end (Fig. 5).

The station trials have shown that such thickness and heaviness of castings are necessary in order that they will stand up under extreme heat without buckling or cracking, will not cool too rapidly when removed from the earth bank, will not crack or scale off, and will endure repeated firing without damage. The extra thickness of metal is especially important for the furnace, so that it will retain its heat while being moved from one stump to the next through mud and rain, making it easy to start a new fire in it without kindling or reheating. The arches inside the casting, aside from reinforcing the walls, are also designed as deflectors to direct the flames most advantageously for an effective fire, and especially to prevent burning out of the stump just above the furnace and the hood with resultant trouble in banking. It may be well to state here that numerous substitutes for these cast pieces have been tried (old iron plate, tiles, brick, etc.), but no satisfactory substitute for them has been found.

The draft pipes are of black iron, two inches in diameter, the long pipe ten feet and the short ones four feet in length. Station trials have shown that a diameter of two inches gives the best results, smaller giving not sufficient draft and larger, too much.

The furnace hook is made of one-half-inch round iron, about three feet in length with a large rounding hook in one end and a flattened loop for hand-hold at the other.

The punching rod is of one-half-inch round iron, about six feet in length with flattened, chisel edge at one end and flattened loop for hand-hold at the other.
The cleaning rod is a slender, straight pole, about fifteen feet in length, and small and straight enough to run through the draft pipe.

NUMBER OF BURNERS REQUIRED

Depending upon the time available for clearing and the rapidity with which the work is desired done, from one to four burner units per man may be employed. The station trials have shown that four units (four furnaces and eight hoods) are usually the maximum that one man, using all of his time, can keep going. Two units constitute a desirable equipment where full time cannot be used but satisfactory progress is to be made. It would seldom be advisable to attempt work with but one unit, as the burner requires attention only at intervals and a one-unit outfit would likely be more or less neglected, and rather slow progress would be made.

KINDS OF STUMPS BURNED

In the station trials the new method has given entire satisfaction in burning fir, pine, spruce, and oak. Other species common to land of agricultural value, hemlock, maple, ash, and alder, are all good burning woods similar to those listed and should be handled successfully with the burner.

An understanding of the character of the stumps with which we have to deal, as to species, is important and is indicated in the tabulation below as reported in bulletin No. 2 of the Oregon State Board of Forestry from data of the United States Forest Service:

<table>
<thead>
<tr>
<th>Timber Species of the Pacific Coast Region*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas fir</td>
</tr>
<tr>
<td>Western yellow pine and Jeffrey pine</td>
</tr>
<tr>
<td>Western hemlock</td>
</tr>
<tr>
<td>Western red cedar</td>
</tr>
<tr>
<td>True fir</td>
</tr>
<tr>
<td>Sugar pine and Western white pine</td>
</tr>
<tr>
<td>Redwood</td>
</tr>
<tr>
<td>Western larch</td>
</tr>
<tr>
<td>Spruce</td>
</tr>
<tr>
<td>Lodge pole pine</td>
</tr>
<tr>
<td>Other species</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Of the species listed above those conifers most common to land of agricultural value in Oregon are distributed as follows:

<table>
<thead>
<tr>
<th>Conifers Common to Agricultural Land in Oregon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas fir</td>
</tr>
<tr>
<td>Western yellow pine</td>
</tr>
<tr>
<td>Western hemlock</td>
</tr>
<tr>
<td>Western red cedar</td>
</tr>
<tr>
<td>Spruce</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

*The Pacific Coast region includes the following, named in order of their total stand of timber: Oregon, 482,900,000,000; British Columbia, 350,000,000,000; California, 344,000,000,000; Washington, 268,000,000,000; Alaska, 150,000,000,000; Idaho, 38,000,000,000; Montana, 55,000,000,000.
It is clear that the chief stump with which we have to deal in land clearing in Oregon and the Pacific Coast region is that of the Douglas fir, often called yellow fir (the old growth), or red fir (the second growth).

The Western yellow pine is of much less importance in land clearing than is indicated by its stand, owing to the fact that most of it is found on soils unfit for agriculture or of relatively low fertility, although of course pine will grow and is occasionally found on good agricultural land.

The Western hemlock is of minor importance, for while found more or less on agricultural land it contains little pitch, roots less deeply, rots out very quickly, and altogether is less difficult to deal with from the land-clearing standpoint.

Western red cedar, except in deep, mellow, moist soils or bottom lands, usually is shallow-rooted and easily pulled over or cracked with powder and pulled. Furthermore, it is usually fibrous-rooted; that is, the roots are many and light and do not offer much body for fire. Frequently also the stump is hollow. Again, the wood contains an oil but no resin or pitch. For these various reasons it is doubtful whether cedar is important from the burner standpoint, and since in many of our logged-off areas cedar stumps are not frequent, no attempt has been made to burn them.

Redwood stumps, of great importance in Northern California because of their great size and high cost of clearing and the high value of much of the land upon which they stand do not occur in the Northwest states except in a very limited number in the extreme southwest corner of Oregon, and as yet have not been tested with the burner.

Spruce burns very well, especially on tideland, where it is very pitchy. Difficulty with spruce consists in the fact that it is so often high-rooted, the root bridges or buttresses standing high out of the ground, and for this reason requiring a larger amount of labor in banking. Spruce also is thin-barked and does not furnish fuel for the furnace, so that bark must be secured from adjoining firs if there be such. Since, however, the spruce is a costly stump to remove by ordinary means, the use of the burner may often be justified notwithstanding the extra labor required in banking. The total amount of spruce to be removed from agricultural land is small and is confined largely to a few counties on the Coast, particularly Tillamook and Lincoln. Unfortunately, a great deal of the most valuable land, especially in Tillamook county, has never been cleared of spruce stumps and the wrecks of these stumps, cut twenty or thirty years or even longer ago, and partly burned and rotted away, stand on valuable pasture land much in the way and costly to remove. They offer in such condition a poor place for the use of the burner. In the case of land more recently cut where the stumps are still sound and in normal condition and not too high out of the ground, and where fir bark is available for furnace fuel (frequently the case on tidelands), the spruce can be successfully handled with the burner method (Fig. 6).

The noble fir, very commonly called "white fir" in Western Oregon north of Josephine county, usually does not burn well, not even in a stove, and hence is not suitable for the burner method. The amount of this species on agricultural land is insignificant, and further, it rots rather quickly and is taken out by ordinary means fairly easily.
The sugar pine and lodge pole pine burn well but grow at the higher elevations and are not found to any extent on lands of agricultural value. The Western larch burns fairly well but is little found on agricultural land.

In general it seems safe to say that with the minor exceptions noted above, any species of stump of reasonably sound, burnable wood or of sufficient size to justify the use of fire, and with roots sufficiently large to carry a fire well (4 to 6 in. in diameter), is a desirable subject for the use of the burner.

SIZE OF STUMP

The outstanding feature of the land-clearing problem in the Northwest, as already mentioned, is the size of the stumps and the excessive labor and cost of removing them through ordinary means. The paramount value found in this new method is that the bigger the stump, the better it burns. The cost of burning decreases as the diameter of the stump increases, just the reverse of the case where ordinary methods are used. Stumps three, six, nine, or twelve feet in diameter, the removal of which by ordinary means is usually prohibitive in cost, are those which the burner consumes most economically and completely. The burner method is essentially a big-stump process.

The experiment station trials indicate that the removal of the smaller stumps, those up to about eighteen inches in diameter and often, under favorable conditions, up to twenty-four inches in diameter, is best accomplished with a puller, supplemented with powder, and that the cost of pulling the smaller stumps is economically feasible. This fact has been well established also in other states where cost of clearing has been investigated.
The stump burner is best used on stumps twenty-four inches in diameter and larger.

In Oregon the ordinary stand of Douglas fir stumps averages about thirty to thirty-six inches in diameter, ranging from two feet to six feet or more, the average size increasing in the sections of heavier rainfall and richer soils. The average diameter and range in pine is somewhat less and in spruce somewhat more; the former being found chiefly in the drier sections of the state—Eastern Oregon—and the latter in the Coast area where the rainfall is heavier. The maximum diameter of Douglas fir on record is 17 feet, spruce 15 feet, and pine 8 feet.

**CONDITION OF STUMP**

The condition of the stump, that is, the number of years since the cutting of the tree, is important. *Green stumps of any kind do not burn satisfactorily and should not be attempted.* Stumps of fir, pine, and other conifers are in good condition for burning at three to four years of age and from five to ten years are usually at their best. At from ten to twenty years of age, rotting of the sapwood and of the heartwood where “doty” combined with loosening of the bark and soaking up of rotted sapwood and heartwood with winter rains, make the stump slightly more difficult to bank and burn. In our trials, however, stumps thirty and more years of age have been successfully burned.

An outstanding feature of this method is that it will burn successfully both stumps and roots that are water-soaked. In a trial at Brewster, where a half of the stumps were “soaking wet” clear through, they were successfully burned. This is possible because of the slow, creeping, charcoal fire employed, which dries out the wood ahead of it as it advances. Wet roots, as long as they are above the water table and surface water is kept from running into them, will burn satisfactorily. Green wood, however, is a very different thing from wet wood. The station trials convince us that green wood will not burn satisfactorily.

Snags, wind-falls, high-rooted stumps, surface-rooted stumps, tidal stumps, hollow-hearted stumps, partly burned and partly rotted stumps, all have been successfully destroyed with the stump burner. Methods of handling these special conditions are described elsewhere. As long as the stump has sufficient sound wood remaining to furnish fuel for a good fire, the burner can be used. Stumps two-thirds rotted or burned away do not offer a satisfactory condition for the burner and are usually better removed with powder and puller. Stumps already burned off to the ground with most or all of the crown burned are best removed by ordinary means.

**SOIL CONDITIONS**

The character and condition of the soil are of great importance in the use of this method, since banking of the stump with earth is an essential part of the procedure.

All types of soil have been used in our trials. Only the sandy type was found unsatisfactory. Fine sandy loams, containing sufficient clay and silt to hold together when shoveled wet, will do sufficiently well, but
any type sandier than these is likely to make an unsatisfactory bank, one that when heated and dry will start to run into the fire and smother it more or less.

Uncertainty on this point may be dispelled by starting a good fire with kindling against the side of a stump. When the fire has a good hold on the stump, the coals should be covered with chunk wood and then slabs of bark placed on the outside so as to give a fairly vertical outer surface, against which a bank should be laid up. After several hours, the wood will have burned away and the bank burned thoroughly dry and hot. Examination of the bank will then disclose whether it will hold up or run.

In Western Oregon, probably ninety percent of the stump lands have the heavier types of soil—loams, silt loams, and clay loams. All of these make excellent banking soil; hence the banking problem, as far as soil conditions are concerned, is difficult or preventive of this method on limited areas only.

In Eastern Oregon, the proportion of sandy soil is much higher, and the heavy pine timber stands most commonly on this type of soil. Hence it is probable that much of this area would not be satisfactory for banking. Furthermore, because of limited rainfall, the soil is moist enough for satisfactory banking only during a short period. Pine stumps cure quickly in Eastern Oregon, however, are seldom rotted or water-soaked, usually are highly resinous; it is therefore probable that the burner may be used successfully on them without the need for much banking. This remains to be determined in later trials.

Gravel is no injury in banking, unless so high in percentage as to prevent satisfactory shoveling or as not to hold together well in the bank when heated.

A wet or moist soil is decidedly preferable to a dry one for satisfactory banking. A dry soil is difficult to shovel, will not make so good a bank, and will not stand up as well.

NO INJURY TO SOILS

Does this method injure the soil? Not in the least. Seven years’ use of this method in addition to three or four years’ study of the old char-pitting method have given the Experiment Station convincing proof that the heating of the thin layer of soil in immediate contact with the fire does not affect or injure the soil in the slightest degree. In fact, the better drainage and aeration produced and the ashes left where the stumps have burned out cause an increased crop growth for some years following the clearing.

Fear of injury to the soil has arisen from the unquestioned damage that occurs when, in clearing with the usual method, deep piles of stumps and down stuff are collected by means of gin poles and donkey engine, or similar means, and the piles burned. The excessive, long-continued heat from the burning of these great piles bakes and cinders the soil, damaging it to such a degree that sometimes for years it is non-productive.

In the stump burner process, however, the thin layer of soil on the inner side of the bank that comes into immediate contact with the fire drops into the pit as the stump burns out. Mixed with ashes and other
unburned earth it produces a mellow, well-aerated condition. The lime and mineral plant-food elements contained in the ashes cause the crops over the areas where the stumps formerly stood to exceed in growth all other parts of the field. As a matter of fact, the outer portion of the bank never becomes heated at all and it is this portion of the bank, as the stump burns away, that is left on top of the pit, forming the major part of the remaining surface-soil cover.

SEASON OF WORK

The most satisfactory banking can be done when the soil is moist, both because the soil shovels more easily and because it forms a firmer bank. For this reason the stump burner is used in Western Oregon and Washington chiefly from October to June, during the rainy season; and in other sections, according to this condition. As a matter of fact, the stumps do not burn as well at this time, because of the wetness of the wood, as they do in the latter part of the summer when thoroughly dry; but the fact that the summer is the busy season for the farmer and settler and that the soil is hard to dig and bank at that time makes the rainy winter season the most desirable period for land-clearing work.

The heaviest rains will not prevent successful procedure with the burner. All of the Experiment Station trials have been made during the months of November, December, January, and February, the wettest months of the year in Western Oregon. A little pitchy wood and dry bark chips for kindling to start the first fires in the cold furnaces are necessary, and thereafter little difficulty is caused by rain. On low land, of course, the actual surface water must be prevented from running in on the burning stump or roots. Aside from this, the fires in the stumps are so thorough and so well maintained by the burner that rainfall does not affect them or wet wood stop them.

Dry soils, particularly of the heavier type, or where the stumps stand straight and only light banking is required, can be used with fair satisfaction as far as results are concerned, but have the objection already noted. In Western Oregon and Western Washington, however, there are only about three months, July, August, and September, when the soil is too dry for the most satisfactory banking.

Frozen ground, of course, has somewhat the same objection as dry ground, only in larger degree, in that it is difficult to dig and to make a firm, solid bank with it.

The season that comes nearest being ideal for burning is early in the fall as soon as the rains have wet the soil to the depth of a foot or so and while stumps and roots, bark and furnace fuel are still quite dry.

DETAILED PROCEDURE IN STUMP BURNING

While the burner method is simple and easily learned, the most efficient procedure to follow to gain the most successful results has been developed through the experiment station trials, carried out under many different conditions, usually against the more difficult stumps where conditions were not ideal for burning. This procedure is described below.
Selecting the Fire Route. First, the route or direction of the fire through the stump should be selected. This route should be the longest way through the stump, generally beginning on a smooth face of the stump between two main roots at ground level, and pointing through the heart of the stump toward a heavy root extension on the opposite side of the stump, if there be such, so that the fire will have to go through the longest route possible. The shortest diameter of the stump should rarely be selected for the fire route. Care should be taken also that the point at which the fire will emerge offers a good position for setting the hood.

![Image](image_url)

**Fig. 7. The firing point. Cut through the bark to bright wood at ground level.**

The Firing Point. Where the sapwood is sound and the bark tight, the next step is to cut away a hand-breadth of the bark at the base of the stump at ground level, until the bright, sound wood underneath is exposed. This is the firing point. Bark is resistant to fire, and it saves time and furnace stoking to cut through the bark to a starting point against the bright sound wood (Fig. 7).

Placing Draft Pipe and Furnace. At the firing point at the base of the stump, the earth should be leveled with the shovel, so that the furnace will set firmly on the ground and snugly against the base of the stump. Sometimes it is necessary to use the ax a little so that the top of the furnace will fit snugly to the stump. On shallow-rooted stumps or old plowed ground the furnace should be set a little above the ground level. After the furnace has been fitted, it should be laid aside and the long draft pipe should be so aimed that the fire will emerge at the opposite side of the stump at ground level at the point where the hood is later to be placed (Fig. 8). It is important that the draft pipe and the base of the furnace are parallel so that the inner end of the pipe does not point upward and fill the aperture under the deflector through which later the hot coals must be crowded against the stump face. The end of the draft pipe should be laid against the bright wood at the firing point, then kindlings of pitch wood and dry
bark chips or the like should be laid over this end of the draft pipe, and then the furnace placed over the pipe, snugly against the stump. A joint of stove pipe is next placed on the furnace shoulder, and the furnace is then banked in with earth (Fig. 9).

Fig. 8. The long draft pipe laid pointing through the heart of the stump, ready for the furnace.

Fig. 9. The furnace banked in and ready to fire and stoke.

The banking directly over the furnace should run from twelve to eighteen inches up the stump. This portion of the bank, if the surface of the soil surrounding the stump is rather loose and light, should be made of the heavier and more compact subsoil. As the bank over the furnace is being laid, it should be tramped several times so that the furnace is tightly sealed to the stump. The fire begins at this point on
the stump and burns here longest, hence it is likely to burn out above
the furnace unless well sealed in this way.

After the furnace has been banked in, the face of the bank over the
furnace should be carefully cut away sufficiently to prevent the earth
coming in contact with the stove pipe, as this contact causes the pipe
to burn out at the point touched. Ordinarily the stove pipe will last
pretty well through the season. It holds up better if riveted.

Stoking and Firing. After the furnace has been banked in, the draft
pipe should be pulled back slightly so its inner end is about two inches
from the bright wood of the stump. The kindling is then lighted and
when well started, the furnace is filled with chunks of bark usually
taken from the stump itself. These chunks are tossed in through the
chimney opening and crowded back with a stick, so that the furnace
is packed tightly to the door and to the top, with bark. The chunks
of bark will make the best fire if packed in either edgewise or with the
outer side of the bark down.

When the furnace has been thus stoked, one or two joints of stove-
pipe are placed on the chimney shoulder so that a good draft is created.
Sometimes with a high stump and the wind blowing over it, or with a
pitchy stump, an extra joint of stovepipe is added to give good draft.

As soon as the first stoking is burned half away, the stovepipe should
be lifted off, the coals pushed well back (beyond the deflector) directly
against the stump base and the furnace refilled with bark, and the chim-
ney replaced. As soon as there is a good bed of coals in the furnace,
usually after the second stoking, the draft door of the furnace is closed
with about two shovels of earth (Fig. 10).

The suction of the fire up the chimney now pulls the air through
the long draft pipe with considerable force. The end of this pipe lying
in the bed of coals is red hot and a blast of flame is thrown against
the base of the stump and a fire hole is started into the stump. Until this hole is well afire, it is necessary to restoke the furnace several times. In the station trials on wet stumps and in wet weather, it was found necessary to stoke or fill the furnace on the average a total of four times before the stump itself was sufficiently well fired to make further stoking unnecessary. Less stoking is necessary under more favorable conditions. New fires should not be started later than mid-afternoon.

It was found that bark made decidedly the hottest and most lasting fire and was most convenient for furnace stoking. Where bark for fuel is not available on the tract to be burned it is usually possible to secure a load of bark from adjoining land. A few hours' work will usually secure enough bark to provide furnace fuel for several weeks of burning.

**Advancing the Draft Pipe.** As the fire advances into the stump the draft pipe is pushed forward so that the end of the pipe is kept from four to six inches back from the burning face in the stump. The condition of the fire at any time may be easily judged by looking through the draft pipe or noting the intensity of the heat from the chimney. Should the draft pipe become stopped up with earth or ashes, the cleaning rod should be used to free it, or it may be pulled out and jarred empty.

In dry, sound stumps the fire advances from two to three inches per hour, while in wet or pitchy stumps it advances only one inch or less per hour; hence it is necessary to push the draft pipe forward only three or four times a day. Before pushing it forward the first time, a stake should be set at the outer end of the pipe so that the distance the fire has advanced and the time it will emerge on the opposite side of the stump can be more easily judged.

In advancing the draft pipe, it is well to push it in until it touches the burning stump wood, and then pull it back about three or four inches. In this way the distance of the pipe end from the burning wood can be more accurately gauged. Speed in burning through the stump and hence maximum use of equipment are aided by advancing the draft pipe more frequently. The end of the draft pipe, however, should not average closer than four to six inches from the burning wood surface, as being too close tends to reduce the fire blast from the end of the draft pipe. On the other hand, little harm is done if the draft pipe is not watched closely and advanced promptly (as for example, when left over night), since the result is merely to burn the hole in the stump larger in area but not quite so fast forward.

**Placing the Hood.** The station trials have shown that on the average three-foot stump, the fire burns through the stump to the opposite side in from twenty to thirty hours. As soon as the distance between the stake and the outer end of the draft pipe shows that the fire has burned nearly through, the stump should be kept under observation, so that as soon as the fire appears on the side opposite the furnace, the hood may be snugly set and fitted over the burned opening. When this is done a joint of pipe should be placed on the hood and the hood banked in firmly and sealed tightly, as was done with the furnace (Figs. 11 and 12).
Where it seems likely that the fire will burn through over night, it is often advisable to put the hood over the point on the stump at which the fire is expected to emerge, put the joint of stovepipe on it and bank it up, so that if the fire should burn through during the night, it will be properly confined by the hood and not burn too large an orifice in the side of the stump for the hood to cover satisfactorily. Where a large orifice has been burned waste wood should be used to fill up the fire cavity and the hood set higher on the stump on an earth base.

**Removing the Furnace.** After the hood has been placed, the long draft pipe is removed and a short draft pipe laid in its place. (The
long draft pipe is carried away and laid in position at the next stump, which has already been prepared for the furnace.) The bank directly above the furnace is carefully removed; or better, if it appears solid enough to stand, it is left intact. The hot furnace is then carefully loosened from the bank, pulled away with the furnace hook and skidded quickly to an adjoining stump, where it is packed full at once with fuel, is banked in, and goes immediately into action without the necessity of kindling any fire (Fig. 13).

Fig. 13. Furnace removed, short draft pipe in place, orifice ready to close and bank in.

In the opening on the first stump, from which the furnace has been removed, a heavy chunk or two of wood is pushed in endwise to fill the orifice. The short draft pipe is put in place, and some heavy pieces of bark are used to fill or cover the opening. The inner side of the bark should be put toward the fire. The furnace opening is then banked in, the bank being laid up carefully so that it will stand. The short draft pipe now extends through the bank into the stump at the place where the furnace stood. The remainder of the stump is then banked. The stump has now been converted into a stove with a draft on one side and a chimney on the other and furnishing its own fuel (Fig. 14). The result is inevitable. Usually within forty-eight hours after the hood has been placed, so great a mass of fire develops on the interior of the stump that the hood and short draft pipe may be removed, the hood opening banked in, and the stump left to finish as a char.

Removing the Hood. As indicated, as long as the hood is left on, the stump is burning under draft. Just how long this drafting should be continued is a matter of considerable importance and not easily judged. Usually the tendency has been to leave the hood on too long. In our trials a number of stumps were burned successfully without using the hood at all. On some it was used only a few hours. On most it was used an average of forty-eight hours.

As previously stated, the primary object of the burner is to set the stump thoroughly afire and produce a great mass of glowing charcoals
in the heart of the stump. This charcoal burns very slowly, if allowed only such air as seeps in through the earth bank. Burning thus slowly, it constantly adds to its mass, extending out toward the roots and gradually extending into each one of them, if there are no earth obstructions. This glowing mass of charcoal produces and holds an immense amount of heat, and when replenished by the fuel contained in the great root crown under the center of the stump, the heat and fire endure a long time, radiating outward towards the roots and penetrating and drying out the wet wood, driving the fire slowly into the roots.

It can be seen readily enough that, if the hood is left on too long, a considerable portion of this charcoal mass is burned away through the access of air from the draft pipe and the too rapid combustion thus permitted. The most likely result will be first, an uneven burning away of the top of the stump, so that the top will not settle into the pit evenly, and second, less certainty of thorough connection of the central fire with all of the roots.

![Fig. 14. The stump is now a stove with draft on one side and chimney on the other. A simple, natural, economical method that gets results.](image)

It is therefore considered advisable, once the stump is thoroughly afire and a great mass of coals has been produced, to remove the hood and short draft pipe without delay. On the sandy types of soil it is especially important not to draft (that is, leave the hood on) too long. When the hood is removed, if it is observed by probing with the punching rod that the bed of coals is shallow and considerably burned away, it is advisable to chunk the cavity well in order to replenish the bed of coals before closing in the bank. It is sometimes worth while, also, to punch down the charcoal from the roof of the cavity.

**Banking.** Either after the furnace has been started, or at the latest, after the hood has been placed, the remainder of the stump should be banked in. This work is not hard, nor does it take long—seldom an hour on the larger stumps and much less on the average stumps. The work, however, should be done carefully, and there is a certain knack to
good banking. On the average land, which is of a heavier type, the surface soil surrounding the stump is used.

Setting the shovel vertically, the soil can be taken up in unbroken shovelfuls and the bank laid and built up around the stump somewhat as a mason lays up a stone wall, each shovelful supported by those underneath, fitting snugly against the stump base, but not depending on it too largely for support. To accomplish this, the earth must not be thrown on the bank, but laid on in unbroken shovelfuls. The base of the bank is made several shovels wide, and each shovel of earth is laid so that the bank top is kept horizontal rather than sloping against the stump, and also so that the "joints" between shovels of earth are "broken," that is, each shovel of earth overlaps and binds on the next one. Again each shovel of earth as it is lifted is turned over as it is placed on the bank and brought down with a slight slap, so that it is brought firmly into place and into good union with the bank underneath.

![Image of a well-laid bank](image)

Fig. 15. The stump has burned off and settled down. Bank has been left erect and segment cut away to show how a well-laid bank will stand up.

The whole idea of banking should be to lay up a bank that will almost stand by itself, so that as the stump inside of it burns away, the bank will not fall in (Fig. 15). The fire inside the bank tends to bake an inner crust on the bank earth, and this helps it to stand up, except in a sandy type of soil, which is likely to run more or less when heated.

The height of the bank rarely need be more than 24 to 30 inches above ground level. Only in old, low, badly rotted stumps need the bank extend over the top of the stump.

The bank should not be made air tight or too thick (about 12 inches at base and 5 inches at top), or, on soils of the heavier type, should not be packed, except directly over the furnace and hood and around the top layer, where it is sealed to the stump by firmly pressing with the foot. The slow seepage of air through a well-laid bank is just sufficient to supply the limited oxygen needed for charring.
In all banking the soddy surface portion of the shovel of earth should be laid crosswise of the bank to aid in binding it together. The grass should not be laid directly facing the stump, especially in the lighter soils, as the burning away of the grass roots causes the bank earth to “run” more readily.

In the lighter types of soil which do not hold together so well, better banking material is secured by throwing aside the surface soil and using the more compact and heavier subsurface or subsoil. Where, as in the Coast counties, there is a light, fluffy surface soil with a good deal of small ground growth, such as salal, so that it is difficult to get solid, unbroken shovels of earth, it is best to throw aside the surface soil and use the more compact subsurface soil. With these light soils the inner side of the bank should be tramped more or less to make the bank more compact.

In “shot” soils, where the “shot” formation is so abundant as to cause the soils to “run” when the heat comes against the bank, it is advisable to tramp the inner side of the bank against the stump sufficiently to “firm” it and thus help to prevent running. Here, also, the firmer subsurface soil often can be used to good advantage for banking.

In the lighter or sandier types of soil, where a heavier subsoil is not available, tramping the inner side of the bank is of considerable benefit. Soils sandier than a fine sandy loam do not bank well, as they run when burned, thus shutting off the fire from the roots before they are well started. In such soils the stump-burning method cannot be used very satisfactorily. The proportion of such light soils on our stump lands, however, is very small.

Banking Roots and Root Bridges. Where, as in the spruce in the Coast counties, the main roots extend well above the ground, sloping or bridging outward (buttressing) from the tree bole to the ground, it is necessary to follow in and out around the root extension in banking, finally bringing the bank around the root extensions up to meet the main body of the stump. These high-rooted stumps cause a good deal of extra work in banking and must be watched in burning, as the bank over the sloping root bridges falls in readily.

On lands where the water table is high or subsoil unfavorable or for other reasons the stumps are surface-rooted, sometimes running for some distance above ground, it is necessary, wherever the root shows, to bank it over with earth. Otherwise, when the fire in the root reaches the exposed area, it will quickly burn out.

Confining the Fire. Confining the fire, keeping it under the earth bank at all times, and at all points, is an absolute essential to the success of this method. The primary object in this process is to produce and maintain a great mass of glowing charcoals in the heart of the root crown. From this mass the fire radiates and creeps slowly down the roots, drying the wet wood ahead of it as it goes. It is this mass of coals and slow, creeping, smoldering fire that make this method so successful in burning out the roots, making the land ready for the plow with little further effort.
This mass of slow-creeping fire is absolutely dependent for maintenance upon the covering provided by the earth bank which reduces the oxygen supply, thereby causing the formation of charcoals, instead of more rapid combustion which would quickly burn the interior of the stump away. Let the air have ready access to the fire through a broken or leaky bank and flames and rapid combustion ensue, the stump fuel burns away, and the fire dies before there is time for it to take hold and get well started in the root system. Flames or blue smoke appearing at any point are a danger signal and indicate always that the bank should be replenished or mended and the fire sealed in. The operator will soon learn to distinguish between the thin, bluish smoke which indicates rapid combustion and the need for bank mending, and the white, steamy smoke which comes normally from points in the bank as the moisture dries out, which need cause no concern.

THE CHAR-PITTING END OF THE PROCESS

Of particular importance in successful stump burning is mastery of the art of char-pitting for completion of the burn. With the removal of the hood, the next step in this method begins—the burning out of what remains of the stump and root by means of the char-pitting process. Success with char-pitting requires understanding and judgment and very little labor. Instructions for it are not easily given. Though those experienced in the old char-pitting method will have little difficulty, the beginner will need to be watchful and learn as much as possible from the experience of others, as well as from his own experience.

Under average conditions, four out of five stumps will go through the charring process satisfactorily if the simple procedure outlined below is followed.

The fundamental and governing principle in successful char-pitting is to keep the fire confined but yet not smother it.

After the hood has been removed and the bank closed in, the fire within the stump burns toward the outer edges or perimeter and no attention need be given it until flame or blue smoke appears at any point (Fig. 16). Usually the stump will burn through somewhat unevenly so the fire will reach the bank at one side before the rest of the stump perimeter has burned through. When the fire meets the bank, it works upward and breaks out at the top. Earth, or preferably sod, should be laid on the bank at that point until the bank is built up again to cover the fire, care being taken not to break the bank or push much of the bank earth into the fire. If blue smoke appears on the side of the bank, loose earth may be used to thicken and close the leak. If a large portion of the bank falls in, the fire should be chunked through the orifice, heavy pieces of waste wood being pushed in until a surface is formed against which bark may be laid and new bank built up.

Usually in two to four days after the hood has been removed, the entire base of the stump will have burned through and the top will settle down into the pit below. The added fuel replenishes the bed of coals below and aids the root fires (Fig. 17).
As the top of the stump settles down, it should be followed up with the earth cover, pushing in the hot bank earth against the wood and adding fresh earth where necessary to keep the fire confined. As the stump top sinks below the top of the bank, the bank should be tumbled over on it and enough fresh earth added to cover and close in the entire surface. This cover, however, should not be heavy or tight. It should be only four or five inches thick, and loose, so as to allow the fire some seepage of air. Too tight a cover will smother and stop the char. The hot bank soil makes the best cover, and usually little fresh soil will be needed.
Gradually the fuel, the stump top, and the root crown under the earth cover, burn away; and in a week or two, sometimes much longer, a considerable depression or pit develops over the center of the stump site, as the earth cover sinks in. It is important not to disturb this mound of earth. For several weeks the outer portion of the mound will be cold to the touch and it will appear as if the fire has died out. By using the punching rod as a probe, running it down into the mound, it will be found usually that there is considerable heat at the center or edges, and if this is the case, the mound should not be disturbed. In four cases out of five, the roots will be burning out satisfactorily.
Occasionally, probing will show no signs of heat. Sometimes this means that the coals have been covered too deeply, and punching a few holes with the shovel handle will give needed ventilation, but usually little further can be done, and it is always inadvisable to dig away the cover to see what is happening. Some of the roots may be afire in good shape, and this would only disturb and risk their going out.

Fig. 20. Same stump as in Figs. 18 and 19. The last fragment of the stump may be seen burning away in the center of the crater.

Fig. 21. Done, and ready for the plow—just a low mound of earth and ashes.

Usually, in three or four weeks, but often not for five or six weeks and sometimes more, the roots will have been consumed and the job is done. (Figs. 18, 19, 20, and 21.)
SPECIAL CASES

High Cuts and Stubs. Sometimes, particularly on high-cut trees, the stump will burn off unevenly and roll off to one side. Where this occurs, it is best to throw a considerable layer of waste wood on the fire, let it start burning vigorously, and then cover it over with earth. The top portion of the stump that has fallen to one side usually may be easily consumed by throwing enough waste wood in the “cupped” end from time to time to keep it burning.

Where the stump top burns away at one side, only a stub sticking up, it is important to chunk the coal bed or cavity underneath the stub and cover with earth, following up the remnants of the stump with earth to keep the fire below sealed in, so that it will follow down the roots on the unburned side.

Fig. 22. Bark and rotten sapwood cut away so that the bank can be sealed to sound wood.

Where Sapwood is Rotten. If the stump is old and sapwood rotted so that the bark is loose, the bark and rotten sapwood should be cut away in a circle around the stump in a band about a foot in width at the height above the ground (usually twenty-four to thirty-six inches) where the bank is to be topped off and sealed against the stump (Fig. 22). The top of the bank can then be sealed tightly against the sound wood, thus preventing the escape of fire at this point. If the bark and rotten sapwood were left at this point, the fire underneath would soon burn the sapwood away and the flames would break out between the inner side of the bank and the stump. The free access of air thus permitted would cause rapid combustion of the sides and top of the stump, destroying the bed of coals underneath upon which the firing and burning out of the roots depend.

Value of Bark. While it is essential to cut a band of bark and rotten wood away where the bank is to be topped off, it is equally important to leave the bark on the stump below this point. This lower bark holds the bank in place, as the fire advances from the center of the stump towards
the outer edge or perimeter. Bark is resistant to fire and slow to burn. This lower belt of bark will stand as a supporting shell or wall inside the bank, preventing it from falling in before the stump burns off and settles down into the pit. If parts of the bank fall in long before the main part of the stump settles down, the earth acts as a dam in cutting off the heart fire from the roots at that point, and is likely to prevent such roots from being well fired.

Where no bark remains on the stump, the rotten sapwood should be cut away to the level of the ground, so that the bank all around the stump will be in contact with the sound wood.

**Hollow or Wind-shaken Stumps.** Where the stump is hollow in the center and the hollow runs well down toward the root crown, this opening should be well packed at the bottom first with chunks of bark, if available, and then with other chunk wood, and then covered at the top with well-packed earth, a layer five or six inches in thickness. This will prevent the hollow in the stump from acting as a chimney and the fire emerging from the top of the stump before the base of the stump has been burned through.

If the stump is cracked from wind-shake, or has a pitchy heart, or pitch seam extending to the top surface of the stump, a six-inch covering of well packed earth should be laid over the top of the stump to seal it shut.

**Pitchy Stumps.** If the stump is especially pitchy, it will burn more slowly, and creosote and soot may accumulate in the stovepipe and even in the furnace and fire hole. In this event, it is usually sufficient to open the draft door of the furnace occasionally by removing the earth placed over it, letting the creosote burn out with the brisker draft thus created, and then the furnace door is closed again. Occasionally, soot and creosote will collect to such an extent in the furnace and fire-hole itself that it is necessary to use the punching rod to stir up and burn out this accumulation.

**Hardwood Stumps.** Hardwood stumps do not take as long to burn out as do the conifers. When the furnace is removed the furnace opening often is not closed but is left open, since hardwoods need more air to burn well. The hood is usually left on only about ten hours. Hardwoods usually burn out completely in four or five days.

**Snags.** The procedure with snags is the same as for other stumps. When they burn through they will topple over, and if of large diameter, may be burned in place, as described elsewhere for logs.

**Windfalls.** Usually windfalls are difficult to handle through ordinary means because of the weight of earth they carry. The burner can often be used on them to good advantage. It should be set to burn diagonally through the upset root crown, starting in at a point in the trunk about two feet above the root crown. The fire route should be banked in, but frequently it will not be necessary to use the hood. A large part of the mass will be burned away and the remaining fragments much more easily handled (Figs. 23 and 24).
Partly Burned Stumps. Where logged-off land has been run over by fire several times, many stumps will have been partly burned. This makes them more difficult to handle with the burner, as often bark is not available for stoking, and the unevenly burned tops are hard to bank so as to bring a fire through to all of the roots. On such stumps the burner should be set low in order to fire the base of the stump and as possible. The furnace is usually started against any remaining stub root crown in those parts of the stump from which the top has been burned away. It is usually desirable to pile and pack closely large and small chunks of waste wood above the root crown where the stump top has been burned away and then bank in and cover as carefully
of the stump, the draft pipe being directed through the heart of the crown as usual, except that the furnace is kept low by digging away the soil where it is placed. Bark for stoking may advantageously be brought from adjoining land, if heavy fir bark is convenient, as bark is decidedly superior to anything else in heating and convenience for stoking.

**Water Pockets.** Sometimes a partly hollow stump will contain a reservoir of water. If this is noted, it should be drained off by boring in from the side at the base of the pocket with a wood auger.

If the pocket is concealed and the water drops down on the fire when the bottom of the pocket is reached by the fire, putting it out, the furnace should be withdrawn and moved to the opposite side of the stump and a new fire started in from the opposite side, the first opening being chunked and then the hood banked in where the furnace first stood.

**Rotted Stumps.** Stumps rotted so completely as to offer insufficient sound wood for a good fire should be blown out with powder, unless sufficient sound wood remains at the base, when sometimes by digging away a pit and trench and putting the furnace low, a fairly good burn can be made.

Stumps badly rotted, but still burnable, usually have to be banked completely over the top (Fig. 25).

**Tideland Stumps.** These are usually spruce, and often with tops burned away almost to the ground level. They are nearly always very pitchy, because of the high water table. They are often burned in summer when the water table is down. On such stumps successful results have been obtained by digging a pit for the furnace and hood and a trench for the draft pipe and putting the furnace below the ground level. The top of the root crown may be covered with waste wood
and banked in and covered over as well as possible. Tideland stumps not partly burned but intact are handled in the regular way and usually burn out exceptionally clean.

**Earth Dikes.** Often a wedge or ridge of earth will extend up underneath the root crown between interstices of the root sufficiently to obstruct the fire blast from the furnace. When a look through the draft pipe shows no fire directly at the end of the pipe, although the pipe has been cleaned of any possible earth by use of the cleaning rod, it is quite likely that the draft pipe has come against an earth dike. Punching the draft pipe against this dike will indicate usually whether it is an earth dike or not and sometimes the punching will break through it and the fire blast will resume its work. If not, the draft pipe may be deflected upward or to one side and thus burn past the dike. If this cannot be done, it may be necessary to remove the furnace and punch away the dike with the iron punching rod. When this is done, the cavity should be refilled with waste wood, the furnace replaced and the fire started again. Occasionally it may be necessary or desirable to move the furnace to the opposite side of the stump and start again from that point (Figs. 26 and 27).

**PREPARATION FOR CROPPING**

After the burning is completed and it is certain that the root fires have burned out, a good procedure is to take a light plow and plow first a shallow and then a deep furrow close around each stump to determine, where no visible signs of main roots remain, whether there are any that have not burned away below plow depth. Some, of course, will be found. These may be removed with team and chain or loggers' hooks or root plow with block and line. Where the stubs of stumps with
root attached remain, a fire may be built against them and banked in
and the root burned out, or a little powder may be used to loosen them
for pulling.

When all seems clear, a little work with the shovel to level down any
parts of the mound that may remain is usually all that is required.
Where the stumps have been numerous and close together, so that the
banking has left the ground uneven, a log or timber drag of some sort
or a scraper may be used to level down the surface sufficiently. Then
the ground may be plowed, dragged, disked, and dragged again until
in condition for seeding. Oats or potatoes make an excellent first crop
after clearing.

Fig. 27. Same stump as in Fig. 26. Two weeks later, earth removed to show roots
burned out completely, three feet below ground. Note earth dikes in center.

COST DATA

Stump Burner Method. The investigations of the stump burner
method made by the Experiment Station indicate clearly the reduction
in cost of clearing big stump land by this means. Of the three cost
trials made, one was under average conditions as to age and condi-
tion of stumps and character of soil and two under extremely un-
favorable conditions, which tested the limits of the possibilities of
this method. In addition to the three cost trials fifteen other field
tests of the method were made in as many different localities and
conditions in Western Oregon, corroborating the findings in the main
trials.

In the first two trials the time and the cost were obtained (1) for
banking and burning the stumps, (2) for finishing up for the plow. In
the third trial a detailed record was kept of the condition of each
stump and the labor and time required for each phase of the operation
on each stump.

In all of the cost data submitted below it should be clearly under-
stood that the costs of clearing shown are for the removal of the big
stumps only. Surface clearing and removing the smaller stumps are not included. The cost of this part of the work varies from $5.00 to $25.00 per acre though rarely as high as the latter figure. Furthermore, the cost of this part of the clearing is the same whether the big stumps are burned or removed with powder and puller. The great reduction in the cost of clearing with the burner method is in the removal of the big stumps, which are the controlling factor in Northwest land clearing.

Necessarily as the method was entirely new when its study was undertaken by the Experiment Station much experimenting to determine the best method of use was done in all of the trials. The results of the trials are briefly summed up below.

**Trial No. 1, Jefferson, 1915**

In this trial made in November and December, 1915, the cost was determined of clearing the land of 196 Douglas fir stumps, ranging from a minimum diameter of 20 inches to a maximum of 66 inches, with an average diameter of 39 inches.

Owing to ignorance of the best methods of use, this first trial was largely experimental in nature and not representative or conclusive as to cost. Certainly every condition was extremely unfavorable to the successful use of the method.

(1) The soil was a light, sandy loam very unsatisfactory for banking. Further, it was old plowed land, loose, and with no sod to help in banking. The bank "ran" or fell in and cut off the fire from the roots in many cases.

(2) (a) The stumps were all old, cut twenty years or more, badly rotted in the heart and sapwood so that all the bark remaining had to be removed and nearly all the stumps had to be banked clear over the top. (b) They were thoroughly soaked up with the heavy rains of November and December and in some cases the water table rose into the root crown during the trial. (c) From long plowing around them, the stumps nearly all "sat high" above the ground level of the fields, frequently causing the furnace, through our ignorance, to be set too low on the root crown to do the best work. (d) Most of the stumps were surface-rooted, making it more difficult to drive the fire into them than if they had been well covered.

(3) As stated, the best method of use of the new burner had not as yet been worked out and many costly mistakes were made in this first trial on this account.

Only our ignorance of the best use of the new method permitted us to make such a poor selection for an initial trial, and only the fundamental soundness of the method itself made it possible to bring the trial through successfully. While this trial taught us many things we ought not to do, it also cost us heavily in the later removal of unburned roots for not hav-
On completion of the burner work it was found that:

On 68 stumps 85 percent of the roots were burned out.

On 105 stumps 55 percent of the roots were burned out.

On 23 stumps 20 percent of the roots were burned out.

Average of 196 stumps 61 percent of the roots were burned out.

**COST OF STUMP BURNING, TRIAL NO. 1, JEFFERSON, 1915**

(196 stumps—Average diameter 39 inches)

<table>
<thead>
<tr>
<th>Operation</th>
<th>No. of days</th>
<th>Cost</th>
<th>No. of stumps per day</th>
<th>Cost per stump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of banking (labor at $1.50 per day)</td>
<td>18</td>
<td>$27.00</td>
<td>10</td>
<td>$0.14</td>
</tr>
<tr>
<td>Cost of burning (labor at $1.50 per day)</td>
<td>65</td>
<td>$77.50</td>
<td>3</td>
<td>$0.50</td>
</tr>
<tr>
<td>Cost of banking and burning (labor at $1.50 per day)</td>
<td>83</td>
<td>124.50</td>
<td>2</td>
<td>$0.64</td>
</tr>
<tr>
<td>Cost of removing unburned roots (labor at $1.50 per day)</td>
<td>133</td>
<td>109.50</td>
<td>1 1/2</td>
<td>$1.01</td>
</tr>
<tr>
<td>Total labor cost, ready for plow (labor at $1.50 per day)</td>
<td>216</td>
<td>324.00</td>
<td></td>
<td>1.65</td>
</tr>
<tr>
<td>Interest and depreciation on burner equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>complete</td>
<td></td>
<td>7.00</td>
<td></td>
<td>.04</td>
</tr>
<tr>
<td>Two boxes of powder, caps and fuse</td>
<td></td>
<td>16.00</td>
<td></td>
<td>.08</td>
</tr>
<tr>
<td>Total cost, ready for plow (labor at $1.50 per day)</td>
<td></td>
<td>$347.00</td>
<td></td>
<td>$1.77</td>
</tr>
<tr>
<td>Total cost with labor at $2.00 per day</td>
<td></td>
<td>455.00</td>
<td></td>
<td>2.30</td>
</tr>
<tr>
<td>Number of stumps per acre, 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per acre @ $2.00 per stump, $30.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market value per acre of land cleared, $90.00.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of roots destroyed, 61 percent.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The prevailing wages for ordinary farm labor for winter season work were at that time $1.50 per day, but the cost is also given with wages at $2.00 per day for the purpose of comparison. The farmer who would always have at hand work that could be done in spare time, not readily otherwise employed, returning a compensation of $1.50 per day, would in normal times have no cause for complaint, particularly when the work brought a direct increase in the value of his land and production.

The cost of removing the unburned roots was let by contract, but the actual time used is shown in the tabulation. This work was all done by hand with ax and shovel, fire, and a little powder. Its cost could have been greatly reduced by use of a team and block and line.

No trial was made of the cost of clearing this land by ordinary means since extensive data on this were already available. Although the tops of these stumps were damaged, the roots were perfectly sound. To have blown them out with powder would have required an average of at least 25 sticks per stump, or a cost for powder alone considerably in excess of doing the work complete with the burner. The powder cost ($2.50 per stump for powder, caps, and fuse) added to the labor of blasting, gathering up, piling, and burning the fragments, removing the remaining roots, and filling the holes, would have brought the total cost to double that of stump burning.

**Cost of Burner Equipment.** If the burner equipment was used steadily during the burning season of the year, approximately eight months,
each unit should be able to cover at least 200 stumps. On this basis for a year’s work our experience has shown the following consumption or depreciation of equipment.

### COST PER STUMP FOR USE OF EQUIPMENT

(200 stumps burned per unit per year)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stove-pipe, five joints per unit consumed</td>
<td>$1.00</td>
</tr>
<tr>
<td>Draft pipe, four feet per unit burned away</td>
<td>1.00</td>
</tr>
<tr>
<td>Depreciation, 20 percent on furnace and two hoods, value $20</td>
<td>4.00</td>
</tr>
<tr>
<td>Interest at 5 percent on total equipment per unit, value $30</td>
<td>1.50</td>
</tr>
<tr>
<td>Total for 200 stumps</td>
<td>$7.50</td>
</tr>
<tr>
<td>Cost of equipment per stump, $.037</td>
<td></td>
</tr>
</tbody>
</table>

![Fig. 28. View of part of stump patch, trial No. 2. Only three roots were left to remove after burning was completed.](image)

**Trial No. 2, Crabtree, 1916**

In this trial conducted during November and December, 1916, the costs were obtained on the removal of 97 Douglas fir stumps ranging from two feet to eight feet in diameter with an average of 42 inches (Fig. 28).

The soil was a brown loam of good quality and quite satisfactory for banking, except for a period of four days during the trial when the surface soil was frozen. The stumps had been cut from ten to fifteen years and were in average good condition for burning. Our knowledge of how to use the burner had been greatly developed by the mistakes of the first trial.
COST OF STUMP BURNING, TRIAL NO. 2, CRABTREE, 1916
(97 stumps—Average diameter 42 inches)

<table>
<thead>
<tr>
<th>Operation</th>
<th>No. of days</th>
<th>Cost per day</th>
<th>Cost per stump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor of banking and burning complete</td>
<td>32</td>
<td>$48.00</td>
<td>$0.50</td>
</tr>
<tr>
<td>Cost of removing unburned roots</td>
<td>1</td>
<td>1.50</td>
<td>.02</td>
</tr>
<tr>
<td>Interest and depreciation on burner equipment</td>
<td>3.88</td>
<td></td>
<td>.04</td>
</tr>
<tr>
<td><strong>Total cost, ready for plow (labor at $1.50 per day)</strong></td>
<td><strong>69.88</strong></td>
<td><strong>$0.56</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total cost, with labor at $2.00 per day</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of stumps per acre, 30.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per acre of land cleared $110.00.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of roots destroyed, 99 percent.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furnace on stump Average 27.7 hrs.</td>
<td></td>
<td>Range 16 to 50 hrs.</td>
<td></td>
</tr>
<tr>
<td>Hood on stump Average 32.7 hrs.</td>
<td></td>
<td>Range 16 to 50 hrs.</td>
<td></td>
</tr>
<tr>
<td>Time required for stump to burn off Average 4.2 days</td>
<td></td>
<td>Range 2 to 7 days</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 29. A big fellow (over 8 feet in diameter) in trial No. 2. Eight to ten dollars’ worth of powder would still have left much work to do to finish for the plow.

The hood, the excessive use of which in the first trial proved a mistake, in this trial was used for much less time per stump, and this fact is believed to account in a considerable degree for the excellent success in burning out the roots.

The cost of clearing this land with powder would have been somewhat higher than for the land in trial No. 1, as the stumps were sounder and heavier. It is believed the minimum average requirement would have been 30 sticks of powder or $3.00 per stump for powder fuse and caps alone.

Except that the soil on the average stump land is somewhat heavier, this patch of stumps was typical of the majority of our big stump lands on thousands of acres throughout Western Oregon. It is true that one might seldom get so high a degree of success in destroying all of the
roots as in this particular instance, but any method that will get 80 to 90 percent of the main roots above plow depth is satisfactory. In this trial, after the burner work was completed, only three main lateral roots were struck in plowing the ground.

**Trial No. 3, Brewster, 1918**

This trial was conducted during November and December of 1918, a detailed cost and time study being made of 100 Douglas fir stumps ranging from 2 feet to 7 feet in diameter with an average diameter of 35 inches.

The conditions in this trial were very unfavorable for the most effective use of the burner method, but the trial was undertaken with a full knowledge of this fact, in order to determine as carefully as possible what might be considered a maximum cost under rather extreme conditions where the proper use of the method was pretty well understood.

![Fig. 30. Same stump as in Fig. 29. The last stub nearly burned off. Stake shows other edge. Not a root left when complete. Cost about $1.00.](image)

These stumps stood on a piece of first bottom on the Santiam river on a sandy loam soil underlaid at varying depths, but usually somewhat shallowly, with gravel, and with a high water table through the summer months.

The stumps ran in age from three to twenty years and as a whole were quite unfavorable specimens for burner work. A careful inspection of them showed that 40 percent had loose bark and some rotted sapwood to be removed; 32 percent were rather too green for satisfactory burning; 73 percent were "doty;" 66 percent were pitchy, making them burn somewhat more slowly and less surely; 98 percent were deep-rooted, connecting the stump with the water table during the summer and thus causing a large percentage of the stumps to be either sour or wet and the roots
almost universally wet. In addition the weather was very wet and tended to slow up the work a good deal.

**COST OF STUMP BURNING, TRIAL NO. 3, BREWSTER, 1918**

(100 stumps—Average diameter 35 inches)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Man hours</th>
<th>Percent of total</th>
<th>Total cost</th>
<th>Cost per stump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparing and banking (labor at $1.50 per day)</td>
<td>213.5</td>
<td>35</td>
<td>$32.03</td>
<td>$0.32</td>
</tr>
<tr>
<td>Tending furnace</td>
<td>217.5</td>
<td>36</td>
<td>32.62</td>
<td>.33</td>
</tr>
<tr>
<td>Tending char</td>
<td>29.5</td>
<td>5</td>
<td>4.43</td>
<td>.94</td>
</tr>
<tr>
<td>Rebuilding fires</td>
<td>25.5</td>
<td>4</td>
<td>3.52</td>
<td>.94</td>
</tr>
<tr>
<td>Other work</td>
<td>111.0</td>
<td>10</td>
<td>16.66</td>
<td>.15</td>
</tr>
<tr>
<td><strong>Total for banking and burning</strong></td>
<td>597.0</td>
<td>100</td>
<td>$89.55</td>
<td>$0.90</td>
</tr>
<tr>
<td>Removing unburned roots</td>
<td>176.0</td>
<td></td>
<td>26.40</td>
<td>.26</td>
</tr>
<tr>
<td>Leveling ground for plowing</td>
<td>29.0</td>
<td></td>
<td>4.36</td>
<td></td>
</tr>
<tr>
<td>Leveling ground for plowing (14 horse hours)</td>
<td></td>
<td></td>
<td>1.46</td>
<td>.06</td>
</tr>
<tr>
<td><strong>Total labor cost, ready for plowing</strong></td>
<td>892</td>
<td></td>
<td>$121.70</td>
<td>$1.22</td>
</tr>
<tr>
<td>Powder, fuse and caps for removing roots</td>
<td></td>
<td></td>
<td>16.00</td>
<td>.16</td>
</tr>
<tr>
<td>Interest and depreciation on equipment</td>
<td></td>
<td></td>
<td>4.00</td>
<td>.04</td>
</tr>
<tr>
<td><strong>Total cost, ready for the plow (labor at $1.50 per day)</strong></td>
<td></td>
<td></td>
<td>$141.70</td>
<td>$1.42</td>
</tr>
<tr>
<td><strong>Total cost, with labor at $2.00 per day</strong></td>
<td></td>
<td></td>
<td>181.80</td>
<td>1.82</td>
</tr>
</tbody>
</table>

Number of stumps per acre, 18. Cost per acre at $1.50 per stump, $27.00. Market value per acre of land cleared, $100.00. Percentage of roots destroyed, 88 percent.

**AVERAGE TIME REQUIREMENTS, BREWSTER TRIAL**

(100 stumps)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Range</th>
<th>Ave. per stump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of stumps</td>
<td>2 to 7 ft.</td>
<td>3.49 in.</td>
</tr>
<tr>
<td>Height of stumps</td>
<td>2½ to 9 ft.</td>
<td>49.1 in.</td>
</tr>
<tr>
<td>Furnace on stump</td>
<td>11 to 53 hrs.</td>
<td>27.3 hrs.</td>
</tr>
<tr>
<td>Total number of stokings of furnace</td>
<td>2 to 8</td>
<td>5.0</td>
</tr>
<tr>
<td>Time required for stump to burn off</td>
<td>2 to 9 days</td>
<td>4.0 days</td>
</tr>
<tr>
<td>Preparing and banking stumps</td>
<td></td>
<td>2.1 hrs.</td>
</tr>
<tr>
<td>Tending furnace</td>
<td></td>
<td>2.2 hrs.</td>
</tr>
<tr>
<td>Tending char-pitting end of process</td>
<td></td>
<td>.3 hrs.</td>
</tr>
<tr>
<td>Miscellaneous work in burning</td>
<td></td>
<td>1.3 hrs.</td>
</tr>
<tr>
<td>Total work of banking and burning</td>
<td></td>
<td>6.0 hrs.</td>
</tr>
<tr>
<td>Finishing up after burning ready for plow</td>
<td></td>
<td>2.0 hrs.</td>
</tr>
<tr>
<td>Total time, ready for plow</td>
<td></td>
<td>8.0 hrs.</td>
</tr>
<tr>
<td>Percentage of stump tops that fell off to one side of pit</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Percentage of stumps, all roots burned out</td>
<td>61%</td>
<td></td>
</tr>
<tr>
<td>Percentage of stumps, roots partly burned out</td>
<td>39%</td>
<td></td>
</tr>
<tr>
<td>Percentage of main laterals burned out, all stumps</td>
<td>86%</td>
<td></td>
</tr>
</tbody>
</table>

**RATE OF BURNING AS AFFECTED BY CONDITION OF STUMPS**

(Brewster trial, 100 stumps)

<table>
<thead>
<tr>
<th>Condition of stump</th>
<th>Average diameter</th>
<th>Average time to burn out</th>
<th>Average time per hour</th>
<th>Average time hood on</th>
<th>Average time stump burned off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitchy</td>
<td>37 in. 38 hrs.</td>
<td>3.97 in. 50 hrs.</td>
<td>4.5 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-pitchy</td>
<td>32</td>
<td>1.14</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sour</td>
<td>37</td>
<td>1.32</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cured</td>
<td>34</td>
<td>1.09</td>
<td>4.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young</td>
<td>39</td>
<td>1.02</td>
<td>5.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old</td>
<td>33</td>
<td>1.10</td>
<td>4.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Dotty&quot;</td>
<td>35</td>
<td>1.02</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound</td>
<td>38</td>
<td>1.26</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The rate of burning varies according to the condition of the stump. Sound stumps are shown to burn 23 percent faster than “doty” stumps, and non-pitchy 17 percent faster than pitchy. Frequently a very pitchy stump will take twice as long to burn through. The rate was low on all the stumps in this trial. In a number of other tests where conditions were more favorable 2 inches per hour was a fairly common rate, and 3 inches per hour was sometimes reached in Douglas fir. In spruce, particularly, and in pine the rate is faster.

Fig. 31. View of burners at work, trial No. 3. Very unfavorable conditions for burner work.

Fig. 32. Same ground plowed and ready for crop. Total cost of clearing $25.00 per acre.
Cost With Powder. In order to get at the cost of clearing this land by ordinary means, 10 stumps scattered through the field where the stump burning was done were selected as typical and representative in every way of those burned. Expert powder men were selected to do the work and they did it well. The cost is shown below.

### COST OF BLASTING OUT STUMPS, BREWSTER TRIAL

<table>
<thead>
<tr>
<th>Range</th>
<th>Ave.</th>
<th>Man. hrs.</th>
<th>Total cost</th>
<th>Cost per stump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of stumps</td>
<td>23 to 61</td>
<td>35.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height of stumps</td>
<td>39 to 90</td>
<td>51.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of sticks of powder</td>
<td>15 to 80</td>
<td>26.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor of blasting at 30¢ per hr.</td>
<td>15</td>
<td>5.40</td>
<td>$26.50*</td>
<td>$2.65</td>
</tr>
<tr>
<td>Taking out roots and filling holes @ 15¢ per hour per hour</td>
<td>45</td>
<td>6.75</td>
<td>.68</td>
<td></td>
</tr>
<tr>
<td>Taking out roots and filling holes, 30 horse hours @ 7½¢ per hour</td>
<td>2.25</td>
<td>.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piling and burning fragments</td>
<td>10</td>
<td>1.50</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td><strong>Total cost, ready for plow</strong></td>
<td></td>
<td></td>
<td><strong>$42.40</strong></td>
<td><strong>$4.24</strong></td>
</tr>
</tbody>
</table>

*80 sticks of powder per 50 lb. box at $8.00 per box, including caps and fuse.

Other Tests. In addition to the three cost trials reported above, 15 other field tests of the method have been made, all under the supervision of the writer with the exception of the one in Lincoln county, as follows: Benton county, 2; Linn county, 3; Lincoln county, 1; Clackamas county, 1; Washington county, 1; Columbia county, 3; Clatsop county, 1; Multnomah county, 1; Lane county, 2.

In these tests Douglas fir, western yellow pine, spruce, and oak were burned; the diameters of the stumps ranged from 1½ feet to 12 feet; age 5 years to 35 years; soil, fine sandy loam, loam, silt loam, and clay loam, on river bottom, tideland, valley floor, and red upland.

In every case the burner demonstrated its economy and efficiency in burning out stumps and roots following the methods described herein. Repeatedly it was shown that on the average Douglas fir stump, one man with 4 burner units could average 3 stumps per day, and this is a pretty good rough measure of cost. Only on spruce or under very unfavorable conditions with fir would this average not hold true. On pine and oak the work was faster, as the diameters were smaller, less banking was required, the furnace required less time, and the hood did not need to be kept on nearly so long as in case of fir. With 5 burner units the writer believes a good worker conversant with the method, working on the average fir stump under reasonably favorable conditions, might be able to average 4 stumps per day.
SUMMARY OF COST DATA

<table>
<thead>
<tr>
<th></th>
<th>Trial No. 1</th>
<th>Trial No. 2</th>
<th>Trial No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of stumps</td>
<td>196</td>
<td>97</td>
<td>100</td>
</tr>
<tr>
<td>Range in diameter, inches</td>
<td>20-66</td>
<td>24-96</td>
<td>24-84</td>
</tr>
<tr>
<td>Average diameter, inches</td>
<td>39</td>
<td>42</td>
<td>35</td>
</tr>
<tr>
<td>Condition of stumps and soil</td>
<td>Very bad</td>
<td>Good</td>
<td>Bad</td>
</tr>
<tr>
<td>Average percentage of roots burned out</td>
<td>.61</td>
<td>.90</td>
<td>.86</td>
</tr>
<tr>
<td>Labor cost per stump of banking and burning</td>
<td>.64</td>
<td>.50</td>
<td>.90</td>
</tr>
<tr>
<td>Labor cost per stump of removing unburned roots</td>
<td>1.01</td>
<td>.02</td>
<td>.32</td>
</tr>
<tr>
<td>Powder cost per stump of removing unburned roots</td>
<td>.06</td>
<td>.00</td>
<td>.15</td>
</tr>
<tr>
<td>Cost per stump for use of equipment</td>
<td>.04</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>Total cost per stump, ready for plowing</td>
<td>1.77</td>
<td>.56</td>
<td>1.42</td>
</tr>
<tr>
<td>Total cost with labor at $2.00 per day</td>
<td>2.30</td>
<td>.72</td>
<td>1.82</td>
</tr>
<tr>
<td>Estimated cost of removing these stumps without burner, for powder only</td>
<td>2.50</td>
<td>3.00</td>
<td>2.65</td>
</tr>
<tr>
<td>Actual total cost with powder, complete for plowing</td>
<td>4.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximate number of stumps per acre</td>
<td>15</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td>Cost per acre of clearing with stump burner</td>
<td>25.55</td>
<td>16.50</td>
<td>25.55</td>
</tr>
<tr>
<td>Estimated market value per acre of land cleared</td>
<td>90.00</td>
<td>110.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

SUMMARY OF TIME DATA

<table>
<thead>
<tr>
<th></th>
<th>Average number of hours per stump for furnace</th>
<th>Average number of hours per stump for hood</th>
<th>Average number of days for stump to burn off and settle</th>
<th>Range, days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27.7</td>
<td>32.7</td>
<td>4.2</td>
<td>2.7</td>
</tr>
<tr>
<td>Range, hours</td>
<td>16-50</td>
<td>8-63</td>
<td>8-63</td>
<td>2-6</td>
</tr>
<tr>
<td>Average number of hours per stump for hood</td>
<td>39.3</td>
<td>11-75</td>
<td>4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Range, days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ADVANTAGES OF THE STUMP BURNER METHOD

Outstanding features of this new method may be briefly summarized as follows:

Lessened Cost. It reduces cost of clearing big stump land 50 percent or more as compared with present methods, making it possible to clear logged-off land at a cost at which it can compete in the open market with similar lands already cleared. With labor at 20c an hour, the average big stump costs from $0.75 to $2.00 to complete the job ready for the plow.

Easier Work. It greatly reduces the laborious character of land-clearing work. Land clearing with present methods is probably the most back-breaking, heart-breaking, and hence unattractive work that the man on the land undertakes. The hardest work in this method is shoveling the bank (a short, light task compared with the old grub hoe work), and banking usually requires less than one-third of the total labor expended in the stump burning process.

Less Work. It leaves the ground in very satisfactory condition for plowing and cropping. There are no holes to fill, no stumps to pile and burn. The earth bank and ashes fill the stump cavity, leaving the ground nearly level. The stump and roots are burned in place.

No Soil Damage. It does not injure the soil, but improves its condition and crop productive power.

Uses Cheaper Labor. It is especially well adapted to Pacific Slope seasons. The burner can be used as soon as the soil gets wet in October,
throughout the winter, and until the soil gets too dry to bank in June. During this period hired labor is cheapest and the farmer himself has most time available for land-clearing work.

Fits the Settler’s Labor Program. The burner fits in with farm and other work. A battery of four burners will keep one man busy full time, but two burners may be used if desired so that only a few hours daily or at odd times may be expended, thus fitting in with winter chores and winter farm work.

Practical. It is a simple and natural process without complexities, easily learned and applied, requiring only a little patience and study to master.

No Expensive Equipment. It requires only a simple, inexpensive appliance that may be used hundreds of times and then sold to a neighbor at little less than original cost.

Adds Interest. The use of fire is interesting to most men. The burner puts fire and wits against the stump instead of costly powder, tedious pulling, and sweat and endurance with a grub hoe.

Reduces Cash Outlay. The usual method requires heavy cash outlay for purchase of powder, where the burner method requires only a small investment and spare-time labor.

PART II. PRELIMINARY STEPS IN LAND CLEARING

OTHER METHODS OF BURNING STUMPS

Value of the Land. Obviously prior to any clearing most careful consideration must be given, first, to the probable value of the land when cleared—its possible and most profitable use as affected by its location with reference to market, community advantages, etc.—its productive capacity as affected by soil, elevation, topography, climatic conditions, etc. A volume might be written on trees, brush, and other plants as indicators of soil fertility. Large trees do not always indicate a fertile soil. Usually density or heaviness of growth is a better guide than size of individuals, or than species, although species tell much. The best guide is the county agent, or agricultural college authorities. Second, must be considered the cost of clearing as affected by many different conditions and comparison of cost with market value of similar land already cleared. It is by no means wise to buy stump land just because it is cheap unless one is sure that, including the cost of clearing, in labor, time, and cash outlay, its total cost will be less than that of similar land already cleared.

Pasture and Forest Land. Thousands of acres of rolling land west of the Cascades too steep for profitable tillage but contiguous to good farm land may be profitably reclaimed for pasture, yet do not justify the removal of the stumps. Surface clearing (that is, slashing and burning of brush, making up of the marketable wood, and piling and burning of the dead and “down” stuff), followed by a seeding to grass, fencing into sections for rotation of pasture, and “stocking up,” would convert this land into profitable pastures.
A still larger area of hill and mountain land too rough or isolated for profitable grazing should go back into timber production. It is the hope and dream of every forward-looking citizen that, with state and private owners cooperating, a feasible policy of practical reforestation will be worked out and put into effect before this natural resource of the state is further depleted.

Aging of Stumps. There can be no question that the aging of the stump has a vital relation to economy of clearing. Green stumps of any kind are not burned successfully with the stump burner, nor can they be removed by ordinary means (powder and puller) without greatly increasing cost.

Under the climatic conditions west of the Cascades nearly complete rotting of hardwood tops and roots, if sprouting has been prevented, usually occurs in six to ten years, while in three to four years the smaller roots have rotted sufficiently to reduce greatly the cost of pulling and removal of earth from the roots, yet the tops are still sound for the choker. At two to three years of age the large hardwood stumps are sufficiently cured for satisfactory burning.

In conifers (firs, spruce, etc.) the stump is sufficiently cured to burn well four to five years after cutting, and from five to fifteen is usually in ideal condition to burn and from five to ten years of age in best condition for powder and pullers. Beyond ten years little is gained for use of powder and puller as the smaller stump tops are getting unsound for the choker and in the larger stumps the main roots still persist, little affected sometimes for a period of thirty or forty years, or longer.

Slashing and Burning. Slashing the stump land clean is a necessary preliminary to removing the stumps. If slashing is done immediately after logging a great deal of work is saved. Usually before the clearing stage is reached plenty of small growth has developed. If this is heavy it should be slashed to lie all in the same direction in order to maintain the best possible contact for firing. If this surface growth is thin it should be piled in windrows for good contact, the windrows being made parallel with the prevailing wind. The brush should be thrown in from the margin to leave a clean fire lane for necessary fire protection.

For hardwoods and other deciduous growth it is best to slash in full leaf, in spring or early summer, in order to reduce sprouting later. Hardwoods should be cut two to three feet from the ground to reduce root sprouting and also to facilitate pulling. Where the stump burner is to be used the large snags and dead trees need not be cut off unless it is necessary to reduce danger of fire spreading from the burning tops. Large logs or stumps rotted clear through, should be broken up so that they will dry out during the summer prior to setting the slashing afire. Sometimes it is possible to pile small “down” stuff so that it will have good contact and burn out when the slashing is fired.

It is decidedly better not to pile stuff over the large stumps, as they are more easily handled afterwards with the burner or with powder, if not partly burned away previously, but left with bark and bole intact. Nothing puts a stump in worse condition to handle than surface fires that
burn away the larger portion of the top, making it necessary to remove each root individually.

Very large logs may be burned in place by splitting them horizontally with powder and piling small stuff at intervals to start the log afire. Splitting a large log for burning in place is easily done by boring a hole horizontally in line with the center of the log every 8 or 10 feet and charging with one-half to one stick of stumping powder, or better yet using a splitting gun and one-quarter to half a pound of black powder. The horizontal splitting of the log makes a chimney for the fire so that the log will burn from the inside out and thus keep afire and burn out quite completely.

The cleanest burn is usually obtained by firing in September. A fire permit should be secured and every precaution taken to avoid fire spreading to adjoining land.

Some men prefer to set fire to the slashing on a rather windy day, but where the slashing is heavy and thoroughly dried out, a quiet day, preferably very early in the morning or at night when there is the least wind, is a safer time to start. With no wind fire may be set on two sides. Wind not only increases the danger of the fire spreading but often prevents a clean burn unless the slashing is thin and has not been windrowed. On heavier slashings it is usually better, if there is any wind, to burn against the wind to secure the cleanest burn and greatest safety.

For the benefit of our future forests it is well to remember that land that is to be reforested is best burned in the spring directly after logging to avoid destroying the seeds from which the new forest comes.

Seeding. On land with green stumps or any other land that is not to be cleared immediately, grass seed should be sown in the ashes as soon as they are cool and before the first rains. Ashes make an ideal seed bed for grass as the first rain covers the seeds. An excellent mixture for Western Oregon is 10 pounds of perennial rye grass, 5 pounds of orchard grass, and \( \frac{1}{2} \) pound of white clover seed per acre. Sometimes a little timothy and alsike seed is added to this mixture. A chest or tube seeder facilitates uniform spreading of the seeds.

It is highly important not to pasture such seedings the first year but let the grass get well rooted and go to seed. If the land is pastured the first year stock should be kept off at least during the spring until the grass roots get well set.

Following a very heavy burn with plenty of ashes it is possible to get good results on the better types of land by broadcasting vetch and wheat, particularly if the land is soon to be cleared and grass not desired. Such seeding can be pastured with cattle, hogs, or sheep.

On land with little or no brush, a heavy growth of fern burned in September and seeded in the light ash will frequently give a good stand of grass. On stump lands without either brush or fern ash where the surface has been sufficiently cleared it is sometimes possible to disk or spring-tooth sufficiently to make a fairly satisfactory seed bed for sowing grass in the fall.
On seedings where there is considerable deciduous and hardwood growth the pasture is first used by cattle and goats and then by sheep and goats. On logged-off land where there is little deciduous growth the pasture is used first by cattle, then sheep, and then by goats. Grazing is continued for three to five years, and the land is then ready for clearing.

Goating. A volume might be written on this subject, but a few suggestions must suffice. On newly slashed hardwood land nothing equals the goat for quickly destroying sprouts and thus the vitality of the stump. It is important to kill such growth immediately or in a few years the land is harder to clear than in the beginning.

If oak is cut two to three feet above the ground the sprouts are more likely to start from the stump instead of from the roots, and stump sprouts are much more easily destroyed than root sprouts.

It is often claimed that goats will not destroy certain kinds of brush such as willows, hazel brush, dogwood, etc. It is true goats will not destroy brush that is too high for them to reach. Tall brush should be slashed ahead of the goats to a height they can reach. It is also true that goats have preferences in brush, and if there are not enough goats for the acreage they will destroy only that which they like best. Goats also like grass and if there is plenty of grass they will not do much with the brush. Hardwood land to be goated should either not be seeded or the grass pastured off first with cattle or sheep. Poison-oak and madrone are generally considered to be the brush that goats like least. Goats, if properly handled, will destroy nearly all other deciduous growth in two years.

An important requirement for success is to use enough goats. From four to five goats per acre on fairly heavy growth is not too much. On
large areas it is also important to fence the land in sections, concentrating the goats on each section for a short time until browsed clean, then moving them to a new section and then back again to the first section. In this way the browse is kept fresh for the goats and thus more quickly destroyed. Where properly handled, the writer has seen goats do almost perfect work repeatedly.

Surface Clearing. This term may be applied to clearing away the surface debris either before or after the slashing and burning is done. It may be done partly prior to burning and the remainder afterward. If in the burner method only two burner units are used, the time not used in tending the burners may be expended in surface clearing. The chief operation in surface clearing is the piling and burning of logs.

Piling. Some sawing of long sticks of small diameter is necessary so that they may be handled. Piling in small piles fairly high with sticks lying parallel, six to ten logs, is cheaper and better than piling in large heaps with the gin pole. Small piles damage the soil much less in burning and can be more easily tended when they "cup out." Logs and stumps should always be piled separately to get the best results. On small stump land handled with the puller the cost of disposing of the stumps is a considerable item. The Conrath piler much used in Wisconsin is one of the best devices for piling stumps.

In piling small logs that cannot be readily handled with the peavy, a chain or half-inch wire cable 20 to 30 feet long and two timber skids may be used with satisfaction. The pile is built by passing the cable end under the log to be moved and hooking it into the log that is the center piece of the pile. With this "rolling hitch" the logs are rolled up until the base, consisting of four or five logs lying parallel and close together, is formed. On the five base logs four more logs are piled, then three, then two, and then one on top, the skids being used to roll the logs up on the pile as it grows higher. Two men and a team can often surface clear as much as an acre a day of fairly heavy stuff this way.

Very large logs may best be burned in place as already described, starting the splitting and fire at one end.

PULLING STUMPS

A stump puller equipment of some sort is an essential part of the work of clearing land, no matter what other methods may be used in conjunction with it. Where the stump burner is used for the big stumps, a puller device of some kind, supplemented with small amounts of powder, is used on the stumps less than two feet in diameter. Discussion of methods of pulling stumps can not be given here, and only a brief statement can be made regarding the various common pulling devices. Our experience has shown that the smaller stumps can be pulled efficiently and economically by any of several different devices supplemented with a limited amount of powder. For average conditions and means, perhaps the best devices are logger's hooks, root plow and block and
line or the two-horse capstan puller or the recently invented engine-operated capstan puller.

The Donkey Engine. A great deal of land has been cleared in the Northwest with the donkey engine (combined with powder, of course). While this method gets fairly rapid action, material objections have been found to its use.

First, it requires a capital investment beyond the reach of the men who do most of our land clearing. A good donkey outfit costs $4,000 or better, though sometimes a good second-hand gear can be had for less.

Second, it does not reduce the cost of clearing sufficiently to be economical; i.e., to clear land at a cost less than the market value of the land when cleared. For this reason, organized community effort with a donkey outfit will not necessarily solve the land-clearing problem.

Third, the operation of such an outfit is by no means simple and requires skilled and experienced labor.

Fourth, this method does not get rid of all of the roots, nor fill the holes, and hence leaves much hand and team work to do.

Fifth, burning of the huge piles of stumps and logs laid up with the donkey outfit damages the soil.

Hand Pullers. The antithesis of the donkey puller, the hand puller, does good work and requires only a small investment, but it is slow and very laborious, in fact a real “man killer.”

The Tripod Puller. The tripod puller is a powerful and effective vertical-lift puller fairly satisfactory on light stands and light soils, but slow and cumbersome to set up and move about.

The Farm Tractor. The farm tractor does fairly good work on light stuff, and where the farmer owns one it may be used to advantage, but can not be considered satisfactory equipment for regular land-clearing.
work. The larger tractors are used successfully for plowing out brush up to 3 inches in diameter, a heavy grub breaker with 24-inch share and high clearance being used (Fig. 34).

**Block and Line.** One of the best methods for the man of limited means is the block and line. Double- and triple-power pulleys may be used. Powder is a necessary supplement.

**The Horse Capstan Puller.** This is a standard and efficient pulling equipment. With loggers' hooks, root plow, good take-up device for the cable, good chokers and a power pulley, supplemented with powder (for loosening the stump, shaking off the earth or cracking it), the capstan puller, horse operated, is an efficient and economical method of handling the smaller stumps, although somewhat slow and tedious. In pulling with the capstan, the size of the stump or part pulled should not be larger than a team can handle afterwards in dragging off and piling.

![Image](image-url)

**Fig. 35.** The gas-engine-operated puller, efficient and labor saving on the smaller stumps.

Usually a size that can be pulled with a $\frac{3}{4}$-inch wire cable is about as large as can afterward be handled by the team. A $\frac{3}{4}$-inch cable with a capstan permits a 20,000-pound pull, and this is about as large as ordinarily should be used.

**The Gas Engine Capstan Puller.** This device in its improved form, invented by an Oregon man, has been used extensively in our experiment station work.

An ordinary 6-horse-power stationary farm engine is connected by gears to a capstan, all being mounted on skids so that the puller may be easily moved about. The puller operates at two speeds for light and heavy pulls. It does the work somewhat more rapidly and economically than the horse-operated capstan, with somewhat less danger of accident, and is decidedly less tedious (Fig. 35).
STUMPING POWDER

Powder is a most valuable and indispensable adjunct and necessity in all land-clearing work as a supplement to the puller in handling stumps up to 24 inches in diameter or thereabouts. Its most advantageous use is in loosening the stump and shaking off the earth, splitting stumps for the puller, removing stubs or heavy fragments of roots, splitting logs, etc. Almost universal experience throughout the country has shown that the 20 percent powder is the best strength, except perhaps on very sandy or gravelly land. Powder is not chemically injurious to the soil, but frequently throws a good deal of undesirable subsoil on to the surface.
Powder is not dangerous if its use is understood. Where stumps are thick and divided charges may be used advantageously, however, the employment of an electric firing device reduces the amount of powder and labor required, somewhat decreases the total cost of clearing, and greatly increases safety. Nine out of ten powder accidents in land clearing are due to the use of cap and fuse.

No accurate rule can be stated as to the amount of powder to use that will fit the needs of any given case. Two general rules sometimes given may be of some guidance to the beginner.

1. The number of pounds of powder required to shoot a stump clear of the ground is the same as the square of the diameter of the stump in feet, (Ex. 2 ft. diameter—4 pounds of powder, 6 ft—36 pounds, etc.)

2. The number of sticks of powder required to blow large stumps clear of the ground (under most conditions in the Northwest) is the same as the diameter of the stump in inches.

Neither of these rules is satisfactory for small stumps.

3. For cracking stumps ready for the puller use \( \frac{1}{3} \) to \( \frac{1}{2} \) the amounts specified above.

THE USE OF CHEMICALS

Inquiry regarding the use of chemicals in destroying stumps is so frequent, and hope that an easy way may be found in this direction is so common, that it may be well to state here that no method of destroying or even aiding in the destruction of stumps through the use of chemicals of any kind has yet been found. The mere physical mass of the stump and its roots is so great that the cost of any sufficiently effective agent would probably be too great, entirely aside from the possible injurious effect on the soil.

The most common inquiry is regarding the use of saltpeter, saltpeter and kerosene, etc. This has been tried repeatedly and found of no value. Some, no doubt, have been misled in this because a stump already in excellent condition to burn without treatment of any kind, has been charged with saltpeter and then burned successfully.

The use of stumps for by-products through distillation has been studied extensively and is still under investigation. Something helpful in reducing the cost of land-clearing may eventually result, but under Northwest conditions the procedure has not been found feasible as yet.

THE CHAR-PITTING METHOD

As frequent inquiries are received regarding the old char-pitting process, a brief statement regarding the procedure followed and a comparison with the stump-burner method seems desirable here.

Since the stump-burner method is a modified char-pitting process all that has been stated regarding kinds and conditions of stumps, character of soil, procedure in banking, etc., applies to the old char-pitting method as well.
Procedure. In regular char-pitting the usual procedure is to remove the bark around the base of the stump about one foot in height, then encircle the stump with several layers of kindling, consisting of sixteen-inch wood, split to stove-wood size, and mixed with some bark. This kindling is laid against the stump, upright but overlapping and slanting in the direction the fire is to run, so that the fire will be led from the starting point as easily and as rapidly as possible around the stump (Figs. 38 and 39). Two layers of the kindling wood, or somewhat less, are used. The wood is then banked over with earth, the bank being kept
about four to six inches in thickness, and sealed to the stump at the top following the same procedure in banking as described for the stump-burner method except that the bank is made somewhat less thick and less compact, to permit better ventilation.

An opening about a foot wide is left in the bank in the windward side. Here some pitch wood and fine kindling is used to start the fire. Sometimes in wet weather a handful of ashes saturated with coal oil or fuel oil mixed with sawdust, is used to start the fire. As soon as the fire is started briskly it starts to encircle the kindling under the bank of earth and usually in half an hour or so the opening in the bank where the fire has been kindled may be closed over with a slab of bark and banked in. In this way the stump is slowly set afire on the outside, and thereafter the chief requirement is care to keep the fire banked in. Usually the best results are secured in the summer when the stump and wood are dry, although banking is more difficult at that time.

Another method of char-pitting in many ways preferable to the foregoing, is what may be called side-pitting. Instead of laying kindling and firing all around the stump, a pit is dug at an interval between two main roots, a foot or more below ground level. The bark is cut away at this firing point and fire started in the pit. This is then covered over and maintained until the stump is afire at this point and then the stump is banked in.

Comparison of Char-pitting and Stump-Burner Method. The chief difference between the two methods is: (1) the method of setting fire to the stump, and (2) the character and effectiveness of the fire produced. In these two respects the difference in favor of the stump burner method is so great as to put it in a class by itself.

As has been stated heretofore a very great difficulty in the old char-pitting process was that of learning how to start the fire successfully, causing most beginners to discard the method entirely, and even to the experienced operator always a source of more or less difficulty, especially in wet weather and with wet stumps. With the stump burner method, on the other hand, starting the fire is easy and certain, regardless of the weather or condition of the stump.

The difference in the character of the fire produced by the two methods is almost as pronounced as the difference in the methods of starting the fire. In char-pitting the fire burning from the outside of the stump, burns away the connection between the stump and the roots and between the stump and the bank, at the very outset. Thus some roots are not thoroughly fired and do not burn out, and further the bank is left unsupported by the stump and falls in more readily and increases the difficulty of either producing or maintaining a thorough firing of the stump, and usually cutting off the central fire from the roots. With the stump burner, on the other hand, the heart of the stump is fired first and from this point the fire gradually burns outward to the perimeter of the stump leaving the bank undisturbed until the whole stump sinks in, and maintaining permanent connection between the central fire and the fires proceeding down the roots. The result of this difference in the character
of the fire produced is that where char-pitting will burn out fifty percent of the roots, under the same conditions the stump burner will burn out eighty percent or better.

OTHER METHODS OF BURNING STUMPS

Open Burning. Occasionally a stump thoroughly dry, pitchy and in ideal condition to burn may be burned out fairly well or even completely by piling waste wood on it and firing. Very seldom, however, will all of the roots burn out, and only rarely are stumps found that will burn out any portion of the roots this way. Open burning, therefore, that is, burning without banking, however the fire may be started, fails to give satisfaction in burning out roots.

Splitting and Burning. Enough powder is placed under the stump to crack it and make a cavity underneath, which is filled with wood and fired. This method is better than the preceding method but also fails to burn out the roots satisfactorily.

Trenching and Cracking. This method is used with fair success on pine. A narrow trench, eight or ten inches deep, is dug around the stump, and from the bottom of the trench a hole is bored downward to the heart of the stump and charged with a stick of powder, which cracks the stump. A fire is then started with kindling in the trench. One operator was observed using this method, who after the fire was well started covered the whole stump with wet, rotted straw, which tended to confine the fire and thus burn out the roots more effectively.

One-Hole and Two-Hole Methods. This method is used chiefly on pine. A hole about thirty inches deep is dug on one side of the stump, the earth being cleaned away from the tap root, and in this hole a fire is set. Sometimes a second hole is dug on the opposite side and a connection between the two punched through, fire being set in both holes.

Boring and Burning. A number of boring and burning methods have been tested and used more or less. The boring is done by means of hand augers, augers mounted on a frame work and operated by cranks, augers mounted and operated by gas engines, and double augers mounted to bore vertically and horizontally at the same time. One method used with considerable success on pine is to dig a pit twenty inches in depth on one side of the stump, then from a point slightly below ground level on the opposite side of the stump bore a hole slanting down into the bottom of the pit, where a fire is then started.

Under this head are found also many variations of what is sometimes called the intersecting hole method. One of the most common and best of these is to bore a slanting 1¼-inch hole into the stump about 18 inches, starting about 18 inches below ground level. Then a vent hole from ground level and at right angles is bored to meet the inner end of the first hole. The first hole is then fired with a hot iron, and when well afire a 1¼-inch pipe is inserted and used as a draft pipe. In all of these intersecting hole methods, however, setting a stump afire is by no means
easy, particularly where the stump is soaked up and the weather wet. Furthermore, as in all burning methods, unless the stump is banked in, only a percentage of the roots will be burned out.

**Decapitation Method.** This is one of the best of the burning methods and has been given considerable study by the Idaho Experiment Station. A stump is sawed off as close to ground level as possible. The upper part of the stump is then lifted up enough to insert stones around the edge so that there is a distance of two to four inches between the base and upper part of the stump. Fire is then started in this space, usually in the summer. The two burning faces radiate their heat against each other and thus aid in burning out the root crown. The stump may be banked in and thus greatly increase the effectiveness in burning out the roots.

**Air Blast Method.** An engine-operated fan sending an air blast through piping to the stump to force the fire down into the stump and roots has been extensively tested. It has not been found to burn out the roots very satisfactorily, and a considerable expense for the equipment and its operation and the attention required have made the method impracticable.

**Hood Burning.** It is claimed that something more than twenty patents for different sorts of devices for hooding and burning stumps have been issued. Usually the idea is to cover the stump completely with a hood made of sheet-iron or other material. The stump being fired, the draft and chimney of the hood permit it to be burned out pretty completely, if it is dry and in fairly good condition. The difficulty in this method is that it does not burn out the roots; furthermore, the destructibility of the hood, the difficulty of moving it and setting it up, the cost of the hood and the number required, the difficulty of covering the larger stumps, and the slowness and labor cost of the whole procedure make this method impracticable.
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