discussed. The use of sodium arsenite over a large area is described. Possible disadvantages of the method are elaborated and a case for carrying out this type of thinning in preference to leaving the stand untended is put forward.

References

ONE-MAN CHAIN SAWS

By J. L. HARRISON-SMITH

Chain saws are here to stay, there is no doubt about that, and more and more people will be using them as their value as time savers is better appreciated. Having had some experience with several makes of one-man saws over the past 2½ years, the writer puts forward these notes in the hope that they may help others both in the selection and operation of machines to suit their particular needs.

Types

One-man saws may be divided into two distinct types, those in which the whole saw is turned on its side when it is used for felling and those in which the cutter-bar only is turned while the engine remains upright.

The former includes the English Danarm and Liner, the Norwegian Jo-Bu and several American makes such as the Disston, Homelite, Reed-Prentice, McCulloch and Woods Boss. The layout makes for strength and rigidity and one would also expect it to allow the building of a lighter saw for a given power. Actually this does not seem to work out in practice for most of the makes mentioned are substantially heavier than many of the other type. It ought also to facilitate cheaper construction but there again some saws so made cost a good deal more than swivel-bladed makes of similar cylinder capacity.
On the other hand there are certain disadvantages. To allow the cutting of low stumps with the fixed-bar types it is usual to set the cutter-bar somewhat off centre, generally nearer the right side of the machine. Then when the saw is turned on its right side the blade is near the ground and one can cut a stump almost at ground level. However it is not always convenient or even safe to cut from the same side of a tree and when the saw is tipped over the other way a low stump cannot be cut. There are also other disadvantages and the writer has had some unpleasant experiences getting foul of unprotected spark plugs; it is not hard to imagine how an accident could arise from such a situation. Other troubles that have arisen have been the failure of the chain lubrication system, inaccessibility of the clutch or throttle control or both, and the lack of a good hand grip. Actually one does not find these troubles on American saws and it is only on the European machines that one has to look for such snags. Competition in the American field is keen and such defects never reach the production line.

Various devices are adopted to allow the carburettor to function while the machine is tipped over. European practice favours having the carburettor-petrol tank assembly on some sort of a swivel so that when the rest of the machine is tipped over they remain upright. This is a weak point for sooner or later air leaks develop and as all the engines are two-strokes air leaks are particularly serious. Other schemes adopted are the swivelling of the float chamber only and on at least two American machines the fitting of a universal carburettor which will operate in any position.

The fixed cutter-bar arrangement has the advantage of permitting the chain lubrication system to be arranged without any external pipes (though it is not always done), for pipes are always a weak point and seem to get caught in every branch within yards.

In the other type of saw, that in which only the cutter-bar turns while the engine remains in the normal position, it is equally easy to cut from either side of the tree and still cut a low stump. There is also no danger of getting foul of spark plugs, and the controls and chain lubrication system continue to function properly. The machines are built with the crankshaft fore and aft and the drive to the chain sprocket is through a bevel gear from the front end of the crankshaft. In addition to felling, these machines can be used for undercutting with the blade turned upside-down.

On some saws the blade can be locked in any position whatever by some sort of clamping arrangement, generally an over-centre lever, but in others there are definite positions where the blade is located by a lock-pin. On these latter there is generally a choice of six positions; the blade may be vertical for cross-cutting, horizontal to right or left for felling, inverted for undercutting and at 45 degrees right or left for putting in the top cut of a scarf. There is little to choose between the two different arrangements for with the latter
any other angle can be achieved by tilting the whole machine. It has been found that the engine can be tilted a long way from the horizontal before its running is affected.

Clutches

Almost all American saws have automatic clutches, i.e., those operated by some sort of centrifugal device which starts the chain running as soon as the engine is speeded up. European saws on the other hand have, within the writer's experience, manually-operated clutches, some worked by levers and some by Bowden cables. The automatics are of course by far the best—and the safest—and of the manually-operated clutches the lever operated ones are the best. The cable types which the writer has tried have all been poor, unreliable and prone to getting hooked up in branches and other obstructions. They are devices to be avoided.

Cutter-bars

Here again we have two distinct types, the straight bar and the bow-saw. In the former the blade varies in width with different makes. It may be a wide "beaver-tail" as in the McCulloch and the Danarm or it may be narrow and parallel as in the I.E.L. The beaver-tail shape is the more mechanically correct as the chain is made to follow progressing curves and it can be run quite slackly without danger of its jumping off the bar. However there is a disadvantage too: unless a large log is being cut it is impossible to use a wedge. On the other hand, with the narrow parallel bar a wedge can be used in quite a small log but the chain must be run tighter if there is to be no trouble with its jumping the bar.

The bow-saw type of machine is used more particularly for cross-cutting and I think it can be said that it is not generally recommended for felling. Not having used one, it is impossible to speak from experience. For cross-cutting the type is really excellent for there is rarely any trouble with the saw jamming in the cut when sawing a bridged log. The average chain cuts a kerf about 3/8th inch wide so that there is very little chance indeed of the bar being caught by a pinching log. There is of course the disadvantage that the saw cannot be drawn out through the cut once the log has pinched. One must cut right through and risk the saw being damaged by the sudden breaking away when the cut is completed but the risk of damage can be minimised by the intelligent use of wedges.

Chains

Chains are of two distinct types, those having teeth like an ordinary saw and those having the gouge type tooth. The latter are known variously as planer chains, router chains, etc. according to the names given by the particular makers. The writer has used both types and found that the gouge type is the only one worth even considering for
pine. It will also handle harder timbers but as the hardness of the timber increases it gives place to the tooth type and when such woods as matai, dry tawa and rata have to be cut the tooth type chain is the better.

In pine there is little difference in the cutting speed of the two chains but the gouge type is very much easier on the engine and sprocket and should therefore be cheaper to operate. It is also vastly quicker to sharpen and can be touched up in three or four minutes without removing the chain from the machine. On the other hand it is not easy to sharpen the tooth type chain on the machine and the whole operation of removing it from the bar, touching it up and replacing it takes about 20 minutes.

**Starting mechanisms**

American machines without exception are fitted with a “re-wind” starting mechanism; one pulls a handle attached to a wire and this in turn revolves the engine. As soon as the wire is released it returns to its case, ready again for instant action. On the other hand, all English and Continental machines which I have tried have been started by winding a cord around a pulley and then pulling on it. This is not so bad if the engine starts first pull every time but two-stroke engines are notoriously capricious and an engine that is not starting well can waste a great deal of time. To increase the difficulty, the tubes which form the frame of some makes overhang the starting pulley and winding the starting cord is then infinitely more difficult. As re-winding starters have been fitted to outboard motors for about 20 years it is amazing that English and Continental makers have not adopted them for their saws and one is forced to the conclusion that the designers never get out in the field to try-out their machines. Of all the time saving devices that could be fitted the re-wind starter is the most desirable.

**Fuel and Oil**

In all the machines with which the writer is familiar the lubricating oil for the engine has been mixed with the petrol. Only the proportions have varied from make to make. At one end of the scale there is the Danarm saw which is fitted with a Villiers motor and uses a sixteen to one mixture of petrol and oil; at the other end there is the Titan with an eight to one ratio. Whatever the mixture it is important that the maker’s directions be followed and hard starting is almost certain to result if the correct proportions are not used.

The amount of fuel consumed is small, so small as to be hardly worth considering when making up costs. It has been possible to make some studies of fuel consumption and in cutting three-foot pulpwood from dry *Pinus radiata* the rate worked out at 7½ cords of wood per gallon of fuel mixture. This included felling as well as cross-cutting. In another experiment, thinning 23-year-old *Pinus*
radiata to waste, the fuel consumption was about 1 1/2 gallons per acre. It will thus be seen that in comparison with labour charges the cost of the fuel is small.

In addition to oil which is mixed with the petrol, oil is needed in the transmission of some saws but here the usage is very small indeed and not worth considering. But lubricating oil for the chain is another matter and if the chain is to be kept properly and adequately oiled a lot is needed, a good deal more than is used to mix with the fuel. However here it is quantity and not quality that is important and the writer has always used old engine oil with perfectly satisfactory results. Oil of 20 or 30 S.A.E. viscosity rating is suitable and heavier oil can always be broken down by adding petrol or diesel fuel oil.

Operation

In felling with a chain saw there is one cardinal rule—never, never, never cut a tree right through. This may seem to be a very obvious caution but it is easy enough to do and if it does happen there is every chance that the tree will sit down on the cutter bar, screw round and wreack the machine.

For felling small plantation pine, say trees up to 60 feet high and 9 inches d.b.h. it was rarely found necessary to scarf a tree. The usual method of felling was for one man to operate the saw and another to give the tree a push with his axe. This was enough to topple most trees and any with contrary leans were cut part way through and then knocked over by felling other trees on to them.

The practice of allowing the helper to push the tree with his axe is slightly dangerous for the helper's feet are than a little too close to the saw blade. If the blade is suddenly taken out of the cut or if the helper stumbles a serious accident is possible. A "push-pole" is much safer for it not only keeps the helper away from the saw but also allows him to get more purchase on the tree, while he is also slightly less vulnerable to falling cones and branches.

In felling larger trees which have a contrary lean we have used a long-reach jack with great satisfaction. The jack is of the lever type with a quick return mechanism and it has been used to shift trees of up to 15 inches d.b.h. which have been as much as four feet out of the vertical.

However since chain saw wedges have become available these have been used and the jack has been dispensed with. These wedges are made of aluminium or magnesium alloy and are fairly soft; no harm is done to the chain on the saw if it happens to touch one of them. They can also be driven with the back of the axe, though this is not recommended. They are extremely light and one can be carried in the hip pocket without the slightest inconvenience.

These wedges are made with a thick point, a point not much
thinner than the width of the saw kerf and they must therefore be
inserted into the cut before the tree sits back. Had they the long
thin point of the normal wedge they could not be used with a small
tree because they would reach the chain too easily.

There would seem to be still another advantage in the alloy
wedge; it is easy to melt down and recast. The metal has a low
melting point and even be melted over a fire of pine cones. Casting
is easily done in sand so that when a wedge burrs over, as happens
relatively quickly, it can easily be reclaimed. As even the smallest
wedge costs 10/- or thereabouts this is worth while.

We have found that in falling trees which have to be scarfed it
is frequently better to put the scarf in last and not first as is invariably
done when a hand-saw is used. The back cut is made with the chain
saw, which is then removed and taken away out of reach of falling
debris. The wedges are then tapped in and the scarf put in with the
axe. The scheme makes for safety as breaking tops can be heard
starting on their way down and appropriate avoiding action taken.
When a chain saw is running, is it impossible to hear anything else!

However, other things being equal, the scarf can be put in with
the saw instead of the axe and this is generally quicker. It is not so
accurate, of course, and where a tree has to be carefully felled a few
blows with the axe may be needed to correct any error made with
the saw.

Cross-cutting

Here the one-man chain saw has a very great advantage over the
hand operated cross-cut saw—there is no need to have standing room
on both sides of the log. Logs actually touching can be handled, the
near log being cut with no more than a mark on the bark of the far
one. Another advantage is that should a log pinch, as so often
happens, the saw blade can be withdrawn through the cut as distinct
from lifting it up. The action is the same as when one detaches the
handle of a cross-cut.

When small timber is being cut it will be obvious that some
trouble must be experienced from the saw blade being pinched in the
cut and to get over this trouble the "bow-saw" has been developed.
In the bow saw the chain does not return along the back of the blade
as in the more usual type but is carried over a frame. The bar
which actually carries the chain on the cutting side can thus be made
with a thin back and this greatly lessens the chance of pinching.

Speed of cutting

The speed of cutting depends principally on two things, the power
of the engine and the state of the chain. The one-man saws that the
writer has handled have all been rated at about 4 h.p. and have had
engines of from 90 to 125 cubic centimeters capacity. Most of the
American machines have been of 90 c.c. and in a well designed engine this gives ample power and yet still permits the building of a machine which is light enough to be handled easily. The Danarm saw has an engine of 100 c.c. and the Liner and Jo-bu have been built on to a 125 c.c. English "Aspin" engine. Though the last two use the largest engines they were when tried no faster than the other makes with smaller engines. This was probably due to their using tooth type chains, while all the others had gouge type chains.

Engine power being equal, the speed of cutting then depends on the state of the chain and here two factors have to be considered. One is the sharpness of the cutting edge of each tooth; the other is the depth of cut, or the thickness of the shaving which each tooth removes.

Sharpness is of course a variable factor and just how sharp a tooth can be made depends on the wood being cut. One naturally cannot have a very sharp and thin edge when cutting hard timber and it is finally a matter of experience as to just how thin the edge can be filed.

The depth of the cut or in other words the thickness of the shaving which each tooth removes is regulated by a "rider tooth" which is a projection in front of each cutting edge. It slides along the wood just in front of the cutting edge and regulates the depth of cut of the tooth behind it. Getting just the right amount of cut is largely a matter of experience and in jointing the rider teeth one should proceed with caution. For a start a new saw with a new engine is better run as received from the factory. Later, when the engine is "run in" it may be found that there is power to spare and that the operator finds that he is putting a lot of weight on to the machine to make it cut fast enough. That is an indication that the engine will handle more cut and the rider teeth can be filed down a little. The amount of cut is easily measured by placing a straightedge along the top of the teeth and measuring with a feeler gauge the clearance between the straightedge and the riders. For pine the writer has found that a clearance of .035 inch is sufficient for a new machine but this can be increased to .045 inch or even .05 inch when the engine is run in. About .06 inch is the absolute maximum when cutting pine for the engine is overloaded with a greater cut than that.

Accidents

One criticism levelled at chain saws is that they make so much noise that it is not possible to hear breaking tops and branches. This and the remedy have already been discussed.

Accidents actually inflicted by the chain are in the writers experience infrequent, although it is obvious that a great deal of damage could be done in a few seconds if one fell on the chain while it was running. In this connection the machine fitted with the automatic clutch has a very great advantage for as soon as the throttle
lever is released the engine slows down and the chain ceases to run. Machines fitted with manually operated clutches could still cause bad wounds even though the engine was running at idling speed as it would be doing when the throttle was released.

In addition to accidents to the operator there are also accidents to the machine and these range from such simple things as broken chains to complete destruction by a falling tree or a wandering bulldozer.

On the first chain-saw tried by the writer the chain broke several times on the first day and breakages continued until the chain was taken from the machine and the rivets closed up with a hammer. No trouble was experienced afterwards but it is amazing that such a defect should be allowed to get away from the factory. Actually mending the break did not take long for the makers had thoughtfully provided spare rivets and a small hammer for just such an occasion.

Bent cutter-bars are about the most likely mishap and this is no greater disaster for on the two occasions on which it has happened on our job the bar has been easily straightened in the field with the back of an axe and a tree stump.

A bent bar is a likely result of a tree sitting back and if, when this occurs, there is any danger of the tree coming over on the engine it is better to unbolt the bar from the machine and take the latter out of harm’s way. Then there is only the bar and chain to ruin and this will be found a lot cheaper than smashing the whole machine.

**Buying a saw**

Here there are many points to consider and the most important is not first cost, but rather the unit cost of the article to be produced. If the saw is to be used for felling in hilly country a light machine is essential. Unless it is thinning to waste, speed of cutting is not very important for the felling operation is only a small part of the day’s work. If the machine is to be used for cutting pulpwood at the stump or fence battens or for crosscutting on mill skids a fast saw is more important and one can tolerate more weight. Along with weight goes balance and what we might call “handleability” which is very important from the operator’s point of view. If the operator likes a saw he will take an interest in it and look after it; if he does not like it he will not look after it and it may eventually get smashed by a falling tree, become the victim of a tractor or even fall over a cliff (as has actually happened).

“Handleability” is really the summation of a number of factors—weight, balance, good starting and ease of operating the controls. At 47 lbs. the Danarm was the heaviest saw used and it was too heavy for a man to use for more than about an hour at a time. The lightest so far has been the I.E.L. at 33 lbs. but the 3 h.p. McCulloch is advertised as being only 25 lbs. This last has not been used here and all other machines tried have been between the I.E.L. and the Danarm.
Balance is most important and a saw that has no weight in the blade is tiring to use for one has to force it all the time. There is also a peculiar and possibly dangerous gyroscopic effect when the engine of a tail heavy saw is running. The writer had a very narrow escape from injury when picking up such a machine.

The ease or otherwise of operation is also greatly affected by the position of both the controls and the handles of the machine. Handles placed well apart allow one to manipulate the saw easily and surely but when the grips are close together there is little control.

Starting has already been touched on and there is probably nothing which will make a man like or dislike a chain-saw more than its starting ability. If a saw is starting badly have it sent back to the workshop before the bulldozer gets it.

On machines fitted with automatic clutches there is only the throttle control and the blade swivelling mechanism (if any) to worry about and these controls should be readily accessible no matter what position the saw is in. If the saw is afflicted with a manually operated clutch it should be easy to operate and reliable, staying on or off as desired. One which suddenly starts the chain running when least expected can be very dangerous.

The cost of running a machine then boils down to fuel and oil, which has already been discussed, the amount of time the machine saves (which depends on speed of cutting and ease of operation), first cost and cost of spare parts and replacements.

First cost varies greatly, from not much over £100 for the Danarm to over £229 for the 3 h.p. McCulloch with the I.E.L. at about £145 and the Titan at something like £175 in between these extremes. Dollar exchange of course influences cost for the Danarm is English, the I.E.L. Canadian and the others mentioned are American.

More important than first cost is the cost and availability of parts and replacements for it is no use having a machine held idle for three months while the agent indents a couple of piston rings, as one agent cheerfully offered to do for the writer.

Parts most likely to be needed are chains and sprockets, spark plugs, pistons and rings, cutter-bars, clutch facings, ignition parts and bevel gears in about that order. On some makes parts will last better than on others so there is no rule to follow but it is well worth having a look over the agents stock of spare parts before making a purchase.

So far nothing has been said about the length of the cutter-bar but this of course depends on the size of the timber to be cut. The general idea seems to be to have a cutter-bar somewhat shorter than the diameter of the largest cut which it is expected to make. This saves some extra weight and gives a saw which will handle most of the timber. When a tree which is too large for the bar is encountered it can be side-scarfed with no great trouble. Generally speaking a
24 inch cutter-bar is large enough for a one-man saw and if the timber is so big as to require a longer bar it would be better to buy a two-man machine. There are, of course, exceptions, such as a man working by himself cutting fence battens from logging waste or cross-cutting on a mill skids in pine or tawa, but the rule remains true in general.

To handle the slightly larger timber there has recently been developed in America what are called “intermediate” chainsaws which can be operated by either one or two men. These weight about 50 to 60 lbs. but they are beyond the scope of this article which deals only with one-man chain-saws.

Summary

Variations in design and construction of one-man chain saws are described in detail, and their advantages and disadvantages discussed. Methods of operation are dealt with, and advice is given on the points to be considered when buying a chain saw.

THE INFLUENCE OF ALTITUDE DENSITY OF STOCKING AND EXPOSURE ON THE HEIGHT GROWTH OF PINUS RADIATA IN BEAUMONT FOREST

By C. R. CRUTTWELL

Introduction—Beaumont Forest is situated in South Otago on the eastern slopes of the Blue Mountains, a range of regular shape that runs from north to south. *Pinus radiata* was planted over about 3,000 acres in 1927-28, ranging from 150 feet to 2,050 feet above sea level. The stand of *Pinus radiata* is of interest not only because it is in a locality typical of the zone of transition between the dry extreme climate of Central Otago and the milder and wetter coastal regions but also because it extends continuously from the deep valley of the Clutha River to high exposed ridges.

In the course of a volumetric assessment by the line-plot method it was found that many of the factors influencing height growth are so uniform that variations in height growth could largely be attributed to those factors that are not consistent over the whole crop. Among the factors found to be uniform are the source of seed, date of planting (within 2 years), spacing (8x8 feet), lack of recent thinning, freedom from injury, the mineral constituents of the soil, the steepness of the topography and the rainfall. The important factors that are not