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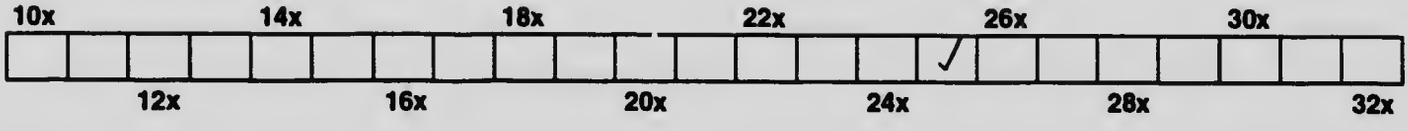

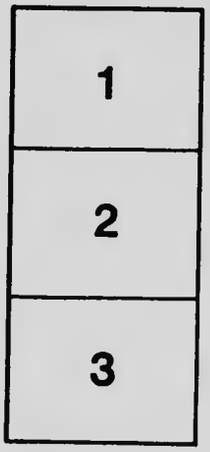

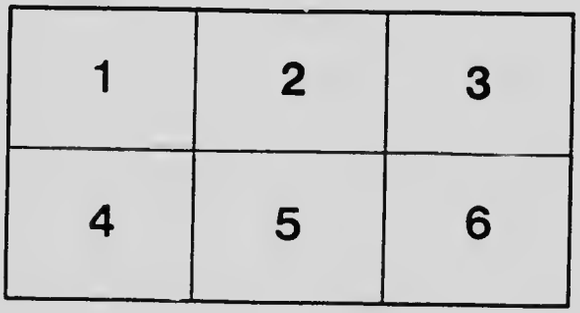

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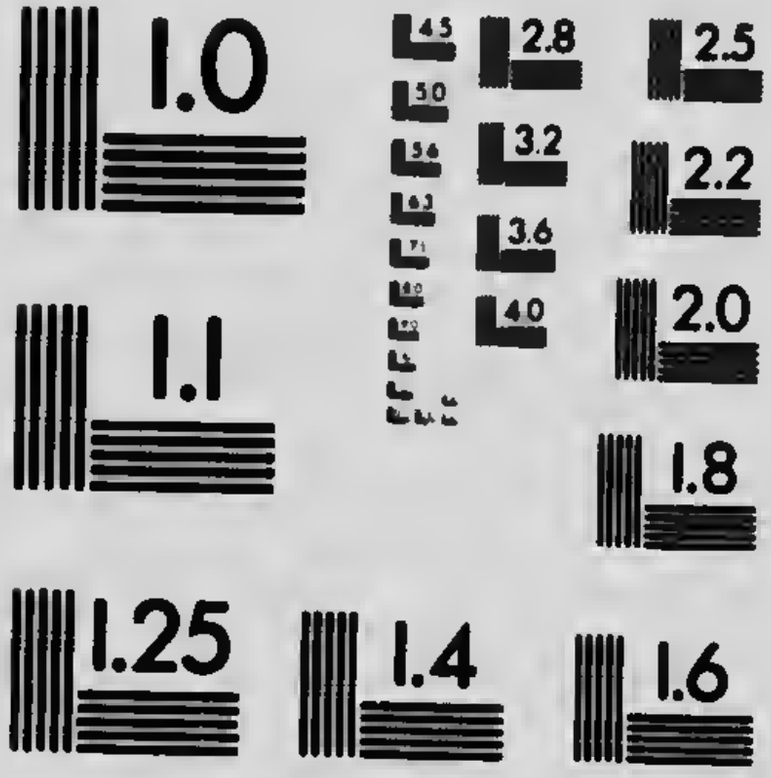

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PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE.

CLEARING LOGGED-OFF LAND AND CHAR-PITTING UP-TO-DATE.

By Prof. H. W. Sparks, Supervisor Demonstration Farms, Washington State College, Pullman, Wash.

WE believe our Pacific North-west is making a serious mistake in not giving more attention to this first and all-important part of utilizing our logged-off land. The land must be cleared before it is fit for homes, before the home-builder can hope to support himself and family, and the old methods take the best part of a life, before they have begun to live. We have seen men bent and broken long before their time by the needless drudgery of clearing their land by force of body. We believe much of this can be, and must be, avoided. This can be done by bringing together all the material we have, taking a little of the best from each and formulating new methods. This has proven successful in all other lines of industry and will do so in clearing the land.

There has been some progress made, but there is still room for improvement. The char-pit process is proving a great help to many, and will be useful to a great many more as they master the art of such control of the fires as to cause them to burn down, reversing a natural tendency by direction of well-known natural laws; but before going into a discussion of these laws, let us begin with methods of burning over the land as the first step in clearing.

The removal of a large portion of the lumberman's leavings by means of fire may best be accomplished by systematic preparation of the refuse for burning.

The man who undertakes land-clearing should first go on to the ground and definite' plan the work. He must first study the conditions of the soil, the amount and nature of the material to be removed, the time available for the work, and the methods best suited to all these, together with his ability and inclination to apply them. For the average conditions and for the man of limited means and time to devote to the work, we suggest the following plan: There will be some underbrush, large, half-rotten, water-soaked logs, a lot of old tree-tops, culled logs, and stumps. Any time a day or even a few hours is available for the work, remove the bark from the stumps and

logs, which facilitates drying out. Wet logs should be split open, and this may be accomplished by using some powder, boring holes in those logs that are sound enough to admit of boring, or chopping as deeply as possible with an axe into those that will not permit of boring. Charge the bored holes in the usual way with about one-half stick of powder, or put the powder into the chopped holes and cover with a few shovelfuls of earth, and fire the same as the first. We have found that in boring the holes the powder will do better work if the holes are bored slanting or at an angle about half-way between the centre line of the log and a line at right angles with that centre line. Good results are obtained with not more than one-half stick of powder, shattering and splintering, so that the air and sun have a chance to dry out the log preparatory to burning.

We have found that the mattock is a useful tool for removing the bark, and a steel bar, or, better yet, a piece of 2-inch gas-pipe with a steel chisel-bit welded into one end and a steel point at the other end. The chisel-end is used for splitting small rotten logs, and is useful also as a lever to pry open the partially split logs and for other purposes for which a lever may be used. The other end may be used to punch holes for powder under stumps and logs requiring but light charges. If there is any underbrush it should be slashed as soon as the foliage is out, first cutting that which is underneath so that none will be missed; then pile this material so as to produce a good burn. We repeat these words, *a good burn*, because a good burn will be of very great advantage in after-work, and reasonable diligence applied to facilitate that good burn is time well spent.

There has been a considerable number of what we believe to be wilfully misleading statements of damage done to the soil by burning by those who are interested in other methods. It is true that all the organic matter on the surface is burned up. As a rule, this organic matter would not be available in the soil and must be removed before we can produce crops, and we believe it is better burned off the surface of the ground, where the ash will be evenly distributed, than it would be by piling in great heaps.

As has been stated in other places in this article, the natural tendency of all heated air is to rise, and when these fires are ra[illegible] are at their hottest, you would find upon examination that that her[illegible] end very far down into the soil, and the little organic matter th[illegible] out in the surface can be much more easily replaced by the grow[illegible] r crop for a year or two than could the material thus burned out [illegible] away from the land to be burned.

Perhaps a word of caution may not be amiss about the time to burn. The burning should not be undertaken in the closed season without a permit from the local fire warden, but as early as possible after the end of the closed season and before the material is saturated with fall rains. The object is to destroy as much of the waste timber as possible with fire where it lies on the ground, with the least possible labour and handling. Much can be done to assist in this work by throwing a few chunks against the logs in such a way that they will burn through, so that the ends may then be swung around together and burned. In the hands of the skilful operator, fire is the best friend and most useful agent of the land-clearing forces. "Keep the fires burning" should be the slogan of every man in this work. Pile the chunks that can be handled against the larger logs in such a way as to burn them into pieces that can be handled, and if there are more of these small chunks than is needed for one fire, hold some in reserve for a second and perhaps for several other fires to follow, so that the big pieces are reduced to proper size for handling as

completely as possible without resorting to saw and axe. One of the most successful land-clearers we have found claimed that fires were burning every day of the year on his place.

We have noticed in passing over burns that where one log crosses another, or where two logs have lain together, the fire has done wonderful execution, and sometimes a comparatively small stick lying across a large log has been the cause of burning the log in two. And, again, since beginning these investigations of land-clearing methods, we have frequently noticed that some of the stumps are burned out completely, roots and all, by the ordinary "good burn," and since logs do not burn in spots or roots burn underground by chance, a study of the cause producing these effects will result in a better understanding and utilization of these potent factors when we try to duplicate them. The burning of a log at the point of contact with another is largely due to radiated heat. The heat generated by the burning wood of each is radiated to the other, by transmitting the energy produced by its burning to the other, thus driving out the elements not favourable to combustion, which are usually there in the form of water. This radiated action is in direct proportion to the distance between the burning portions. Those who have measured this force have laid down the rule that radiated heat diminishes in intensity by the square of the distance radiated. Thus: let heat radiated 1 inch be represented by 1, then that radiated 2 inches would be diminished by the square of the distance radiated (two), which would be 4, or diminished to 1-4. By the time we have reached 12 inches the intensity is diminished to 1-144 or the square of 12. This explains why logs burn when together and go out as soon as separated. This power is also an important factor in burning out stumps.

By the use of a good cover over the fires that follows the fires up closely at all times, we get the full force of this radiated heat on to the roots below the ground, and this proper covering conserves all this heat.

Another equally important factor working in harmony with this is that of artificial draughts or currents of air which bring to the burning material the necessary oxygen, and another fixed law may be here observed—namely, heated air expands, and in doing so moves upward, the colder air rushing in to fill the vacuum formed brings the oxygen necessary for the chemical process of combustion which we call burning. The stumps that burned out by themselves were naturally in condition to be well fired, and because of the material being especially favourable for burning, or of the close contact of some radiating body, they were burned out below the surface until the vacuum was formed by the heated air rising and cold air rushed in with its store of oxygen and facilitated the burning. A natural air-current was set in motion.

If we look into the holes where the burning is in progress, we will see that the fire is advancing most rapidly at the bottom, because that is where the incoming current of cold air with its undiminished supply of oxygen first comes in contact with the burning root. This burning of the under portion first still more facilitates the further burning. The portions of charcoal and ashes dropping to the bottom, thus partially covering the ground and acting as a non-conductor of heat, also reflect that heat back again to the burning portion. There is a law of radiation that operates here which should be understood—namely, if heat strikes a reflecting surface perpendicularly it is reflected back perpendicularly, but if it approaches the reflecting surface at an angle it glances off at an equal angle on the other side. This principle is also an important factor in covering over our fires artificially, to which we will refer again later.

THE CHAR-PIT METHOD OF DESTROYING STUMPS.

There seems to be a well-founded report that this method was first used by some Germans in Oregon about twenty years ago, but for some unknown reason the art was lost, or, rather, seemed to lie dormant for several years. Rumours of the method had g e out, and we believe the later methods are due to difference of understanding of these first reports. After investigations, we became convinced of the value of the method and gave our first public demonstration of it under the management of the Extension Department of the State College of Washington, during a meeting of the Cowlitz County Pomona Grange, October 28th, 1909. Several demonstrations were given in different parts of the State as a part of the regular Farmers' Institute work. After learning that the method, while proving so successful in the clay soils, was a failure in sandy, gravelly, loam soils, we commenced some experiments at Lake Whatcom in the winter of 1909-10 with the object of learning the reason of this, but were called away from the work again before any definite results were reached. Taking up the work again in co-operation with the Bureau of Plant Industry, Department of Agriculture, Washington, D.C., in September of 1910, Mr. Harry Thompson, representing the Federal Department, and the writer undertook work on the farm of Mr. Henry Duportis, at Adna, in order to obtain reliable data of the costs, and to study the factors with view of extending the system to the supposed unfavourable soils.

Later in the fall and winter I undertook a series of experiments designed to make the method applicable to stumps in soils which were too sandy or gravelly to permit its successful use without some soil-binder, and other experiments to ascertain whether fuel-oil or other cheap combustible matter might not be successfully and economically used in starting the fires under the stump.

Cost Data.

The following data as to cost of removing stumps from burned-over land was obtained during the fall of 1910. Three distinct methods of firing the stumps have been observed, and cost data for each method were secured. The plan most generally used is that known as the "Yount method," since Mr. Harry Yount, of Woodland, Washington, was one of the first farmers who made use of this method of destroying stumps. His method consists essentially in starting a fire entirely around the base of the stump, under a covering of earth and sod, which confines all the heat of the fire to the stump and causes it to "char" or become destroyed by the same general process as is utilized in charcoal-pits. Mr. Yount has been using the method for several years, and in order to furnish exact data on the cost, he commenced August 30th, 1910, to fire twenty-four stumps, performing all the labour necessary to complete burning-out of these stumps in thirty-six hours, which at 25 cents per hour gave a total cost of $37\frac{1}{2}$ cents per stump. These stumps were of an average size, 40 inches at the cut-off, varying from 24 inches for the smallest up to 72 inches for the largest.

About the 1st of September, Mr. Harry Thompson and myself fired 100 stumps on the farm of Henry Duportis, of Adna, Washington, the average diameters of which were 32 inches at the cut-off and 46 inches at the bottom. The work of firing the 100 stumps was complete in four days and four hours. The after-care consisted of one hour each morning and evening for three weeks, making a total of 130 hours, at 25 cents per hour equals 3.33. Ninety-seven of these 100 stumps were burned out successfully, which gave an average cost

of 34.3 cents each. J. W. McCutcheon, of Adna, burned out 130 stumps from an old field in thirty days. Mr. McCutcheon paid $2 a day for labour, making $60 for the 130 stumps, or 46 cents each. Mr. David Fay, of Adna, removed thirty-nine stumps from an old field in eight days' time for firing and three hours a day for five weeks in after-care. He valued his time at $2 per day, making a total of $37, or 95 cents per stump. These stumps were much above the average size, all the smaller ones in the fields having been removed by other methods.

Another successful plan for applying the same principles with a slight change of method is that employed by Mr. W. H. Booth, of Sequim, Washington. In 1908, with the help of his two boys, he removed 661 stumps from 16 acres in nine weeks, and in 1909 he destroyed 350 stumps from 12 acres. In 1910, 225 stumps from 8 acres were destroyed, not keeping any record of the time for the last two years. Counting nine weeks' time at $36 per week for the three labourers would give $324 as a total cost of removing 661 stumps in 1908, an average of a little less than 51 cents per stump. These stumps were removed from old fields where all small stumps had been previously taken out. The average size of these stumps was fully up to anything that was found in the State, being very large. Mr. Booth's method is to fire the stump at but one place. He first prepared good fuel from good wood by cutting it up during the winter season in convenient sizes to handle. This is piled up to dry, and the firing is not undertaken until the driest part of the summer months. He then selects some part of the stump where two large roots are coming out near together from the stump, and digs away the earth from 15 to 18 inches deep or until he gets a little below the point where the two roots fork. He then goes on the ground and builds a good fire in each one of the previously excavated holes and leaves it burn several hours uncovered; then if there is good bed of hot coals and the stump begins to show indications of taking the fire, he replenishes the fire with a little fuel and covers over with earth about the same as formerly described. The after care consists of keeping the stump banked up ahead of the fire all way round. Mr. Booth thinks that on large stumps it would probably pay to fire them from two opposite sides, as that would very much hasten the operation. This method of burning by firing from one place is necessarily slow for each stump, but where there is plenty of work ahead in firing other stumps, the time required for a stump is not so large a factor.

The most favourable data that we secured is that furnished by Mr. A. W. McCormick, of Woodland, Washington. Mr. McCormick had an old field with a large number of stumps which he contracted to have burned out by Mr. Geo. Lanham at 50 cents a stump. Mr. Lanham commenced work August 12th, 1910, keeping, at our request, accurate account of his time. He successfully burned out 219 stumps in 108 hours. This is the most favourable record we have obtained, and we believe that the burning was done under the most favourable conditions that we have yet seen. The time, August and September, was when everything was very dry, there having been no rain to speak of for more than two months. The natural slope of the hill was very much in favour of cheap destruction, in that there was a very good slope to the west and toward the prevailing wind at that place. This field had been ploughed for many years in the same way, throwing the furrows downhill, thus banking up the upper side of each stump and removing much of the earth on the lower side. Mr. Lanham, with his axe and mattock, would pull down some of the half-rotten wood from around the top of the stump, build a little fire under the exposed part of the roots, cover over with soil, and

go on. The stumps being pretty well banked up as described, there was little more to do than to visit the fires regularly and keep them covered as the burning progressed. It should be said, however, that of the 200 he fired, twenty-one failed to catch by the first firing, leaving 210 successfully burned out. The work here reported and all the figures given were obtained under most favourable climatic conditions and in a soil naturally adapted for this method of burning.

We have no reliable data at hand as to the cost where artificial covering for the fires has to be hauled to the ground, but think from experience that where the material for covering may be had so that the operator can haul in three or four loads of clay or cinders a day, the average stumps, say of 40 inches diameter, can be burned out under average conditions for somewhere between 50 cents and $1 each, which is much less than the expense of removal by any other known method.

We believe from our observations that it will pay those desiring to clear land by this method to so plan the work as to take advantage of favourable seasons and conditions, and that the method will not be so successful in the heavy clay soils during the extreme wet seasons as it will be during the more favourable season, since there will not be so much success in burning out the roots, because of the water-holding capacity of the heavy clay and consequent wetter condition of the roots. On the other hand, we believe that in the sandy, gravelly loam soils the burning will be just about as successful during the wet season as at any other time, because of the fact that such soils are naturally well drained and the soil-saturation is not so great as with the heavy clay soils.

CONCLUSIONS FROM OUR EXPERIMENTAL WORK.

The results of our experiments show the following facts: First, the "char-pit" method, which has been repeatedly demonstrated to be economical in operation and very effective in removing stumps standing in clayey soils, may be successfully applied to stumps on sandy lands. This can best be accomplished by using some artificial cover rather than the soil surrounding the stump for covering the material to be fired. This artificial covering material must be such that it will not be affected by heat, and should be porous or granular in form so as not to cause too rapid burning, since the object of the process is to char rather than to completely destroy the stump. Coal cinders have been found to be excellent cover for this purpose. Clay soil when heated by the fires underneath takes on granular character which fits it to serve admirably for this purpose. Lime and sand mixed as in the preparation of plasterer's mortar makes a good artificial cover if no cheaper material is available.

Second: The firing of stumps which are very wet on the outside may be facilitated by driving a number of large spikes through the wet outer layers into dry portions of the stump, leaving the spikes projecting out into the kindling material from which the stump is to be fired.

Third. Where cheap fuel for kindling the fires around the base of the stumps is not available, fuel-oil may be economically and satisfactorily used for this purpose. It is best applied by mixing with dry sawdust, as a given quantity of oil will go much further if used in this way. Fuel-oil might be purchased in bulk at some central point and there mixed with the proper proportions of sawdust, and this mixture hauled to the land which is to be cleared. Under favourable conditions and seasons, firing by means of kindling-

wood placed around the entire base of the stump is the cheapest process and no other fuel than that to be found on the premises is necessary.

Fourth: The use of artificial aids to combustion requires considerable skill in order to control the amount of heat generated, and will not be generally successful in the hands of common operators.

Fifth: Roots that have not been burned deep enough may be burned again, always easiest at the charred end. Both stumps and roots are easily cut from the under-side.

The experiments were conducted at different places with the view of better testing the methods in the varied soil conditions and to give the greater number of those interested an opportunity to see the methods.

DIRECTIONS FOR USING THE CHAR-PIT METHOD OF DESTROYING STUMPS.

We first give directions for the method adapted to clay soils. Starting in after "a good burn" on the stumps, if the operator will follow as soon as the ground is sufficiently cool, he will find many stumps with sufficient fire as not to require any more than perhaps a few fragments of bark or other light material added to them to secure a good start, which should be covered immediately with earth. Stumps not so burning should be treated as follows:—

First remove the bark to the ground; then if the sap-wood is wet or green, chop into the inner, dry wood. Now procure some fuel for the good start. In the dry season any half rotted material that can be secured easily will answer, providing there is enough dry material to start the fire. Pile this fuel around the base of the stump in such a manner that the fire will follow. The fuel should be continuous and fairly uniform in quantity and quality. It does not make any difference whether the wood is set on end or laid lengthwise. Where some of the fuel is long and there is a portion of the stump where there is a side sufficiently straight to allow the piling of long pieces without leaving too much space between the fuel and the stump, this may be done so as to save labour or breaking up the wood. As to the amount of fuel to be used much depends upon conditions. If the fuel is piled to reach about 15 inches high and about the same distance out at the ground-line, this will be sufficient. Our experience indicates that it is best to have less rather than more kindling material if it is so arranged that the fire will burn evenly, thus allowing the cover to settle uniformly. If the fuel burns too quicker in some places than in others, the cover settling down as the fuel is burned at these places leaves breaks, thus permitting the heat to escape.

Place some of the finer material to act as kindling next to the stump and under the main supply of fuel to lead the fire and start the burning next to the stump, keeping the fire as near as possible to that which it is to burn. To further conserve the heat, cover over the fuel with the soil most convenient. In friable, loose soil the manner of putting on this cover is important. If carelessly done, or if an operator stand at a distance and throws the soil, there will be a breaking up into the finer subdivisions of soil, which will fall into the crevices of the fuel and perhaps considerable portions of it drift in between the fuel and the stump, thus protecting the stump from the fire. Hence, the best results will be secured by laying each shovelful of earth on the fuel without throwing; and if the soil shows a tendency to break up, fill in around the stump at the top of the fuel with the most convenient material

at hand, small pieces of bark, rotten or wet wood, ferns, twigs, or anything that will hold the fine material up at the start. Build the soil covering up from the bottom and cover the top tight. Be careful at the top of this covering to close all the holes. A few shovelfuls of finer earth sifted over this portion of the covering will be found to be an advantage. Allow the air to enter freely at the bottom, since, as the burning proceeds, that air becomes heated and rises to the top of the covering, where it will escape if there are any holes; but if confined within the space, the cover soil becomes hot and that heat is radiated back to the stump. If the soil covering settles down to the horizontal or nearly so, this heat is radiated back to that portion of the stump which we wish to burn, namely, the roots, and this is the special reason for keeping the fuel down to the lowest minimum for successful firing.

Cover all the fuel except a small opening to the windward side, where some kindling should be placed for the purpose of conveying the fire around the stump. Leave this opening on the windward side of the stump, so that when the wind blows it has a tendency to drive the fire in under the cover. As soon as this fire is well under the cover, which may easily be told by the operator from the amount of smoke issuing through the covering at different places, cover that opening in the same way as the rest of the fuel was covered. Sometimes, if it has not been convenient to reach the newly fired stump at the proper time and the fuel has burned out pretty well at this opening where it has been exposed to the strong air-currents, it may be necessary to fill in with a few small sticks or pieces of bark, which takes the place of that burned out, before banking up.

The stump may now be left to care for itself for several hours, while other parts of the work are done. The operator should make regular visits to each of the stumps to see that they are progressing as desired. If he finds holes breaking through the covering any place, these should be filled up, avoiding at all times packing the covering. Leave a loose, porous covering, because the more air-space there is in this cover, the better non-conductor it is, air being a non-conductor of heat. As a general rule, the operator will find it best to arrange his work so that most of the stumps can be fired in the morning, leaving the afternoon so far as possible for the removing of bark, getting the fuel ready, and fully preparing the stumps, all except the setting fire to the kindling. Then fire early in the morning in order that this first fuel may become burned down to a bed of coals before night, and the earth covering settled down to a position where there is less danger of breaks in the cover. Then, if these newly fired stumps are looked over as late as possible before retiring for the night, they take care of themselves until the early morning with a very small percentage of failures.

If a stump has been successfully fired, about twenty-four hours after the fire has been applied, white smoke will be seen issuing from several places around the stump. At times we have thought that the fire had not caught some of the stumps, but upon examination find considerable heat there. If such stumps are left alone for a day or two, the fire seems to gradually gather force by slowly drying out the wood, then begins to burn quite rapidly. From that time on the operator should visit the stumps regularly night and morning, dividing his time as evenly as possible, as it is quite essential that the stump be not left too long at one time to care for itself, as the fire burning under this cover will gradually eat into the stump and work its way from under the covering. If allowed to go too long in that condition, the accumulated heat is lost through the opening. We have found that the fires usually burn better at night. The incoming air is cooler, and consequently expands more

when coming in contact with the fire, thus stimulating stronger draught with more oxygen and better burning.

This work is very light, but exacting in its nature. Regular visits must be made to each stump, and where the fire has gone beyond or through the covering it must be covered over with more soil. It is best to cover these openings with dry, hot earth from near the fire, replenishing from the soil outside over the top of this to keep the required thickness of earth over the fire. This should be kept as nearly as possible between 2 and 4 inches, the depth depending largely on the nature of the soil and the method the operator wishes to employ; that is, either to burn rapidly and consume most of the charcoal as fast as carbonized, or to burn slowly and preserve most of the charcoal. The amount of this covering regulates the speed of burning. A fairly good guide for the operator is to watch the colour of the smoke issuing from or through the covering. If the smoke is blue, moves upward rapidly, and the fire can be seen through the cover, the carbon is being consumed too rapidly. This calls for more cover. But if the smoke is dense and white and moves slowly, this indicates good work, the moisture and gases being driven off without actual burning of the charred wood, which is the desired condition. Heavy clay soil does not break up much, but retains the form as shovelled on, and is not as good a non-conductor as a soil that breaks up into smaller particles; hence a little more of this heavy soil must be used for the same speed of burning than would be necessary for the soil that breaks up better. On the other hand, if the cover disintegrates from the action of the heat as sandy-loam soils do, there is a tendency for this fine soil to run in the fire before it is well established in the stump and smother it. Also, these sandy-loam soils, which from their nature are inclined to settle down closely together when hot, are better conductors of heat, and conduct the heat away from the stump instead of conserving it and radiating it back to the stump.

In the course of a few days the fire will have progressed so that the stump will be cut off about the top of the earth covering and fall to one side. If the proper care has been given during the first few days of burning, covering the fire as it progressed into the stump, there will be but a small portion remaining to be covered. This should be completed as soon as possible after the stump has burned entirely off. From that time on the care consists of regular visits by the operator. As before stated, there are two distinct methods which may be adopted: that of rather heavy covering, which is much slower, but preserves the charcoal, and that of rapid burning, promoted by a light covering, consuming the charcoal as fast as possible. In the slow burning the soil is heated less and is left in better condition for agricultural uses.

In a few days more, the crown of the stump should be entirely burned out. A little experience soon enables the operator to judge of the progress of the burning by the appearance. The covering will settle down so there will be quite noticeable depressions with smoke issuing from them. The cold air from the outside finds its way into the lower places, bringing the full store of oxygen and the fire burns faster, eating out still greater spaces until there is at times a considerable opening in the front of each of the roots that the fire is following out into the soil. Encourage and assist this burning by following up the fire with the soil. If a rapid burn is desired, leave a very small air-space at the top of the hole. If a slow burn is preferred and it is desired to convert the wood into charcoal, fill up the entire space with not more than 3 or 4 inches of covering over the fire. This checks the air circulating so that not more than enough oxygen reaches the fire to carbonize or char the wood.

It has been the opinion of many who have tried it that this method is not adapted to gravelly or sandy soils, but our experiments have convinced us that it may be profitably employed by modifying the method to the needs in the changed conditions of soil. We have done this successfully as follows: Prepare the stump in the usual way, that is, removing the bark and digging away the objectionable soil to about the depth one would want to plough, making a trench around the stump, wider at the top than at the bottom, the sides sloping toward the stump. Now put the fuel in this trench, using in the dry season the same amount of fuel and placed in the same way as we have described above. During the unfavourable season a concentrated fuel may be used with good success. Where dry sawdust is available, use about one-half bushel of this in the trench with kindling-wood laid around next to the stump, then use from 1 to 3 gallons (depending on the size of the stump) of fuel-oil poured over this kindling-wood and sawdust. Next place a small amount of coarse wood and pieces of bark, or any good fuel which may be at hand, over the top of this, and fill in with pieces of bark, chips, rotten wood, or ferns around the top of the fuel to prevent the dirt falling in between the fuel and the stump at the start; cover the fire and care for the stump as before described.

For unfavourable soil conditions an artificial covering is necessary. This may be of any material accessible that is sufficiently granular in form so that it will not settle together too tightly, making as nearly as possible a non-conductor of heat. We have used successfully ordinary coal cinders and clay hauled from the nearest supply point. The coal cinders and clay make a splendid covering except in time of heavy precipitation. They do not have the capacity to absorb the moisture that the clay has, hence more water reaches the fire, although our experience with this feature of the work has been limited. However, this does not seem to make a great deal of difference, as the cooling, heat-absorbing effect of the water in the clay gives about the same result.

There is an advantage in the cinders for artificial covering. The supply can be taken up from a stump burned out and carried to the next stump to be burned. Perhaps in time we shall find other materials that will take the place of these where they are not convenient. We have been frequently asked whether it might not be possible to use sheet iron or other like substance for this covering. At first thought it would seem that this would be possible, but in actual practice it fails, first because such materials are conductors of heat and conduct the heat away from the stump, and, second, they are rigid and do not follow the fire closely. Any cover that is rigid might be successful for a time, but when the material has burned away some distance the radiating effect is lost, and since radiated heat diminishes as the square of the distance increases, the loss is apparent.

We do not think it advisable to use large pieces of bark for fuel, but if the bark is broken up pretty well it serves the purpose of fuel when placed on the outside of the fire. Bark is a natural non-conductor provided by nature with many air-cells to protect the growing trees from the extremes of heat of summer and the cold of winter, but when broken up into small pieces and placed around the top it will take the place of fuel, although it is not as good as dry, sound wood, except to fill the smaller spaces between the other fuel.

From our observation, where clay which has been shovelled over a few times before being placed over the fuel is used for artificial covering, it is pretty well broken up, so that, in placing it over the fuel, there are not many air-spaces left around the bottom to help draw the fire around the stump at

the start. We have found it advantageous to so lay in a few pieces of bark or other material that there will be openings left around near the ground-line to admit the air.

The fuel-oils may be had very cheaply wherever they are used for fuel in factories, steamboats, or railroad engines, costing about $3 when bought by the barrel, but as little as 90 cents per barrel in quantities. One barrel of oil used as we have suggested is sufficient for from twenty to thirty average stumps, and where one can use his time to advantage, this is about as cheap a fuel as one could get by any method of preparing fuel. There is a further advantage in the fact that oil is a concentrated fuel and permits the maximum heat-production in the minimum space.

It has been our observation that light-coloured clay soils are stronger reflectors of heat and the fire seems to burn better and faster than with the darker-coloured soil.

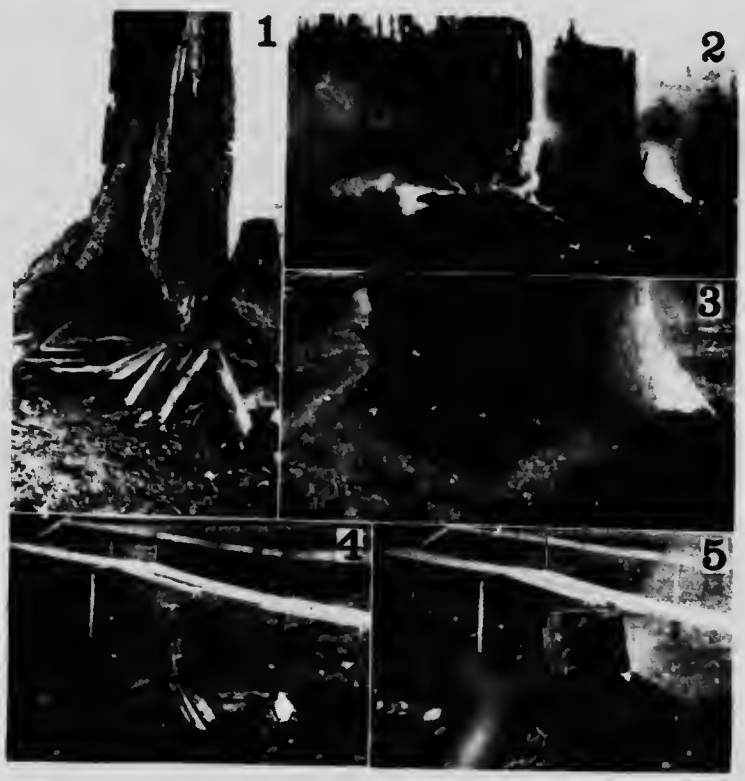

PLATE 1.— Methods of preparing stumps for char-pitting.

Fig. 1. Kindling in place, ready for covering. Note arch at opening to be left uncovered until fire is going well.

Fig. 2. Kindling covered and fired. These stumps were fired only on one side. As the fire works around the stump it must be kept covered to prevent loss of heat.

Fig. 3. Stump ten hours after firing, showing how the fire eats into the stump. This must be followed closely by earth covering.

Fig. 4. Stump growing in sandy soil, with kindling arranged ready for artificial covering.

Fig. 5. The same stump as shown in Fig. 1, covered with coarse coal cinders, ready for firing. After fuel is well kindled, opening must also be covered.

Since the above was written we have had another year's experience, which has added something to our knowledge of removing stumps by the char-pit method. We find from our correspondence and personal interviews with individuals that a large number who have not thoroughly understood the method have tried and have had poor or indifferent success. For some reason there are many who have got the idea that they must cut a lot of wood similar to cordwood, and make a regular charcoal-pit; one writer going so far as to condemn our method because it resembled a smoking volcano, he advocating the smaller fires, similar to that practised by Mr. Yount, of Sopena, as related in Bulletin 101 of the Washington State College.

We believe now that when conditions are favourable there is no need of chopping any wood. We find that the old half-rotten wood around the stump, together with some of the bark, is all the fuel that we need to fire the stump, and we believe, as a general rule, that stumps can be fired with less material by digging a small hole between the forks of two roots and getting the fire a little under the stump. Our experience has led us to the practice of using less and less fuel, using the least possible amount necessary to fire the stump, as with a smaller amount of fuel there was less danger of the covering caving in, and losing our fire by heat escaping through the opening.

As an instance of this misunderstanding, we will quote the following from a little leaflet published in south-western Washington. Our purpose in quoting this is not only to show the misunderstanding of the method as advocated by us, but also to make more clear to the reader the real factors to accomplish this burning, which is practically the same as that used by us, except that we believe that we accomplish the work under the same conditions as that where this method was employed with much less labour. We quote from a letter written by Mr. M. E. Murdock, of Willipah, Washington:—

"In answer to your inquiry concerning my experience in burning stumps, I have this to say which may be of interest to you and the public who may be interested in the clearing of land.

"My experience started in the summer of 1911 on what is called the Hazeltine Place, on Ward Creek, Pacific County. Here I tried what is known as the Sparks method of char-pitting, and although I found it successful, I also found that it involved a great amount of work in the preparation of wood and in the care necessary in keeping the fire covered after it had burned for some time. This difficulty will be readily understood by those who have done such work.

"Afterwards, I went to Coyle, on Hoods Canal, and there Mr. Geo. Eaton, formerly of North River, who had just bought some land at that place, was just commencing to clear his land. He had a number of stumps which he wished to get out of his clearing. I was teaching the school there, and as I had Saturday to myself I started with him to try some new things in burning stumps, and we were so successful that we want everybody to know about it.

"We worked in the following way: We reasoned, in the first place, that the draught in a cook-stove always tends to burn out the fire-back first, and we judged rightly that if we could utilize that principle in burning a stump it might save a large amount of the labour and wood used in char-pitting. We got several pieces of iron pipe about 5 feet long and about 2 or 3 inches in diameter; also a bar having a wide chisel-edge. In attacking a large stump, we chose a place where two large roots came to an acute angle, and at such a place we dug down until we were some little distance below the base of the stump. With our sharp bar we cut all bark and most of the rotten sap-

wood away, and made a space large enough for a good fire well in under the base of the stump. Then we dug a small trench out at right angles from the stump, and in this we laid our iron pipe. This was intended for a draught-flue for our fire. We used about two good armfuls of short wood or bark which was reasonably dry in making our fire, and after it was well started we commenced building a wall of clay (wet if possible), so as to enclose our fire in a semicircular cone, using the two large roots mentioned above as part of the wall of the enclosure. This wall we made thick and carried it up sloping to within a few inches of the side of the stump. Now we had a good fire with a good draught-flue, and the base of the stump was the fire-back. My readers can see the rest of what would happen without my telling it.

"The base of the stump got very hot and it was not long, with that powerful draught of oxygen, until the whole base was burned away. After the fire got very hot, however, we found it best to stop all draught and cover it up tight. In covering the fire we were careful to heap plenty of earth or clay on the upper part of the sloping walls, so that when the wood underneath burned out the clay would settle and close the air-space. After the fire was once started the work in keeping it going is very little. A man can fire five stumps a day easily, and he can take care of fifty or sixty after they are fired well.

"During the time the snow was on the ground in November, 1911 we had several stumps that were well afire, and, although we did not visit them for several days, we found that they went on burning, and the wet and snow did not affect the heat of the fires. Those stumps tumbled over a day or two afterwards and their roots are burning yet.

"This is no dream of a theorist, but a tried and proven method. We took our coats off and went at the work, knowing that we had discovered a good thing, and that it meant something to the poor men who have work to do and who cannot afford to employ giant powder and donkey-engines. I suppose we have at the present time not less than thirty stumps burned out, and the trunks of which are lying on their sides, and their extended roots are still burning far out from the centre of the old bed, which is all clear. The best time that we made was five days for a stump 4 feet through. We burned several large ones, and found that size made no difference in the amount of work, but took a longer time to burn."

We have, since Bulletin No. 101 was written, tried out a few experiments looking to the better adaptation of this method to the unfavourable gravelly soils. We have believed that if we could devise a good method of internal firing similar to that that has been in practice for some time among many of our people, that is, of boring auger-holes in such a manner that they intersect some little distance inside the stump, applying the fire there, covering as soon as the opening burned out is large enough, we will then have started our fire inside of the bark. Those who have had experience in burning out roots by any method will probably have decided that the thick, heavy fir-bark will stand for considerable time after the wood is consumed, thus holding up the objectionable gravelly soil, and we hope by this method to save the labour of digging the trench around the stump, and also to reduce the amount of covering necessary.

Looking toward the accomplishment of this theory in the month of January last, near the City of Olympia, Washington, we tried out an experiment which we believe can be used successfully under conditions where the soil around the stump is not favourable for burning. We dug a small hole between a couple of projecting roots that would hold a good, big armful of

wood, and in this hole we built our fire and covered over with what we will call an artificial covering, made by scooping out a small hole in the ground near the stump and dumping into it two wheelbarrow-loads of fairly good clay. To this we added water and thoroughly mixed the water and clay to about the consistency of thin mortar; then added about an equal amount of sawdust, which was thoroughly mixed into the clay mortar and let stand overnight. In the morning we started the fire in this hole that we had previously prepared, and covered over with this mixture. As the fire advanced into the stump we kept the fire covered over lightly. We found that as the clay sawdust mixture got hot the sawdust was completely burned out, leaving a very light, porous clay, which was what we expected and wanted. The two wheelbarrow-loads of clay used in this mixture was sufficient to burn out a stump that was 4 feet in diameter at the t[illegible] (We are enclosing a picture of that stump taken the third day after firing.) This stump went over on the fourth day and was practically burned out. We do not know that this method would be practicable under all conditions, but think there is a strong probability that it can be used successfully, and have outlined a theory of its application, which we shall try out at the first opportunity.

Stump 4 feet in diameter three days after firing.

We think it is quite possible that the manufacture of this breeze may be too complicated for the average home-builder, but we hope that the time is not far distant when this or any other method has been proved practical will

be given Government aid to the extent at least of furnishing this material to the actual users at cost, and we do not think it need be very expensive for every man who has land to clear to secure enough of this material to keep quite a large number of stumps burning all the time.

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