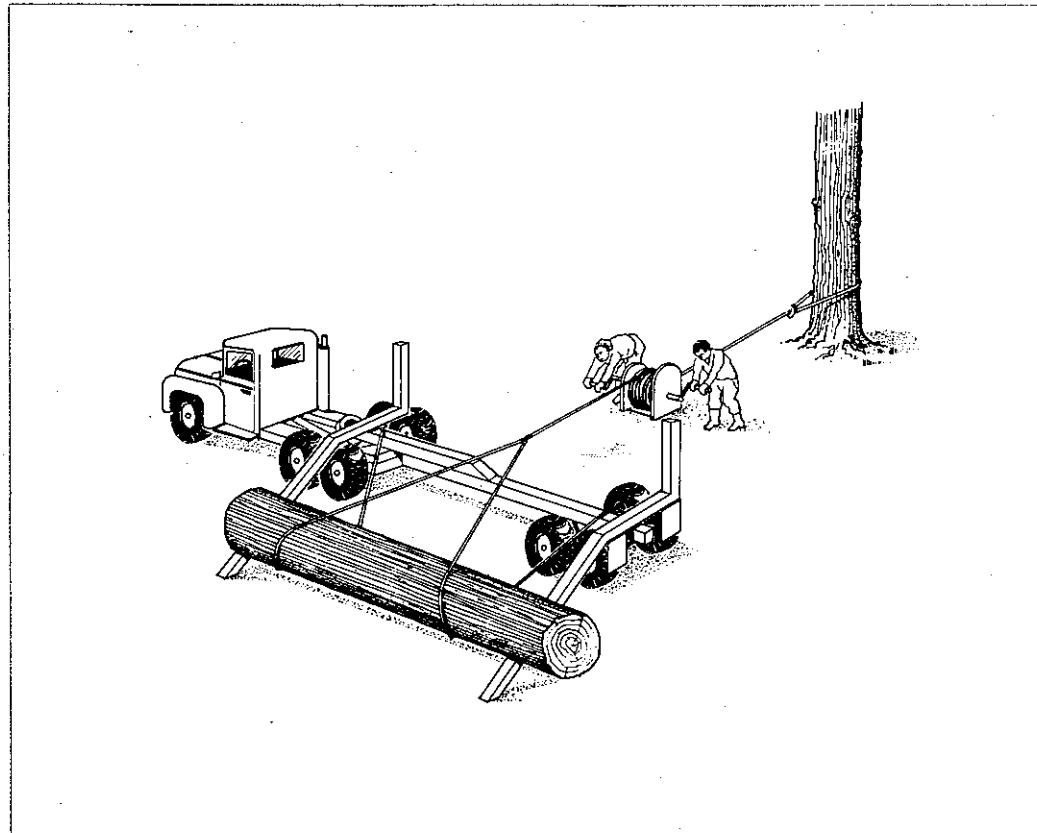
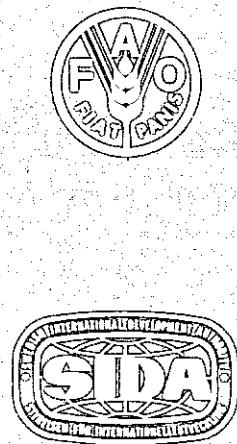


basic technology in forest operations



**FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS**

**basic technology
in forest operations**

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F O R E W O R D

This Handbook on Basic Technology for Forest Operations deals with the manufacture and utilization of tools and mechanisms meant to reduce the expenditure of physical energy and improve productivity in labour-intensive forestry operations.

The aim is to make forest work easier, to promote self-reliance at the community level and to decrease dependence on foreign currency. It is not meant to support or encourage heavy labour-intensive operations.

The Handbook is mainly for the use of forest owners and operators (forest owners associations, independent operators, logging foremen and supervisors); extension personnel (extension specialists, training schools); tool manufacturers (machine shops, blacksmith shops and the like).

FAO attaches great importance to these educational and training activities as a means of transferring knowledge and technology to developing countries.

The Handbook is written in clear and simple language and tries to explain as much as possible through abundant illustrations concerning tool design or use. It is issued in English, French and Spanish.

The publication of this handbook was made possible by a special contribution from Sweden, under the FAO/SIDA Government Cooperative Programme (GCP/INT/343/SWE).

The main draft has been prepared by Ross Silversides, Canada in collaboration with Gunnar Segerström of the Logging and Transport Branch of FAO. Advice has been given by Bernt Strehlke, ILO, Mikko Kantola and Klaus Virtanen, Finland and Jørgen von Ubisch, Tanzania. Illustrations were prepared by Alex Golob, Canada. The draft has been scrutinized by the participants in the FAO/SIDA Consultation on Intermediate Technology for Forestry, held in India from 18 October to 7 November 1981. The Project Leader was Gunnar Segerström, FAO.

I N T R O D U C T I O N

In the course of recent years it has become apparent that forest operations in countries whose development is at the initial or intermediate stage are overmechanized. Machines and equipment much too sophisticated and expensive are often being introduced with far reaching results, mostly negative. Socio-economic conditions as well as low levels of technical expertise in those countries argue against this trend which in fact is the best example of how not to proceed in the transfer of technology.

Two categories of technology exist today: hard and soft (Goulet, 1975). Hard technology is expensive, capital-intensive and complex. Soft technology is relatively inexpensive, labour-intensive, flexible and adaptable to local materials of non-standard quality which can be installed, repaired and maintained by people with modest technical knowledge. This is Basic Technology.

Because most developing countries are in tropical or semi-tropical latitudes, labour productivity tends to be low: dietary deficiencies plus heat stress cannot produce the high energy outputs obtainable through labour in temperate climates. For this reason there have been attempts to replace manpower with machines. But, from a social and economic point of view, displacing workers (bringing in machines) where there is already a surplus of labour, and draining capital resources to provide machines and spare parts is counterproductive. The importation of sophisticated equipment tends to increase the dependence of developing countries on the industrialized world, with serious economic and political implications. This has been described as simply a transformation from domination by foreign colonizers to domination by foreign technologists (Hanlong, 1977).

Pattern of development

There is a pattern of development which most countries have followed in their progression - from predominantly agrarian, through industrialization, to the post-industrial stage. Many developing countries are still predominantly agrarian today, while others are in a transition stage, partly agrarian and partly industrialized.

At this point in their development they might find it useful to profit from the experience of countries which have preceded them in reaching higher stages of development, though in the end they will mostly learn from their own mistakes. We know that early attempts at mechanization were strongly resisted by labour, even though the work of those directly concerned was

made easier. In many cases technological development was used as one more means for one social class to maintain control over another. This is still true, whether the technology is sophisticated or not. In the latter case, small-scale technology is at times believed to lead to "mini-capitalism", going to people who can afford to buy it and not necessarily to those who need it.

Another factor to be considered here is political (Goulet, 1975). As we have seen, alternate technology offers many advantages - from its low cost to the simple and available materials it requires - but above all it is easy to teach, to learn and to apply. But in spite of all this, and the fact that it is cheap and attacks unemployment better than hard technology, it is not widely accepted. Leaders in many developing nations are reluctant to have their countries classified as technologically second-rate.

However, it is necessary to develop and introduce a technology which will enable men to work in a manner and under conditions socially productive and personally satisfying. It follows that man should be in control of his tools or machines. He, not the machine, should be the pace-setter. The technology introduced should "maximize work opportunity for the unemployed and the under-employed", rather than the output per man which is the conventional view. Thus we reach the inherent conflict between what is considered socially desirable and what is considered uneconomic - in short, the conflict between public and private interests.

The utilization of basic technology should not imply that it is a primitive method, as is sometimes believed. Such technology should truly include the best possible scientific knowledge. Let us take a look at some examples: Modern technology has produced hardened teeth on hand saws, teeth that do not require sharpening and, as a consequence, the blade can be used until the teeth are dulled, and then discarded for a new one.

In India, a country that knows the importance of proper design and good maintenance of its equipment, the saw was put under scrutiny (Chandra, 1978). Studies carried out in cooperation with Sweden's Royal College of Forestry showed that work output could be doubled and the energy input reduced by half when using saws well designed and maintained, instead of badly kept saws made of poor steel. This represents a 400 per cent improvement. A similar study was made, comparing the conventional two-man, peg-tooth crosscut saw with a one-man bowsaw: the bowsaw proved to be more efficient by almost 100 per cent.

In earlier times in Finland, bowsaws framed with steel were found unsatisfactory for it was impossible to obtain a suitable tension in the saw blade (Kantola, 1978). But the tension obtained in a wooden saw frame was found to be twice as strong or more, and only when manufacturers strengthened their steel saw frame to comparable tension did the all-steel saw become widely accepted.

Appropriate technology in forestry and the practical applications

Appropriate technology is technology which is most suitably adapted to the conditions of a given situation. It is compatible with the human, economic and material resources which surround its application.

In forestry, the work involved consists of cutting, dragging and lifting in a wide range of combined operations. With larger scale operations which are well financed and managed, it is possible to use fairly high levels of mechanization, but this is not the case with the small-scale highly labour-intensive operations which are the subject of this handbook. The purpose of development in this sphere is to show men how to work smarter not harder.

The five simple machines

All tools or machines can be reduced to one or more of five simple machines which were known to the ancient Greeks who reduced them to a relatively simple formula. The formula is effort \times effort distance = resistance \times resistance distance. The product of effort times effort distance is called work.

The five tools or machines are the lever; the wheel and axle; the pulley; the inclined plane or wedge; and the screw. Simple tools, usable in forestry operations, all fall within one or other of these basic machine types (Figs. 1 to 5).

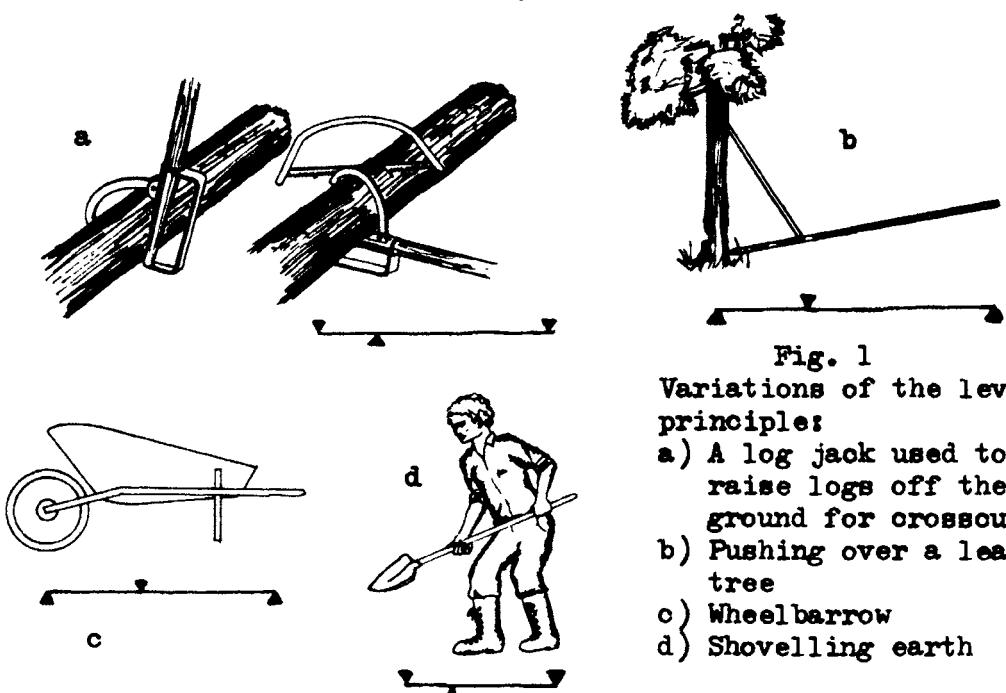


Fig. 1
Variations of the lever principle:

- a) A log jack used to raise logs off the ground for crosscutting
- b) Pushing over a leaning tree
- c) Wheelbarrow
- d) Shovelling earth

It has often been stated that the wheel was one of the earliest inventions of man as it did not occur in nature. It would appear that the wheel had a parallel development, that of the trail or road in which obstacles are reduced to a minimum so that the wheel can roll along with a minimum of effort. The two-man one-wheel waggon is one application of the wheel that could considerably lighten human effort in carrying heavy loads. Rolling friction encountered and the height of obstacles which can be overcome are a function of the diameter of the wheel used (Fig. 2).

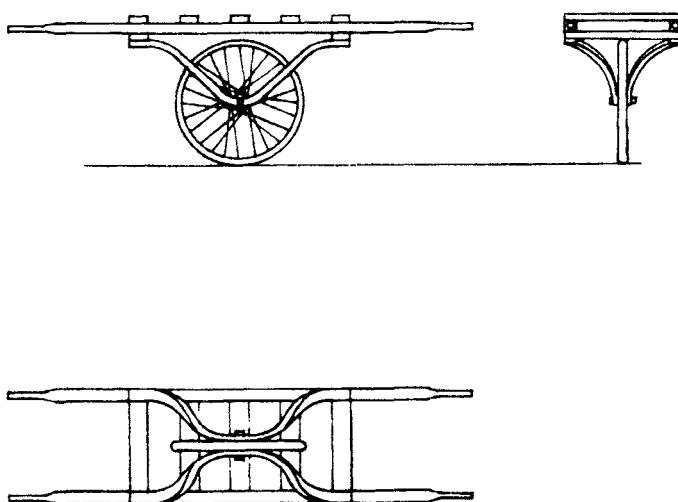


Fig. 2 - Two-man one-wheel waggon

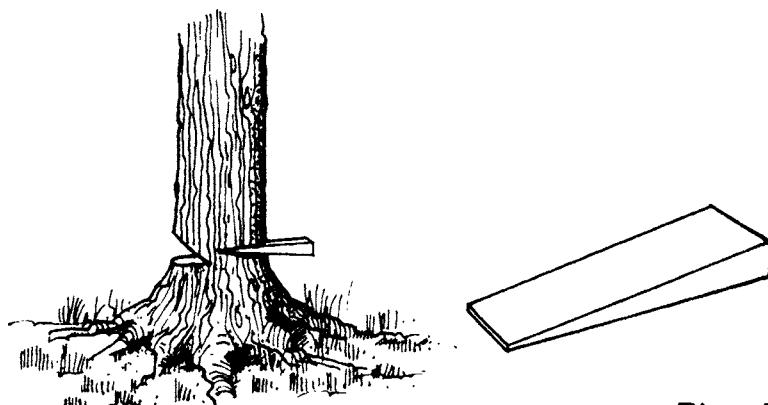


Fig. 3 - The wedge

Wedges are often used in logging, particularly in felling operations (Fig. 3). Their use permits the forest worker to control the direction in which he can fell a tree. If one wishes to determine the force exerted by a wedge, it is found from the ratio between its thickness and its length. Any reduction in force required is accompanied by a reciprocal increase in distance.

Forestry operations may not be in the form of the simple principles but in combinations of the principles in a wide variety of forms. One such possible combination is a simple arched axle mounted on wheels with a device for raising logs off the ground (Fobes, 1951). In this instance a ratchet jack is used, but it could as easily have been a screw type jack (Fig. 4).

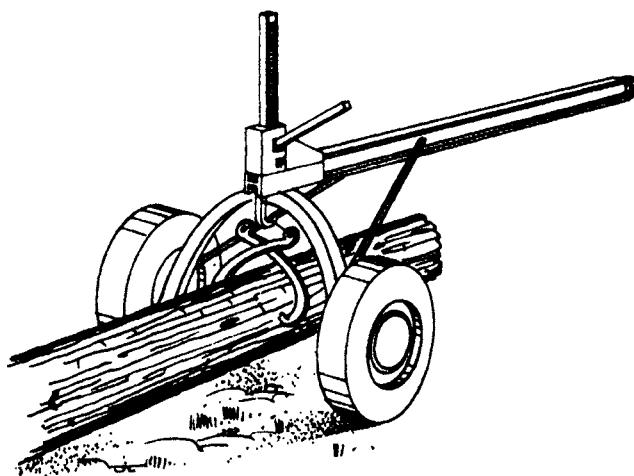


Fig. 4 - The combination of principles, lifting the front end of the log to reduce friction, using wheels to further reduce friction, using the ratchet jack with lever to lift the front end of the log, all illustrate how tools and other equipment develop.

Another example of a combination of simple machines, the lever and the pulley, are illustrated in Fig. 5. This example shows a device which permits a man alone to load logs (Fobes, 1949). The upper end of a log tong has a lever arm with an eye

welded to it and a pulley is attached to the eye. On the lower end of the opposite tong an eye is welded to which a rope is attached. From the tong eye the rope passes through the pulley to the loader operator. A pull on the rope easily unhooks the tongs from the log. This makes possible the elimination of a top loader which is normally a very hazardous task and reduces the danger and difficulty of retrieving a pair of tongs swinging at the end of a loading line.

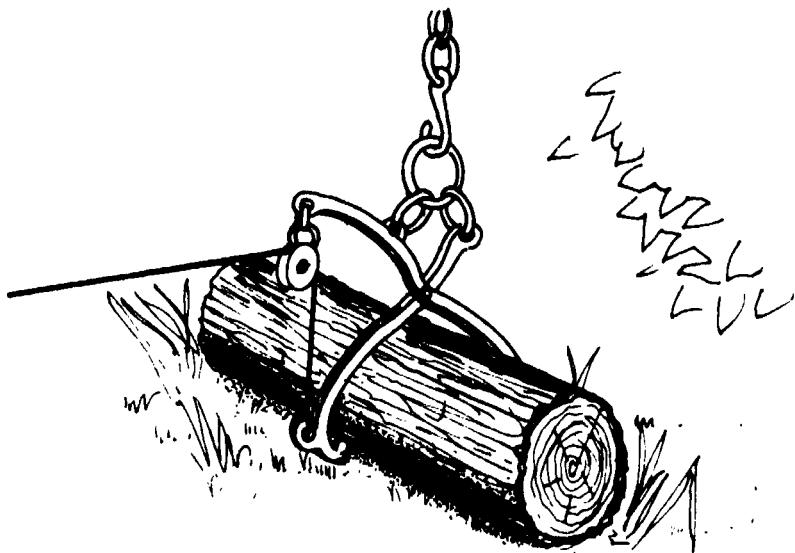


Fig. 5 - Log tong

The force of gravity is another source of energy used in forestry operations which is not often considered consciously. It can be utilized in many different ways for various operations. River driving or timber floating is one form of utilization of gravity. Another means of using gravity is to skid wood downhill over a suspended wire (Koroleff, 1956). From experience, over slopes of 25 to 75 per cent and up to 460 metres in distance, two men can move about 28 m³ per day. This is the poor man's aerial cableway and can be operated with very small wood quantities because it is so portable. Yet another way to utilize gravity is by means of a simple "V" trough, sections of which are made of two boards 4 metres in length, 2.5 cm thick and 20 cm wide. If the gradient is not sufficient, the inside of the boards can be coated with old oil. By banking the chute sections, relatively sharp curves can be negotiated.

CUTTING TOOLS

The axe

The axe has two basic functions, to cut and to split. The axe is a common example of the wedge or inclined plane, one of the five basic machines. The sharp edge of the axe makes the cut and the wedge-shaped head back of the edge follows and opens the cut.

Just when the axehead was fastened to a wooden shaft is unknown in time, but by doing so, the effectiveness of the axe was improved enormously. The extension of the axehead from the fulcrum of the wrist greatly increases the force that it is possible to exert on the cutting edge.

Axeheads

a. Design and application

There are different designs of axes depending upon the use for which the axe is intended. Felling axes, used to chop into tree trunks, require a profile that cuts and wedges. An axe used predominantly for limbing does not require the same tapered profile as the thickened taper which results in a splitting action.

In choosing an axehead, for proper balance, the bit of the axe should be in the arc of the circle having its centre at the centre weight point which is shown just below the centre of the eye. The eye of the axehead is oval tapered towards the blade. Originally axe handles were round but the axe in use tended to turn in the chopper's hand. The elliptical shape of the axe handle which now fits into the oval eye prevents the axe handle from turning in the chopper's hand.



Fig. 6 - Axehead

It is essential in an axe to have not only a sharp blade but also one of proper proportion. When axes are first purchased or made they will have a proper proportion, but as the bit of the axe is sharpened after use, if the blade is not also filed

or ground, it tends to become thick and will not cut properly, and tends to glance off the wood it is cutting. For this reason, when the bit of the axe is sharpened, the blade of the axe should also be filed or ground back for a distance of 75 mm back from the bit.

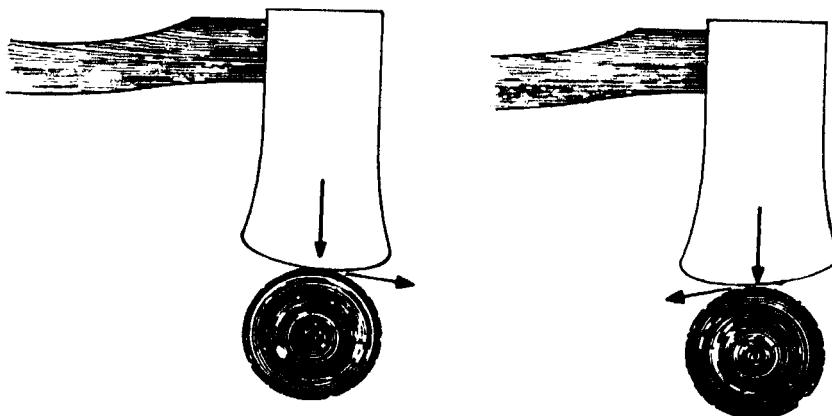


Fig. 7 - Axe blade profile

A splitting axe is normally heavier and wider than a chopping axe. The weight of the axehead should be 1.5 kg and the width of the butt 75 mm. Axes designed specifically for splitting should have a ridge on each side of the head which permits easy removal of the axehead from splits in logs or bolts. The bit of the axe will have a straight edge which should lie in a plane parallel to the handle, and the taper of the axehead is straight. This offers the best wedging configuration for splitting.

Table 1
Optimum weight of axehead

Description	Weight
For small trees and brush	0.7 - 0.8 kg
For large softwoods	0.9 - 1.2 kg
For large hardwoods	1.3 - 1.7 kg
For large tropical woods	1.3 - 2.3 kg

b. Manufacture

Axeheads are traditionally made from two types of steel (Fig. 8). From the heel to the butt the head is made of tough soft steel (1) and the cutting blade is made from high quality carbon steel (2). The soft tough steel can withstand shock loads, pounding and other misuse, while the blade edge or bit of high quality steel will remain sharp under use.

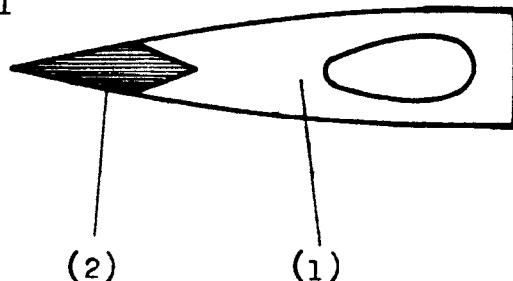


Fig. 8 - (1) Soft tough steel
(2) Cutting blade of high carbon steel

One method of manufacturing an axehead is as follows: (Fig.9)

1. A piece of soft steel is heated.
2. An eye is made towards one end of the block or piece of steel,
3. The opposite end is opened out.
4. A piece of high quality steel is inserted in the opening to form the blade.
5. The soft steel is forged to the blade.
6. The axehead is sharpened and finished off by being hampered and sharpened.

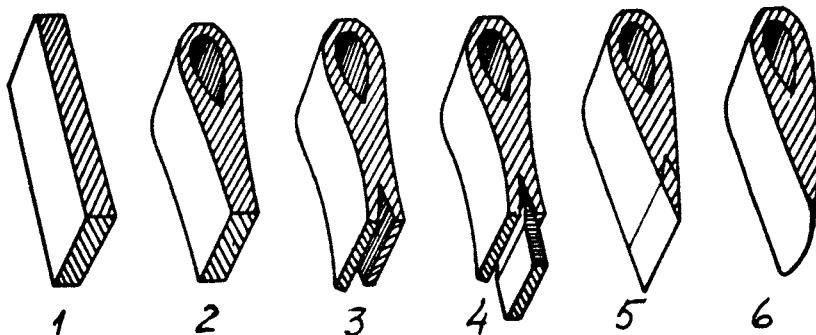


Fig. 9

In the latest techniques in the industrial manufacture of axeheads, all of the axehead is of the same material and the quality is high carbon steel, heat treated under strictly controlled conditions. If possible, commercially manufactured axeheads should be purchased and used because of their quality. However, when this is not possible, good quality axeheads can be produced locally.

Fig. 10 shows how the axehead may be shaped by cutting out the desired pattern on a rectangular piece of iron and heating it and folding it as shown in (1). A wedge of high carbon steel is inserted in the lips of the folded metal (2), then a metal pattern is inserted in what will be the eye of the axehead and the metal is hammered over and around the pattern until the eye is formed (3). Following this the blade and the bit of the axehead are hammer welded.

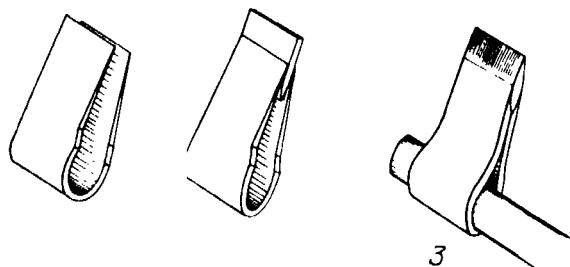


Fig. 10

Another method of fabricating an axehead is to build up the head from pieces of high quality steel (Fig. 11). The different components are joined by welding. The example in question is for a heavy 2 kg axehead made from five pieces of steel. The butt of the axe (1) is made from mild steel 16 mm x 16 mm x 90 mm. It is fitted between the side pieces of mild steel. The sides and the butt insert are ground at an angle and then are welded together. The side pieces are of mild steel 45 mm thick, 89 mm wide and 165 mm long. These two pieces (2) are heated and forged to a long taper. They have holes 2 cm in diameter bored through them (3). When the bit is fitted in place, these holes are then filled with weld and ground smooth.

The bit of this axe (4) is made of tool steel and could be made of discarded headsaw or cutoff saw material. It is 45 mm thick, 140 mm wide and 125 mm long. The tapered sides are welded to the bit and then ground smooth.

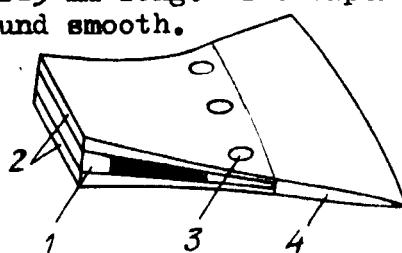


Fig. 11 - Axehead manufactured by welding

After the axehead has been shaped by welding and grinding, it must be annealed, hardened and tempered. The annealing will relieve the stresses caused by welding. The mild steel can be hardened by heating it to a cherry red and quenching it in oil. Then the axehead is heated slowly from the eye towards the cutting edge or bit. When the bit is a dark straw colour, the axe is ready for sharpening.

Fig. 12 shows another means of making an axehead, which is to take a strip of mild steel and to weld a piece of round iron to it at its midpoint (1). The steel strip is heated and bent around the round iron (2). A piece of tool quality steel is inserted between the ends of the folded steel strip, extending some 25 mm back from the ends (3). The mild steel and the tool steel are shaped and hammer welded together and roughly shaped (4). The tool steel bit is shaped and then annealed, hardened and tempered before sharpening with a file (5) and the axehead is finished (6).

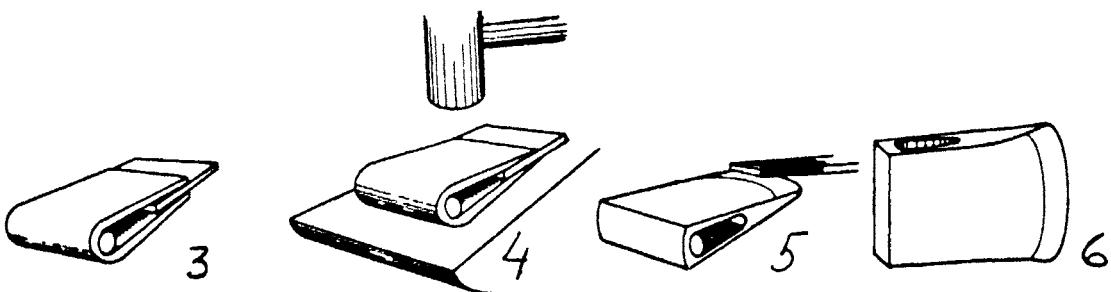
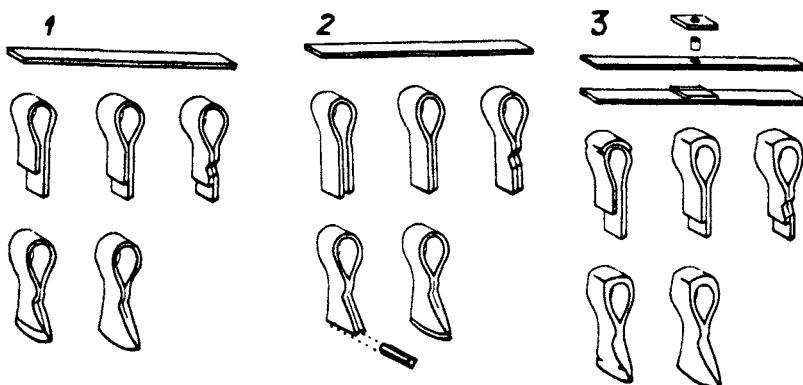


Fig. 12 - Manufacture of axehead

There are a number of variations in the forming and final shaping of axeheads and six different examples are shown in Fig. 13. They are:

- (1) Single piece round headed axe (2) Double piece round headed axe (3) Single piece square headed axe



- (4) Single piece square headed axe
(variation) (5) Double piece square headed axe (6) Broad axe

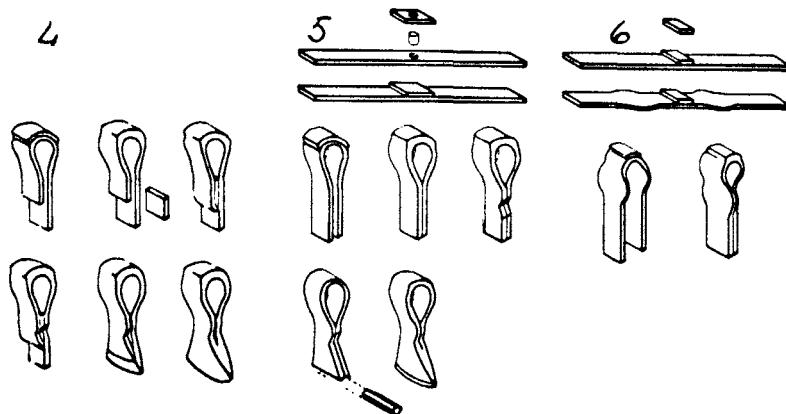
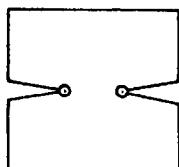


Fig. 13 - Variations in forming and shaping axeheads

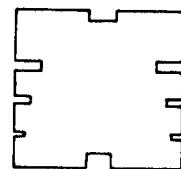
c. Sharpening

It is important to have the proper taper in an axehead and this can be established and maintained by means of a taper gauge. Heavy axes and axes used in cutting hardwoods require a stronger shoulder close to the bit as compared with axes to be used in softwoods only.

A common taper gauge has two openings corresponding to the correct taper of the axe bit for hardwoods and for softwoods. The axe blade must be shaped so that it fits exactly into the right opening (Fig. 14 a).



(a)



(b)

Fig. 14

Another type of taper gauge has three rectangular openings each for hardwood and softwood (Fig. 14 b). The width of the openings corresponds to the correct thickness of the blade, if it is inserted with the bit touching the bottom of the opening. Two further openings are used for checking the thickness of the blade at a distance of 60 mm from the bit. The gauges are made from sheet metal as follows:

Species	Distance from edge - mm	Thickness of blade - mm
Hardwood	1.5	1.0
	5.0	2.0
	10.0	3.5
Softwood	2.5	1.0
	5.0	2.0
	10.0	3.5

d. Grindstones

Tools are sharpened by wearing away the metal with an abrasive grit. A coarse grit wears away the metal much more rapidly than a fine grit (Fig. 15). The grit actually wears away metal, producing a sawtooth-like edge with teeth matching the size of the grit, coarse grit produces a rougher edge than a fine grit.

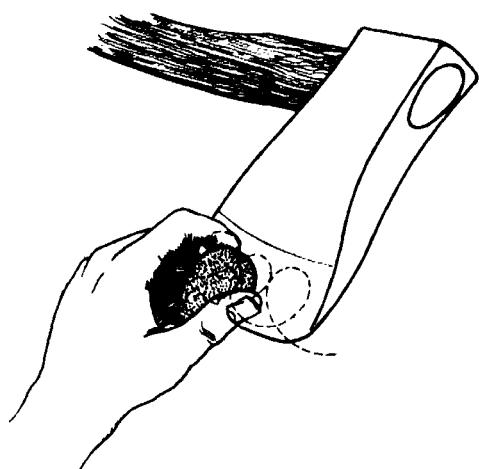


Fig. 15 - Sharpening axe
with whetstone

Sandstone is a commonly used form of grit and it can be shaped into circular grindstones or oblong flat sharpening stones. Water aids in sharpening and tends to prevent the pores in the stone becoming clogged with minute particles of steel. The use of water tends to keep the tool being sharpened cool and prevents its temper from being drawn (Fig. 16).

When sharpening an axe, a file may be used. The blade should be thinned back for some 6-8 cm from the bit. If available, a wet, slowly-turned grindstone should be used. A coarse file leaves the surface too rough, while an emery wheel is liable to heat up the bit and draw the temper of the blade. When grinding, the axe-head is moved backwards and forwards. The stone is turned towards the bit of the axe. The grindstone may be kept wet from water in a tin suspended above the stone or it may be moistened by passing the stone through a reservoir of water. The water container may be made of wood, tin, or even part of an old discarded tyre. The tyre is shown in Fig. 17. It is nailed inside of the opening in the sawn or hewn plank which forms the sharpening stone stand.

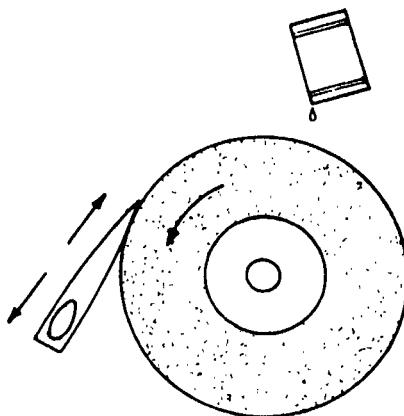


Fig. 16 - Sharpening axe
on grindstone

It is important not to leave the stone standing in water as the stone will tend to soften and wear away more quickly than the remainder of the stone, so that the stone becomes worn out of round.

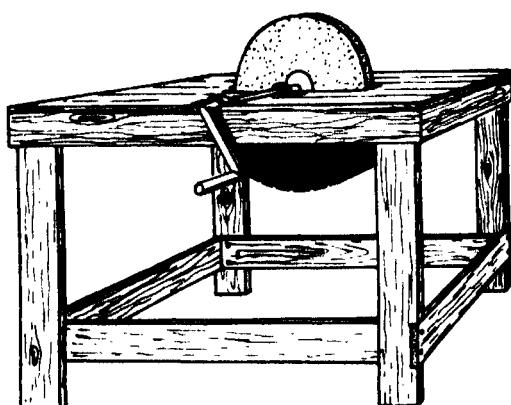


Fig. 17 - Use of discarded tyre
as water container

It is considered that a narrow grindstone is the most efficient, perhaps 6 cm in width. With a narrow stone less pressure holding or forcing the axe against the stone is required. The axe is held crosswise to the stone

when grinding (Fig. 18 a). If the axe is ground with the bit parallel to the face of the stone (Fig. 18 b), it will tend to gouge out the stone creating a rut so that the axes cannot be ground properly.



Fig. 18 - a) Proper method of sharpening axe
on a grindstone b) Wrong method

A means of increasing pressure of the axehead on a grindstone is by using the lever principle with the fulcrum being a nail-studded board fastened to the back of the grindstone against which one end of the lever is pushed (Fig. 19).

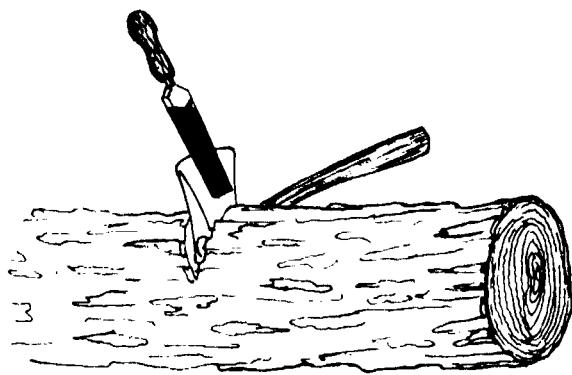
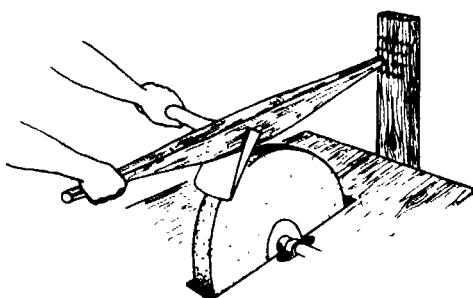


Fig. 19 - Method of increasing pressure of axe on grindstone

Fig. 20 - Method of sharpening axe in woods

To sharpen a single bitted axe, when working in the woods, a means of holding the axehead is essential. An acute angled notch, about 30° , is chopped in a log or felled tree. The notch should be wide enough to accept the axe butt. This should hold the axehead steady and permit working on it with a file or sharpening stone (Fig. 20).

Care must be taken to maintain grindstones in good working order as a worn or chipped stone is dangerous to use and men are

unwilling to work with it and tend to use a file instead. Stones should be kept free from grease and oil and should not be left standing in water when not in use. Grindstones may be turned by hand or can be powered by a bicycle (pedal power) or driven by a small motor where electricity is available (Fig. 21).

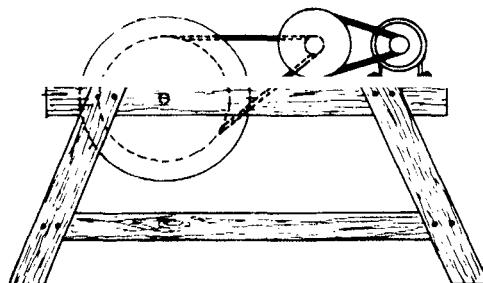


Fig. 21 - Electrically driven grindstone

e. Files

Most files today are manufactured and are not hand made. However, files can be made and a brief description of their manufacture is shown in Fig. 22. A piece of file steel is rolled out in the shape of a file. The metal is placed in an annealing oven at a red heat and allowed to heat slowly for a period of several days. The metal is then soft enough to work with. The file blank is laid on the top of an anvil and held in place by a strap across it with the ends on the floor and it can be held down by stepping on the ends of the strap. The file cutter uses a chisel with a blade wider than the blank. The chisel used to cut the file grooves is held at an angle which gives a cut of approximately 55 degrees from the perpendicular, and the angle of the chisel making the cut is 25 degrees from the axis of the file. The purpose of the chisel is to indent the steel, not to

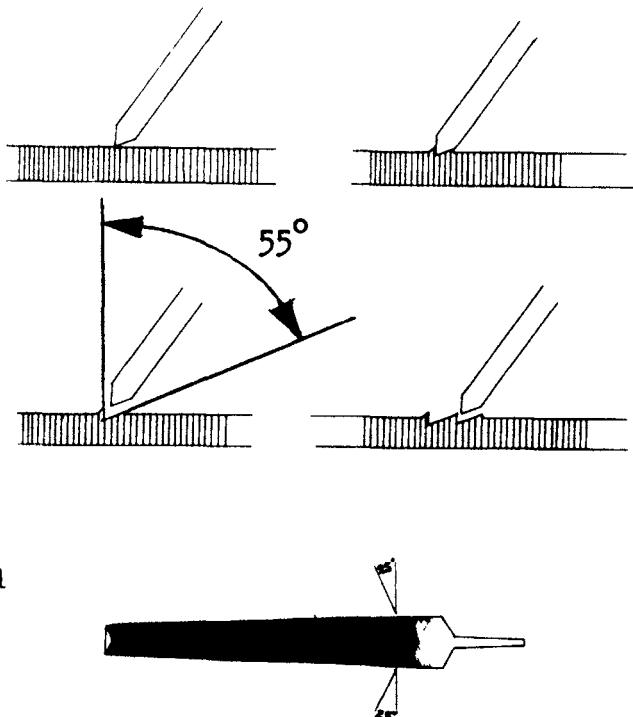


Fig. 22 - Manufacture of file

cut a tree, and therefore the cutting edge is usually slightly blunt. The file blank is kept well greased or oiled at all times. A skilled file cutter can cut the file teeth at the rate of about 60 to 80 blows per minute.

Cutting blanks by hand tends to bend the blank slightly and it must be straightened out after hardening. The file is coated with a paste to prevent the teeth from oxidizing while being heated and the files are then put in the forge and heated to a cherry red and cooled suddenly in brine for hardening.

Axe handles

a. Design

There is a considerable variation in axe handles, from straight round handles for tools used in working in two directions, such as a splitting axe, or a double bitted axe, to oval curved handles recommended for felling and branching axes.

The choice material for an axe handle is hard-wood, high in elasticity and strength, taken from the butt end of a young tree or from the outer zones (sapwood - Fig. 23) on an older tree. The wood should be well seasoned and free of knots. The portion of the billet from which handles are produced should be chosen with care so that the grain will be straight and run parallel to the axis of the handle.

Straight grain wood is strong while cross grain wood is weak, as is face grain which has a tendency to warp (Fig. 24).

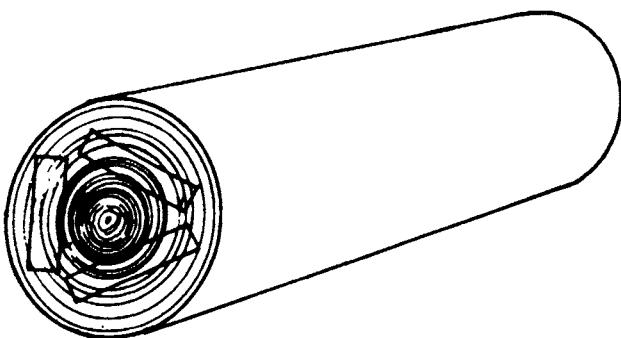


Fig. 23 - Selection of axe handle blanks



Fig. 24 - Effect of wood grain on axe handle

An axe handle for chopping and branching axe weighs about one kilo. Its length should be between 70-80 cm and the length of the handle in relation to the user should equal the distance from the cutter's armpit to his fingertips, or from his hand to the ground when placed at his side while standing erect (Fig. 25). For tropical woods normally longer handle is required.

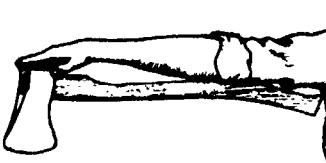


Fig. 25 - Proper length of axe handle

When a piece of seasoned handle stock has been selected, the template of the axe handle is laid along it to obtain the best direction of grain. The outline of the handle is traced onto the piece of handle stock. The shape of the handle can be copied from an existing handle or it can be made according to the following measurements. The measurements given are for two types of axes - the smaller general purpose axe for chopping and limbing and the heavier slightly larger splitting axe.

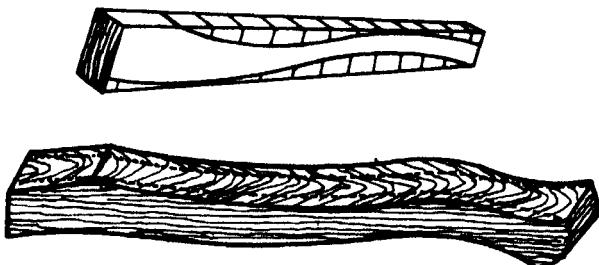
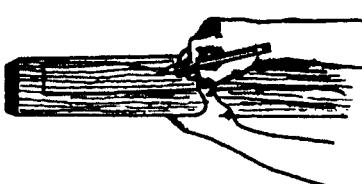


Fig. 26 - Shaping of axe handle

The pattern made from a thin piece of wood is held against the board and its outline traced on the board (Fig. 27).

The handle stock is cut with a bowsaw to follow the shape of the pattern and a chisel and mallet are used to cut away the excess wood.

The handle blank is shaped in one direction, then the upper figure is traced on it and the saw cuts are again made to trace out the handle pattern.

The handle is rough shaped with a chisel and mallet or by means of a sharp axe. The final shaping is done with a spoke shave or a wood rasp and the fine finish is given by scraping with a piece of broken glass and then rubbing down with fine sandpaper.

A vise is of great assistance in making an axe handle. Such a vise makes it simple to work on the handle as it leaves both hands free for the work (Fig. 28).

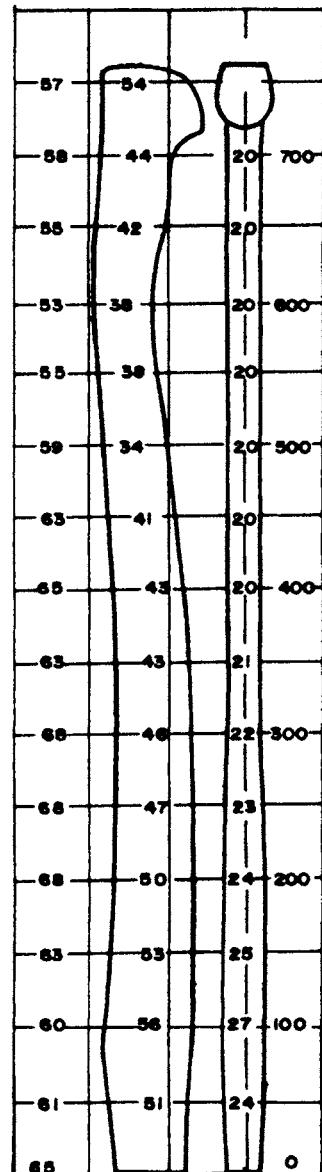
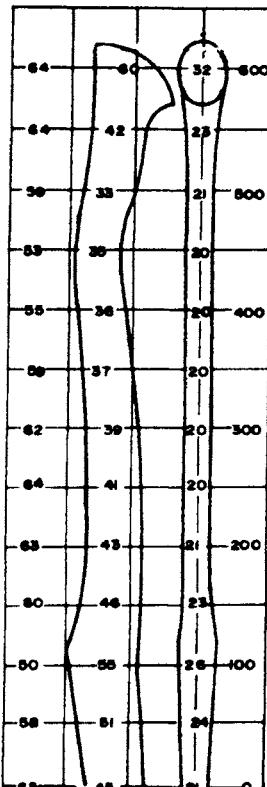


Fig. 27 -
Templates for
axe handles.
Measures
in mm.

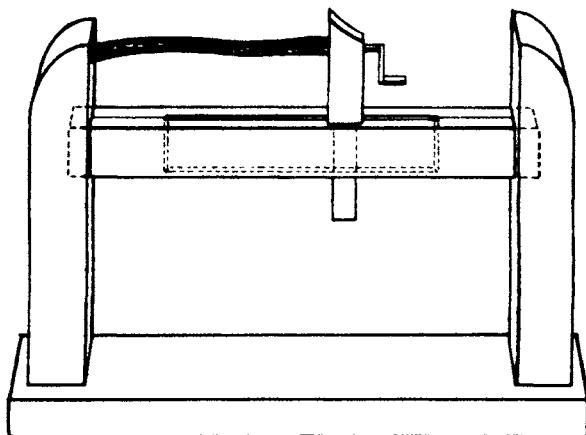


Fig. 28 - Vise for
shaping axe handles

b. Hanging new handles (Fig. 29)

1. The front end of the axe handle is shaped and fitted into the eye of the axe with a drawknife and wood rasp. The head should rest on the shoulder of the handle, with the end of the handle protruding from the eye of the axehead.
2. The handle is inserted into the eye of the axe and the axe is tested for alignment and "hang". The line of sight should pass through the toe and heel of the axehead and through the knob of the axe handle.
3. Remove the handle from the axehead and make the wedge slit with a thin saw blade.
4. Cut a wedge shaped piece of hardwood.
5. Assemble axe handle and head and drive in wedge.
6. Test again for alignment. The test for proper hanging is by placing the axe on a level surface and, if properly hung, the bit will rest at its centre.
7. Remove excess of handle from top of axehead.

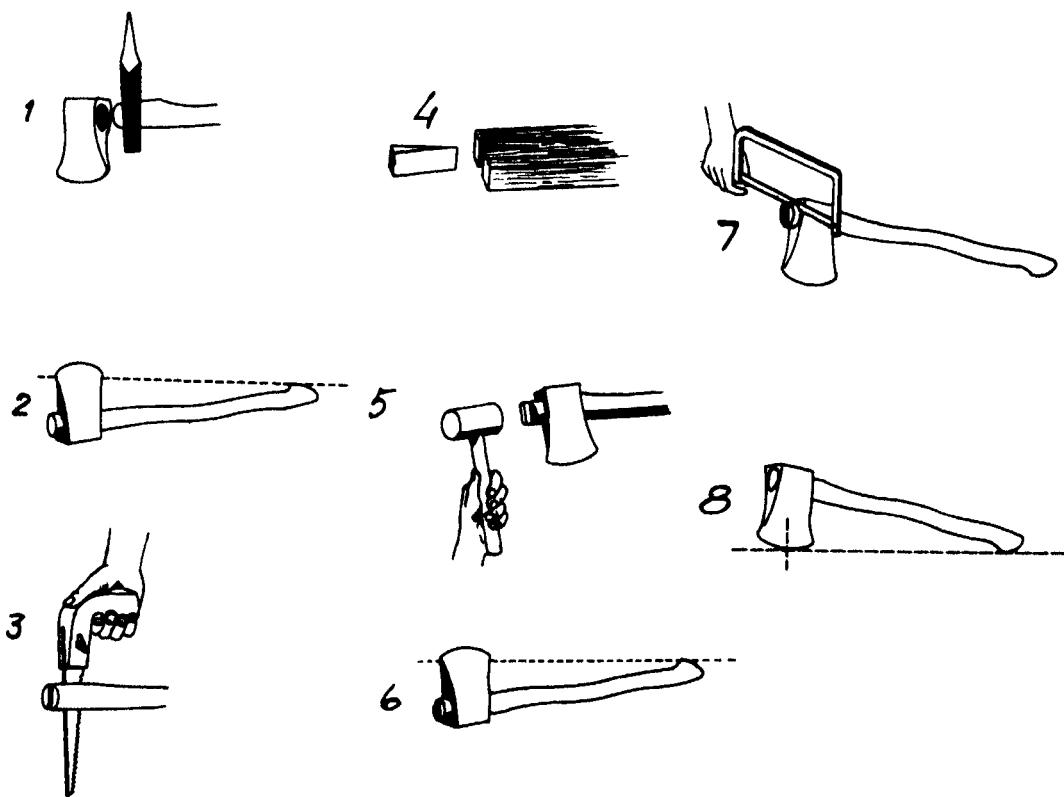


Fig. 29 - Hanging new axe handle

The wedging of axe handles in the eye of the axe serves to hold the head in place. If the handle is allowed to dry out, the wood may shrink and the head loosen. This may be remedied by soaking the axe in water for a short period so the wood will absorb water, swell, and tighten the handle onto the axe head.

The wedge may be cut out of a piece of hardwood. It is driven into the handle. Before it is fully sunk, incisions should be made with a knife on both sides. Then when the wedge is fully driven in, it can be broken off below the level of the end surface of the handle. Later the wood of the handle will tend to swell over the end of the wedge and hold it firmly in place.

Sometimes a second wedge, small and made of steel, is driven into the axe handle at right angles to the wooden hardwood wedge.

The end of the axe handle is split with a chisel or axe. If considered advisable, the handle of the axe can be softened in hot water for 20 to 30 minutes. One wedge or two may be used.

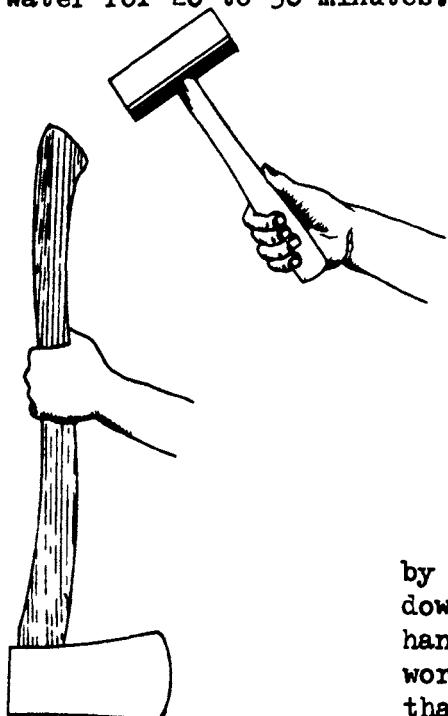


Fig. 31 - Fitting axe handle into eye of axehead

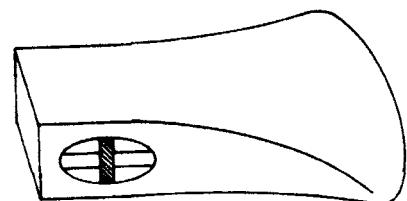


Fig. 30 - Axe wedge

Wedges should not be allowed to penetrate the handle below the depth of the eye of the axehead. The wedges are inserted in the split and with the knob of the axe handle on the ground or a hard surface, holding the wedge in the hand, the wedge is cautiously driven down into place. When the wedge is inside the handle wood it is hammered tight.

Usually in the process of hanging an axe, tightening the axehead onto the handle is done by holding the axe in the air upside down and hitting the knob of the handle with a mallet. This action works because the wood is lighter than the axehead and when hit it accelerates more rapidly than the axehead so the wood penetrates the

eye of the axe. Tightening can be continued until the head reaches the shoulder (Fig. 31).

c. Replacement of handles

The breaking of axe handles is an occupational hazard when working in the woods. It creates problems because if the head is tightly wedged onto the handle, it is extremely difficult to remove so that a new handle may be inserted.

Frequently the remaining portion of the axe handle is cut off almost flush with the axehead and then the remaining wood is burned out. This is not recommended for common usage because of the danger of destroying the temper in the bit of the axe. However, if suitable care is taken it can be done successfully. A quick method might be to bury the blade of the axe in a pail of damp sand to protect the bit and to burn the wood out of the eye with a blow torch (Fig. 32).

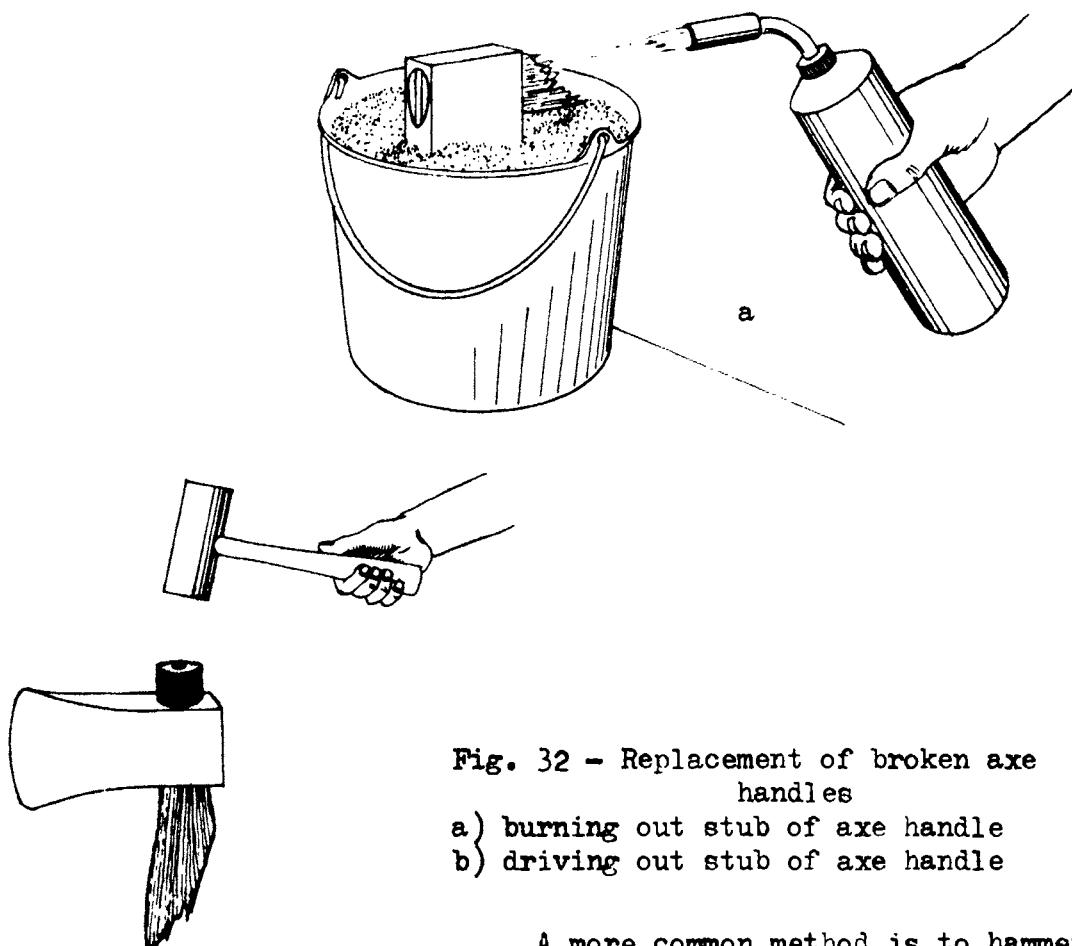


Fig. 32 - Replacement of broken axe handles

- a) burning out stub of axe handle
b) driving out stub of axe handle

A more common method is to hammer the handle stub out of the eye of the axehead.

Saws

Crosscut saws

Sawing is one of the major operations in timber harvesting. Saws are used to fell trees as well as to cut them into bolts or log lengths. Saws replaced axes for these operations because the use of axes resulted in too great a wastage of wood.

A main requirement for efficiency in sawing is the use of long, properly timed strokes. When bucking wood with a one-man saw the saw strokes should be at least three quarters of the length of the sawblade, preferably longer. Long strokes keep the blade in good working order longer. With short strokes the section of the blade mostly used dulls quickly and the set of the teeth on that section becomes less than on the rest of the blade and this difference increases saw resistance in the cut.

When felling or bucking with a two-man crosscut saw it is essential that the blade is not pushed by either worker. This action will cause the saw to buckle and bind in the cut.

An important factor in getting maximum productivity with a minimum of effort in sawing is in developing a working rhythm, a long steady reciprocating stroke. The pace established with a two-man crosscut saw should suit the stamina of both workers. With a one-man bowsaw, good rhythmic cutting with long strokes will result from 60 to 65 double strokes per minute. A faster rhythm than this would tire a worker rapidly and usually results in shorter, less efficient strokes.

It is helpful if one has a good understanding as to how a crosscut saw cuts (Fig. 33). It gives purpose to caring for the saw, its sharpness, and the relation of the cutter teeth to the raker teeth. The most widely used crosscut saws today have four cutter teeth (1), a raker tooth (2) and four cutter, a raker tooth, and so on over the entire length of the sawblade. The cutting teeth are bevelled alternately so that every second tooth scribes the wood being sawn on the opposite sides of the cut. They have the effect of two chisels, each slicing a side of the cut. The raker teeth act like the blade of a plane and peel off cut fibres and collect them in the sawdust gullet and carry the sawdust out of the cut.

Where timber is large in diameter, the gullets should be large to carry the shavings out of the cut and to prevent the saw

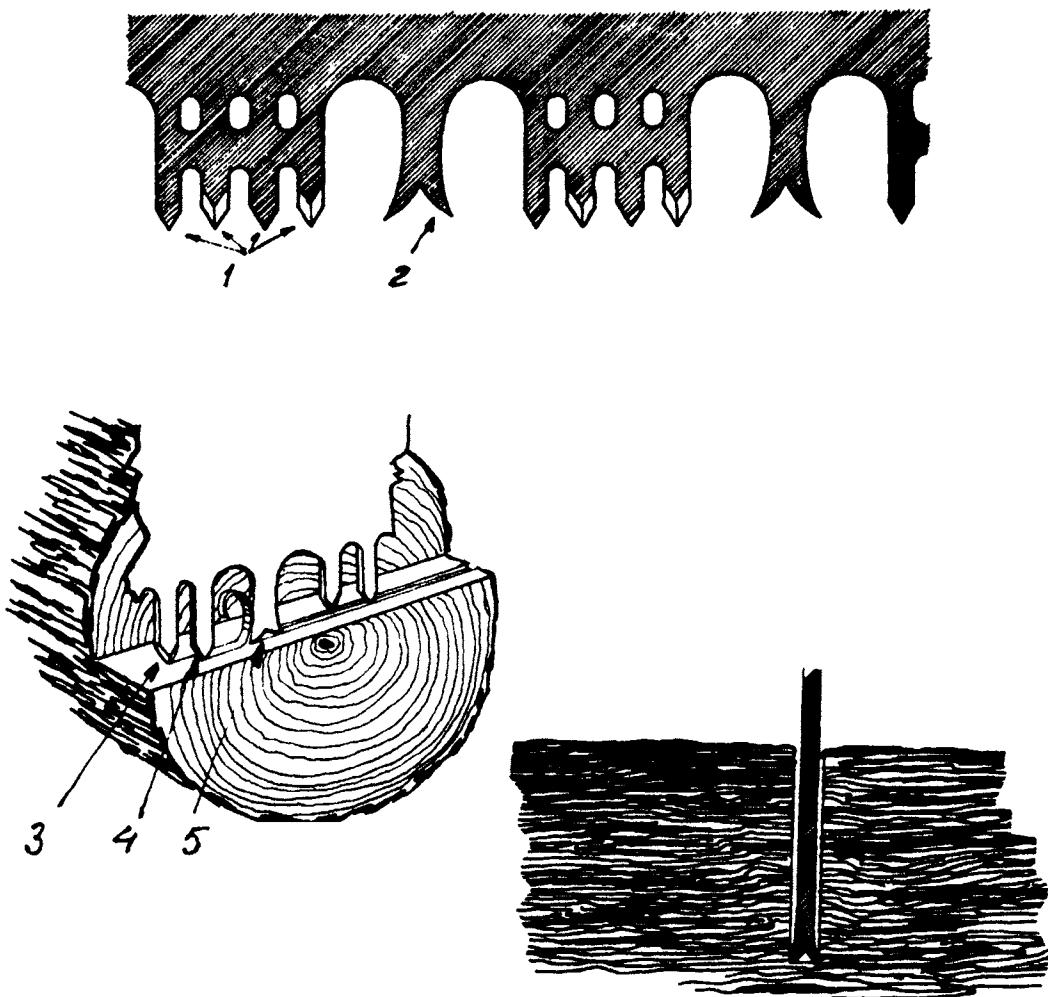


Fig. 33 - Action of various teeth of crosscut saw

from binding. Sawtooth (3) scribes the surface, sawtooth (4) on the opposite side of the cut scribes the surface and the raker (5) cuts out and removes the wood between the two scribed lines. The relation between the raker and the cutters must be maintained because if the raker teeth are too short, too little wood is removed and there will be considerable friction between the cutter teeth and the unremoved wood. If the raker teeth are too long, too much wood is removed and the raker has to plane through uncut fibres which requires considerable energy.

The relation between the cutting teeth and the raker teeth depends upon the fact that the cutting teeth tend to compress the wood as they cut and this wood springs back after the teeth pass over it. As a result, wood fibres are not cut as deeply as the teeth penetrate. The rakers following the cutter teeth must be shorter by the amount that the wood springs back so that no unsevered wood is removed.

The depth of raker below the points of the cutting teeth will vary with type of wood, its moisture content, etc. A good average figure would be 0.30 mm and this could be modified up or down from experience.



Two basic crosscut saw patterns are recognized, saws for felling trees and saws for bucking felled trees into logs. Felling saws have a concave back and are narrow from teeth to back to facilitate wedging a cut in behind them. They are flexible and usually are tapered. A tapered saw is narrower at its back than at its cutting edge. This reduces the tendency for the saw to bind in its cut and tapering the saw from front to back of blade also means the saw requires less set than would otherwise be the case.

Fig. 34 - Action of cutting tooth of crosscut saw

The one-man curved handle crosscut saw used in China is a highly efficient tool to be used for felling and crosscutting of soft- and hardwoods.

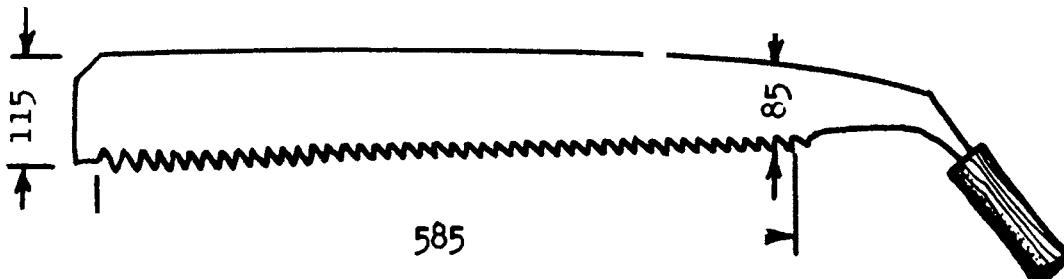


Fig. 35 - The Chinese one-man curved handle crosscut saw

Blade length:	500 to 600 mm	
Blade thickness:	at teeth	1.5 to 2.0 mm
	at back	1.0 mm
Width:	about	60 to 120 mm

This one-man curved handle saw is made of good quality e.g. high carbon steel. It has a curved handle which is not parallel to the saw blade. When operated the pull strength can be divided into 2: one parallel to the blade producing cutting work, the other vertical to the blade, producing infeed work. This results in a high efficiency. Due to the short length of the blade, it is very convenient and can be easily carried into the forest. Finally, its maintenance is simple due to the uniform teeth.

a. Crosscut saw maintenance

The device usually used to ensure that all the sawteeth are of a uniform length is called a jointer (Fig. 36). These are usually purchased tools from saw manufacturers but can be readily made by a forest worker or village blacksmith.

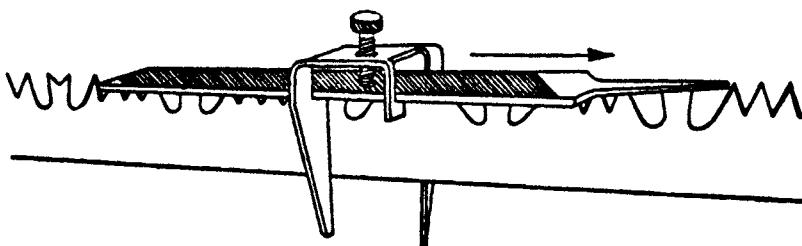
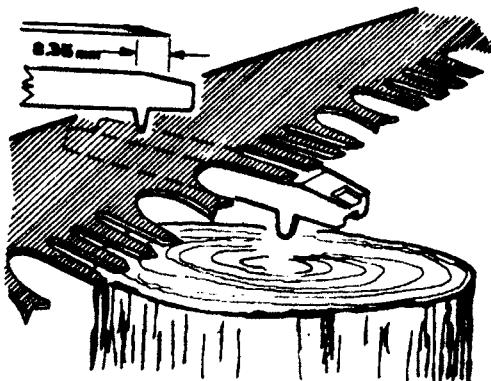


Fig. 36 - Simple small steel jointer for levelling the teeth



The commercial model of a jointer is made of high carbon steel. The surface of the raker adjusting cut is hardened. It must be harder than a file as the file rests on it while filing down the rakers. The tools look simple, but must be made with great accuracy.

There are two basic methods of setting saw teeth, spring setting and hammer setting. Hammer setting is recommended for crosscut saws while spring setting is used almost exclusively for one-man

Fig. 37 - Saw set for crosscut saw

bowsaws. Spring setting is not recommended for crosscut saws because of the possibility of bending the whole tooth and not just the tip, and because such teeth do not seem to hold a spring set well.

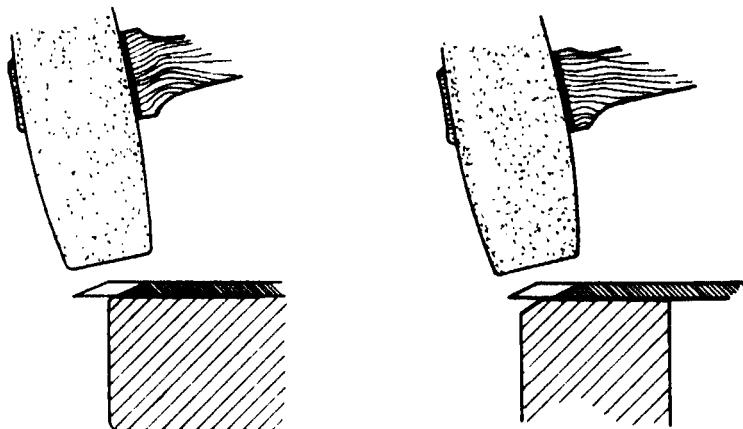


Fig. 38 - Hammer setting of crosscut saw tooth

Two approaches to setting a saw are to use a setting stake or a hand anvil. The latter is recommended as being more flexible and easier to work with.

The degree of set in saw teeth is variable from almost zero in dry hardwood to 1 mm in very soft wood. A set of 0.25 mm is an average set. The slope of the bevel on a setting stake should be approximately 30 degrees which will permit a maximum set of 0.50 mm.

When working with a 1½ - 2 m long crosscut saw, the use of the stump mounted setting stake is awkward for one man but good when two men working together can hold the saw and hammer set its teeth.

The other method for setting the cutting teeth of a cross-cut saw is with the use of a hand held anvil. The setting hammer should have a small face to permit striking one sawtooth without interfering or touching the teeth on either side of the tooth being worked on. The hand anvil should be a piece of steel weighing about one kg with a flat face. A piece of axle or shaft 3.75 cm in diameter and 12.5 cm long will serve the purpose. There does not have to be a bevel on the face of the hand anvil as there is on the setting stake, although this is practical.

b. Saw filing devices

A practical device used for filing crosscut saws on the job is a tree stump from a less valuable tree, cut off at elbow height

(Fig. 39), for convenient saw maintenance. A vertical and an oblique cut are made into the flat surface of the stump. The saw is held in the cut, inverted, by using small wooden wedges.

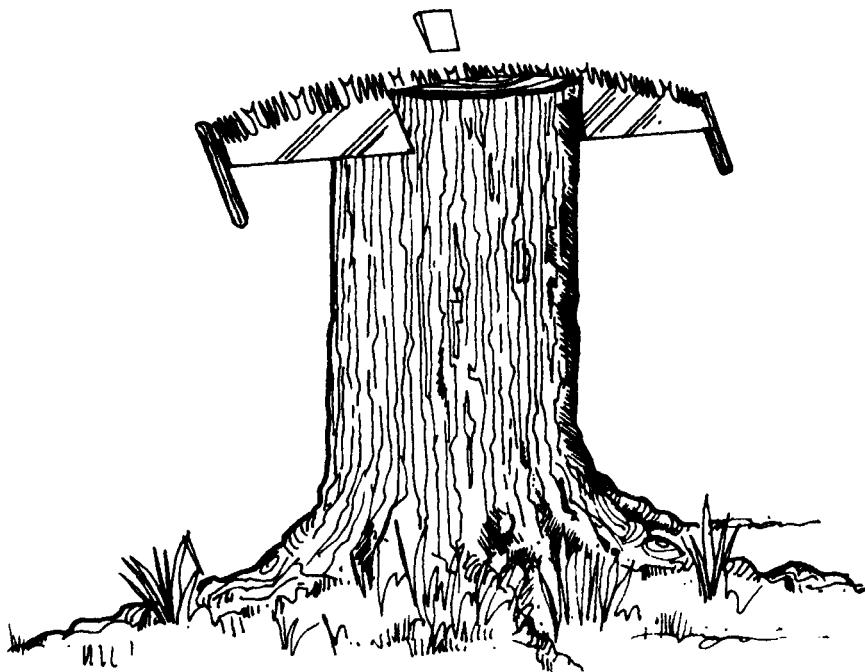


Fig. 39 - Stump vice for filing crosscut saw

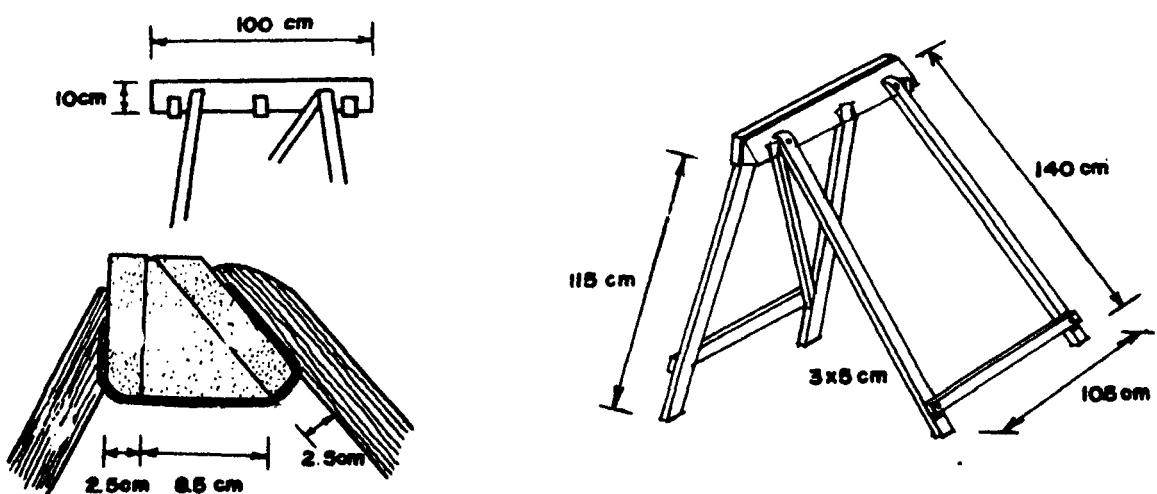


Fig. 40 - Portable wooden vice for filing crosscut saw

A portable wooden vice is often used by experienced loggers. This vice is built of two boards enclosing a wedge-shaped central piece and connected by three leather straps. Four wooden legs are screwed onto these boards and when erected the saw is held between one of the two boards and the centre piece in either a vertical or an oblique position. Hardwood is normally used for the clamp, while the legs are of lighter softwood. This vice can be used for both two-man crosscut saws and bowsaws.

c. Crosscut saw handles

Patented type handles are often sold with saws. If, however, this is not the case, there are a number of simple methods of attaching handles (Fig. 41). In (a) a flat piece of metal is shaped around a metal or wooden form (1), the size of the handle (2) to be used. The metal is flat for 3 cm and this section has holes drilled through it to receive the bolts which fasten the handle to the sawing blade (3). The ends of the metal (4) are bent at 90 degrees to add stiffness and strength to the bracket.

In (b) the handle is entirely of wood, shaped for a two-handed operation with a grip for one hand and a vertical rod for the other. A slot is cut into the handle (5) and the saw blade is inserted and held in place by three bolts. In (c) the bracket for holding the handle is a piece of flat metal shaped and fastened to the saw blade with two bolts. The pointed shape of this bracket adds stiffness and support.

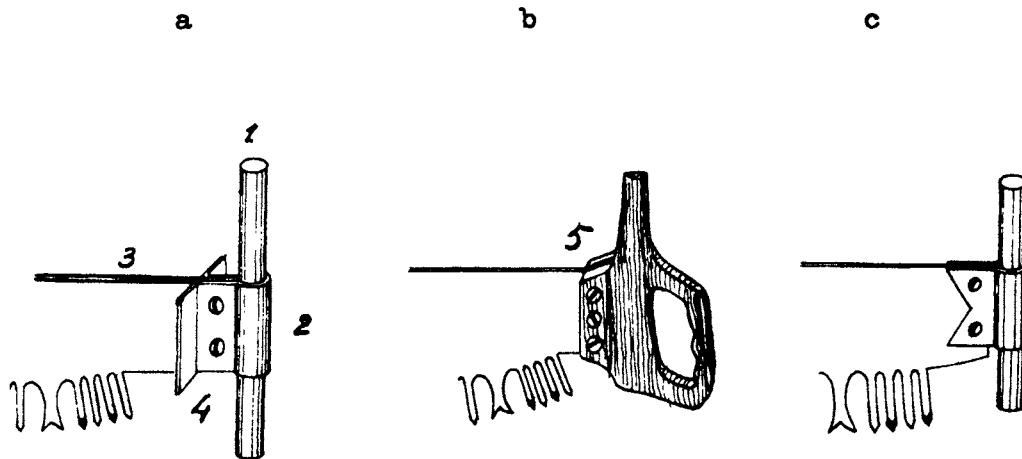


Fig. 41 - Various types of crosscut saw handles

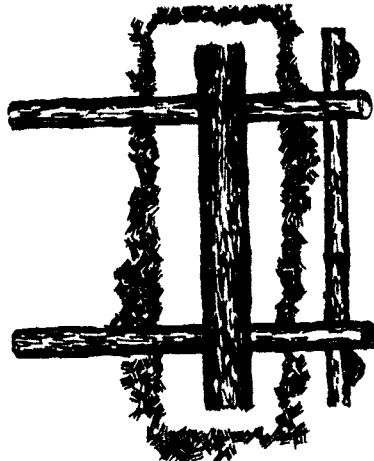
Pit sawing

The reduction of logs in the forest to squares or to planks is not uncommon in lesser developed countries. It is a frequent operation in the forest, where labour-intensive work is desirable or where there are no roads and the resulting timbers are carried out of the woods manually or by animals over long distances to where road transport is possible.

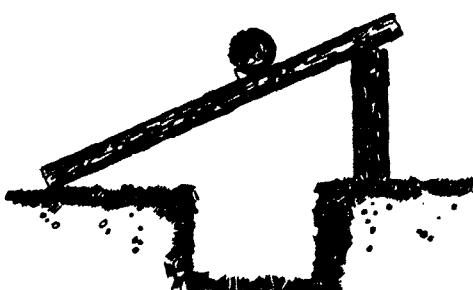
Pit sawing is what generally the name describes (Fig. 42). A log framework is built over a natural gully or washout, or a trench is dug in the soil about 75 cm deep. The size of the trench, width, length and depth, will vary with the height and disposition of the framework over the trench. The trench dimensions depend upon the size and technique used by the lower man in pulling the saw downwards.

The same technique can be used without utilizing pits by means of making a scaffold high enough for the tower man to work below the log.

The framework of the saw deck can consist of two sloping logs, up which the log to be sawn is rolled. When the log is in position over the pit, it is wedged in place to hold it static, to prevent its rolling back down the skids. Sometimes the slanting skids are notched at the point above the pit.



Once the log is in position, an opening cut on it is made. Sometimes the bark on the log is chipped away along the general line of the proposed first cut. A chalk line, which is cord coated with chalk, lead black or other colour, is laid along the log to give the desired line for squaring. The manner in which this is done is to lay the cord along the desired line, hold it tautly to the log at each end, lift it in the centre and let it snap back along the log. It will leave a linear mark accurately along the log for the sawyers to follow.



Depending upon log size and wood density, the production of the pit saw producing squares varies from one to three logs per

Fig. 42 - Sawpit

day. The temperature of the day has a dominant effect upon output, as human effort and corresponding output rapidly decrease with an increase in temperature. Shade should therefore be provided.

The saw used in pit sawing is quite different from the conventional two-man crosscut saw, which of course is designed to cut across the grain of trees. It has no raker teeth and very coarse peg teeth which are sloped towards the bottom end of the saw.

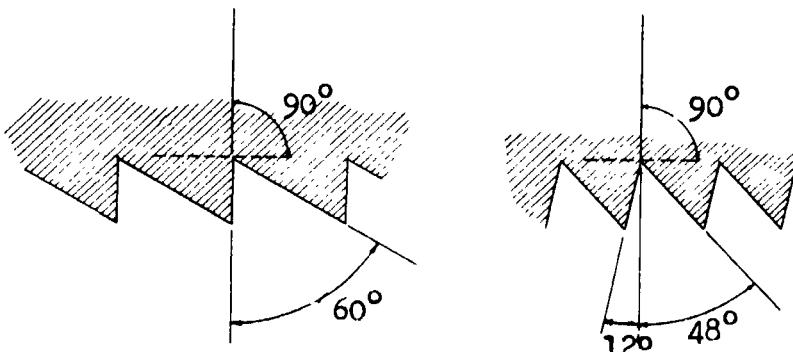


Fig. 43 - Pit saw teeth

Two men are required to operate a saw. One man stands on top of the log and the other in the pit. Working in these two rather awkward positions, the two men laboriously cut off slabs to square the log or to saw the log into planks. The top sawyer's function is to pull the saw upwards while the bulk of the work is done on the downstroke by the man in the pit, assisted by gravity and the rake of the saw's teeth.

As the saw progresses in the cut, the cut is kept open with wooden wedges which help prevent the saw from binding. The handles of the saw are at right angles to the saw blade. Often there is but a single contact between the handle and the blade and the handle loosens and becomes inefficient. It is often stabilized with wire but more permanent solutions are desirable.

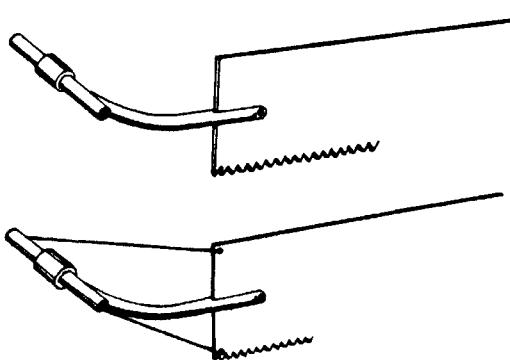
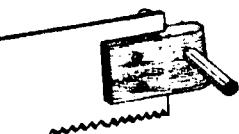


Fig. 44 - Pit saw handles

A wooden handle may be made similar to that shown. There is a two point contact with the saw blade. The bottom handle of the pit saw must be readily detachable so that the saw can be drawn out through the cut if required. For this reason the slotted handle is designed to fit over the end of the saw and to be held in place by a wedge or wedges.



The rip saw teeth normally begin with a straight front which becomes curved in time as a result of sharpening and filing. The gullet or throat room is a vital point in sawing for upon this depends the amount of "feed" which the saw can carry. If this dust chamber is not sufficiently large or properly formed, the sawdust will not be carried out of the cut and the saw will "choke".

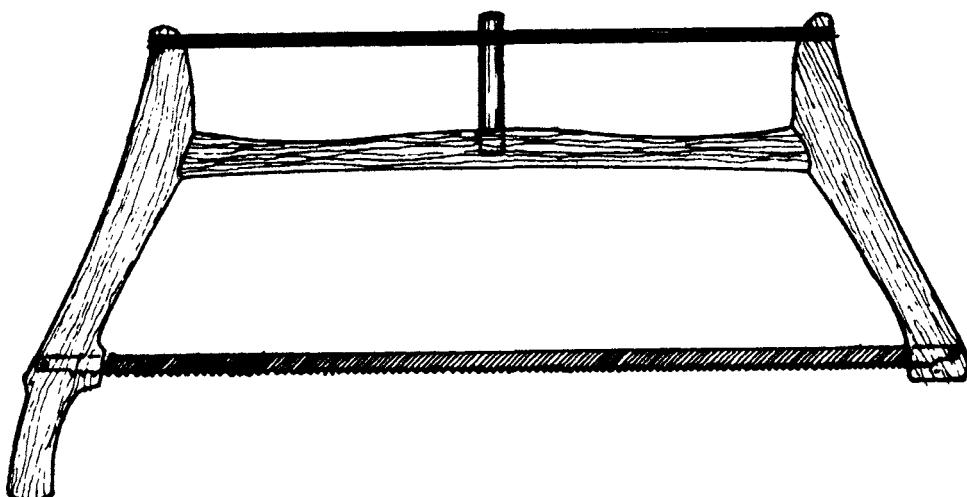


Fig. 45 - Wooden frame bowsaw

Bowsaws

In most forested countries the bowsaw replaced the crosscut saw wherever the tree size permitted. As might be assumed, the bowsaw is a small tree or small log saw, perhaps up to 30 cm in diameter. Above this size the crosscut saw would perform better. The larger the tree or log being sawn, the greater the problem of clearing the sawdust out of the cut. A long saw which permits clearing of the sawdust at both sides of the cut is the most efficient.

The principle of construction of the bowsaw is simple, consisting of two end pieces, one with a handle, a centre cross bar on one side of which is the sawblade, on the other a rope which can be tightened by twisting to put tension in the sawblade (Fig. 45).

The wooden frame which can be readily handmade has been replaced in most countries with a tubular steel frame which is bent in a bow shape, hence the name of the saw (Fig. 46). This bowsaw frame is bent in a manner which will put the tension on the

blade. The tubular steel bow frame is light and easy to handle, but tends to lose its tension over time if the tension is not released when the saw is not in use. The wooden frame with the tensioning rope permits good control over the blade tension, both in and out of use.

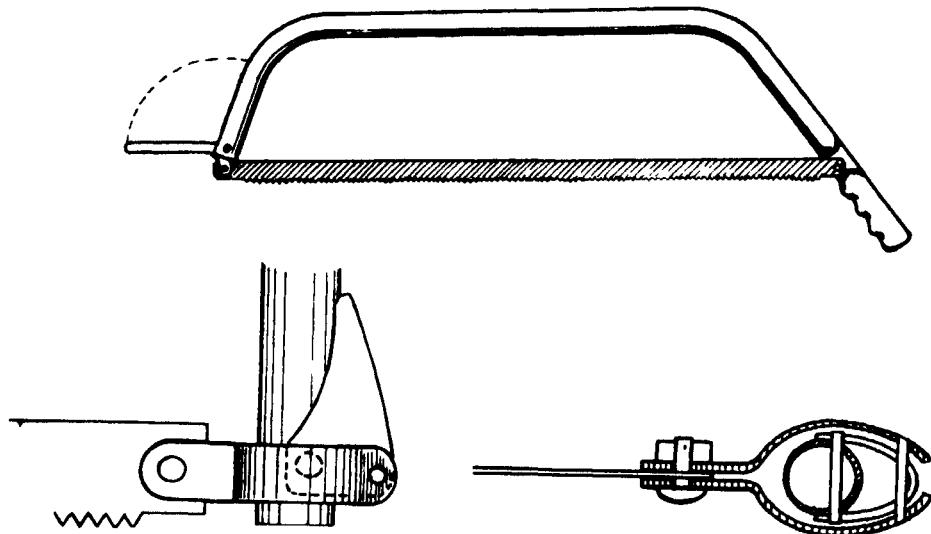


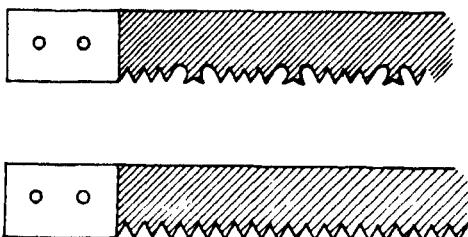
Fig. 46 - Metal frame bowsaw

A spring tension lever on one end of the tubular bowsaw frame permits the release of tension in the frame when the saw is not in use and this also makes the removal of the blade for any reason quite easy.

One favourable aspect of the wooden frame is that it can be readily made from native materials at hand. As long as the length of the sawblade is known, and normally the length is $1 \frac{1}{4}$ m, all that needs to be purchased is the sawblade and a length of rope.

A new technology has assisted in the efficient use of the bowsaw, and this is the hardened tooth sawblade. Sawblades with dull or improperly sharpened teeth, and with the teeth improperly set result in a gross expenditure of energy. For this reason the bowsaw has not found acceptance in some developing countries. If this situation can be overcome with hardened tooth blades which are used until they are dull and then are discarded, the one-man bowsaw is a most efficient tool.

The blade of the bowsaw may consist of all cutting or peg teeth or have a raker tooth for every four cutting teeth. Raker



teeth with a deep gullet have not been found as necessary in the bowsaw as in the longer thicker two-man crosscut saw. This is because the shorter bowsaw does not accumulate as much sawdust between its teeth as does the crosscut saw.

Fig. 47 - Bowsaw blades and teeth

a. Jointers for bowsaw blades

To joint a sawblade is to file all of its teeth to the same length. This is most important as one or more teeth which project above the others will catch and cause the saw to bind and prevent a long smooth sawing motion which is essential. If teeth are too short they will not cut and, therefore, are inefficient. Saw teeth are filed evenly by means of a flat file which is passed over the points of the sawteeth until all teeth are the same height. The file is normally moved in one direction only, the cutting direction.

To ensure that the flat file is held properly, and at right angles to the face of the sawblade, an inexpensive jig can be made of wood (Fig. 48).

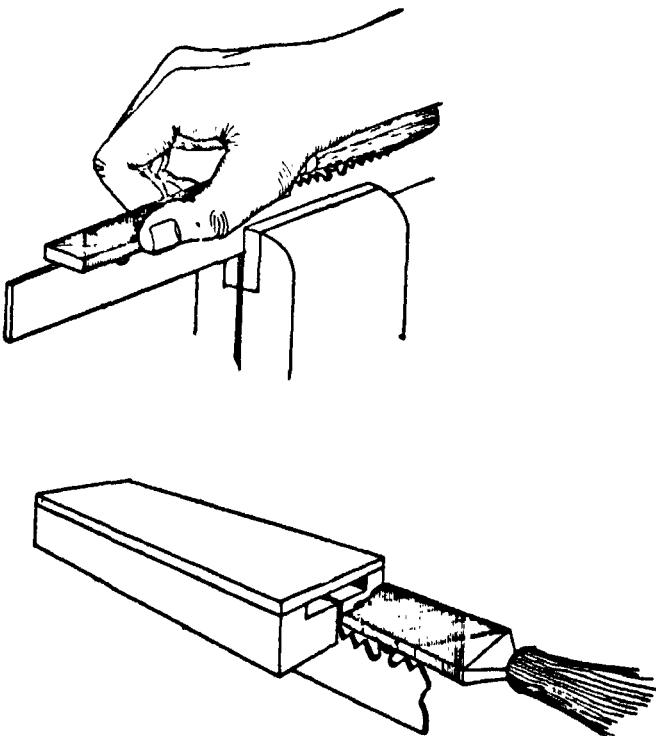


Fig. 48 Jointers for bowsaws

b. Setting tools

In setting a saw, the tips of alternate cutting teeth are bent outwards. The purpose of setting teeth is so that the saw-blade will cut a kerf sufficiently wide to prevent it from binding in the cut. The set should only be this wide or the kerf will permit the blade to flop rather than to guide it accurately through the wood.

The teeth of bowsaw blades are normally spring set with a special tool with a slot in it which fits over the top of the cutter tooth and permits bending the tooth point the required amount (Fig. 49).

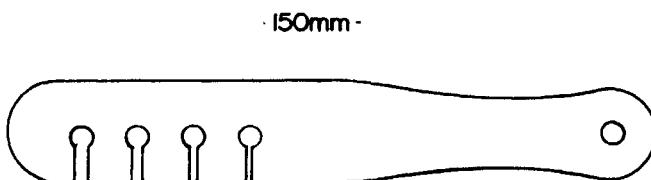


Fig. 49 - Bowsaw tooth saw set

The spring set tool can have a single slot for a standard blade thickness, or a series of slots to fit a variety of blade thicknesses. At the end of the slot there is a round space which protects the tip of the saw tooth while the tooth is being set or bent.

Just as sawteeth are jointed to ensure that they are all uniform in height so, after the sawteeth are set, they must be checked and, if necessary, the set reduced so that the set for all teeth are uniform. Uniformity is essential because, as explained before, one or two teeth, too long or too short or set too wide compared to all the others, will interfere dramatically with the efficiency of sawing.

After a bowsaw blade has been sharpened with a file, there are often burrs formed on the outside of the cutting teeth. These are iron filings which have not detached. If a fine sharpening stone or whetstone is available, it can be used to remove these burrs. If no stone is available, a burr knife can be made and used to cut off the burrs. A piece of discarded bowsaw blade makes suitable material. The teeth should be cut off and the knife sharpened to a point, and the edges of the point filed to form a chisel-type edge, flat on one side.

The holes in the end of the bowsaw blade, through which the blade is held by pins in its frame should be approximately in the centre of the blade. As the blade is sharpened over time the blade is reduced in width and new holes should be punched out. A simple punch can be fabricated from a small block of mild steel (1) with a groove 2 mm wide cut into it (2) and a hole suitably located to receive a punch pin of hardened steel (3). The sawblade is placed in the groove and the punch pin is struck with a hammer to make the necessary hole (Fig. 50).

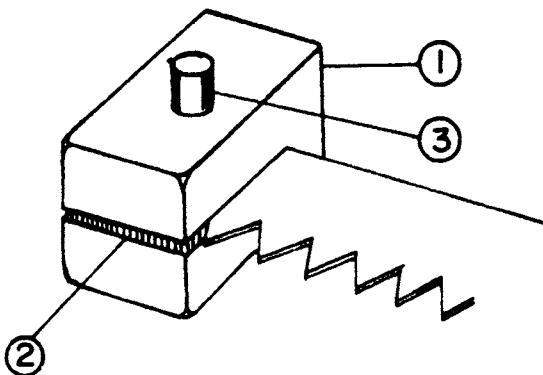


Fig. 50 - Bowsaw blade punch

Sawhorses

A sawhorse normally consists of two cross-shaped ends (fig. 51), held together and substantially braced at a fixed distance apart. It is used in cutting bolts off the ends of longer logs usually for fuelwood.

If logs vary considerably in length, the conventional sawhorse may not prove satisfactory. One made up of two separate units which can be moved in and out can accommodate almost any length of log.

Another alternative is to use just one sawhorse and the end of the stem resting on the ground.

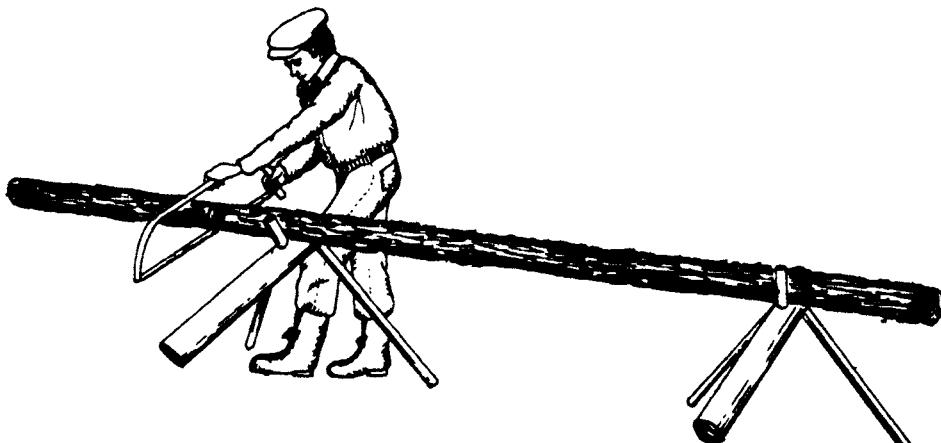


Fig. 51 - Sawhorse for crosscutting

Shaving horse

If boards or shingles or shakes require further dressing with a draw knife, a shaving horse is required (Fig. 52). The shaving horse can be made from rough sawn or rough hewn lumber. A heavy plank $1\frac{1}{2}$ to 2 m long, 20 cm wide and 5 cm thick is used. Four legs are fastened to it, two legs approximately 0.7 m long and two legs 0.35 m long. At a point 0.5 m from the higher end of the now sloping plank, there is a hole bored or cut through the plank, 5 x 10 cm in size. A vertical piece of lumber, slightly less than 5 cm in width and 5 cm thick, is inserted through this hole and held in place by a bolt 0.6 cm in diameter. This permits the upright to swing backwards and forwards. A treadle is fastened at

the lower end and a block is attached to the upper end. Sitting on the upper end, the worker pushes the treadle forward with his feet and the block swings down and holds the work piece tightly in place, as in a vice.

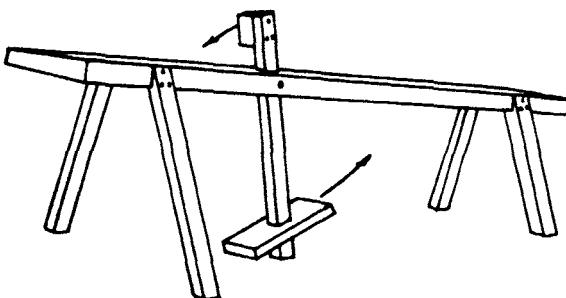


Fig. 52 - Shaving horse

Wedges

Wedges for felling, crosscutting and ripsawing

These wedges are usually made of mild steel with a socket (1) into which a wooden shaft (2) is inserted. The wooden shaft functions as a shock absorber and permits the driving in of the wedge with sufficient impact. Although the lifetime of the wooden shaft may only be one or two weeks, compared with an all-steel wedge, the shaft can be readily replaced. This version of the wedge is considered much safer than an all-steel wedge, as the latter tends to mushroom and produce dangerous metal splinters (Fig. 53).

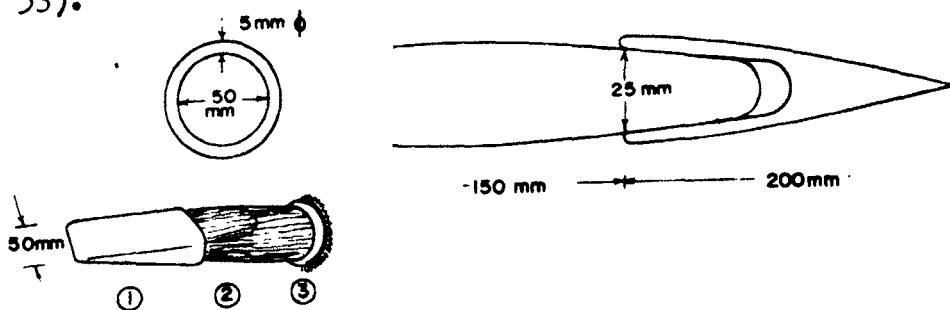


Fig. 53 - Wedge with socket

The wedge itself is made of mild steel and it should be possible to forge and shape it in a blacksmith shop. The socket is shaped so that when the hardwood shaft is inserted there should be an empty space between the wooden shaft and the bottom of the socket. This helps absorb some of the shock when the wedge is being driven into a cut. An iron ring (3) around the top of the hardwood shaft will help prevent the shaft from splitting and permits the frayed wood to be restricted to the shaft above the ring.

In many instances, wooden wedges of dense hardwood are used when crosscutting and felling. They will have a shorter life than the combined metal and wooden wedge, but in turn will cost less. The wood must be well seasoned and be sawn into pieces corresponding to the intended length of the wedge. Wooden wedges are sized according to the use to which they will be put.

Small metal wedges are used for crosscutting and felling with the bowsaw and crosscutting with the two-man crosscut saw. Normally, wedges are made of high carbon steel, but softer than the head of the axe which is sometimes used to drive them into the wood. Aluminium alloy is often used in wedges used with chainsaws.

These wedges often have a ridge on their sides to serve as a guide when they are being driven into a cut.

Splitting wedges

A wedge used for splitting fuelwood, hardwoods principally, can be more sophisticated than those described and more efficient. They are made from high carbon steel and weigh between 600-700 g. These wedges normally have ridges built into them to hold the wedge in place and prevent it from springing back from the slit in which it is being driven. The wedges would be approximately 150 mm long with a bit approximately 45 mm in width (Fig. 54).

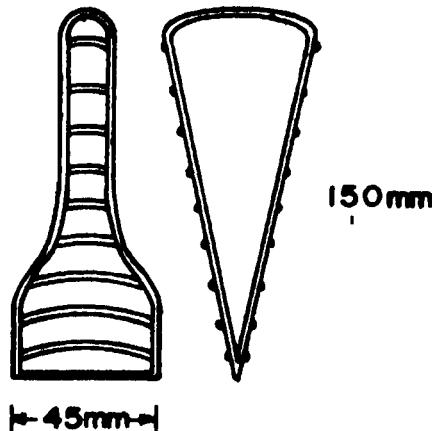


Fig. 54 - Splitting wedge

A different approach to splitting wood, and this only applies to splitting short bolts of fuelwood, is to drive the bolt onto a stationary knife or wedge to split it (Fig. 55). The bolt is placed on the wedge and is cut with a sledgehammer, the first blow normally "sets" the wedge and the second blow is usually sufficient to split the bolt completely. There are different designs of this form of splitter and one of its great advantages is, of course,

that the wedge is not struck and therefore has a long life compared to the wedge that is driven into a bolt.

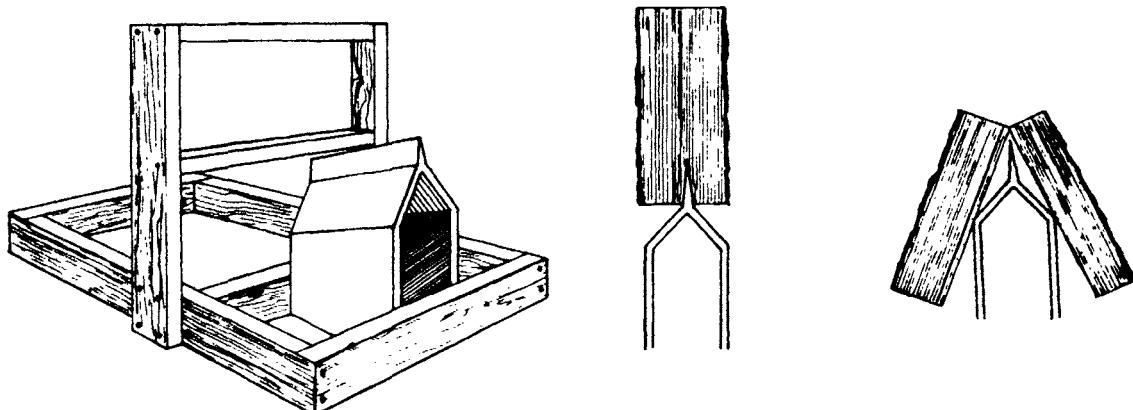


Fig. 55 - Fuelwood splitting wedge

Sledges and mallets

Sledges are used in driving wedges, either to hold open a sawcut or to split wood longitudinally. It is a bad practice to use the butt of an axehead for driving wedges because axeheads are often made of soft iron, particularly home-made heads. Using them to pound wedges would tend to distort the eye of the head and destroy its usefulness (Fig. 56).

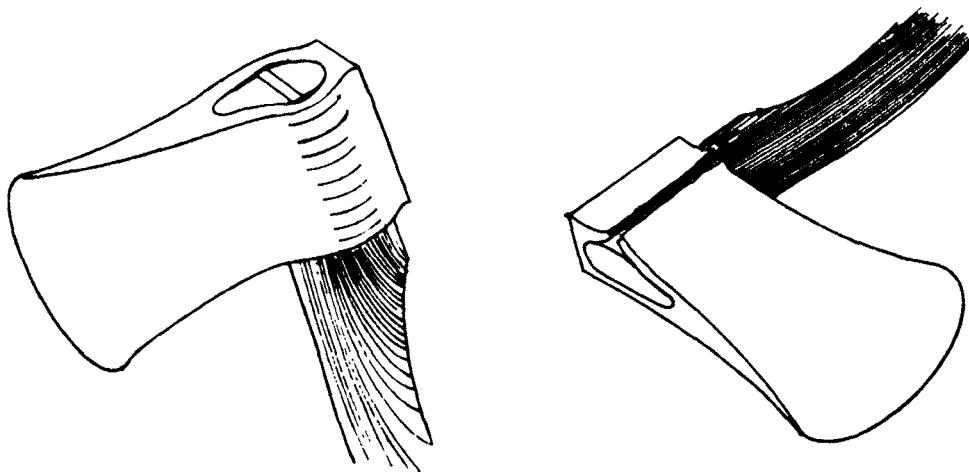


Fig. 56 - Damage to axeheads from pounding

Sledges are most often made of iron or steel, if these metals are readily available. A sledge should weigh about 3 kg, and its handle, which should be straight, should be approximately 80 cm in length. Iron is employed in sledges used for driving wooden wedges, steel is used for driving steel wedges. The steel in the sledge should be softer than that used in the wedge itself. This would tend to prevent metal splinters. The faces of the metal sledges should be bevelled (Fig. 57).

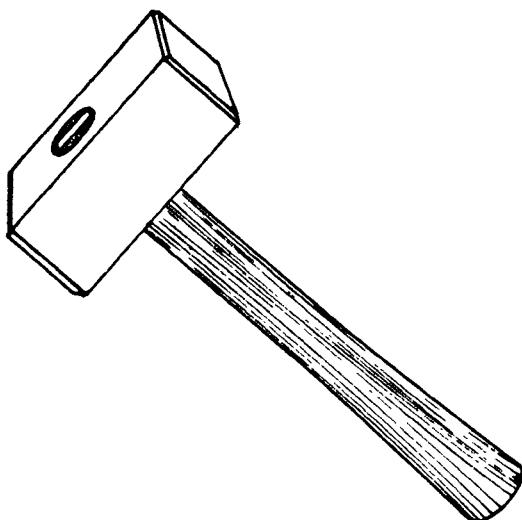


Fig. 57 - Sledge hammer

A wooden faced hammer or mallet has many uses in forestry. It can be used for pounding when using wedges or other cutting tools. One design for a mallet is made with a short piece of pipe about 10 cm in diameter and 12 cm in length (5). A slot is cut at mid-point in the pipe (1) which will permit a wooden handle (2) to be mounted. The handle, which is larger at the top end (3), is forced through the slot in the pipe and through the hardwood insert (4). The pipe gives weight to the mallet, as well as preventing the hardwood head from splitting (Fig. 58).

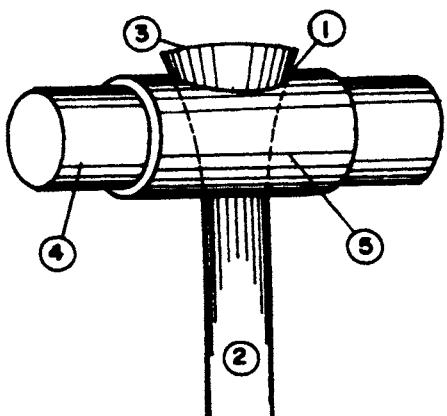


Fig. 58 - Wooden faced hammer

Brush cutters and machetes

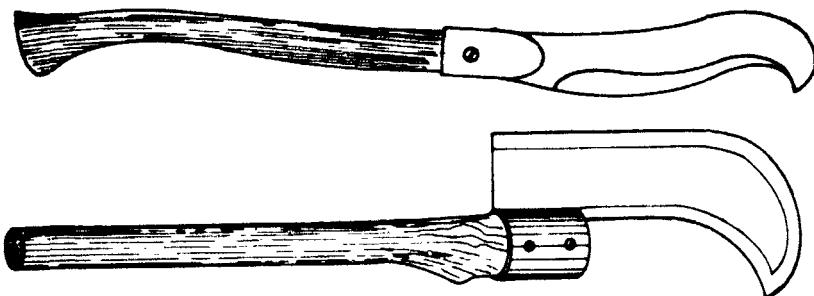


Fig. 59 - Brush cutters

In many regions, machetes are used for cutting brush and very efficiently. However, there are many regions where machetes are not a common tool and brush hooks especially designed for the work may be made. A simple, double-edged brush cutter may be made in a blacksmith shop (Fig. 60). It has a round wooden handle which fits into a short length of pipe, about 10 cm in length and 3 cm in diameter. One end of the pipe is flattened to fit over the shank of the cutting head. An old truck spring of good tempered steel can be used in making the cutter head. Two holes are drilled through the pipe section for screws to hold the head securely to the handle. The hook is sharpened to a fine edge, as well as the back of the hook section.

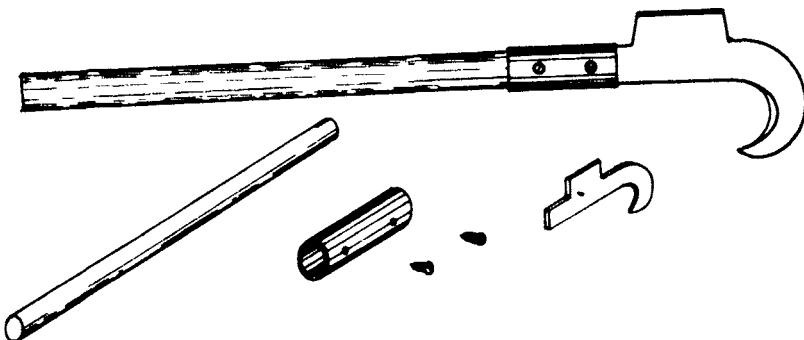


Fig. 60 - Blacksmith made brush cutter

Another design for a brush hook used in clearing light brush has the following dimensions: weight 1.300 g, length of blade 220 mm, with a total length of 840 mm. The handle is a discarded axe handle, while the blade material should be of good steel.

Because double cutting brush hooks are used in just that manner, their handles should be straight. A brush hook of this design can be made from old truck springs shaped and sharpened. High carbon tool steel is preferable.

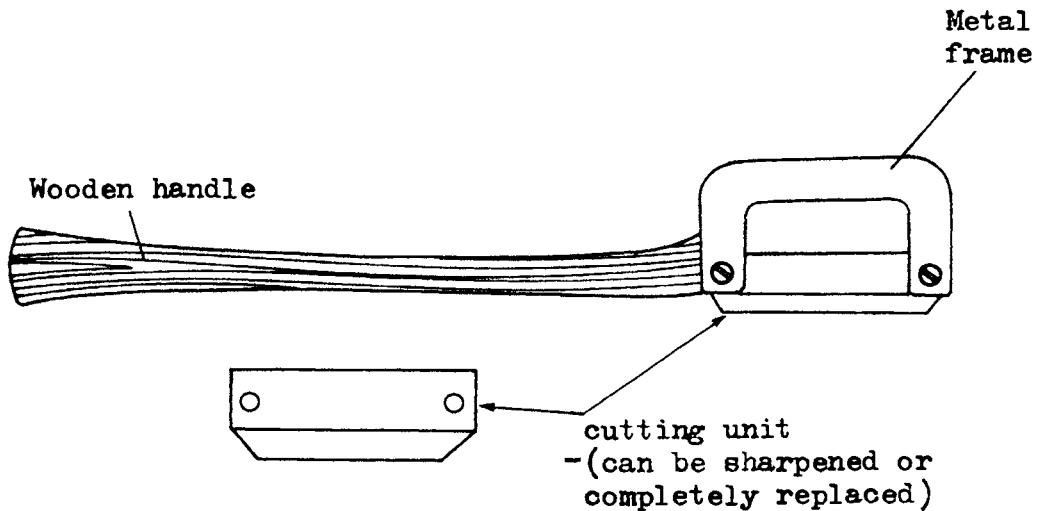


Fig. 61 - Replaceable cutting unit

This tool (Fig. 61) is used for cutting of small trees with a diameter of 10 cm. It consists of a wooden handle which is very similar to that one of an axe with a metal frame and a cutting unit allowing for an easy sharpening or total replacement.

The names Machete, Bolo, or Jungle knife are interchangeable. When locally made, the machete is commonly fashioned out of discarded leaf springs of motor vehicles, old sawblades, or other pieces of hard steel which happen to be available. This tool is used for a wide range of activities such as clearing underbrush, sometimes felling and crosscutting small timber, delimiting, barking, pruning, digging holes in the ground, etc. (Fig. 62).

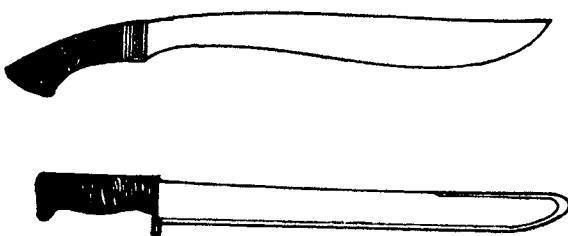


Fig. 62 - Machetes

Because of the local manufacture of this tool there is a wide variety in design. The Philippine bolo design (1) is quite different from that found in Africa (2). The ideal weight for a machete is between 600 and 650 g. If possible, when manufactured, the machetes should be given a good initial sharpening to avoid loss of temper of the steel caused by the double

sharpening done by many workers. That is, if the machete is not properly sharpened during manufacture, the purchaser needs to sharpen the tool himself and will often draw the temper of the blade through grinding.

The dimensions of the ideal machete have a length of 45 cm, with a blade width of 4.5 cm at the handle. The blade width can widen out to 5 cm in order to lessen wear caused by repeated sharpening at the part most frequently blunted through cutting.

Barking tools

Wood is barked in the forest for different reasons. It may be to permit more rapid seasoning and loss of weight for heavy logs which are to be transported by water or by railroad. The logs may be barked for sanitary reasons to reduce the danger of damage by bark beetles. In some instances bark is removed from logs prior to delivery to the sawmill to reduce their weight in transport, but also to reduce the debris and bark which collects at the mill.

In the Philippines the paper industries have developed a barking tool for the thick and rough bark of dipterocarps and

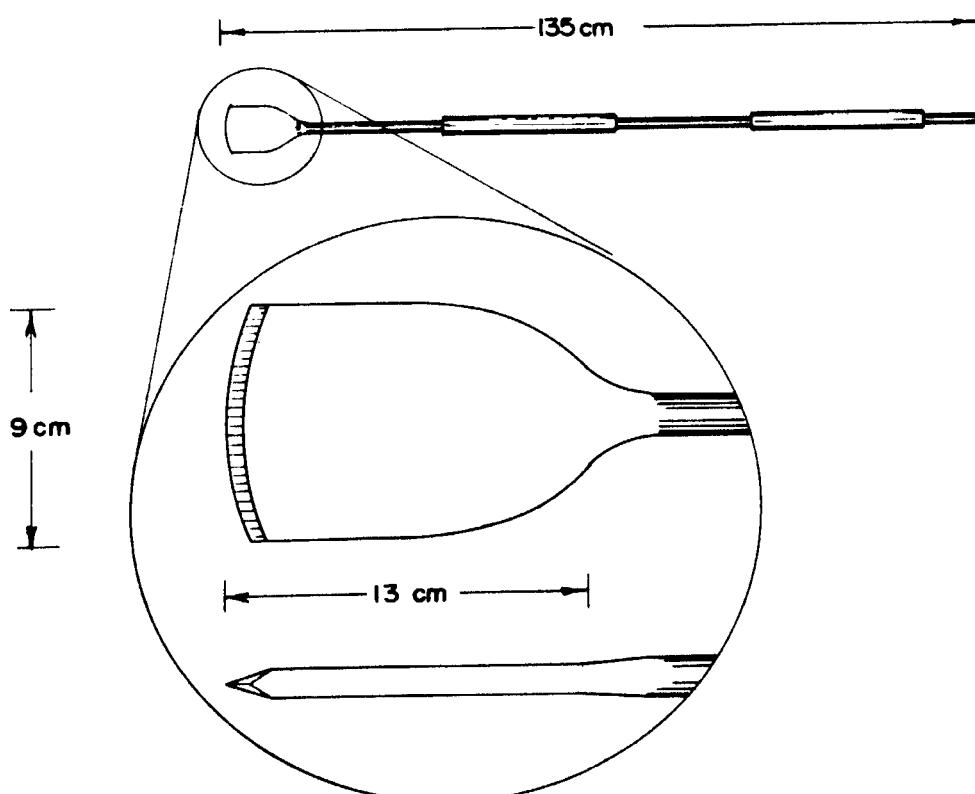


Fig. 63 - Barking spud

other tropical species. The debarking bar developed is made from a piece of iron approximately 1.5 cm in diameter and 125 cm in length (Fig. 63). The handle is made of round mild steel to which is welded a short piece of truck spring. The truck spring section has a curved edge line some 9 cm wide and approximately 10-13 cm deep. The truck spring section is joined to the round mild steel handle by welding. Pieces of rubber tubing are slipped over the round bar to make rubber handles for holding the bar when in use. The blade of the trunk spring normally has a curved edge line and this is used to cut the bark and to slip in under the loosened bark to pry it off the log.

A debarking spud is a barking tool with a blade and a straight handle (Fig. 64). The figure shows a blade approximately 100 mm in width, 220 mm in length, with a weight of approximately 500 g.

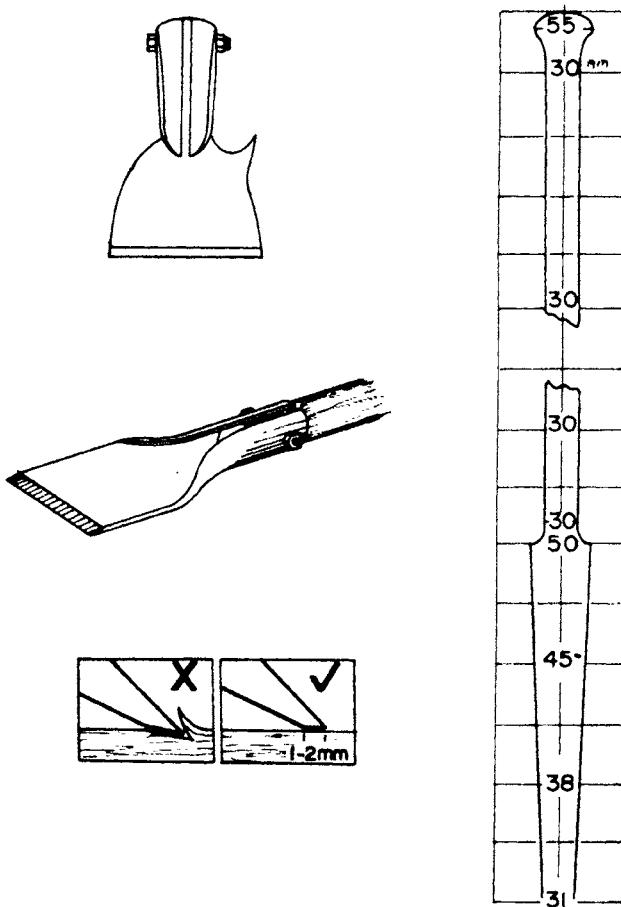


Fig. 64 - Barking spud details
including cutting edge and handle

On one shoulder of the barking spud there is a spike which can be used for turning and manipulating logs. The manner by which the handle is attached to the blade is by means of a socket into which the end of the handle is passed and through which a bolt is inserted through a hole drilled in the handle to securely fasten the blade to the handle.

The blade can be made of a discarded saw blade with a minimum thickness of 2 mm. The blade is welded to a holder of mild steel which wraps around the handle which is held in place by means of a bolt. It may also be possible to make such a spud out of one sheet of high carbon steel with the holder shaped by forging to receive the handle of the spud.

The handle of a barking spud is straight, 100 cm in length, and is a round cross section. The main handle is of uniform thickness. The lower section is thicker to support the hand. At the upper end there is a round knob (approximately 55 mm diameter) to support the bottom of the other hand.

Peeling spuds can be made from materials other than those described above. A garden spade on which the cutting edge is no longer good can be cut down to 10 cm x 20 cm in size to make a very handy log peeler (Fig. 65). The edge of the blade should be ground to a suitable angle so that it will not tend to cut into the log.

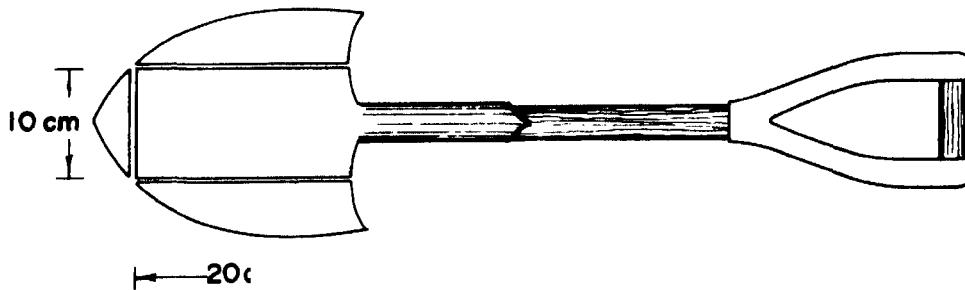


Fig. 65 - Barking spud made from old spade

When working with smaller material, draw knives may be used. These are very effective for the removal of bark during that period of the year when the wood is not in condition to peel readily but must be removed by shaving or cutting off (Fig. 66).

The blade of a draw knife can be made from 0.75 cm by 3.75 cm tool steel. This could be from a discarded circular saw blade or a lightweight car spring. The handles are slab pieces of wood (1)

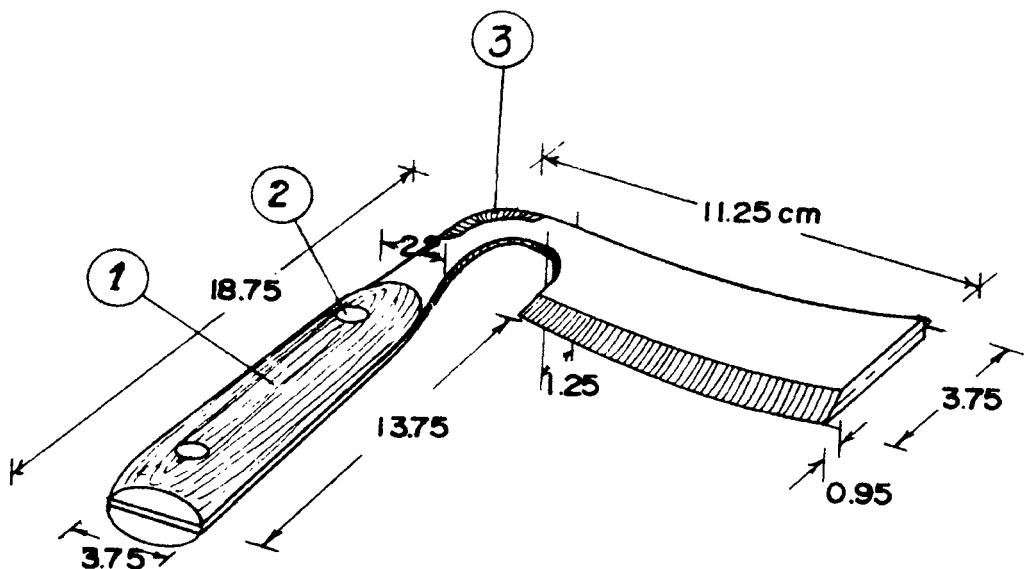


Fig. 66 - Details of drawknife

held in place with truck brake lining rivets (2). The outside corners of the drawknife blade are sharpened as this permits pushing to cut as well as pulling (3).

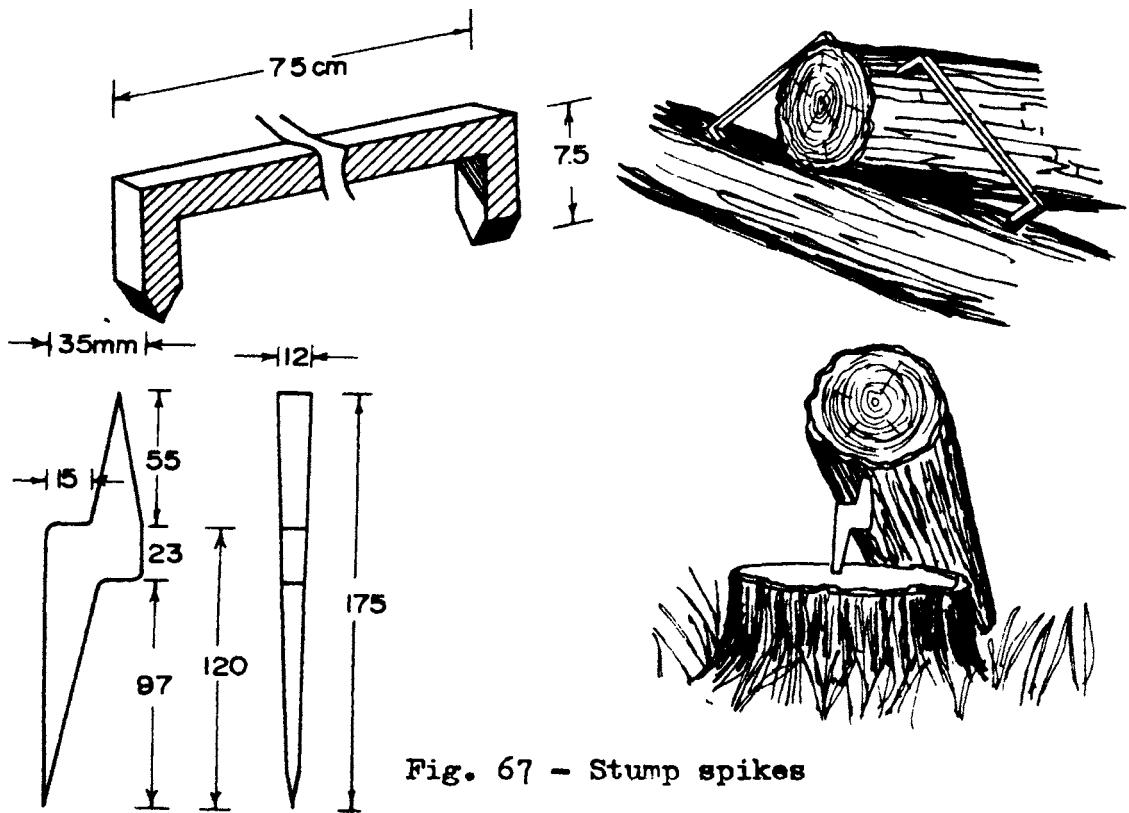


Fig. 67 - Stump spikes

Stump spike. A stump spike is used to hold short wood while debarking it with a barking spud. It is normally made of mild steel and is approximately 175 mm in length. One end of the stump spike is driven into a stump, hence its name, while the end of the pulp stick is dropped on the upper point and held in place while barking.

Other forms of stump spikes have found wide usage. One such form is a steel bar approximately 50 cm in length and 2 to 3 cm in diameter. This bar is bent at approximately 5 cm from each end at right angles to the main axis of the bar. The ends are heated in a forge and shaped to points or else ground to points. One point is normally driven into a bolt or log while the other is driven into a cross log or stump to securely hold the log being worked on.

When peeling short bolts in the forest, peeling stands or trestles are often used. These are somewhat similar to sawhorses which have been described earlier. Working on timber on such supports or trestles is much less fatiguing than if the logs remain on the ground. Moreover, tool edges remain sharp for longer periods if the work is done above the surface of the ground.

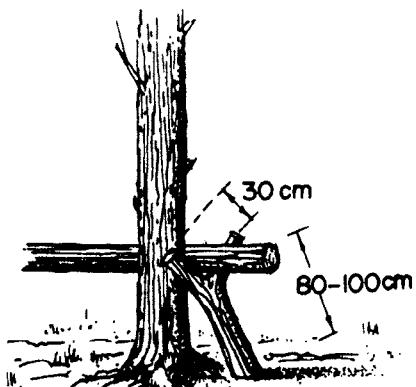


Fig. 68 - Peeling trestle made of a forked branch

A forked branch (Fig. 68) is an easy means of supporting a pole if rested against a standing tree in the woods. Trestles may consist of a wooden post with two legs, and these can be made in the forest with no other tools than an axe and a bowsaw.

A low dovetail trestle consists of a post 200 cm long and 12 cm in diameter. The dovetail cuts 25 cm deep are made about 30 cm and 50 cm from the end of the post. The legs are 70 cm and 80 cm long and about 7.5 cm thick. They are inserted into the dovetail cuts from below. Their feet should be about 65 cm apart (Fig. 69).

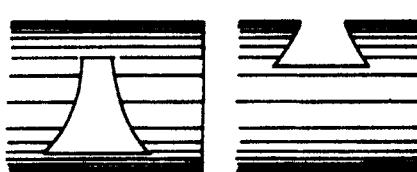
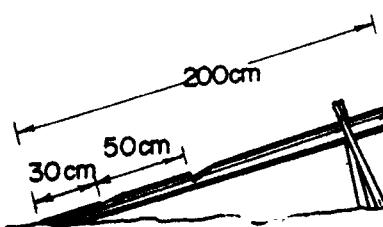


Fig. 69 - Peeling trestle with the legs inserted into dovetail cuts

The top of the longer leg must be so fitted into the dovetail that it is 10 cm higher than the post. This extended leg and two notches made on the upper side in the lower end of the post provide three resting positions for poles that can be put on the trestle by tools such as a log turner or a sappie.

A high dovetail trestle (Fig. 70) is used for peeling billets of wood. It is made of a post 200 cm long and 12 cm thick. The dovetail cuts are made about 20 cm and 40 cm from the end at such angles that the two legs can be inserted with their feet 140 cm apart. The dovetail cuts must be at least 25 mm deep. The legs should have a length of about 180 cm. Their top ends should be about 20 cm above the post. The upper side of the post is squared. A notch is made in the lower end. The billet to be peeled rests between the top ends of the legs and the squared surface of the post and on the notch at its lower end.

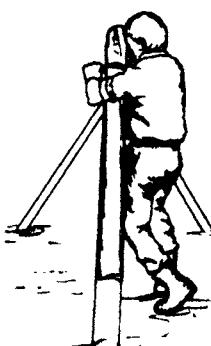
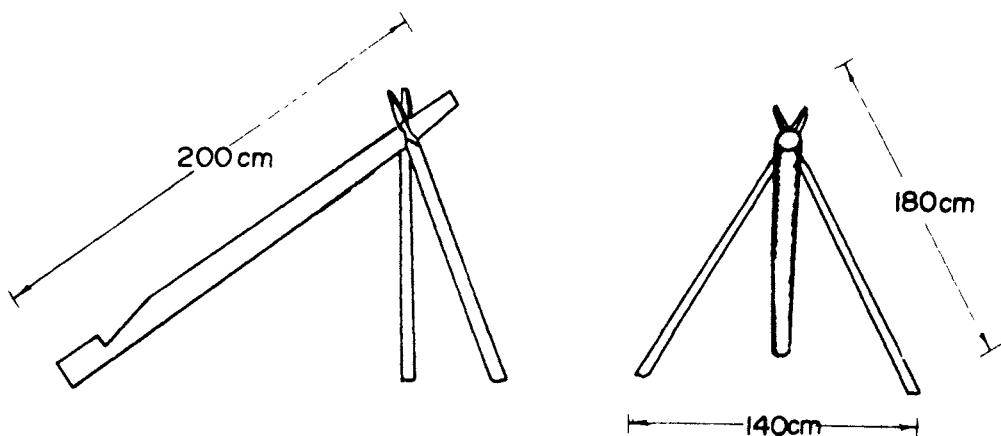


Fig. 70 - Peeling trestle

Girdling tools

In some stand improvement activities, the removal of inferior and undesirable trees in the stand may be required. Rather than felling such trees, which may damage young saplings growing near them, they are often girdled so that they will die on the stump and gradually lose their branches and limbs without damaging healthy trees or reproduction by falling.

Sometimes trees are girdled prior to felling so that they may season on the stump and lose considerable moisture.

A tool called the "handi-girdler" is a simple one-piece tool which makes possible the removal of a three inch bank of bark from the trunk of a tree (Fig. 71). This tool is approximately 30 cm long, 15 cm wide and weighs less than a kilogramme. It is a simple tool and its only maintenance is an occasional sharpening of the cutting edges with a small whetstone or file.

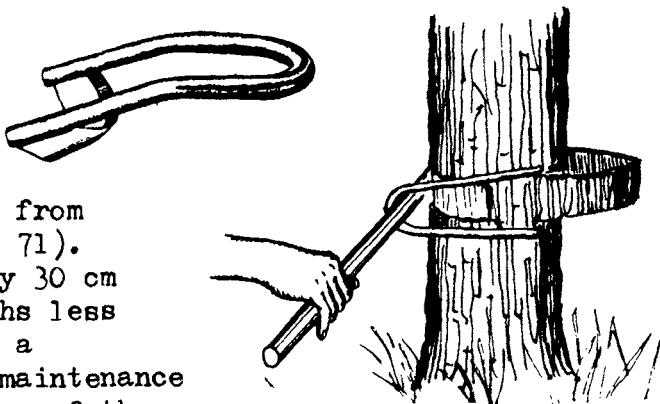


Fig. 71 - Handi-girdler

Another tool quite similar in general appearance is made as an addition to a cant hook and could take the place of a normal hook on a cant hook (Fig. 72). The cant hook handle provides the leverage required to work the girdling tool around a tree thus enabling the forest worker to use his weight more efficiently in pushing the girdling tool. This tool has been found to work especially well on medium to large size trees.

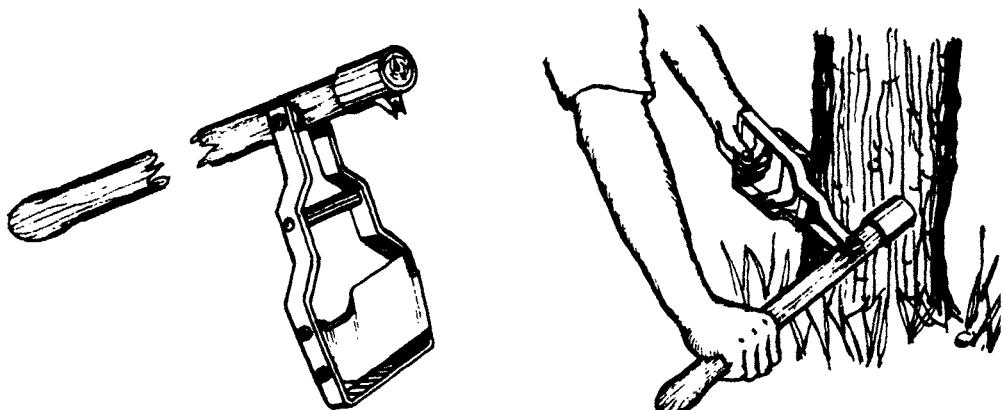


Fig. 72 - Two-handled girdler

LEVERS, HOOKS AND TONGS

Felling

This handbook is not basically concerned with tree felling techniques, but with the tools and aids which will make the process safer and easier for the workmen. These tools and aids will include wedges, mallets, levers and aids to guide trees, many of which have already been described.

When operating in plantations or in forests with trees of small diameter, a "felling bench" has proved to be quite practical and its use is spreading because of its effect on the worker (Fig. 73). A tree is felled across the felling bench and the bench's function is to act as a pivot "fulcrum" for moving and stockpiling logs or tree lengths and to support trees off the ground to facilitate the removal of branches, particularly those on the underside of the tree. The use of the felling bench will make the processing of the tree, after it is felled, safer and faster and physically less demanding.

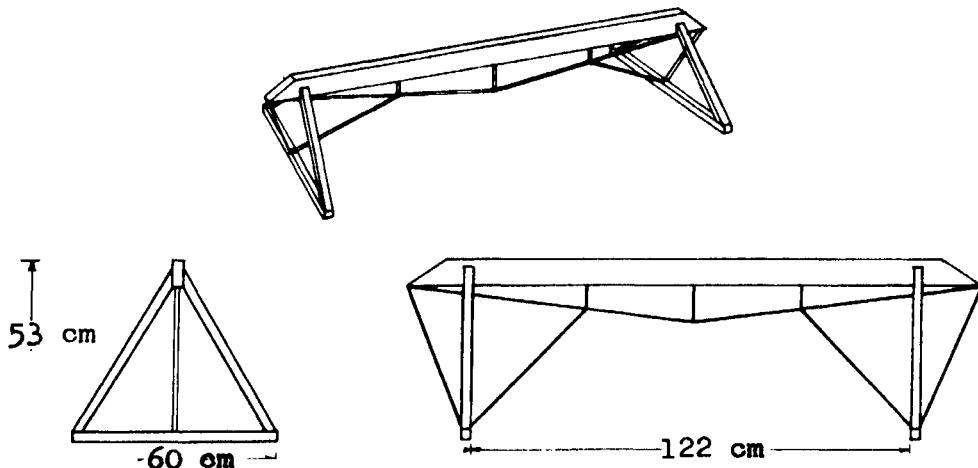


Fig. 73 - Felling bench

Trees should be felled at right angles to the bench and at a distance of approximately one-third of the height of a tree away from it. Once felled onto the bench, a tree can be delimbed, topped, measured and cut into desired lengths. The use of the felling bench permits the stacking of wood, clear of the limbs and tops, ready for forwarding or loading.

The use of the felling bench greatly reduces heavy lifting, reduces back-strain-type injuries. Its main disadvantage is that the bench must be carried around in the forest. However, it need not weigh more than 15 kg, and usually is not moved more than a few metres at a time from tree to tree.

A bench works best on flat country or gentle slopes up to 15 degrees. Trees more than 250 kg can damage the bench when dropped on it, especially if the bench is placed too far away from the tree. Based on experience, the construction of such a bench can be modified to suit local forest conditions.

Not all trees grow straight and perpendicular to the ground. To fell a leaning tree in a desired direction, if levers are used to push it as shown, an increase in force up to nine times is possible (Fig. 74). This means with a 50 kg lifting effort on the end of a pole which is connected to a second pole as shown, a force up to 450 kg can be exerted against the leaning tree to make it fall in the desired direction. If this situation is frequently encountered, it may be worthwhile to make a lever with the push arm hinged to the lift arm, with perhaps an iron spike in the upper part of the lift arm to make secure contact with the tree. The hinge may be conventional strap hinge or perhaps a very simple ring or notch type of hinge.

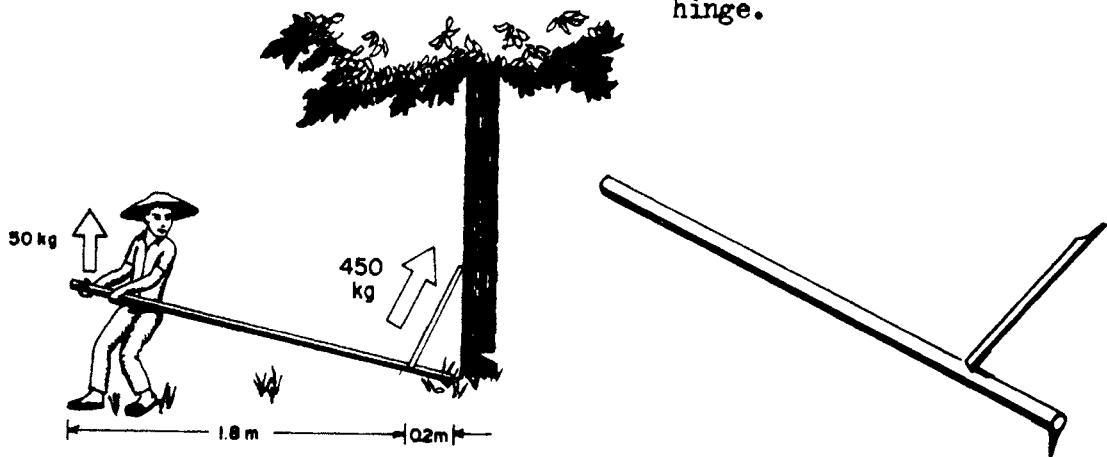


Fig. 74 - Lever for felling tree

Lodged trees

To drop a lodged tree, two poles may be laid on the ground in line with the tree and below the top of its stump. The tree is then pried across the face of the stump so that its butt will slip off the stump and land on the poles and slide along them instead of digging into the ground (Fig. 75).

The hand skid pan is also useful for dropping a lodged tree (Fig. 76). The pan can be placed close to the tree after sawing it off the stump and the wire rope is hooked around the butt. Pulling on the rope shifts the tree on to the rear of the skid

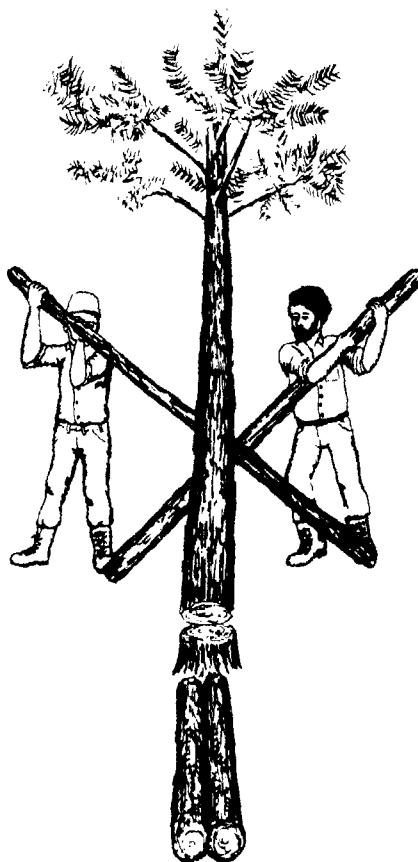


Fig. 75 - Dropping a lodged tree

pan which is then drawn away with the tree until the latter falls. The method is also useful on downhill slopes where the skid pan slides away with the tree immediately the butt is on it. This skid pan can be used to skid out tree lengths, poles or logs by hand for distances up to 100 m.

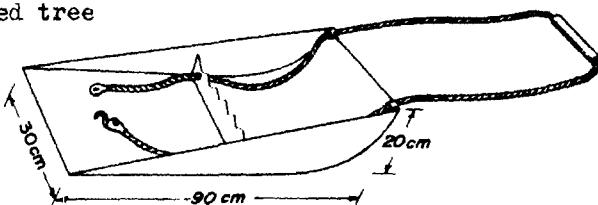


Fig. 76 - Hand skid pan

Moving or rolling logs or trees

A classic form of lever in forestry is the movable hook on a wooden handle used for turning or rolling logs. There are a number of different forms of such a lever. One of the simplest forms is a hook with a ring attached to it. The ring is of a size to permit a stout pole to be inserted through it with which a log can be rolled or moved.

The peavey, named after its inventor Joseph Peavey, in the

United States, was developed in 1850. The peavey (Fig. 77 A), with a spike in its end, was developed primarily for use with logs during timber floating operations.

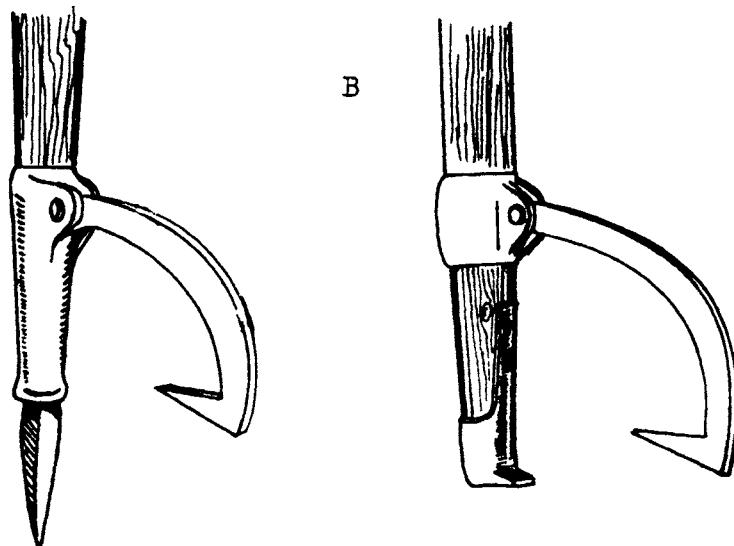


Fig. 77 - Log rolling tools A. Peavey B. Cant hook

The cant hook is used for moving logs on land (Fig. 77 B). As will be seen from the drawings, the handle in the peavey (A) fits into a socket attached to which is the hook, while in the cant hook (B) the hook is fastened to the handle by means of a band. As is the case with most tools and implements used in logging and forestry, there are many variations which develop locally to meet local situations. A home-made cant hook has proved to be very inexpensive and effective (Fig. 78). The tool is bolted onto the handle and the toe ring with lip is driven over the bottom end of the handle with the lip in line with the hook. If wedging on is not sufficient, the toe ring can be held in place with a pin.

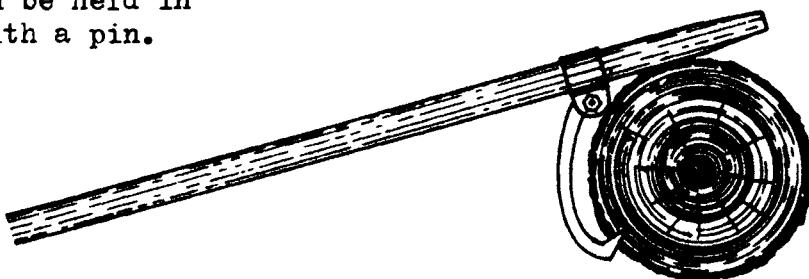


Fig. 78 - Home made cant hook

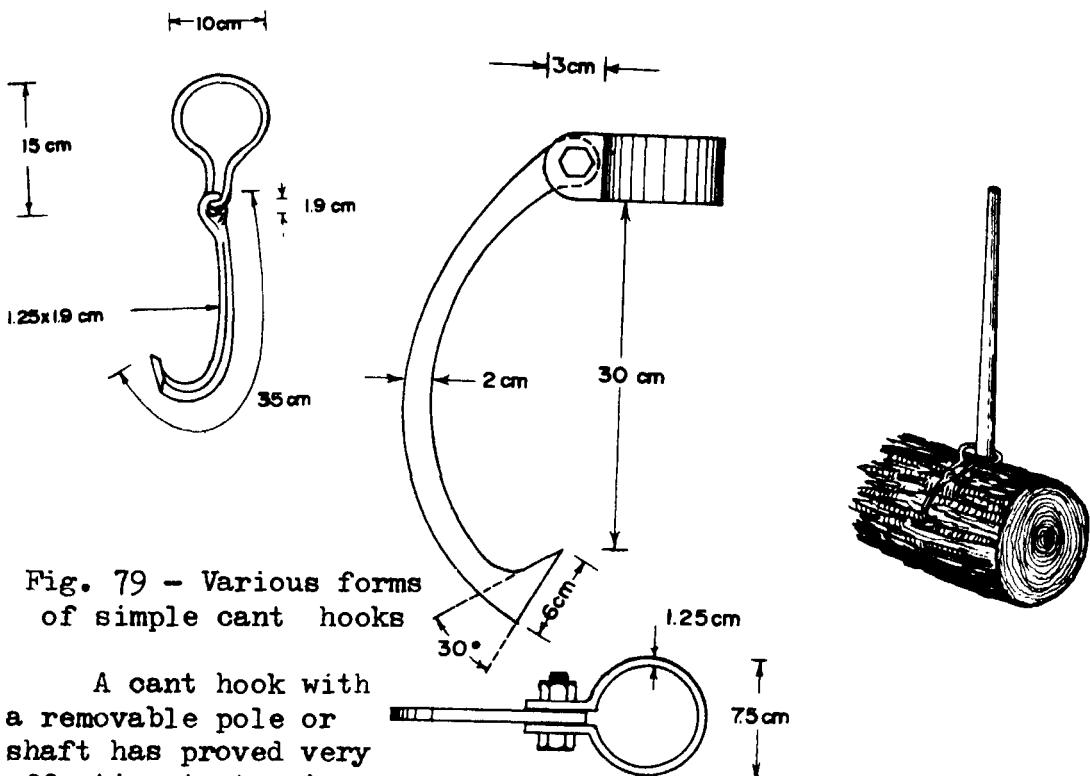


Fig. 79 - Various forms of simple cant hooks

A cant hook with a removable pole or shaft has proved very effective in turning and rolling of logs, in taking down lodged trees, etc. (Fig. 79).

A band of leather, heavy plastic, rope or light steel cable with a loop on one end and a stout sharpened hook at the other end can be used with a pole for rolling logs, similar to the cant hook (Fig. 80). The hook is hammered into the side of a log and the strap is passed around the log for at least one full circumference and then a stout pole is slipped through the loop and is held in place while rolling the log. The dimensions of the band will vary widely depending upon the materials in use. A length of 250-300 cm should be sufficient in most cases.

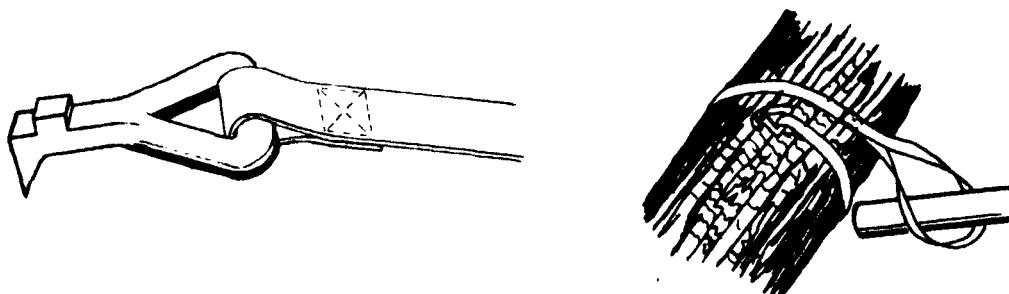


Fig. 80 - Hook and strap form of cant hook

Another variation of the cant hook is the log jack. It consists of an attachment to the handle, opposite to the hook, which results in raising a log clear of the ground for crosscutting.

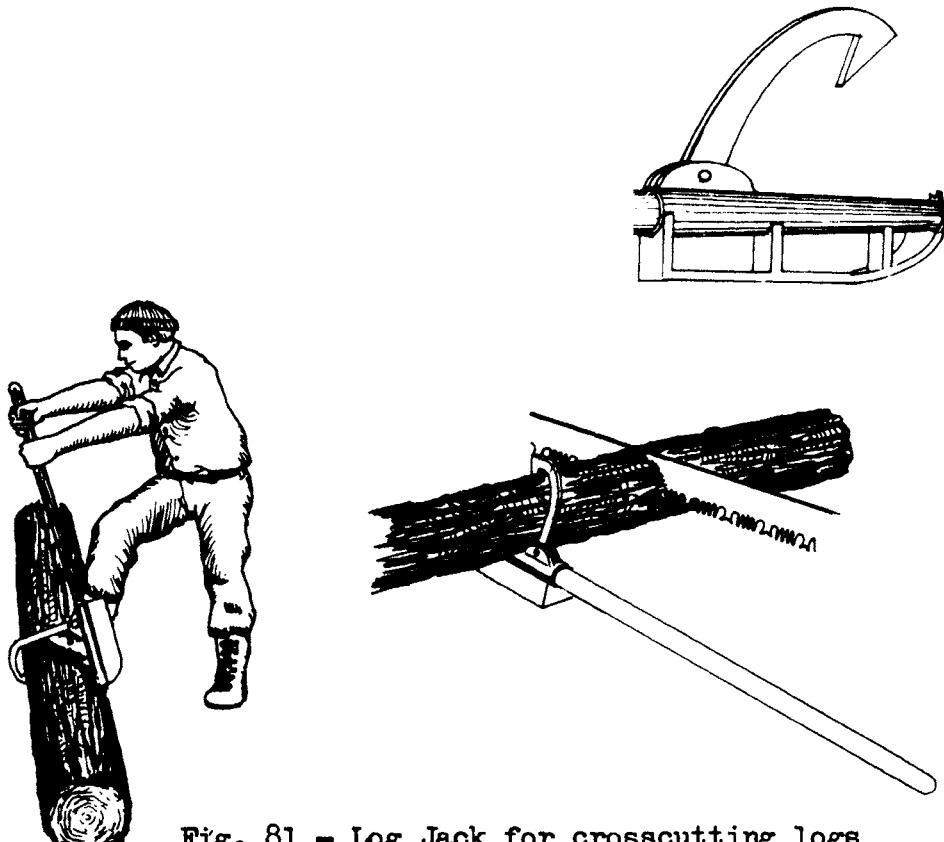


Fig. 81 - Log Jack for crosscutting logs

Log hooks or hand hooks

Hooks of this nature are used in lifting, turning, dragging and loading small logs. Such hooks appear in an infinite variety of shapes and sizes. They really act as an extension of a worker's arm and save him considerable energy in the process. Some hooks are used by catching the end of the log and pulling or lifting, others are designed to catch the log somewhere on its circumference to permit the worker to balance the log or bolt and handle it with minimum effort.

The conventional hook may have a handle in line with or at right angles to the hook itself. If the handle is at right angles to the hook, often a wooden handle is added. In this case the handle should not be round, which permits the ready possibility of slipping in the user's hand. It should be oval shaped so that it can be comfortably grasped and yet will act to prevent slipping.

A useful handhook can be made from a discarded axe handle or

tool handle of similar shape. The axe handle results in a comfortable grip which in turn makes its use more productive. The metal hook is made from high carbon steel. The point on the hook is formed by filing the outer edges. The hook is fastened to the handle with a rivet or a bolt as shown in the diagram. The fastening loop or band is of mild steel. The approximate dimensions are as shown and these can be readily modified (Fig. 82 a).

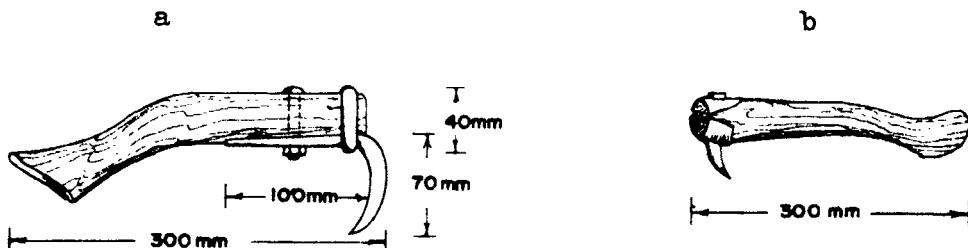


Fig. 82 - Hand hook

Another variation of this type of hand hook is one in which two plates of soft iron are shaped over the end of the handle. The plates are drawn together by a substantial bolt. When suitably tightened, the bolt is sharpened and then bent slightly as shown in the diagram. The point of the hook is then hardened (Fig. 82 b).

A hook with a longer handle than those shown so far can be made from an old axe which has been discarded. The blade of the axe is cut away as shown and the tip of the axe is suitably sharpened and hardened (Fig. 83 a).

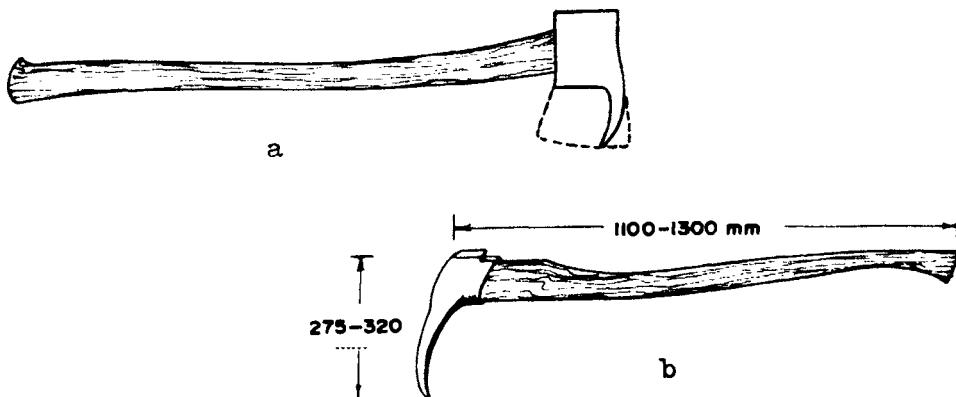


Fig. 83 - a. Pickeroon made from old axe; b. Sappie

Sappie (or Pickeroon)

There are two main ways in which the tool is used, either as a lever to clear a log from some obstacles or it can be driven,

point down, into a log so as to pull it along the ground. In steep terrain, where logs tend to slide by gravity and only require occasional aid, it finds its main use as a lever and also as a hand hook for pulling the log. It is an ideal tool for moving logs short distances (Fig. 84).



Fig. 84 - Use of a sappie

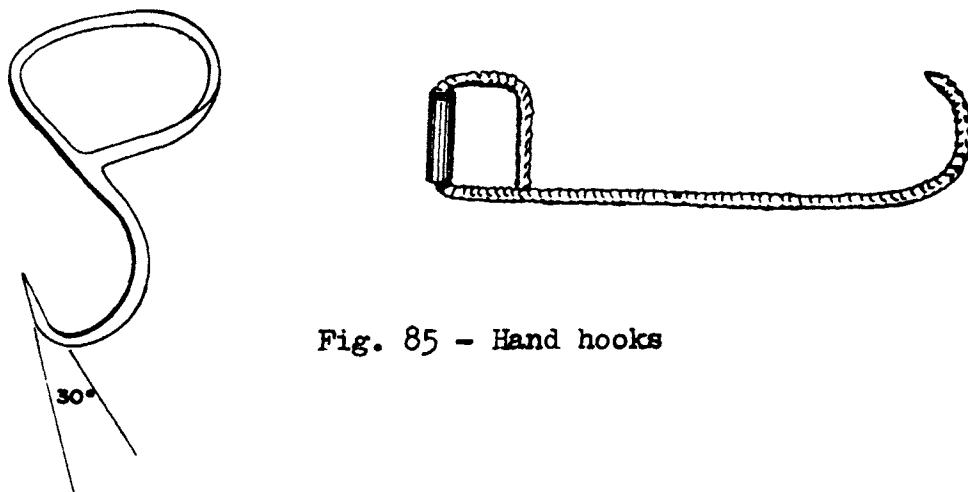


Fig. 85 - Hand hooks

Log tongs or double hooks

Tongs of this type are used in dragging, lifting, loading and staking of logs and bolts. These double hooks

also come in a wide variety of designs and materials as seen in Fig. 86.

In using this style of tongs, the arms are pressed against the circumference of the bolt and open. On lifting, the points penetrate the wood.

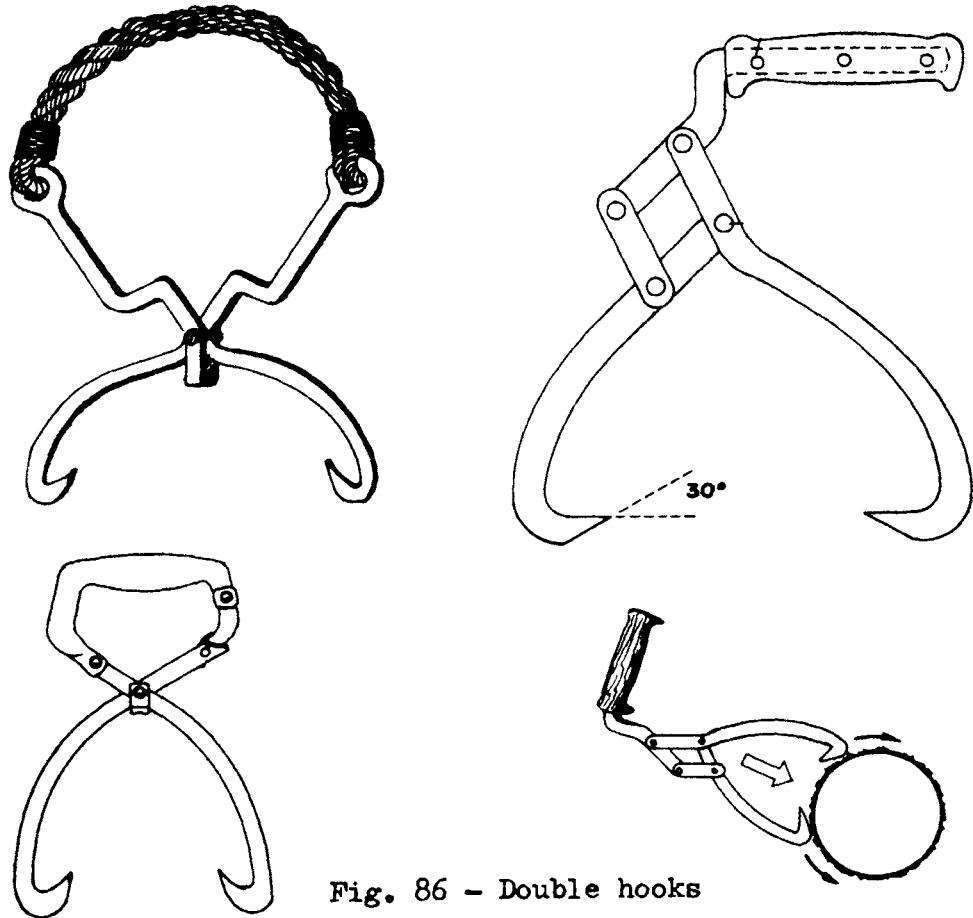
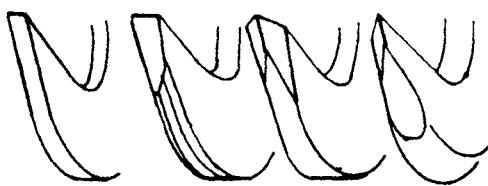


Fig. 86 - Double hooks

The arms of the tongs can be flat or circular in shape. A good length for the tong would be 350 mm, weight about 1.0 kg and a capacity to handle logs or bolts up to 300 mm in diameter.

When making joints by rivetting in the tongs, care must be taken that the joints move freely and are not stiff and binding.



There are a number of variations in the points of log tongs and pulp hooks (Fig. 87).

Fig. 87 - Variations in shape of points of log tongs and pulp hooks

Tongs designed on the same principle can be made for use by one or two men for dragging logs (Fig. 88).

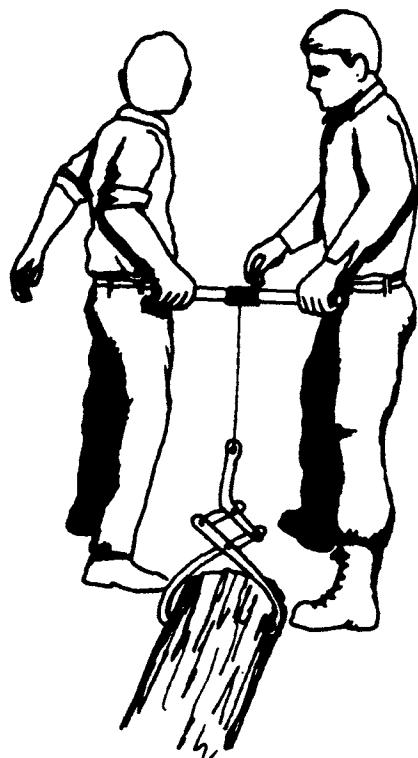


Fig. 88 - Tongs used
for dragging logs

EXTRACTION

Moving and carrying heavy loads without equipment

Where possible, dragging of heavy loads is preferable to carrying them as in dragging a substantial portion of the weight is on the ground, and as long as the friction in dragging the load along the surface is less than 1, i.e. less than the weight of the log, then less energy will be required to drag it than to carry it.

Head loads of wood are, however, a common sight in many parts of the world. In many countries heavy head loads of fuelwood are carried for distances up to 10 km or more. In other areas, hand sawn squares and railway ties are carried long distances in areas where no roads exist. These loads may be as great as 25-30 kg (Fig. 89).

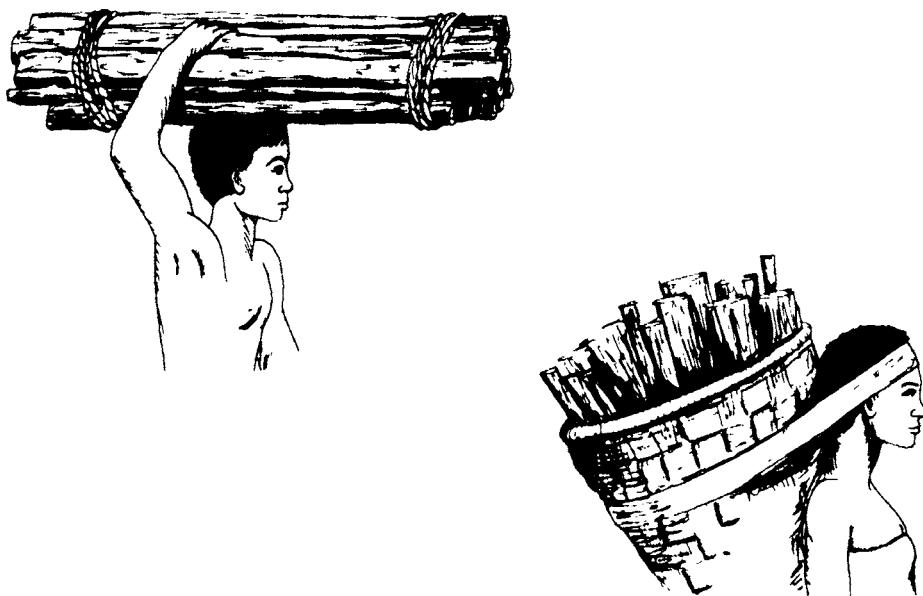


Fig. 89 - Head loads of wood

It is possible to carry very heavy loads on the neck and back muscles by use of the headband or "tumpline". Such loads are carried by porters in Africa, Asia and South America.

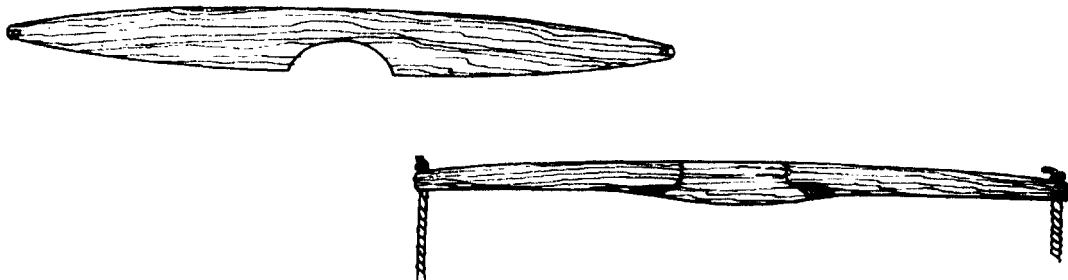


Fig. 90 - Shoulder yokes

Yokes

In some regions shoulder yokes are used when it is possible to balance the load fairly evenly on each side of the bearer. The yokes are carved out of wood and enable heavy loads to be carried with the weight distributed across the shoulders and steadied by the hands (Fig. 90). Very often this same principle is applied using a straight pole. The shoulder is the fulcrum and the loads at each end of the pole counterbalance each other. However, this method places considerable strain on the human body because of the lop-sided loading of the spine.

Another possibility is to use two poles and a simple harness to achieve the same result, with a more equal distribution of the load on the body (Fig. 91). If the load is to be carried fore

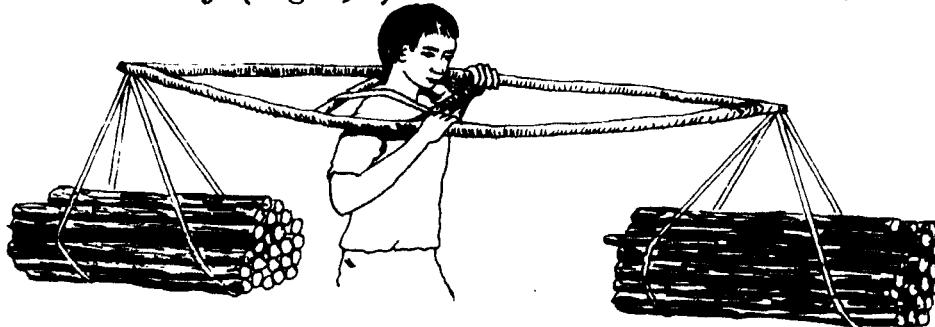
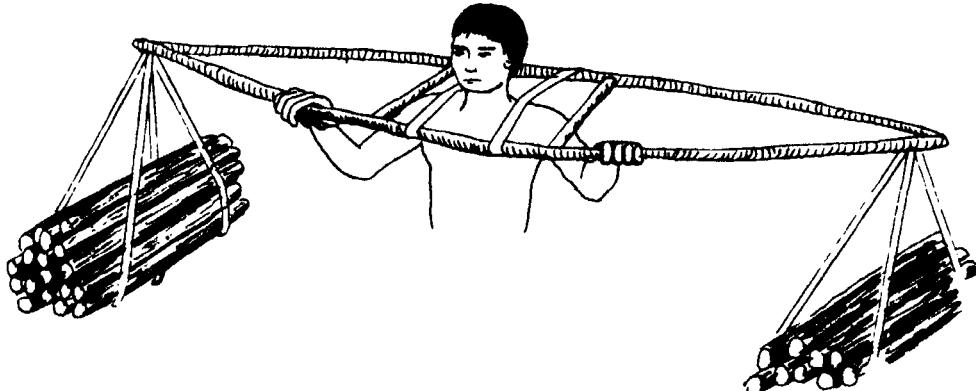


Fig. 91 - Carrying loads on poles - one man



and aft, the harness over the shoulders will be parallel to the direction of the load. If the load is to be carried at the sides of the carrier, and this permits the use of the hands to better control the load, the harness will be again parallel to the direction of travel. If the load is too great for one person, the two-person harness and pole arrangement may prove practical (Fig. 92). In each instance the shoulder harness may be made from material at hand, leather, cloth folded, length of old bicycle tyre casing, etc. Figure 93 illustrates a simple back rack for carrying short firewood bolts

Bundling firewood

The forming of both short and long firewood into tight bundles is of interest, whether preparing head loads or donkey loads. Tight bundles reduce the volume of the load as well as preventing the loss of individual pieces of wood.

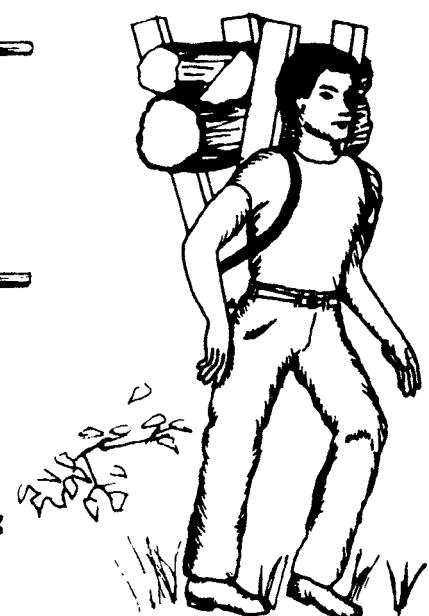
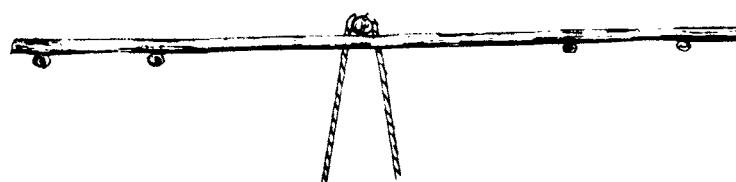
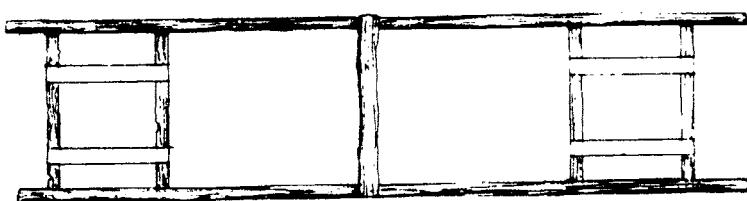


Fig. 92 - Two-man yoke for load carrying

A simple method of bundling is shown in Fig. 94 b. The two poles are approximately 1.3 metres in length. They are connected by a length of rope at a point about 30 cm from their lower end. In the

Fig. 93 - Back rack for carrying firewood

manner shown, cuttings may be compressed into tight bundles for tying. Another variation of bundling equipment is to fix the end of one of the poles to a stump or tree and simply have one moveable pole connected with a piece of rope (Fig. 94 a).

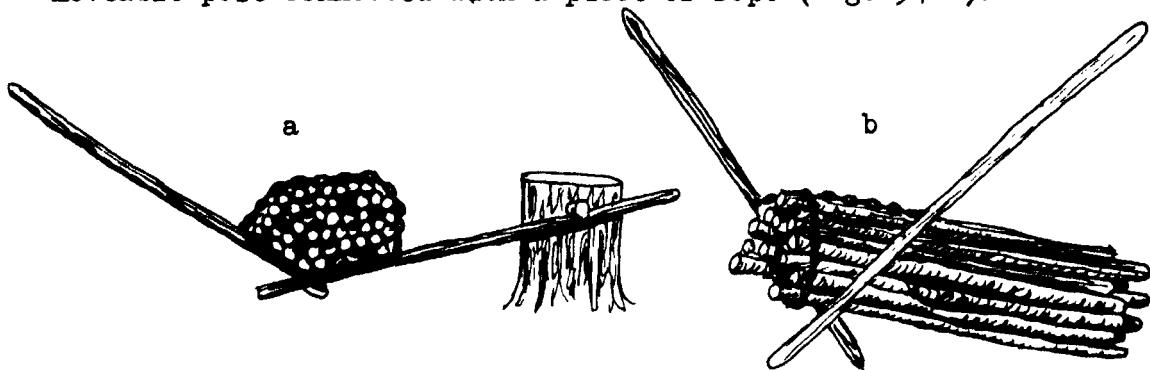


Fig. 94 - a) Using stump to permit bundling by one person
b) The method used in bundling poles

Wheelbarrows

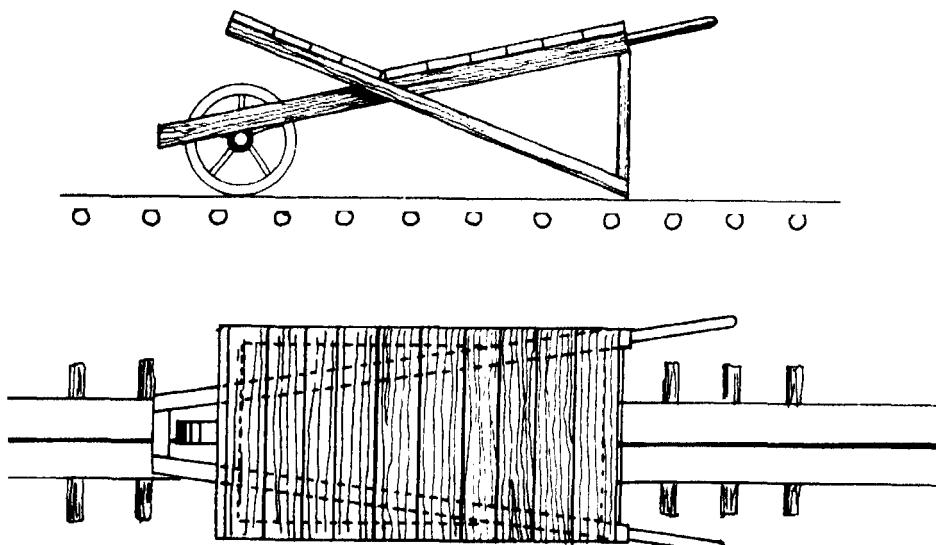


Fig. 95 - Use of wheelbarrow on narrow plank track

A number of different designs of wheel barrows are available. This is a very ancient form of transportation and is widely used throughout the world. It is an excellent method of manually moving short billets of wood on soft terrain if a narrow plank track is laid down on cross stringers to provide a road for such a single-wheeled vehicle (Fig. 95).

Wheelbarrows are made from pieces of lumber and the wheels themselves may be from other vehicles or may be made directly from wood (Fig. 96).

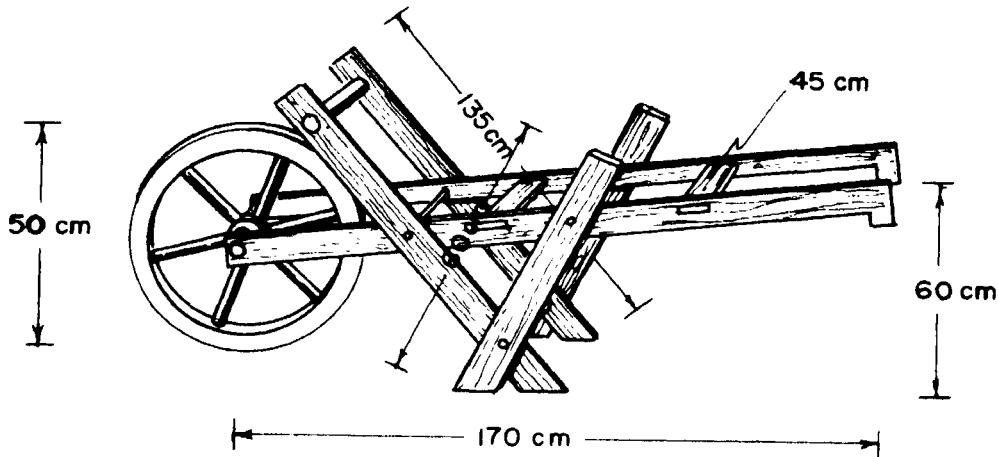


Fig. 96 - Wheelbarrow made from pieces of lumber

If no wheels are available or cannot be made, it is possible carry out the short billets of wood in a cradle. In such a devi two men are required, fore and aft. The cradles have handles an legs and permit the carrying of substantial loads of wood over forest trails.

Sledges

The transportation of fuelwood and smaller lighter billets wood requires different types of sledges than for large heavy lo

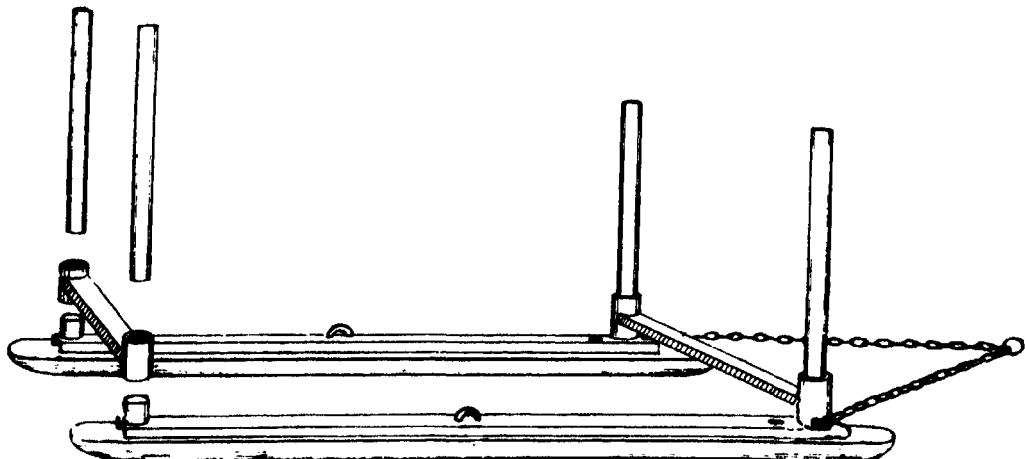


Fig. 97 - Sledge of pipe and angle iron

The sledge as depicted in Fig. 97 would be approximately 5 metres long, 1 metre in width overall, with runners 6 cm wide. The billets of wood are piled crosswise on the runners and are held in place with a rope binder from the rear to the front. One big advantage of such a sledge over a wheeled cart is that it is low and requires less energy to load than does a cart. It can be moved over soft terrain where wheels would sink. Another sledge made of pipe and angle iron can be readily dismantled.

A variation on sledge design has been used for transporting fuelwood. It is made from two discarded bowsaw frames, reinforced with some 3 cm diameter pipe and some 5 cm angle iron (Fig. 98).

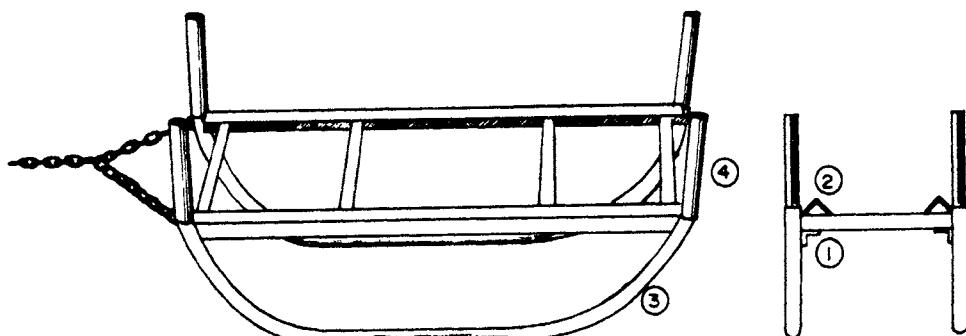


Fig. 98 - Sledge made from discarded bow saw frames

- (1) 5 cm angle iron on side rails and as cross pieces
- (2) Inverted angle iron welded in place. It will help prevent fuelwood billets from slipping sideways
- (3) Old bowsaw frames
- (4) 3 cm diameter pipe to form rack

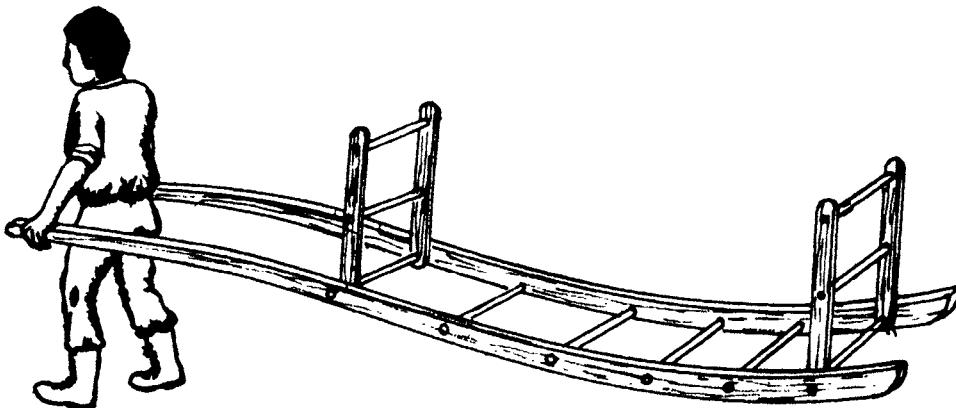


Fig. 99 - One-man sledge for transporting fuelwood

Hand-sulkies

The object is to raise the front end of the log off the ground to reduce dragging or sliding friction (Fig. 100) and pulling down hung-up trees.

In East Africa where draught animals are almost non-existent sulky designs have been well tested.

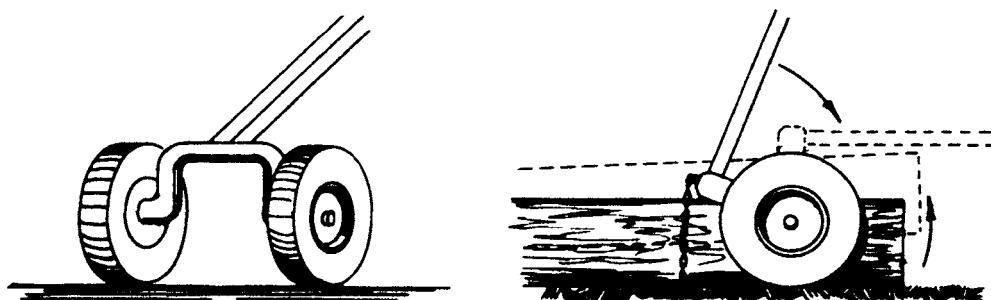


Fig. 100 - Lifting front end of log with light sulky arch

An arch of pipe, either round or square, in cross section is made with wheel spindles welded to the two ends. Wheels are mounted on these spindles and a handle, either wood or metal, is attached to the centre of the arch. If the handle is metal, it can be welded directly and, if of wood, can be fitted into a suitable socket welded to the arch. A removable handle may be more convenient for transporting the arch from one work site to another.

In operation, the sulky is wheeled or lifted into position over the log to be moved. By raising the handle of the arch, the arch is rotated around the axis of the wheels until it rests on top of the log. A light chain is fastened around the log while it is still lying on the ground. When the handle of the sulky is lowered to a near horizontal position, in relation to the ground, the front end of the log is raised.

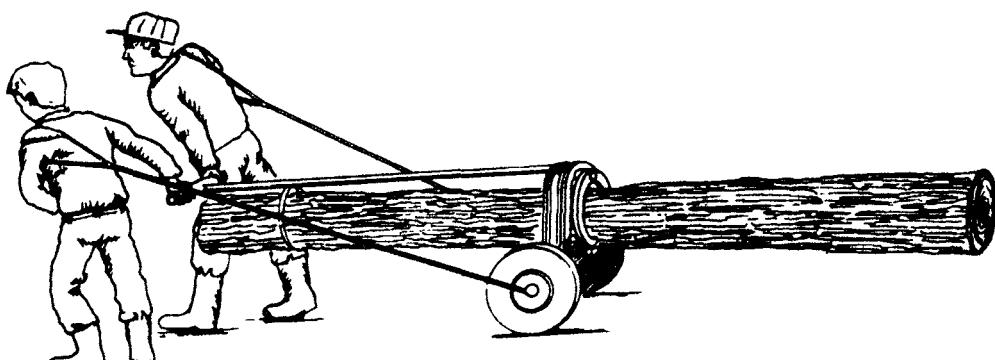


Fig. 101 - Two men moving log with light arch

A simple means of attachment for the chain is to weld a short length of 5 cm angle iron on top of the arch. Several slots are cut in the angle suitable to receive a chain link. This permits easy attachment and detachment of the load (Fig. 102).

Sometimes, instead of chains, tongs are used to hold the log (Fig. 103).

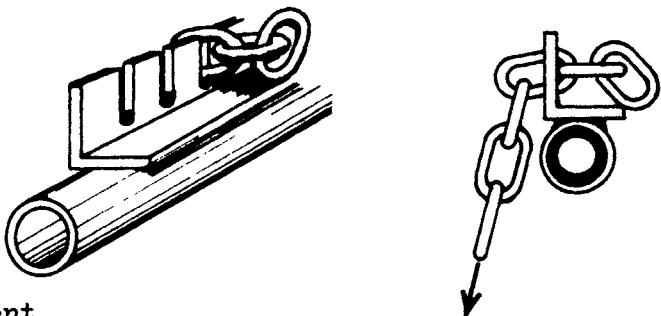


Fig. 102 - Method of chain attachment

With a manually operated sulky for moving larger logs, shoulder straps may be used. These normally fastened to the axle hub of the arch and two men with this equipment can pull very large logs. In this case the pole reach extends to the front of the log being moved and permits the men to manoeuvre the wheels around obstacles (Fig. 101).

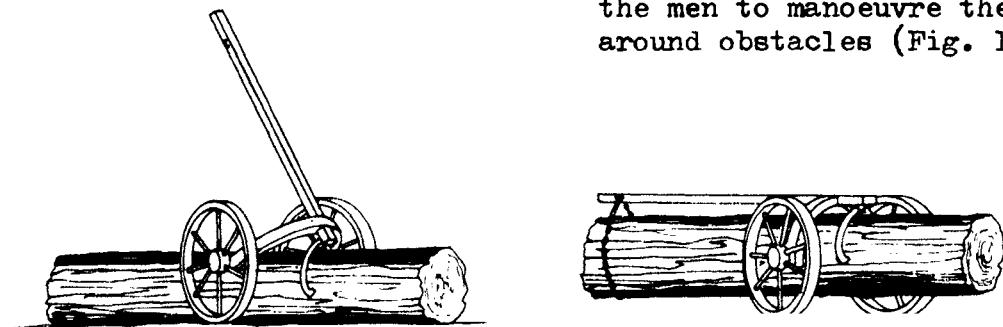


Fig. 103 - Use of tongs to hold log

Light wheeled sulkies are usually used for single logs. If many small logs or tree lengths are to be moved, cables rather than tongs should be used to raise the load off the ground.

The sulky can also be used when hangups occur.

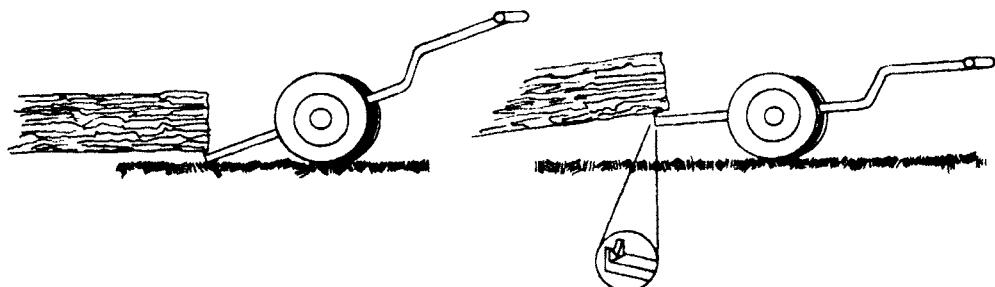


Fig. 104 - Lever principle to lift front end of log

Another variation of a log transport medium supports the front end of the log from its under surface, rather than suspending it from an arch. It is another application of the principle of the lever with the axle being the fulcrum, but the net result is that the front end of the log is raised and skidding resistance is greatly reduced when the log is pulled out of the forest (Fig. 104).

For skidding, sulky working techniques will vary with the steepness of the terrain. It should be carried out on downward slopes but also can be done on flat terrain. On terrain with steepness up to 10% the load should be chained near the point of gravity in order to avoid skidding resistance, the sulky operating as a forwarder. For steepness of 10% - 40% some braking power is necessary which is achieved by chaining the load so that up to 50% of it rests on the ground. This part acts as a drogue as a sailor uses.

Timber carriers

These are very efficient devices for dragging or carrying logs. One carrier with a man on each handle at the front end of the log permits the raising and dragging of the logs (Fig. 105). The use of two, three or more carriers with the accompanying labour will permit the carrying of logs clear of the ground (Fig. 106).

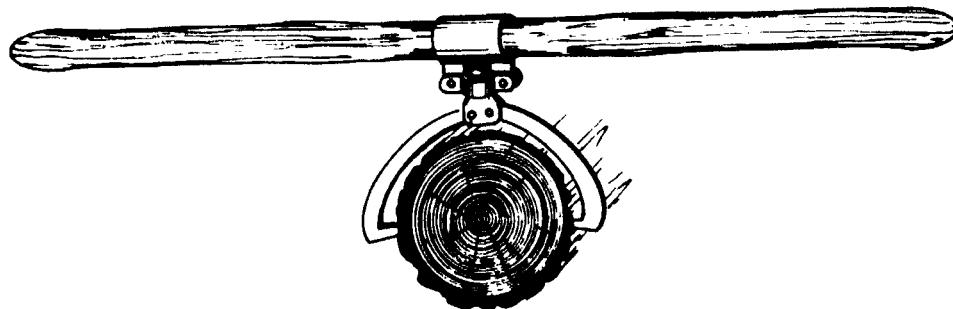


Fig. 105 - Timber carrier

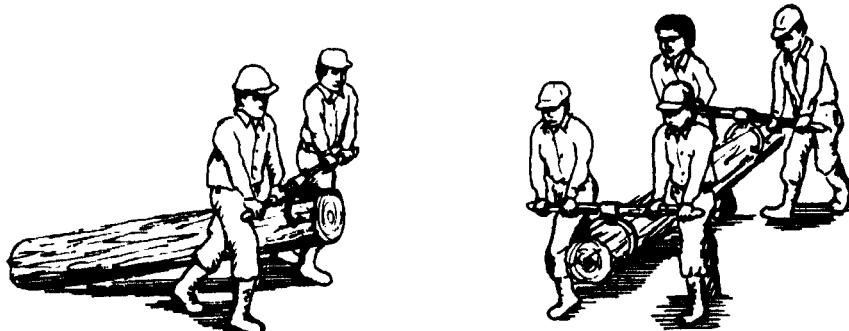


Fig. 106 - Dragging and carrying logs with timber carriers

When using the double hook carrier it is most important that the hooks be firmly set before attempting to lift the log.

To make the hardware for such a timber carrier is within the capability of a blacksmith or small machine shop.

To reduce the effort required for two men to drag a log or for four men to carry one, a pair of wheels on an axle could be used (Fig. 107). A set of small wheels, up to 40 cm in diameter,

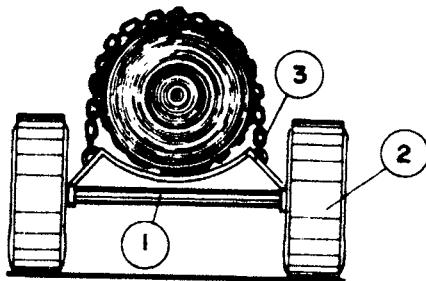


Fig. 107 - Set of wheels to support log

could be made from wood or, if slightly larger in diameter, old used motorcycle or automobile wheels could be employed. A bunk to receive the log would be fastened to the upper surface of the axle. If made of metal it can be welded in place. If made of wood it can be held in place by stout "U" bolts. The gauge of the cart should be about 1 metre or slightly less.

In operation the end of the log would be lifted and the dolly placed underneath it, with the log resting on the bunk. A chain is wrapped around the log to hold it in place on the bunk. The chain would be in two sections and should be pulled tightly around the log and fastened by means of a fid hook (Fig. 108). This is a link formed in the round and then shaped to have a narrow extension, wide enough to slip a chain link into it sideways. This type of fastening is easy to apply and easy to detach. The chain could be 1 cm in diameter and the fastening link slightly larger.

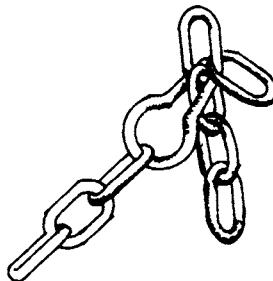


Fig. 108 - Fid hook chain fastener

Kuda-kuda and rolling

There are many simple aids to assist in the manual dragging or rolling of logs. The function of such aids is to reduce friction when dragging or rolling.

In developing countries this means of log transport is common along river banks and lake shores for distances up to 400 metres. The logs should be more or less cylindrical and usually no longer than 4 to 6 metres. The rollway is cleared of obstacles and is

made as straight as possible (Fig. 109 a). Sometimes curves are accepted if it means that large and often buttressed trees can be bypassed. Poles and tree lengths are laid down parallel and the logs rolled along them. If the ground is rough the poles may require cribbing or other forms of support.

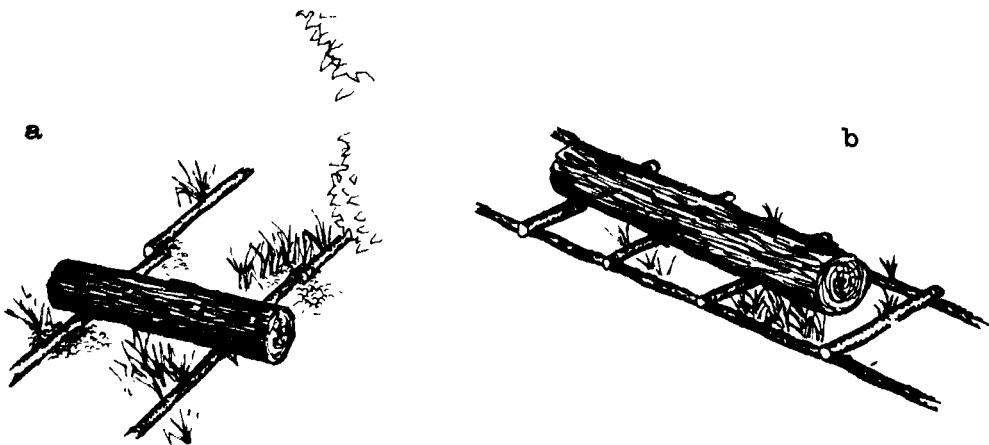


Fig. 109 - a. Pole rollway for logs
b. Use of rollers on rollway

Another version in using such a rollway is to cut a number of cylindrical rollers, four to five in number, and use these as rollers for large logs moved longitudinally along the rollway (Fig. 109 b). The rollers must be moved ahead as they come free.

The rollway and Kuda-Kuda systems still used in Malaysia, Indonesia and Burma, employs a sledge to carry the log and a track of cross members, or skid road, over which the loaded sledge is pushed and pulled (Fig. 110).

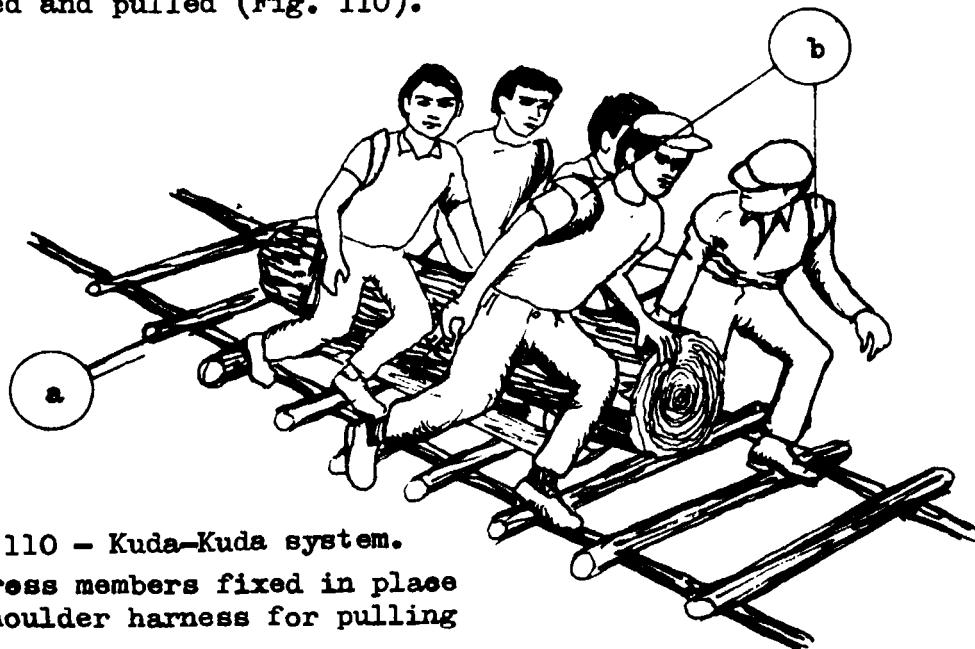


Fig. 110 - Kuda-Kuda system.

- a. Cross members fixed in place
- b. Shoulder harness for pulling

Stringers are notched to hold cross members (a) in place. Sometimes they are spiked or tied in place with rattan. Cross members are spaced to permit a man to step with comfort, about 0.5 m centre to centre. Usually, there are four to six men to a sledge and they wear a shoulder harness (b) of wide material to prevent cutting into their shoulders. The harness is fastened by a rope to the sledge.

When rolling logs onto the sledge, posts are driven into the ground or braced against the back runner to hold the sledge firm and to prevent it from moving sideways during the loading operation.

The sledge runners are rounded at each end so that it can be moved forward or backward without the need to turn it end for end. The profile of the runners is round, in order to have minimum contact with the cross members of the track. The runners are not shod with metal. The bunks of the sledge are designed to hold the runners apart and they are further strengthened with braces. Holes are drilled in each end of the runners for attachment of the rope, cable or chain which extends to the harness of the men pulling the sledge (Fig. 111).

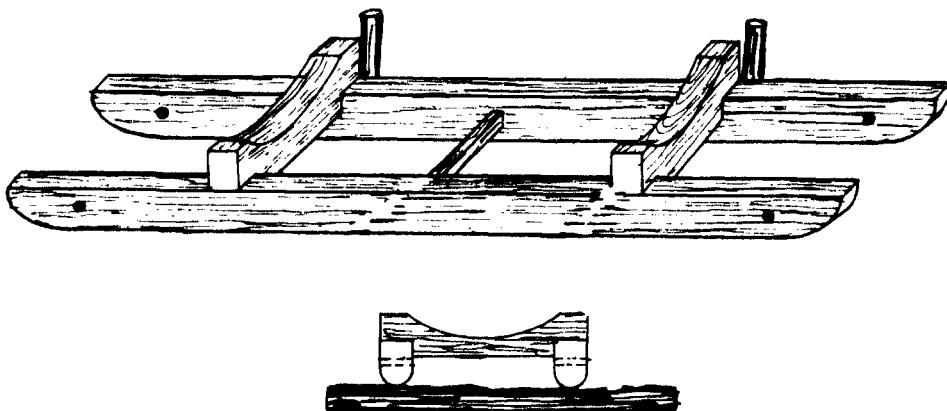


Fig. 111 - Kuda-Kuda sledge

In operation, besides being pulled by men with a harness, pegs are sometimes driven into the log to provide hand holds for men to push and/or pull. In order to make the transport easier, both runners of the sledge and cross members are lubricated with some oil or grease which will reduce the friction. An advantage of the Kuda-Kuda system compared with rolling, is that a much narrower clearing in the forest is required.

Narrow gauge railway

If it is possible to obtain old light gauge rails, these make an excellent track for moving logs (Fig. 112). A narrow right-of-way can be cleared in the forest. Trees are cut low, or areas might even have stumps removed. Cross members are placed at

approximately 0.6 metres centre to centre. Such cross pieces should be approximately 2 m in length.

Stringers sometimes may be laid longitudinally to level up the track, and sometimes they are notched to hold the cross members or ties.

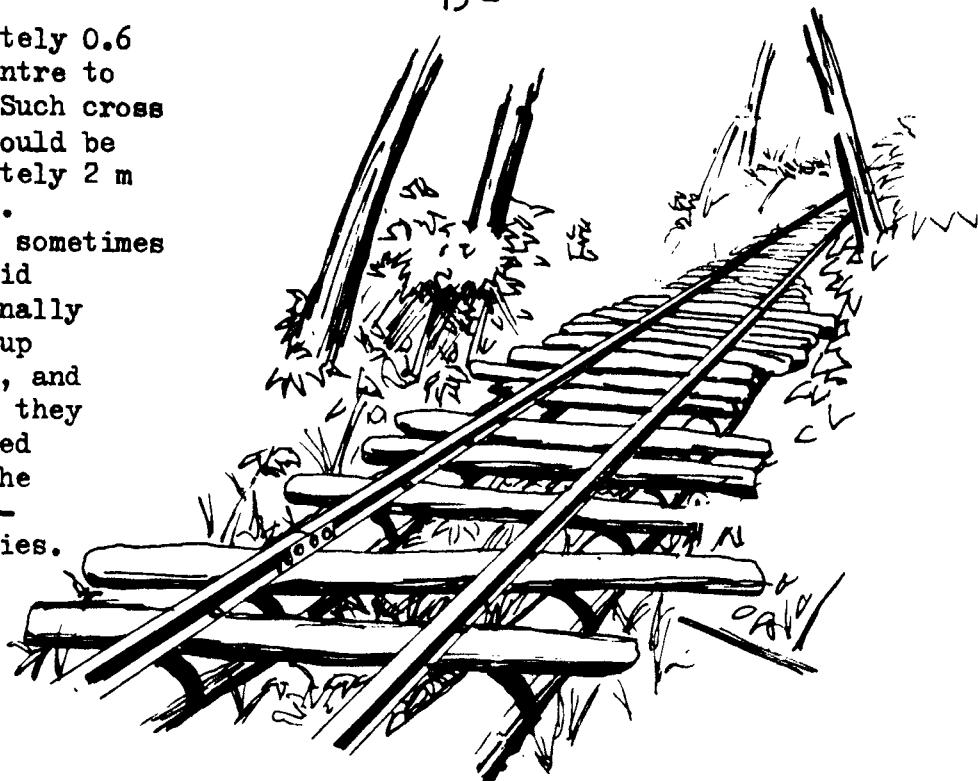


Fig. 112 - Narrow gauge railway

The light rails are fastened to the cross members with railway spikes. A plank track on which men, pulling or pushing a wagon, can walk is laid down between the rails. This makes the work much easier than walking directly on the cross members. A light framed wagon, mounted on an axle bearing light railroad wheels is constructed. The logs are loaded on the light wagon and are pushed or pulled manually to their destination (Fig. 113).

Pole track

Yet another variation of a rail system is the pole track (Fig. 114). Instead of light gauge rails, which frequently are not readily available, long poles or

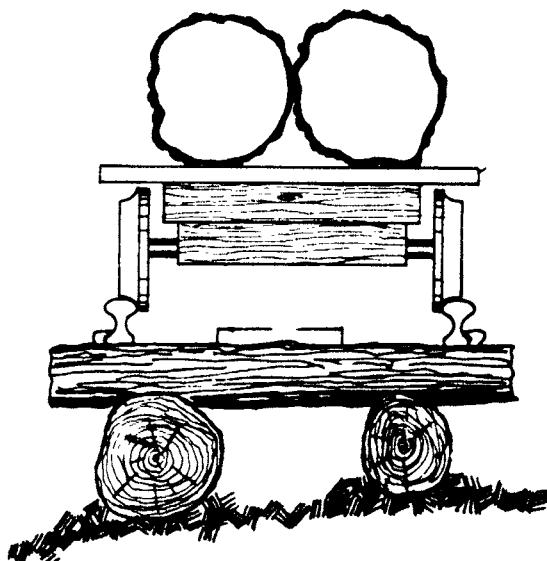


Fig. 113 - Cross section of narrow gauge railway track and wagon

tree lengths are used as rails. The wheels of the wagon are made of wood and are deeply grooved so that they will stay on the poles. Because of crook, sweep and taper of trees, it is not possible to keep the longitudinal rails or tree lengths apart as accurately as in the case of light steel rails. To accommodate this the deeply grooved wheels of the wagon are mounted on their axles in such a manner that they can move in and out on the axle. In this manner they track well even over considerable irregularities. It is sufficient in most cases to lay the cross members 1 to $1\frac{1}{2}$ m apart. The longitudinal poles can be bound to the cross members with wire or they can be spiked in place. If wire is used, it should be countersunk so that it will not be cut by the wheels. A plank walkway or a walkway of light poles is laid down to be used by the workers pulling and/or pushing the log wagon.

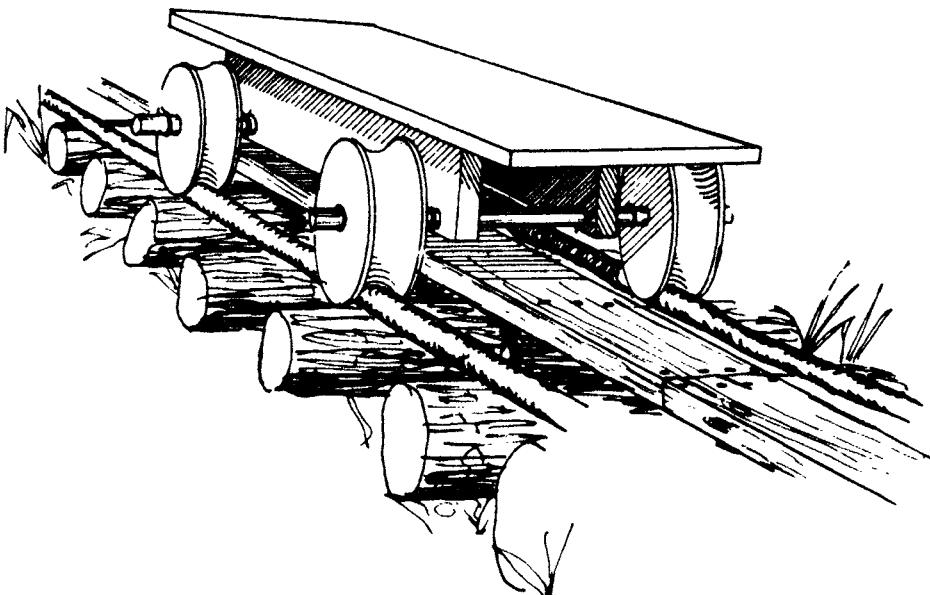


Fig. 114 - Pole track

Logging incline

Another possibility when moving wood up or down steep slopes is a wooden track on which a wagon carries the load. The track is of a similar construction as a light gauge rail or pole track with square wooden rails and cross members of otherwise unusable poles, logs and billets.

The wagon is equipped with flanged wheels to stay on the tracks and is built with loosely coupled sections between the front and rear wheels, so that it can follow the irregularities of the track. The wagon is normally pulled by cable or lowered by a cable depending upon the operation. The power source is located at

the top of the slope, whether a winch to wind up the cable (or pay it out), animal power, or a tractor which can move back and forth as required.

If loads are lowered by such an incline, a braking system can be installed at the top of the slope to control the wagon load of logs in its descent.

Log chutes

Chutes have been used for centuries to move wood off steep hillsides. Permanent pole-type chutes are still used in many parts of the world. Metal chutes of steel have also been used and, during the last years, also chutes made of plastic.

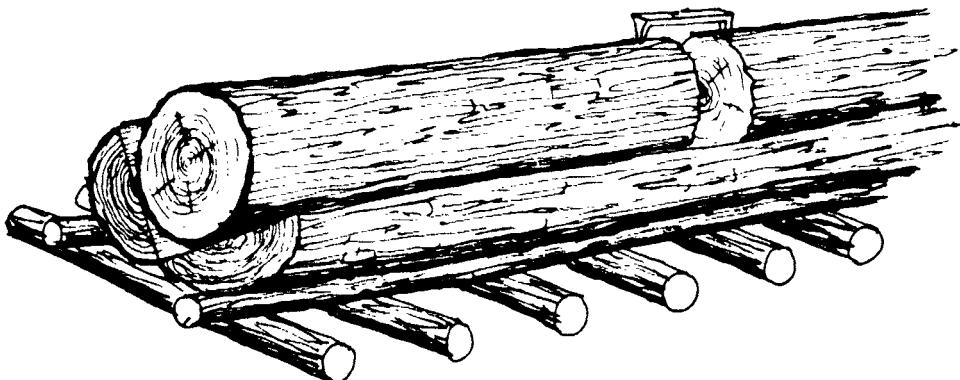


Fig. 115 - Trailing chute

Most chutes depend on the force of gravity to move logs down slopes, but not all chutes are constructed and used in steep terrain. Sometimes so-called trailing chutes are used on flat terrain and logs are moved over long distances by animal power and over shorter distances by manual power (Fig. 115). The purpose of such drag chutes is the same as the skid road, Kuda-Kuda system, pole track, etc., to move logs with a minimum of effort. The drag chute can be made from logs or long tree lengths split longitudinally. The halved logs are laid on the stringers and supported by wedges or smaller poles. The angle between the faces of the two sides of the chute should be as close to 90 degrees as possible. If considered necessary, the faces of the chute can be lubricated with old crank case oil or any material that will lubricate the surface and reduce friction between the log and the chute. Often it is enough to wet the slide with water.

If animal power is available, logs can be fastened end to end up to the capacity of the draught animals.

Portable chutes can be made of planks in a size and manner which permit their easy assembly and dismantling (Fig. 116). Such chutes permit the transport of short logs and bolts over steep difficult terrain. Curves can be used round obstacles with the banking of the chute. Chute sections are normally laid in the ground with some blocking or support by stones, pieces of wood, etc. Chute sections can be combined to lengths up to 100 m. Hardwood boards are found to be superior to softwood.

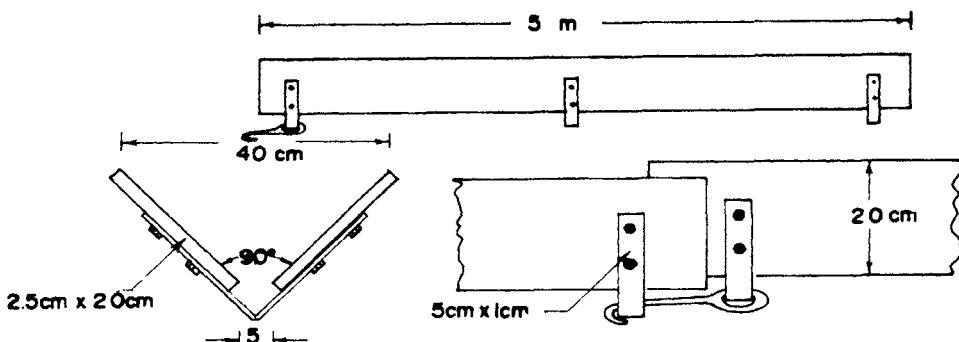


Fig. 116 - Portable plank chutes

Flat iron 1 cm x 5 cm is bent at an angle of 90 degrees. Six holes are drilled in each piece of flat iron to make 1 cm diameter bolts. The wooden planks are drilled similarly and the heads of the bolts are countersunk into the wood so they will offer no obstruction to sliding logs. Three bolts are required in each bracket for strength and rigidity. The 5 cm gap left between the bottom edges of the two boards permits bark and debris to drop through and not form an obstruction.

Moving loads with animal power

Skidding harness

Donkeys and mules are used as draught animals in many countries. Draught horses are less common as they are more susceptible to heat, insects and disease.

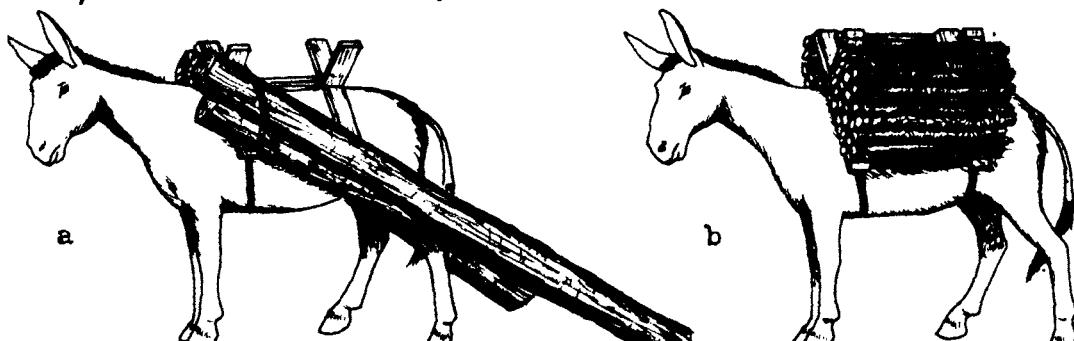


Fig. 117 - Donkeys or mules to drag or carry loads of wood

Draught animals are used to carry or drag loads. Usually shortwood is carried by animals using special saddle racks (Fig. 117 b) and longwood is skidded with one end fastened to the saddle and the other end dragging (Fig. 117 a).

When skidding long logs or poles with mules the minimum harness is best. In all cases a collar is required because draught animals, with the exception of oxen, pull with their shoulders.

Two possible harnesses are illustrated, the use of collar chains (Fig. 118 b) and a single tree and a trace harness (Fig. 118 a).

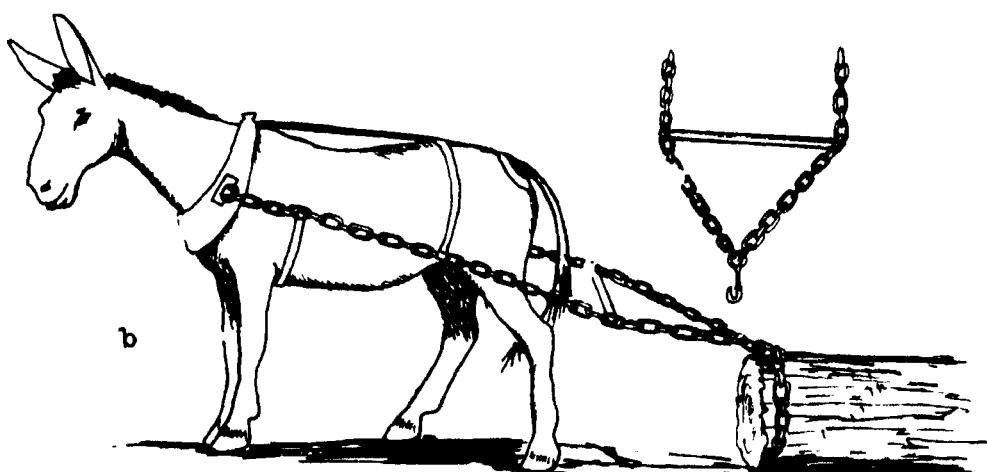
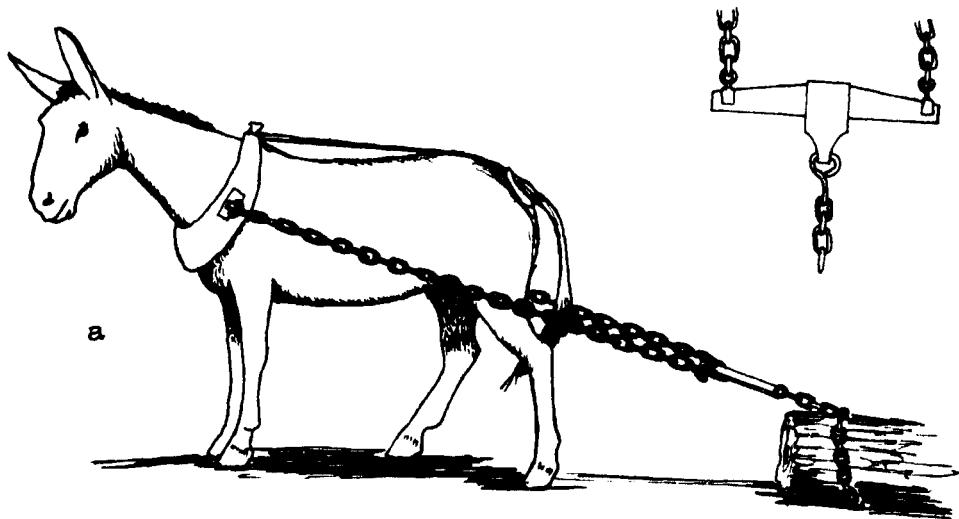
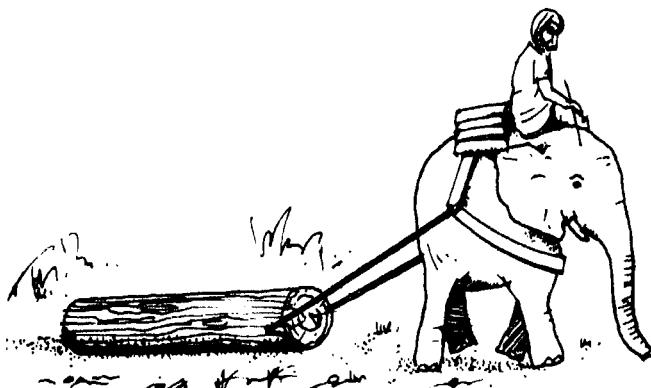


Fig. 118 - (a) Single tree and trace harness
(b) Use of collar chains

If donkeys or mules are used in transporting loads of short-wood, usually the wood is made up into bundles and then fastened to the saddle rack.



Whether the wood is short or long, it is important that loads be balanced as well as possible on each side of the animal to reduce the strain imposed on it.

In Thailand, Burma, India and Sri Lanka elephants are used for skidding and transport of logs. A harness as shown in Fig. 119 seems to give best results.

Fig. 119 - Skidding with elephant

Animal drawn arches and drays

Manual operated arches - also called sulkies - have been mentioned previously (page 66) but animal or tractor drawn arches are also a common equipment for transport of logs (Fig. 120).

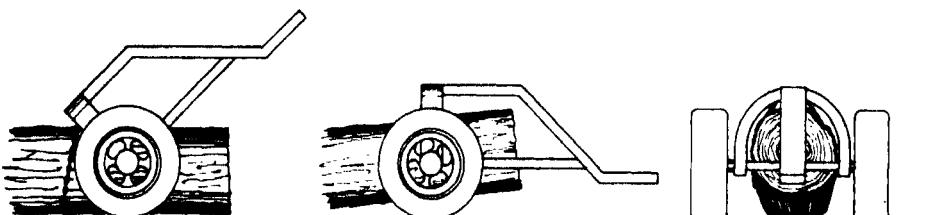


Fig. 120 - Arch with old automobile tires

Drays or other dragging devices are used for long and short wood terrain transport (Fig. 121). Sometimes wheels and skids are used in combination so that on hard ground advantage can be taken of the wheel's characteristics, while on soft ground the skid can pass over where the wheel may become stuck.

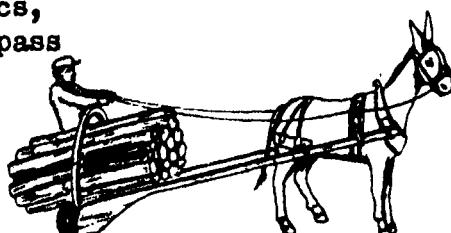


Fig. 121 - Wheels and skids in combination

Old car springs mounted on a rod with spaces between (Fig. 122). The advantage to this is that, unlike a solid pan, which tends to overturn when one side or the other strikes an obstacle, here the individual springs ride over the obstacle they meet while the others are undisturbed. The ends of the logs being transported rest on the springs and are hooked onto the cross rod with rope, wire or light chains.

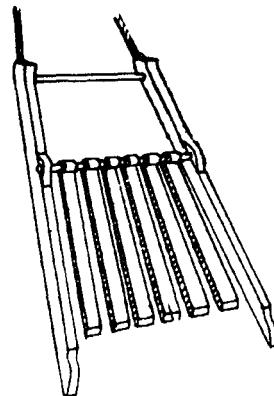


Fig. 122 - Skidding device from old truck springs

Another variation of the animal-drawn dray is an arch made of round pipe fitted onto two skids in the manner as shown in Fig. 123. The pipe arch pivots on a bracket on each skid so that, when it is pulled into place over the load of logs, the arch can be lowered, to rest on top of the logs, towards the end of the pile. A chain is passed around the logs and fastened. When the dray is pulled forward, the load is such that the arch is raised into an upright position, held thereby a chain from the arch to the front of the dray runners.

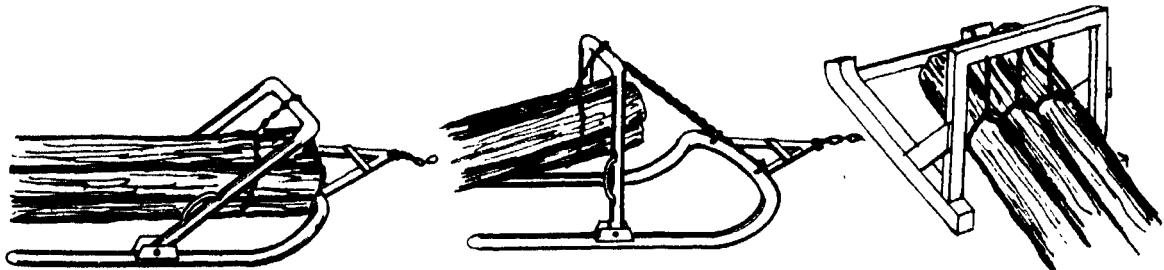


Fig. 123 - Load elevating arch dray

Fig. 124 - Simple dray with arch

A similar principle is used in the simple dray illustrated in Fig. 124. The forward movement of the dray, counteracted by the friction of the logs, holds the arch upright and the front end of the logs off the ground.

A skidding sledge of Norwegian origin consists of light wooden runners, held apart by a cross piece and fastened to shafts with a pivot (Fig. 125). The draught animal (mule, donkey or horse) is backed into position so that the sledge is forced upside down with its bunk resting on top of the log. The log is fastened to the bench by a chain and, when the draught animal moves forward, the sledge pivots on the back end of its runners,

lifting the front end of the log upward and forward so that the log ends up with its front end resting on the bench. The bench is a saw-toothed piece of iron running its length to dig into the bark of the log and to prevent its slipping backwards off the bench. Such a sledge could be modified to be hauled by a small tractor.

A simple transport device for short wood is the skidding cradle (Fig. 126). One example of it was formed from an old gasoline tank from which the ends had been removed. It was one-quarter of the tank wall. It has been found particularly useful in bringing shortwood down off steep terrain. As shown in the diagram, the "U" clamps are bolted to the plate front and rear. The plate itself is 2 mm thick x 1.25 m wide and 2.5 m long.

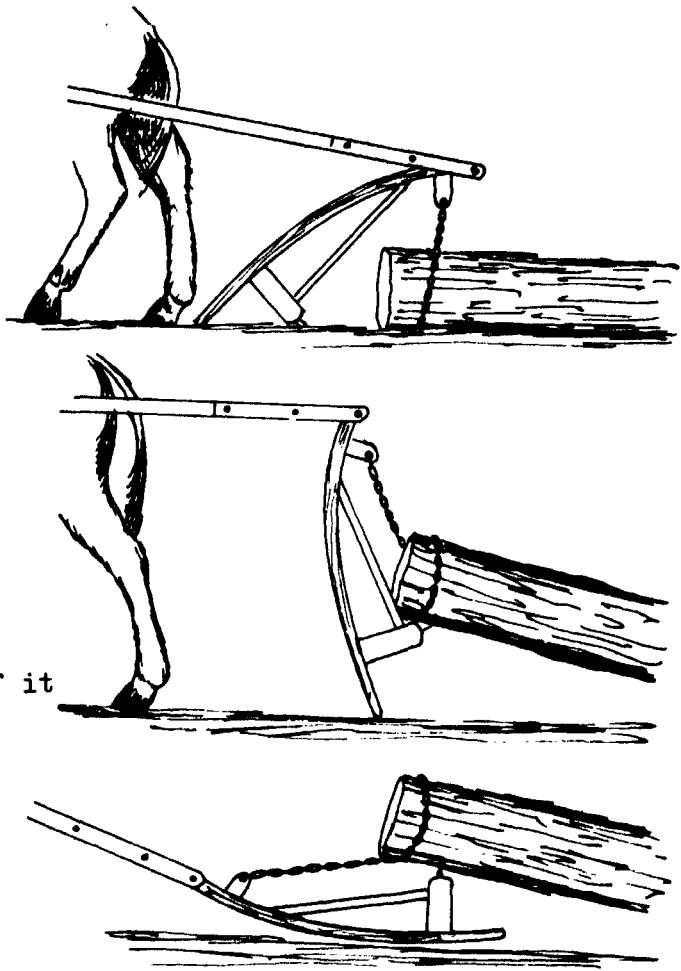


Fig. 125 - Norwegian skidding sledge

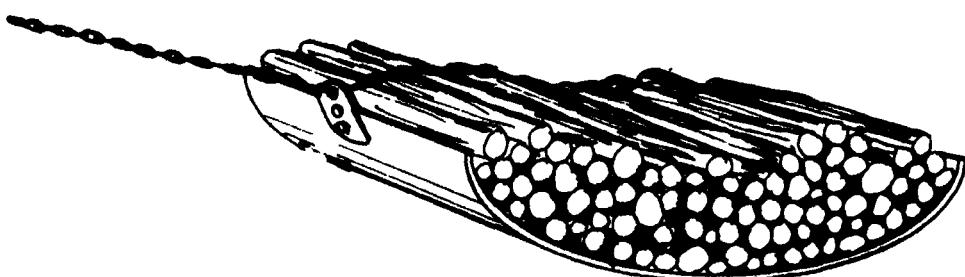


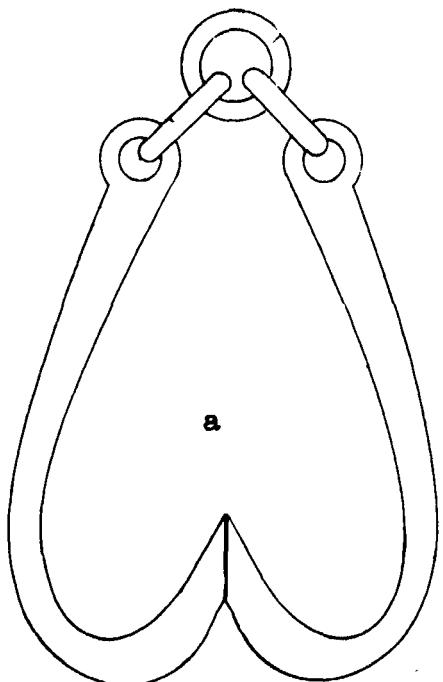
Fig. 126 - Skidding cradle

The normal draught power of various animals

Animal	Average body weight (kg)	Approximate draught (kg)	Average speed (m/sec.)	Power developed (HP)
Light horse	400 - 700	60 - 80	1.0	1.0
Bullock	500 - 900	60 - 80	.6 - .85	.75
Buffalo	400 - 900	50 - 80	.8 - .9	.75
Cow	400 - 600	50 - 60	.7	.46
Mule	350 - 500	50 - 60	.9 - 1.1	.70
Donkey	200 - 300	30 - 40	.7	.35

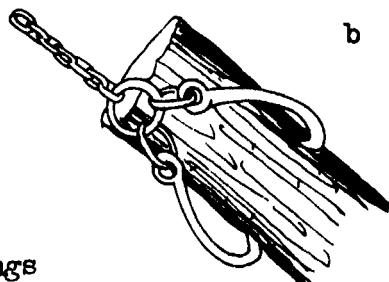
Skidding tongs

These tongs were developed for skidding long length small-sized trees by mules in the southern United States. The skidding distance seldom exceeded 50 metres and the mule could make 10 to 12 round trips per hour.



a

The design of the tongs is shown in the diagram. The ring, which is fastened by chain to the mule harness, is made from 28 cm of 1.5 cm diameter mild steel. The two rings as shown are made from 20 cm of 1.25 cm diameter mild steel. The tong arms are each made from a 55 cm piece of 2 cm diameter carbon steel.



b

Fig. 127-Skidding tongs
a. Shape of elements
b. Elements in action

Skidding cones and pans

When animal or mechanical power is available, there is a much wider choice of log transporting devices and methods than when manual power alone is used.

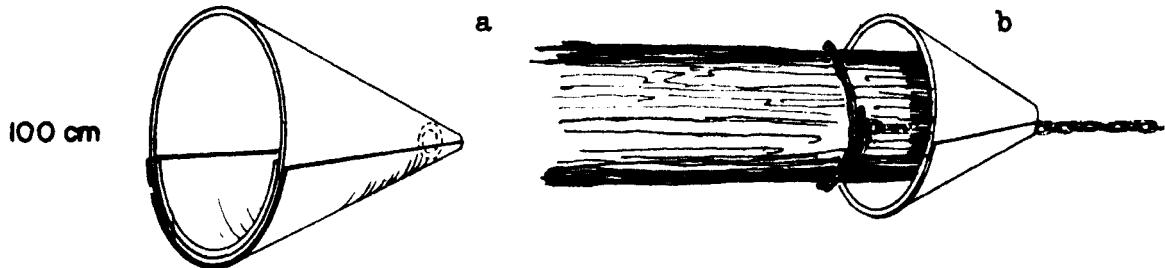


Fig. 128 - Skidding cone a. Shape of elements b. Action in use

When ground skidding logs, one disadvantage is that the front end of the log tends to dig into the ground and pile up earth in front of it. This greatly increases the effort required to move the log. A number of devices have been developed to reduce this effect. One already discussed is to lift the front end of the log off the ground. Another device is the skidding cone which fits over the front end of the log to prevent hangups, to reduce skidding friction and to reduce damage to standing trees as the load slides past.

One way to make a very useful skidding cone is to take a sheet of 2 mm thick metal, 1.5 m in diameter. It is marked and cut into quadrants and folded into a cone. This will result in one thickness of metal on the upper segment and three thicknesses on the lower. The outer edge of the folded metal should be welded. A shackle, 1.5 cm in diameter is bolted through holes drilled through the three thicknesses on the lower side. In use a skidding chain is passed through this shackle from the choked log to the tractive source. The heavy bottom of the skidding cone will absorb considerable wear and tear and, because of its weight, will tend to keep the cone oriented (Fig. 128).

Another version for a suitable skidding cone is by forming a parabolic shape from sheet steel 2 mm thick. The shape can be rounded by forging and the edges joined by welding. A hole is cut in the nose of the cone and this is reinforced by welding a ring of round iron 1.5 cm in diameter around the hole. This will withstand abrasion and wearing forces exerted by the skidding chain (Fig. 129).

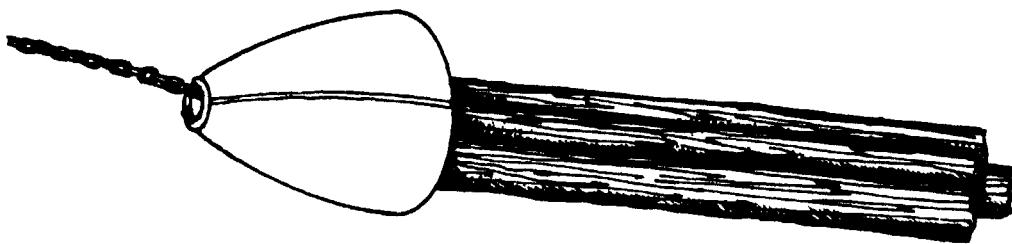
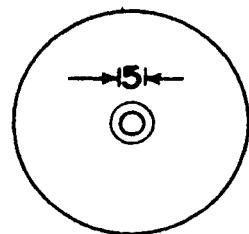


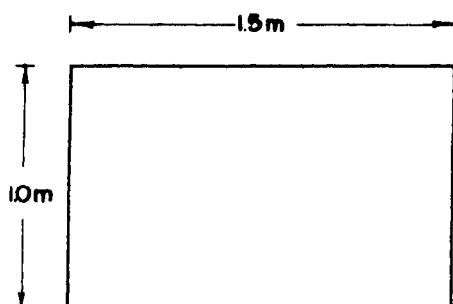
Fig. 129 - Parabolic skidding cone

A skidding pan with nose cone can also be made from a rectangular piece of metal in which the front corners are folded back so that the front of the skidding pan is pointed and shaped to reduce friction. The front end of the log or logs being skidded will ride on the metal pan, keeping it oriented (Fig. 130 a.)

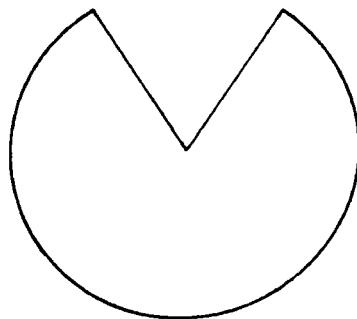


50cm

In the efficient use of the skidding pan, which can greatly reduce the effort involved in skidding logs, the logs to be moved should have one end raised off the ground by piling them on a cross log.



a



b

Fig. 130 - a. Skidding pan with nose cone from rectangular piece of metal
b. Skidding cone from circular piece of metal

This simplifies the operation of putting a chain under and around the logs. The skidding pan is placed at the end of the pile and the chain is fastened around the load of logs. As the animal moves forward, the front ends of the logs are pulled forward onto the skidding pan. The chain from the single tree is then drawn short and fastened.

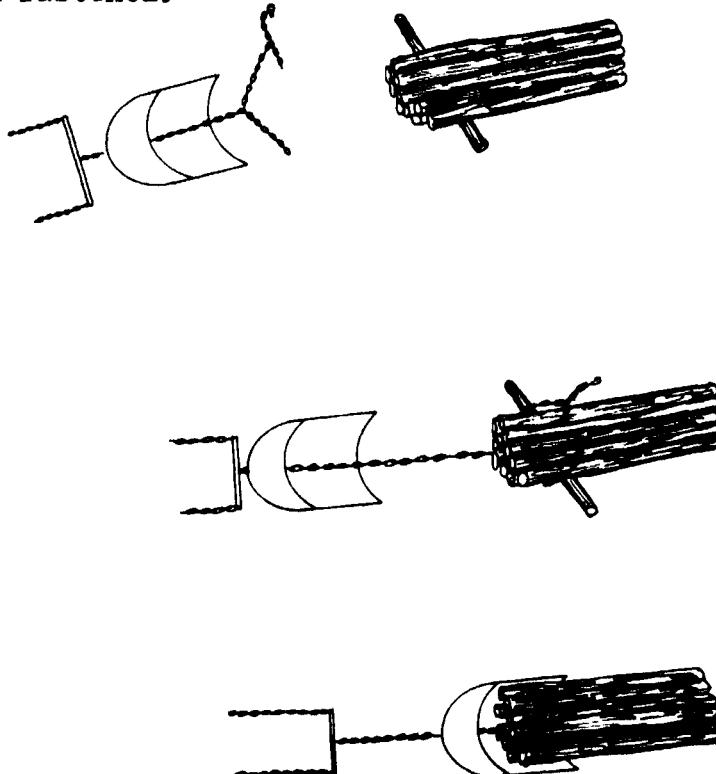


Fig. 131 - Operational use of skidding pan

Big wheels

Big wheels were developed for use with animal power.

The equipment is elementary as it consists of a pair of large diameter wheels on a stout axle (Fig. 132). Wheels up to 4 m in diameter were used although the more common sizes were 2.5 to 3 m in diameter. In the centre of the axle a long beam is fastened, projecting fore and aft from the wheels. The forward beam or tongue was the longer. Immediately behind the axle on the beam is hung a set of log tongs or a set of grab hooks to be used with a length of chain.

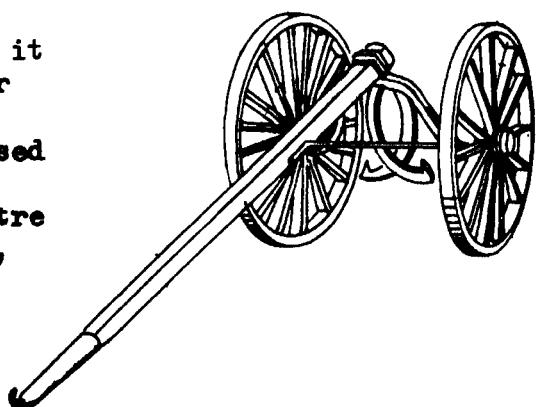


Fig. 132 - Big wheels

The set of big wheels is backed over the log on the ground. The tongue or forward end of the beam is raised in the air so that the short "after beam" goes down then the log is secured with the tongs or chain. When the tongue is pulled down parallel with the ground, it is fastened with a length of chain to the front end of the log.

Another version of the big wheel is called the slip-tongue log cart, because its tongue, which is 9 m to 10 m in length, slides back and forth between guides on the axle (Fig. 133). There is a roller directly over the axle and, fastened to this roller is a lever arm, which is attached to the sliding tongue by means of a chain. The wheels are driven over a log, a catch holding the lever arm and the slip tongue is loosened. As the animals back up, the roller revolves in a quarter circle moving the lever arm, which

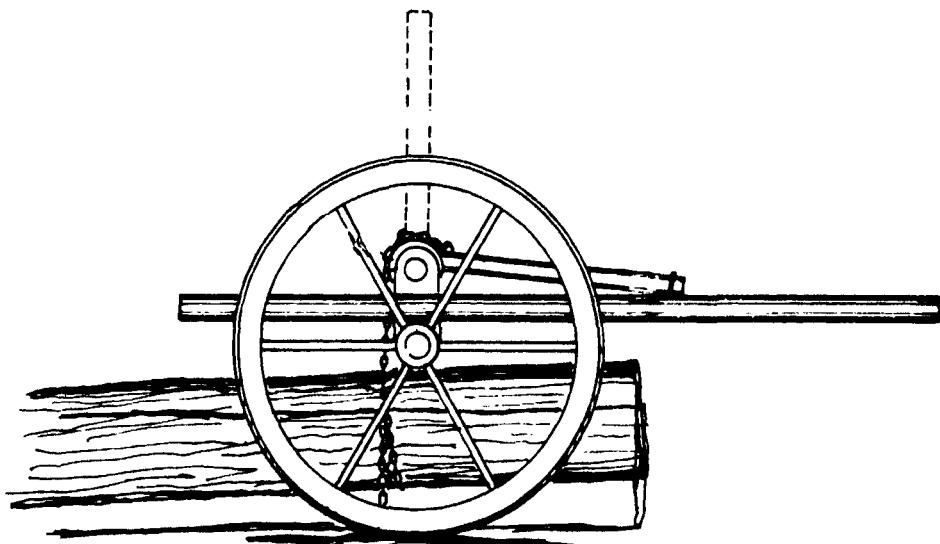


Fig. 133 - Slip-tongue log cart

is in a vertical position. When the animals move forward, the slip tongue slides forward, the lever arm is pulled forward into a horizontal position and this raises the front end of the log or logs off the ground. The lever arm is pulled down and fastened tightly to the tongue and the big wheels and its load are ready to move out to the landing.

Similar devices to the big wheel have been developed for use with tractors, both tracked and wheeled.

Oxen logging

The use of oxen in forest operations was at one time used throughout the world.

The low productivity (pulling force) of oxen and the need for a special training programme for the oxen has resulted in their replacement by machines in most parts of the world. However, in specific circumstances oxen have their place and can be used to advantage.

For logging with oxen yokes are used rather than harnesses. There are two types of yokes used, the shoulder yoke and the head yoke. The reasons for the use of the two yokes is primarily tradition. Few, if any, studies have been made of the relative effectiveness of the two. It is claimed that for logging purposes the head yoke is the most efficient and that oxen equipped with head yokes can produce 200 per cent more than oxen equipped with the shoulder yoke.

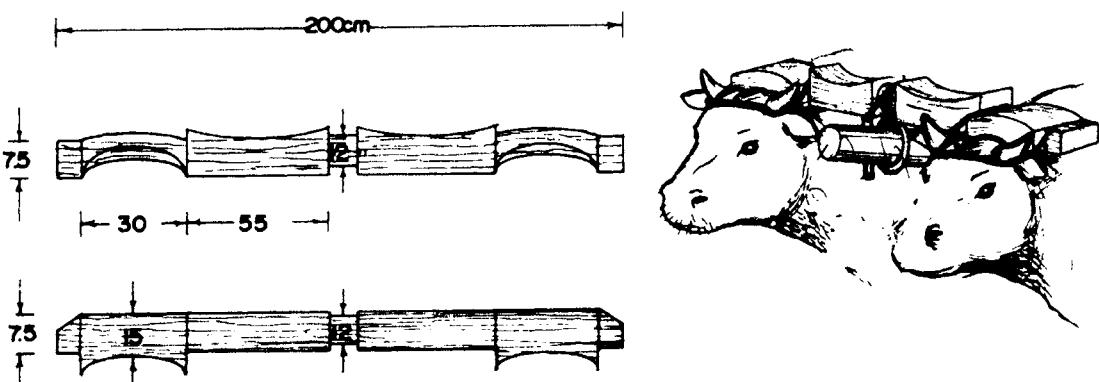


Fig. 134 - Oxen head yokes

The head yoke consists of a solid piece of timber, shaped to set on the upper part of the animal's neck and to be firmly attached to the animal's horns by means of a leather strap. The yoke timber will vary from 1.8 to 2.6 m in length. Three leather straps are used to attach the yoke to the horns and to attach the ox cart or skidding chains to the wooden yoke.

The yoke should be as light as possible, while being sufficiently strong to withstand normal wear, capable of withstanding a load factor of about 500 kg suspended from its centre point. The overall weight of the yoke will be 12-15 kg depending upon the density of the wood from which it is made. Great care must be taken to ensure that the neck saddle fits comfortably and does not chafe.

When attaching the wooden yoke to the animal's horns, care is taken to ensure that the rawhide strap is always between the wood of the yoke and the animal's horns to prevent rubbing and wearing away the horns' surface. The yoke must be attached tightly to the animal's horns to limit the movement of the neck saddle so as to cause the animal minimum discomfort.

The advantages of the head yoke over the shoulder yoke are claimed to be:

1. Greater use is made of the animal's weight as a power source. The yoke is firmly attached to the animal's horns as against free movement on the shoulders. Pull is more even with no loss of power in taking up the slack as is the case with movement of the shoulder yoke.
2. As the two oxen in a team are firmly yoked together, they operate better as a team and coordinate their movements together making maximum use of their combined pulling power.
3. When actually skidding logs the animals adapt themselves to controlling the movement of the timber by raising or lowering their heads which in turn increases or reduces the pull required to move the logs.
4. Oxen can be trained to pick up loads at awkward angles by facing the load, then pulling the load clear by walking backwards until the load is free of obstacles ready for normal skidding in a forward direction.

Oxen must be trained in skidding logs. Training usually starts at three years of age. The first step in training is to win acceptance of the head yoke. This is followed with further training to pull ox carts. Young oxen are trained by partnering them with mature oxen which must have the strength to dominate the younger animal. The normal period of this stage of training is three months. The final training period is in the forest where a young animal is paired with a mature, trained animal and finally with another one his own age. The full training period is six to twelve months, but usually the animal is not considered fully trained until he has reached maturity at about five years of age, and is capable of handling full loads. The average working life of oxen is 10-12 years.

If logs are being skidded, the front end of the log is fastened to the yoke with a 1.25 cm diameter skidding chain. If an ox cart is to be fastened to the yoke, a loop of iron is fastened to the yoke with rawhide. The pole of the ox cart is placed through

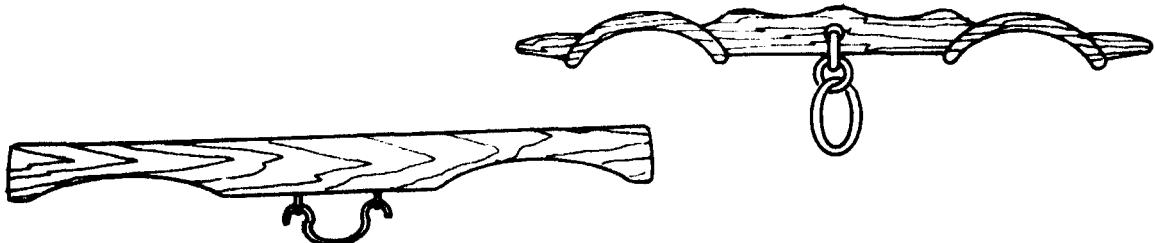


Fig. 135 - Variations of oxen head yokes

the ring and a pin is dropped through a hole in the shaft to hold it in place against the ring (Fig. 135).

Studies have shown that the maximum skidding distance with a team of oxen is about 50 metres on the level, about 15 metres uphill and 200 metres downhill on slopes of 25 per cent. On the level loads will average about half a cubic metre, skidding uphill loads will average a fifth of a cubic metre and skidding downhill some half to three-quarters of a cubic metre.

The head yoke allows extra volume to be added to the load being skidded as the weight is lifted at the front end by the oxen as they lift their heads to walk forward. Obstacles such as stumps are either lifted over or swung around, as opposed to being caught and hit full on with a straight drag off the shoulder. If the load from a head yoke does tend to slide forward so as to get in front of the oxen, then the animals automatically lower their heads slightly and lay the load on the ground.

Properly trained oxen can work successfully in the most difficult conditions where machines would have problems to operate efficiently, if at all, such as handling hardwood logs on muddy downhill slopes exceeding 33 per cent.

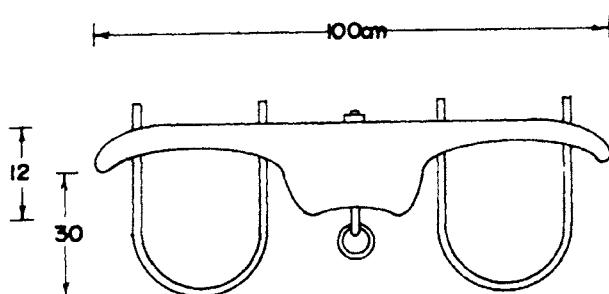


Fig. 136 - Oxen shoulder yoke

The shoulder yoke is more complex to make than is the head yoke. It is made from a rough hewn rectangular piece of wood 1 m x 10 cm x 12 cm. The shape and dimensions will be similar to those shown, but the final size and shape will depend on the size of the oxen. The load to be pulled is fastened by chain to the ring in the centre of the yoke, whether

a cart or logs. The weight of the load being dragged pulling on the ring holds the yoke firmly in place on the oxen's shoulders.

Cable logging

A simple cable system such as the pendulum cableway was widely used in the past. The pendulum cableway can usually be operated without power. The system and other basic but effective systems are described and illustrated in Professor Ivar Samset's publication entitled "Winch and Cable Systems in Norwegian Forestry", 1981. Simple feeding and braking methods for the pendulum system, reproduced from this publication and shown in Figures 137 to 139 are given since they may also prove useful in other situations.

Logs are rolled out onto the load chains from the storage deck (Fig. 137 a). After the chain has been fixed to the carriage and the load chains have been released, the downhill transport starts (Fig. 137 b).

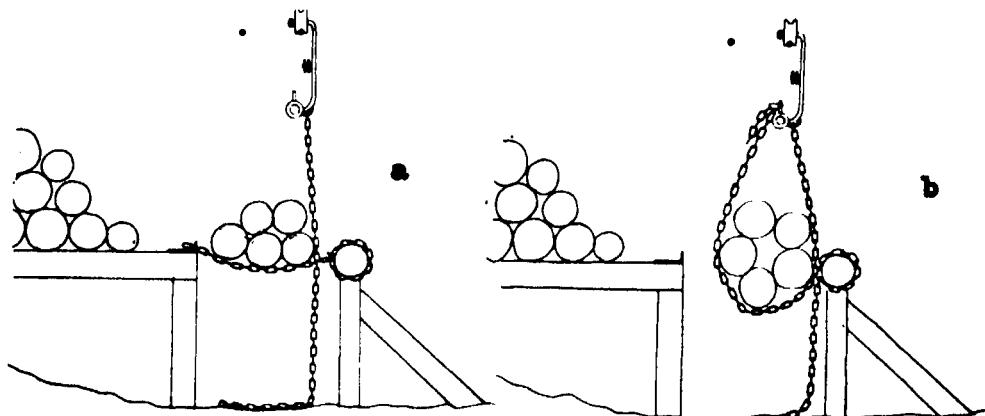


Fig. 137 - a. Load chains from storage deck
b. Chain fixed to carriage and load chains released

For this type of feeder system a simple releasing arrangement as in Fig. 138 can be made.

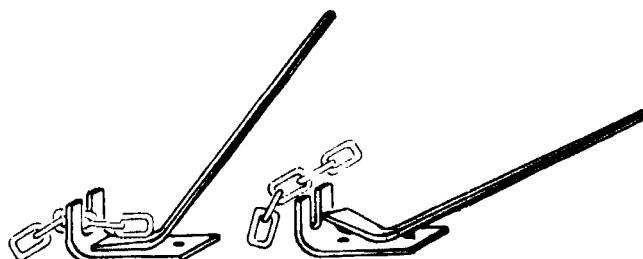


Fig. 138 - Releasing the load chain with a releasing bar

Braking

The pendulum cableway which is a gravity system, needs adequate braking. A simple wood brake is shown below.

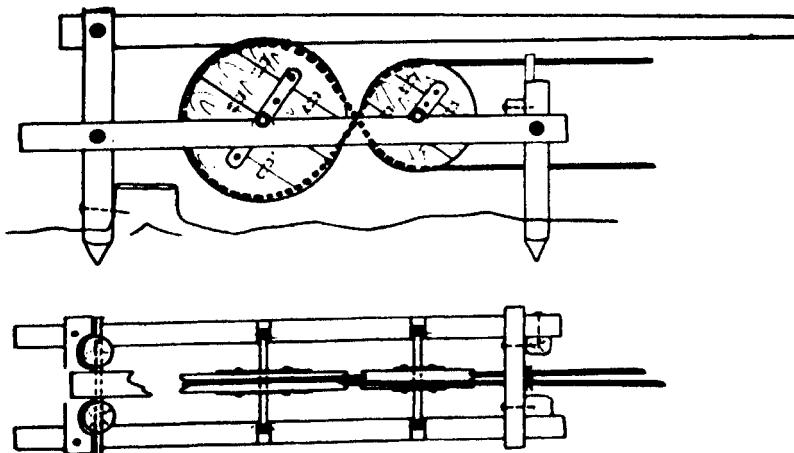


Fig. 139 - Brake built of wood for pendulum cableway

PILING AND LOADING

Logs are generally piled in the forest alongside roads or at landings in concentrations for further transportation. Logs are often rolled up into position by hand. Normally, two poles about 15 cm in diameter and perhaps 4 m in length are used. These are placed with one end on the top of the pile and the other end on the ground and logs are rolled up the inclined poles into place on the top of the pile. This is another example of the inclined plane and the amount of energy required will depend on the slope of the inclined timbers.

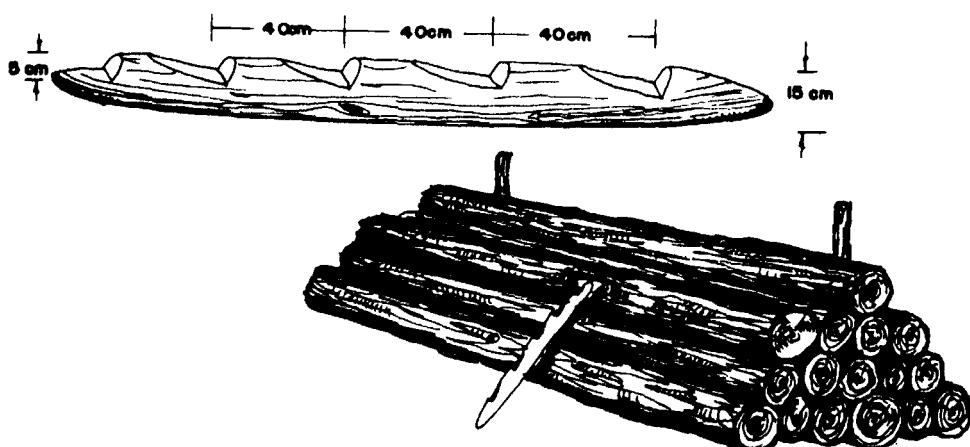


Fig. 140 - Piling jack

Piling jack

One version of such a method of handling logs is called a piling jack (Fig. 140). A piling jack consists of a piece of a fairly light wood species 15-17 cm in diameter with long notches or steps cut into it about 40 cm apart. The jack or "bonhomme" is placed in a slanting position, about one-third of a log length, from the end of the pile of logs. When logs are large the use of two such jacks has proved effective. The steps permit the workers to rest and hold the log in a notched step with little effort. An old horseshoe or a piece of fabricated metal with sharp prongs on it will help keep the jack from slipping sideways or forward as the log reaches the top of the jack and rolls onto the pile. By placing the jack one-third from one end of the pile, when handling a timber onto the pile, the worker will raise one end of the log and rest the log on the jack. He will then swing the log around until it rests upon logs in the pile and will lift his end of the log to the next notch. In this way he will work the log up the piling jack with a minimum of effort.

Log loading



Fig. 141 - Loading logs onto truck
a. From level ground b. From bank above truck deck

The loading of logs on trucks or wagons can be a relatively easy operation or can require a great deal of energy. Wherever possible log piles should be located above the vehicle to be loaded so that with the assistance of gravity they can be rolled downwards onto the deck of the vehicle (Fig. 141 b).

This situation generally exists only in hilly country where roads are cut into side hills. A more normal situation exists when logs must be rolled up poles of skids from ground level up to the deck of the vehicle. Depending upon the length of the poles and their shape the effort required will vary. The longer the poles, the gentler the slopes, the less energy will be needed. Special skid logs with hook prevent movement of the skids (Fig. 142).

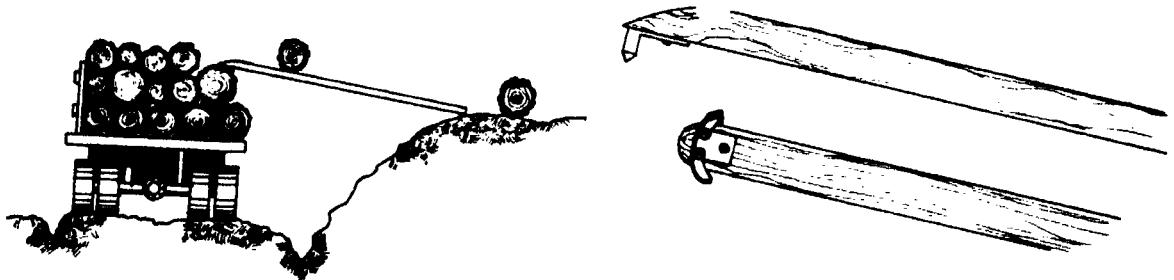


Fig. 142 - Skid logs with end attachments to prevent movement

Sometimes logs are rolled up the skids with the aid of cant hooks which augment human strength by the use of a lever. Again the logs can be pulled up the skids by means of a cable or cables. There are many variations on this theme as the cable can be

pulled directly in line or it can be passed through one or more pulley blocks to change the direction of the pull as well as to provide a mechanical advantage (Fig. 143). Winches and A-frames may be used to provide substantial mechanical advantage over direct human effort (Fig. 144).

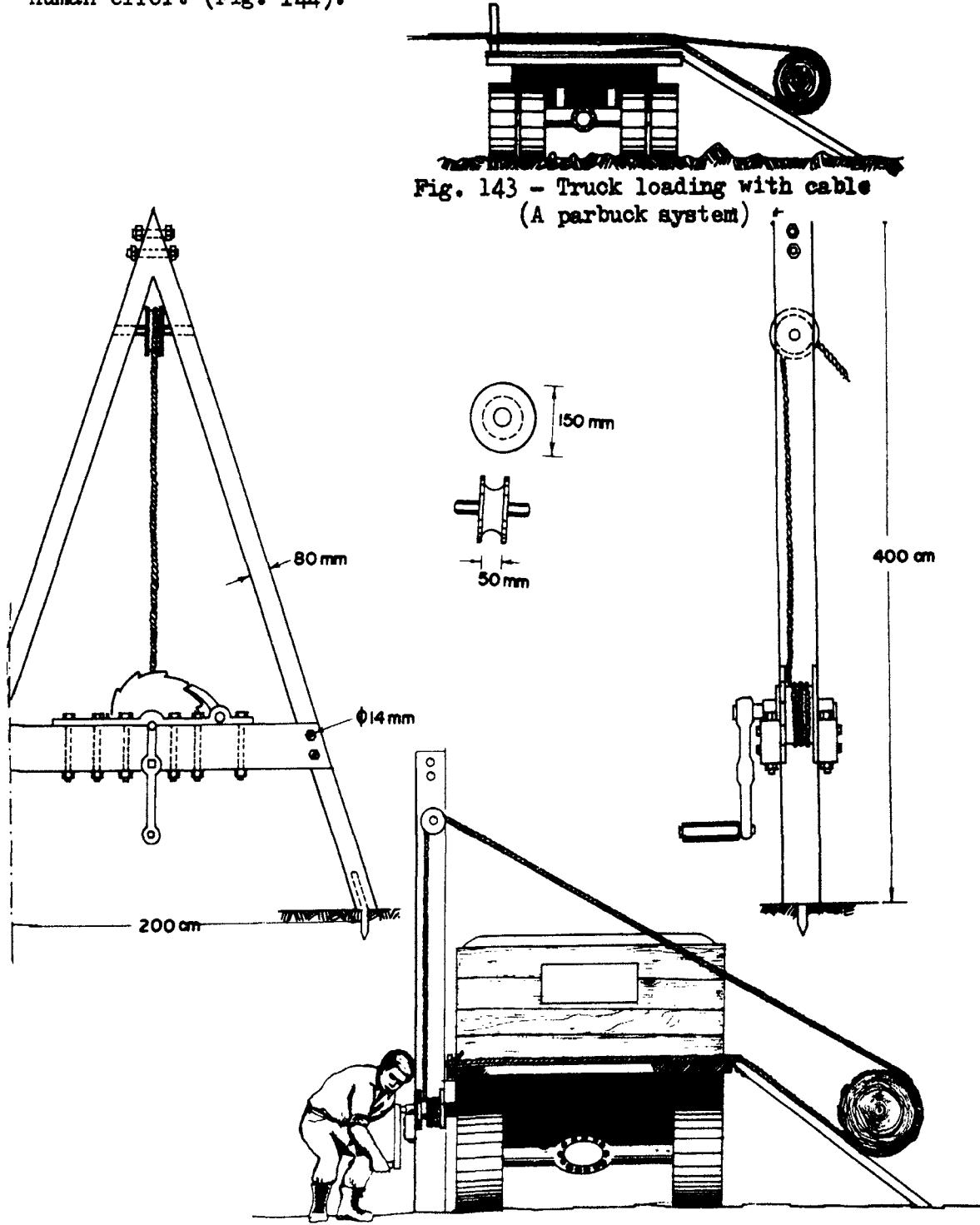


Fig. 144 - A-frame and hand winch for loading logs onto truck

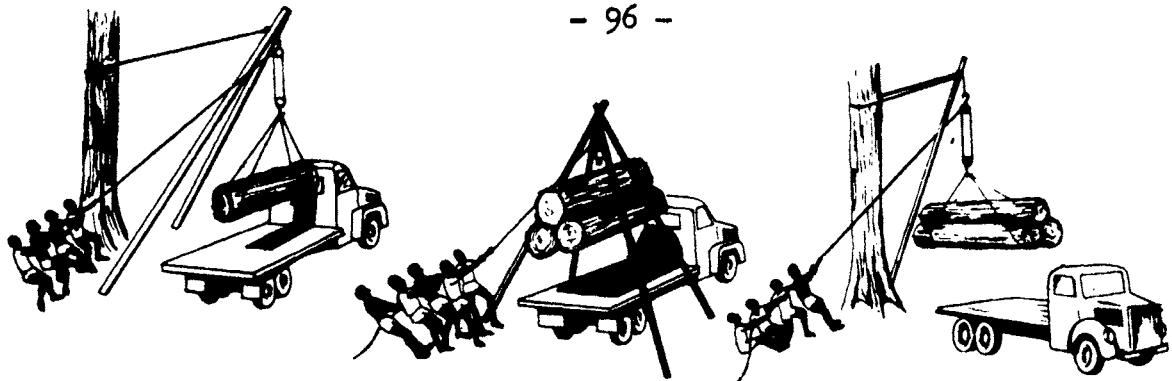


Fig. 145 - Loading trucks with logs
by cable and pulley blocks

Logs can be loaded onto trucks, trailers or wagons by means of systems of pulleys as illustrated in Fig. 145. The pulley blocks may be raised on single poles, on two logs or poles, or on four legs. Each installation will be site specific and depend upon the size of logs, diameter and length, their weight and the type of vehicle being loaded.

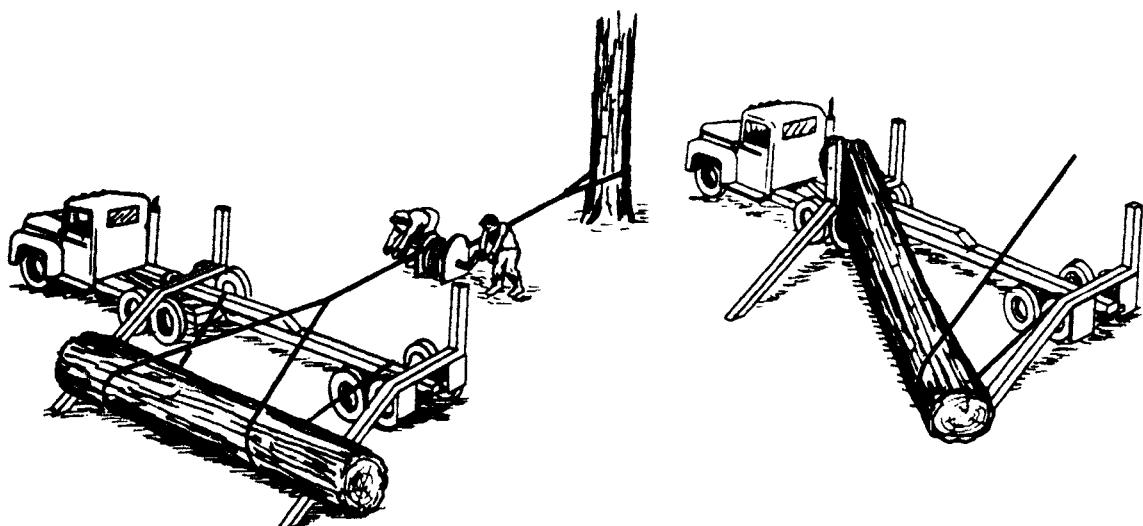


Fig. 146 - Loading trucks with logs by handwinch

A handwinch can be used for rolling big logs up onto a truck (Figs. 146, 147). In some cases, one end at a time can be rolled up and in other cases a double wire is used for easy control over the handling of the log.

Truck loading with a cable and single pulley (Fig. 148)

The cable strength and length which will be required are dependent upon the size of log to be loaded, the location of the tree and the branch to which the pulley is attached.

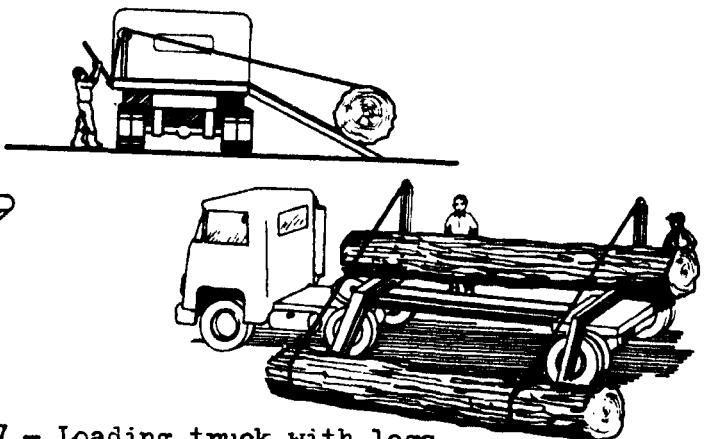
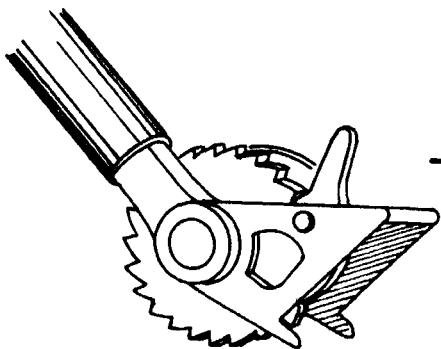


Fig. 147 - Loading truck with logs
with hand ratchet winch

A short length of cable (A) is securely fastened to the main cable (B).

One end of cable B is fastened around the log to be loaded, the other end is fastened to the truck.

The truck advances, lifting the log to the required height and cable A is wound around an adjacent tree with sufficient turns to hold the log suspended.

Cable B is detached from the truck which is then driven into position under the suspended log.

Cable A is slackened off gradually to slowly lower the log into position of the truck.

Also an empty semi-trailer can be loaded onto the truck in order to make the return trip easier, less fuel consuming and reduce wear on tyres.

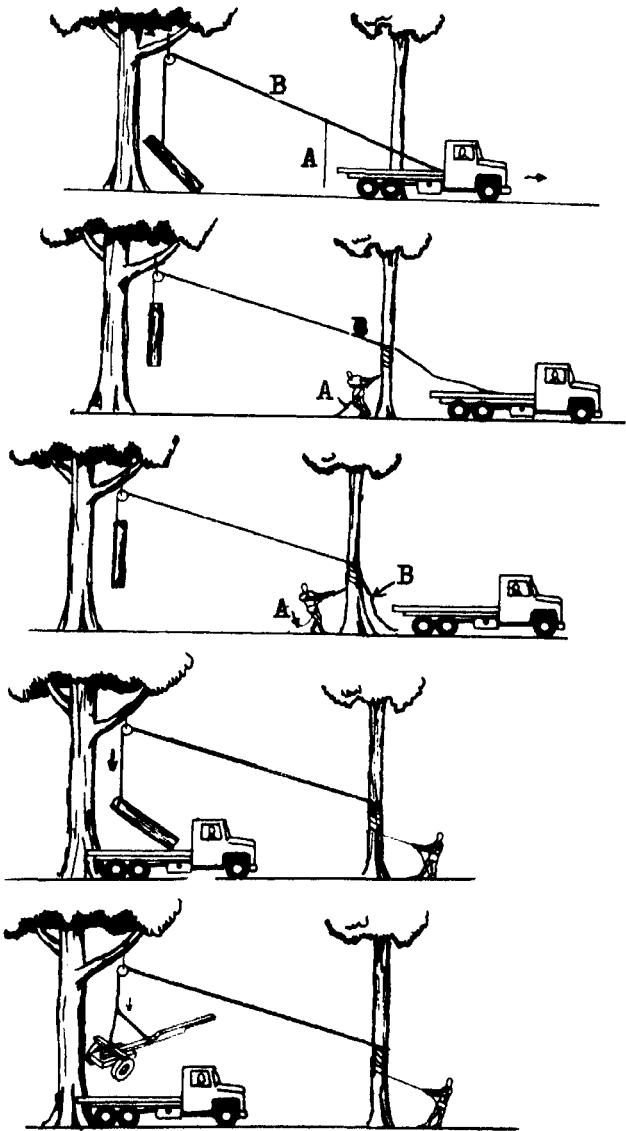


Fig. 148 - Truck loading with a cable and single pulley

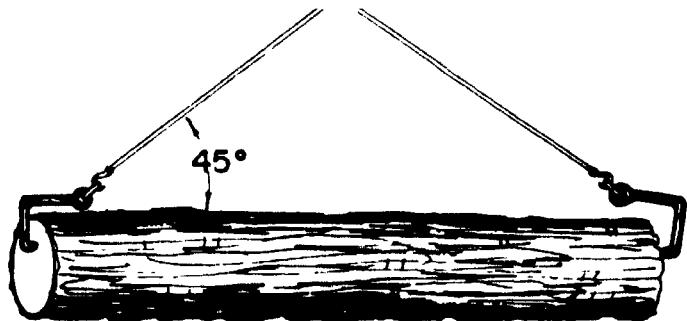


Fig. 149 - L-hook sometimes used in lifting logs

Sometimes an L-hook is used to lift logs by both ends simultaneously from a central hoisting point (Fig. 149).

The loose leg crane (Fig. 150). This loader is so called because of the two loose legs which are fastened to the top of the boom. These legs support the boom, under load, and take up most of the strain. Their use permits the loading of very heavy logs with a relatively light boom. When the boom is tilted from working position towards the front of the truck, the two loose legs are hanging free from the ground and the crane can be moved to next operation.

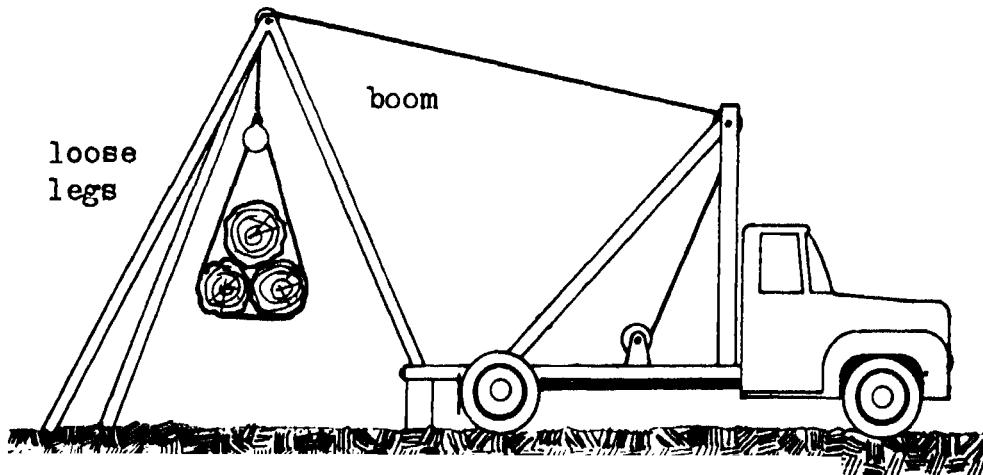


Fig. 150 - Loose leg crane loader

The boom crane mounted on an old truck chassis can be used to lift logs and load or unload them; to recover broken down or wrecked vehicles; to lift heavy items around a garage, store house, etc.

A boom arm supported at the desired height by a bar through the A-frame can be raised or lowered by the winch cable (Fig. 151). The winch cable runs through the pulley at the top of the A-frame to a double block with double wrap to a single block.

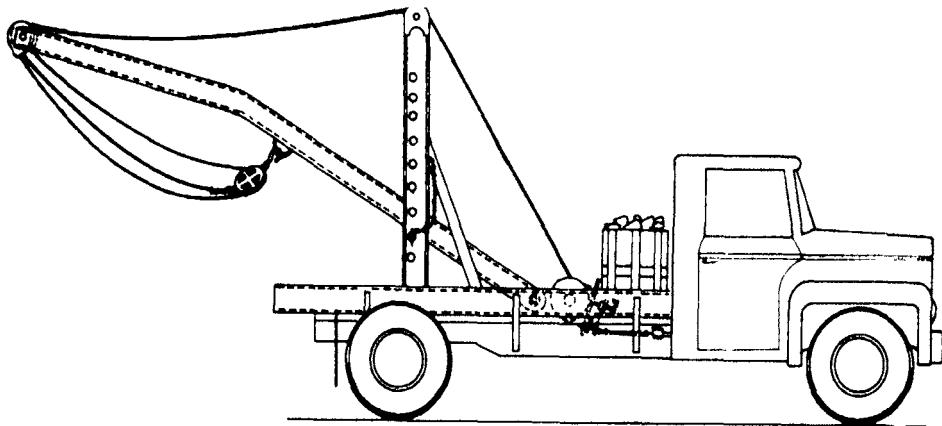


Fig. 151 - Boom crane mounted on old truck chassis

Use of tongs to anchor loaders or skidders

Trees are often damaged by anchoring skidders or loaders to them, as the usual practice in anchoring these machines is to wrap a chain round the tree about 1 metre above the ground. During the skidding or loading operations movement of the chain damages the bark, often girdling the tree. It is often better to use a wire and put wooden strapping around the tree, a method which saves the tree. Another method to anchor the machine, if there is only a stump left, is to use tongs as illustrated in Fig. 152. It has been found by using tongs that set-up time is reduced. The front end of the machine is held down more firmly and anchoring to low stumps is made possible.

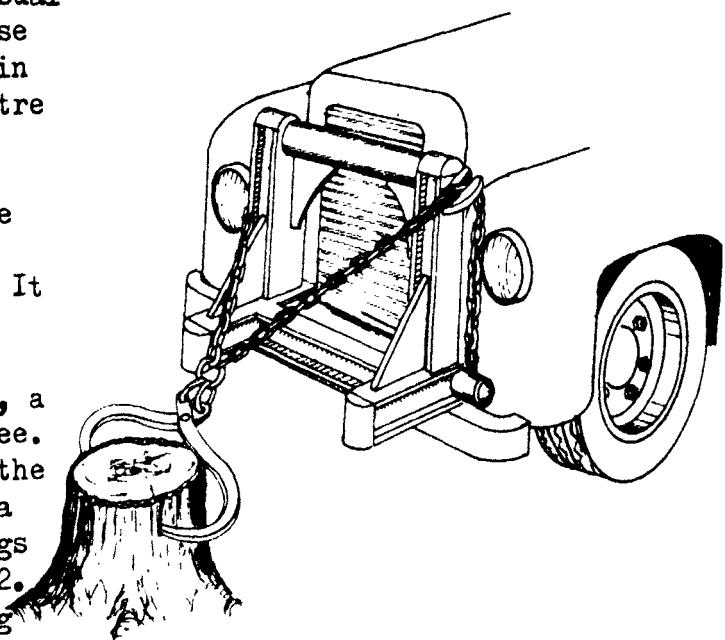


Fig. 152 - Use of tongs to anchor loaders or skidders

TRANSPORTATION

Land transport

Temporary roads - Wooden

Where for timber harvesting permanent roads are not built for one reason or another, temporary roads for truck access are often constructed. On soft terrain, roads can be constructed in a manner to permit truck access at minimum cost. Often the temporary roads can be reclaimed and reused in other locations.

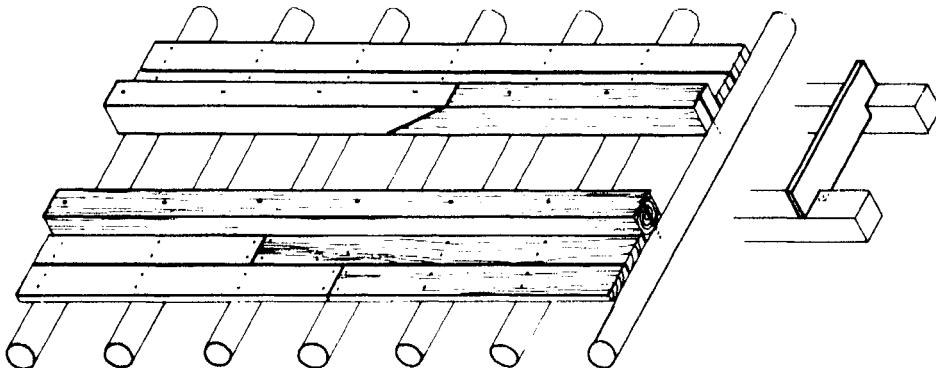


Fig. 153 - Plank fore and aft truck road

If the roads are not to be reclaimed, they may be laid down on and fastened to cross ties. Usually stumps are cut low and are not removed. This tends to preserve the root mat and to provide a more solid foundation for the wooden road. Plank tracks are laid down over the cross ties and are spiked to the ties (Fig. 153). This is not a cheap way to replace the more permanent forest road as the cost of planks may be very high. These planks may not be considered necessary if rails can replace them. These rails may be either logs as described in pole tracks or squared timbers on which the truck can run. A curb log, in the round, or square, is sometimes laid along the inside of the track and is also spiked to the ties. In laying the curb poles end to end the ends are bevelled and overlayed to tie the track together and further strengthen it. The temporary road can be constructed to different standards of load and the timbers used can be scaled up or down in size as required.

The exact width between the rails must be maintained if vehicles are to operate safely over this track. In its construction a gauge should be used constantly. This is the same principle as used when laying down a pole track or a narrow gauge railway track.

To operate safely on such a road, the mudguards of the truck being used must be removed. To the inside of each wheel a flange is bolted. The flange consists of an inner ring approximately 22.5 cm in diameter of 2.5 cm round iron. This is welded to six pieces of flat iron 7.5 cm x 1 cm, bent to fit the contour of the wheel and welded to an outer ring of approximately 80 cm in diameter of 2.5 cm round iron. The large ring stands out about 2 cm from the inside edge of the track and extends about 3 cm below the top surface of the track. The action of this ring might be considered similar to the flange of a railroad wheel which prevents the railroad wheel from moving off the steel track on which it runs (Fig. 154).

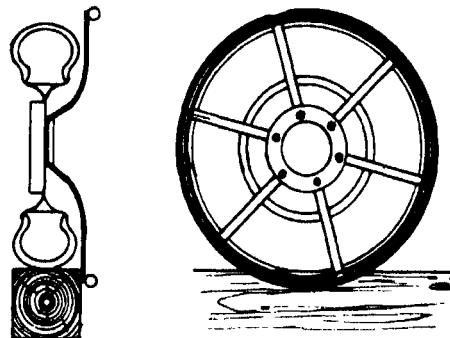


Fig. 154 - Modified tank wheel
for driving on plank road

Trucks or cars operating over such a wooden track should have a stout cross member fastened at the front of the vehicle, under the bumper, about 13 cm above the rails. If for any reason the vehicle runs off the rail, this will greatly assist in getting it back on the track and will prevent it from sinking in soft terrain.

To turn a vehicle equipped for such a track around, where it cannot operate on the ground without destroying the inner ring, a turntable may be located at each end of the track, or at any desired point along the track. These turntables will consist of a section of track, balanced on a central axis about which the track section can be rotated.

Logging mats (Fig. 155)

Logging tracks may be made of 2.5 cm thick hardwood. They are normally 5 m in length x 75 cm in width, but can be made any size to meet local conditions.

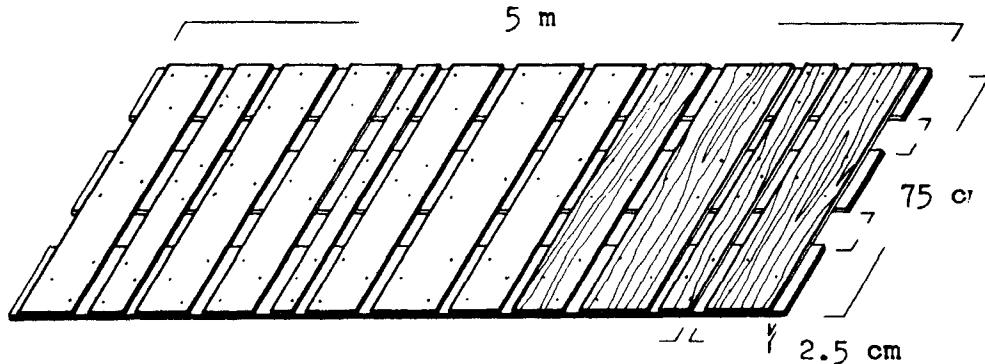


Fig. 155 - Logging mats

Temporary track or mat, made from short sections of plank held together with steel strapping, has also been developed (Fig. 156). Loops in the steel strapping at the ends of the track section, are kept so that lengths of pipe can be threaded through them to hold the ends of each section together, with a hinge-type action. After the pipe connector is in place then iron pins are driven

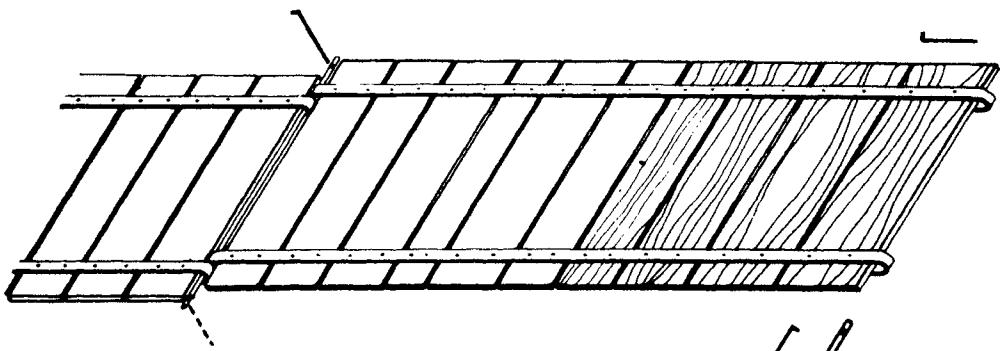


Fig. 156 - Hinged wooden tracks

into the ground through holes in the ends of the pipes. These rods prevent slippage of the pipes and hold the tracks in place against both longitudinal and side movement.

Corduroy roads

Corduroy roads consist of poles or logs, usually of non-merchantable species, laid crosswise to the direction of travel, tightly side by side, to form a solid although rough road. This type of road is used in low, wet, soft terrain, or may be used to cover very rough sections of ground. The logs may be simply laid in place and may or may not be covered with earth to make passage over them easier. If such a road is to be heavily used, then the logs or poles may be interlaced with old used cable, or in some instances may be spiked or tied to longitudinal stringers.

Wooden wheels

Sometimes wheels are made by simply cutting a disc of a log of suitable diameter. However, such discs tend to crack through drying and become weak. Most wooden wheels seen have been built up from planks, often several layers thick, layed with the grain running at right angles to reduce distortion through variation in moisture content and subsequent swelling and shrinking. This is the same principle used in the manufacture of plywood.

A wheel design seen in Honduras appears very practical (Fig. 157). It was made from three pieces of plank about 750 mm thick. The planks were laid down and the wheel circumference drawn on them. The wheel was cut out of these planks and the location of the axle was determined and additional pieces of wood were added as a support to the axle as shown. The portion

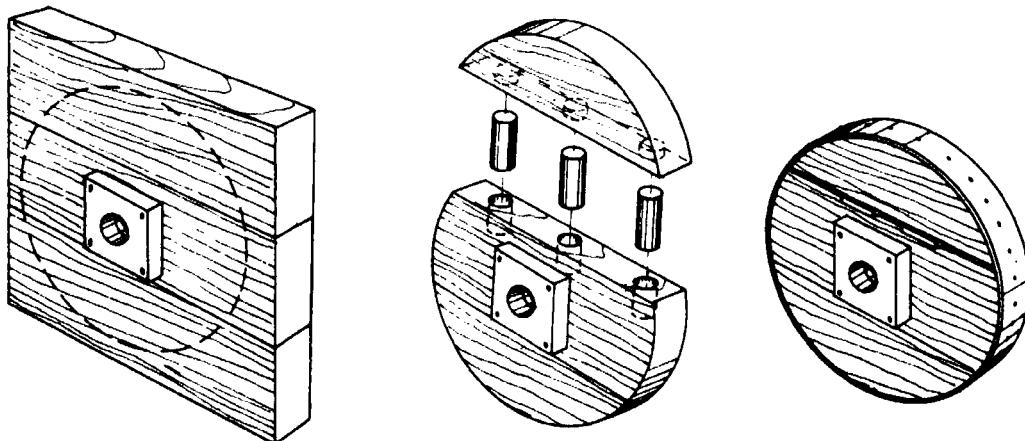


Fig. 157 - Wooden wheel with steel or rubber rim

of the wheel formed from the first two planks was securely fastened together. A steel rim was placed around the circumference of the wheel and securely nailed into place around that part of the wheel made from the first two planks. Sometimes the centre tread of an abandoned tyre is used instead of the steel rim.

That portion of the wheel formed from the third plank is removed and about 1 cm of its flat surface is cut off. Holes are cut in the two opposing faces of the wheel components and snugly fitting hardwood dowels are inserted. The upper section is then fitted back into the rim surrounding the wheel. Wedges are driven into the gap remaining to tighten the upper segment of the wheel against the rim, which is then nailed firmly into place. Normally in fitting iron rims onto wheels they are heated in a forge, fitted onto the wooden wheel and cooled with water to shrink the rim tightly in place. The method proposed applies to solid wooden wheels and does not require blacksmithing.

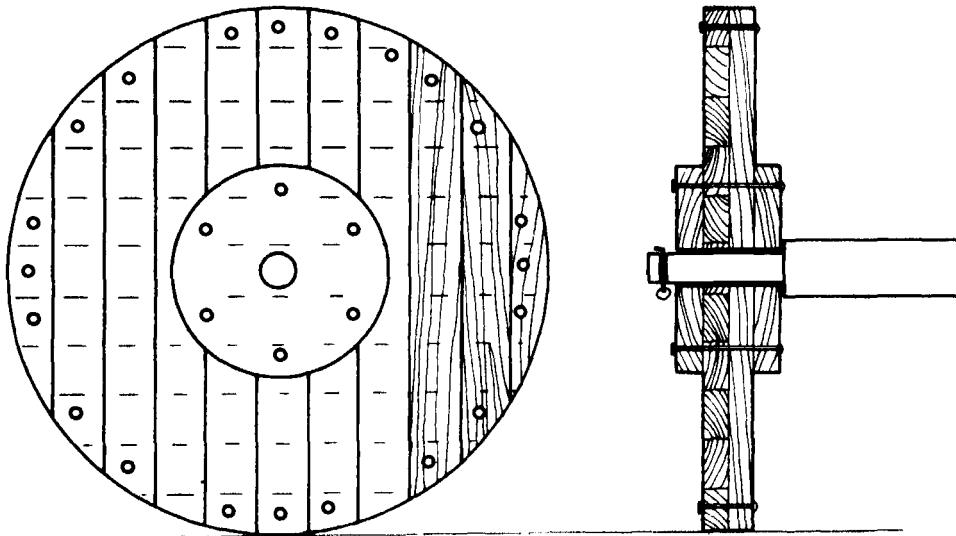


Fig. 158 - Wooden wheel with reinforced hub

Another type of solid wheel can be made from hardwood planks 15 cm x 10 cm, set at 90 degrees to each other. These wheels are then fastened by bolts into place and a steel rim or old rubber tyre tread can be fastened to its circumference. Additional circles made from planks, but smaller in diameter, only some 250 mm as compared to the 650 mm diameter of the wheel, are fastened on each side of the wheel as reinforcement and support for the axle.

Load binder

When trucks are loaded with logs, the logs must be anchored securely in place with chains or cables to prevent the load from shifting or logs rolling off the load.

A load binder is a levering device which is used to tighten a chain or wire around a load of logs. It aids in controlling any load of one or more logs from rolling off the vehicle.

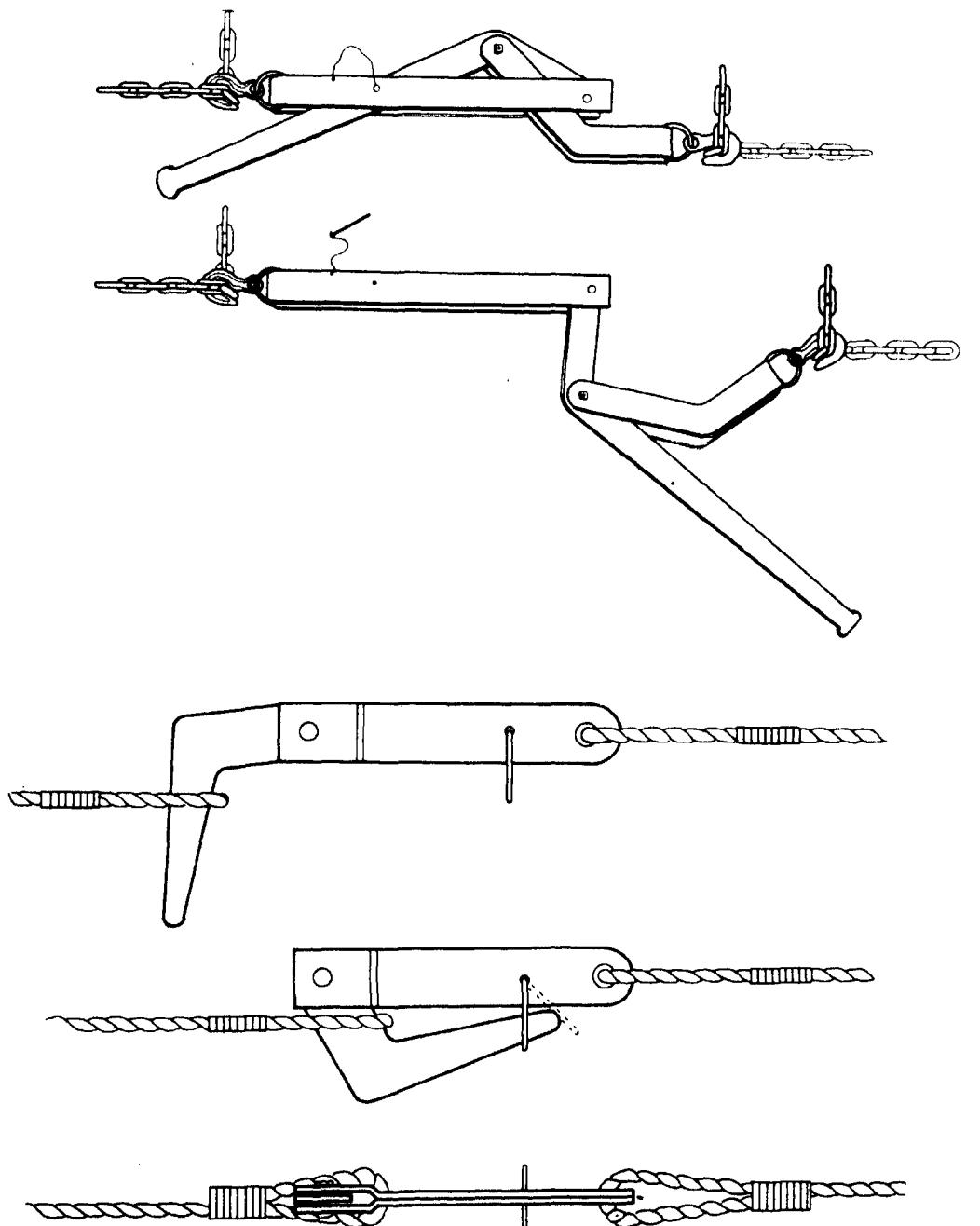


Fig. 159 - Load binders with chains and cables

The binder shown is made of three pieces of flat metal approximately 125 mm by 250 mm. The handle piece may be up to 3.5 cm in width. This binder can be made in any size, but probably a lever ratio of 1:2 is sufficient. The hooks on each of the U-shaped pieces are designed to slip between chain links and to hold the chain very positively.

The chain is wrapped about the load manually and pulled as tightly as possible. The hooks are caught on chain links and the lever is pulled to tighten the chain. If still too loose, one hook should be loosened, the binder extended to its full extent, the hook re-engaged and the lever pulled to tighten the binder. Because of its design, once the lever is in place it should stay there. However, the use of a pin through both the lever bar and the U-shaped member is an added safety factor. Spacers or washers should be placed between the members when assembling, to permit free movement. For wires or strings a similar principle can be used.

Many other practical tightening tools of the same kind are used in various parts of the world. In Asia there is a turnbuckle which also is very useful for these purposes.

A simple method of raising a truck to change a front tyre
(Fig. 160)

A 25 cm diameter bolt of wood is placed crosswide on the road just in front of the bumper of the truck. A 20 cm diameter bolt is placed on top of the 25 cm bolt and is then pushed under the truck until one end is under the axle. The 25 cm bolt is then rolled towards the truck until the top bolt comes up against the bumper. The truck is then driven ahead, the bottom bolt rolling ahead. This forces the top bolt ahead also, raising the end under the axle and lifting the front end of the truck off the ground.

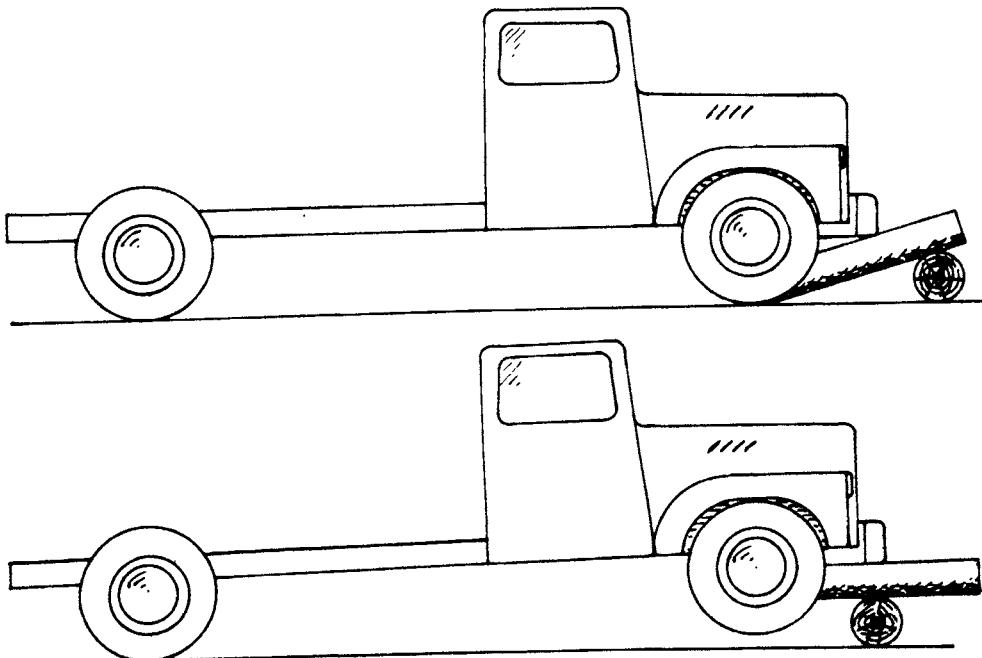


Fig. 160 - A simple method of raising a truck
to change a front tyre

Device for starting heavy loads (Fig. 161)

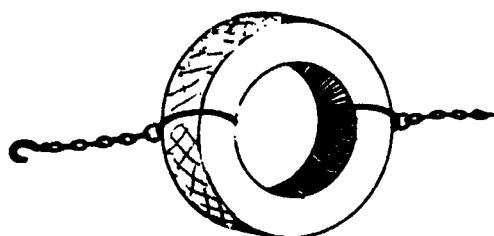


Fig. 161 - Tyre to reduce jerking
when starting heavy loads

A device for 'starting heavy loads, for example a truck which is stuck in a mud hole or which has run off the road into the ditch, is to fit an old car tyre into the chain being used for pulling. This reduces jerking by allowing the strain to come on the lines easily and avoid slippage, and the possibility of damaging the vehicle being pulled.

Water transportation

Means of fastening floating logs into a raft using local materials (Fig. 162)

In order to form a raft from logs, they must be placed parallel together in the water. Cross poles are laid across the logs and may be fastened to each of the logs in turn to hold them together. One method of fastening the cross poles firmly in place is to drill two round holes in the upper end of each log, approximately 7.5 cm in diameter and 15 cm deep.

A flexible sapling, or a strip cut from the sapwood of a young tree 2 cm in diameter and 50 cm in length, is put over the

cross pole with the ends projected down into the holes in the logs. The wedge, $5 \times 5 \text{ cm}^2$ and 25 cm long, tapered at one end is driven into each of the holes, wedging the flexible sapling tightly in place. In this manner, the cross poles are fastened tightly in place and the raft can be built up to any size required by using a suitable number of cross poles and subsequent fastenings.

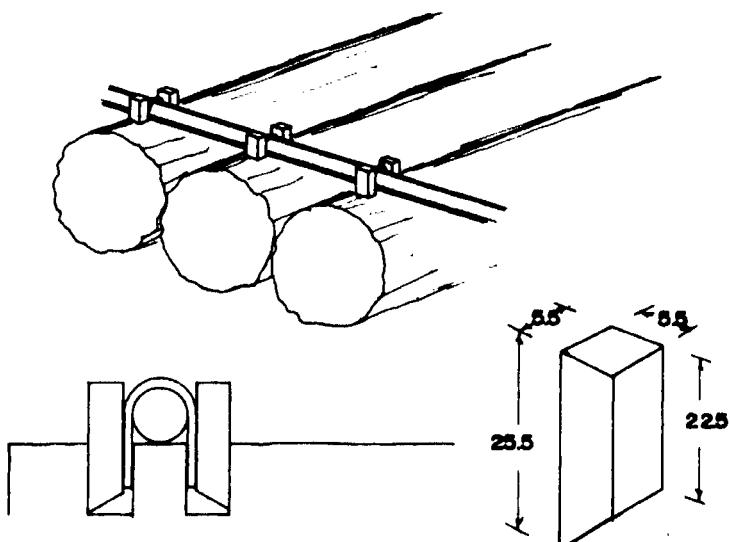


Fig. 162 - Fastening floating logs
into a raft

Another simple means of fastening logs together to make a raft is to use rope, rattan or cable which are fastened to the logs by use of wooden wedges (approx. 2.5 cm thick, 6.25 cm wide and 12.5 cm long (Fig. 163). The wedges must be tapered to a fine point. In the centre of the thin end, a notch is cut. In application, a slit is made with an axe in the upper end of the log and the wedge-shaped boom fitting is driven into this slit. A 1.5 cm diameter rope, knotted at each end, is placed across the axe split prior to the wedge being driven in, and it is held tightly in place by the wedge.

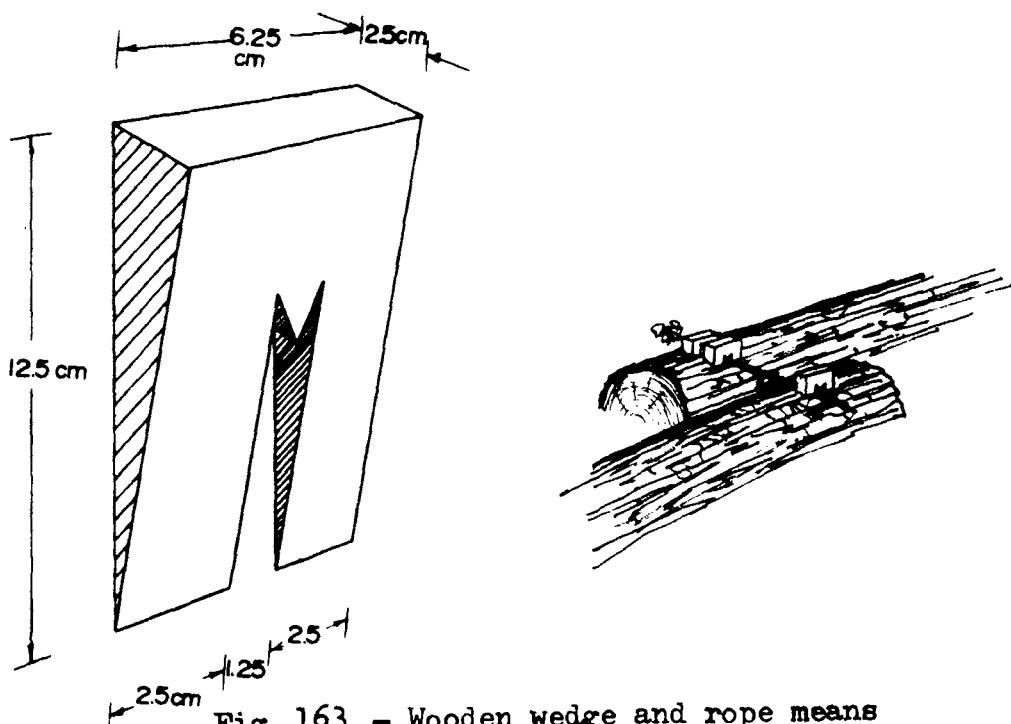


Fig. 163 - Wooden wedge and rope means
of fastening floating logs together

Other simple methods are to make bundles with rattan or soft iron wire or to use a little more sophisticated method with front and side pontoons.

Pike pole or log hook

A pike pole or log hook is a long handled tool, used to guide, to push and pull floating logs. It has a spike for pushing which projects at a slightly downward angle from the end of the handle and has a spike for pulling which is hook-shaped and at a sharp angle to the handle. There are many variations of such a hook, but the one shown in Fig. 164 is made by forging and then bending a sheet of flat metal into a round

shape. It then has several holes bored in it which will fasten the hook to the long wooden handle. The diameter of the holder is roughly 40 mm and the length of the hooks approximately 180 mm in size.

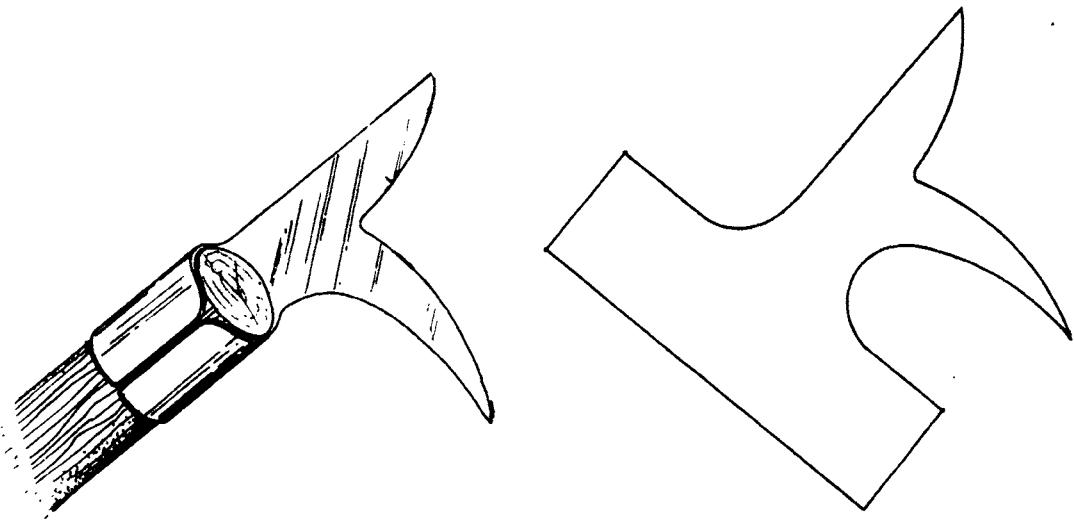


Fig. 164 - Log hook made from a piece of flat metal

BASIC METALLURGY AND BLACKSMITHING

In the local manufacture of forestry tools a major problem is to obtain and then properly treat suitable materials, particularly metals. This was brought out very clearly by the study undertaken jointly by the International Labour Office (ILO) and the Philippine Government's Bureau of Forest Development. Financial assistance for the research was funded by Finland. One of the results of this project was a substantial publication entitled "Appropriate Technology in Philippine Forestry".

This report emphasizes the problem of non-uniform material for small-scale manufacturers, and its result on forestry operations. The studies indicate that wages or cost of labour account for at least 80 per cent of the total costs of labour-intensive work methods. Inversely, the tool cost in such labour-intensive methods is very low. If tools are increased in cost but are also greatly improved in quality, they should pay for this increased cost in a very short period. The improved tools reduce breakage and thus down time.

The paper also pointed out that small workshops cannot take advantage of economies of scale for production in large quantities. It is shown, however, that if the material they have to work with is homogeneous and uniformly of good quality, their production can be increased.

As small workshops cannot afford specialized heat treating facilities, it may be possible to have one shop suitably equipped, as today in some communities a single welding shop serves other workshops that do not have welding equipment.

For the Philippines, as an example, the cost of suitable steel and its proper heat treatment will amount to 50 to 80 per cent above present material prices, but this is not considered too high when depreciation is only a minor cost element, compared to lost time and/or lost production resulting from the use of poor tools.

The following table lists the major types of metals encountered in agricultural and forestry machines. It describes the components of machines commonly made of the different metals and how such metals might be identified. It describes why they are used by the manufacturer and suggests recommended treatments of the materials for repairs. This also applies to the salvaging of many of these items for reworking into tools used for other purposes.

Major types of metals encountered in agricultural
and forestry machines

Type of metal	Machine parts commonly made of this metal	Metal characteristics - how to identify	Why used by manufacturer Common failures	Recommended Treatment of material for repair
Cast iron (Gray, White)	Wheels, gears, sprockets, paws, holders plow points, drill shoes, lever bases, bearing cases	Rusts lightly. Hard to cut. Easy to drill. Shavings crumble. Breaks easily when hammered or bent. Often shows mold marks, very rigid.	Easy to manufacture in irregular shapes. Holds bearings and parts with little wear. When it does wear hard to restore shape.	Don't use oil when drilling. Difficult to weld. Brazes easily. When brazing heat entire casting and cool slowly
Malleable cast iron	Lever castings, clevises, bearing cases, shoes of mower bars, planters, etc.	Similar to cast iron but will bend slightly. Will stand some hammering.	Wears well but faster than cast iron. Has greater tensile strength. Will hold thread for stud bolts.	Similar to cast iron - not as brittle. Can be threaded. Soft on outside and can be cut more easily.
Wrought Iron	Old machines may have some in bolts and braces.	Rust resistant, cut easily, soft to drill.	Will work easily. Can be bent to any shape, high tensile strength.	Weld by any process. Threads and forges easily.
Cast Steel	Gears and sprockets, brackets, plow points	Hard to drill and cut. Rusts slowly. Takes very high polish, rigid and high ten- sile strength	Can be made in different shapes, expensive. Wears slowly, dependable	Welds by any process. Holds thread well. be heated and re- shaped or forged slowly. Temper carefully.
High Carbon Steel	Cutter bars, discs, springs, chisels, drills wrenches	Shows rust quickly. Hard to drill or cut. Temps well. Holds shape well. High tensile strength.	Expensive. Can be tempered to suit tough job. May wear some.	Welds by any process. Can be re-tempered but not too often. Can forge slowly. Holds thread well.
Soft Center Steel	Plow points and other wearing points	Same as cast or or high carbon	Same as cast steel. Will break.	Same as cast steel but forge and temper more carefully.
Cold Roll Steel	Shafting and frames where straight pull tensile strength is required	Rusts easily. Easy to cut, drill and forge. Bends easy cold.	Good wearing quality as a rotating shaft. Cheap. Cuts easily with grlt.	Weld by any process. Shapes or forges easily. Cannot be tempered.
Hot Roll	Angle and chan- nel iron frames where twisting and strain occur.	Same as cold roll steel. Usually made in strips and angles.	Good wearing and rigid quality. Will break and fatigue.	Same as cold roll steel but can be tempered slightly.
Bronze and Brass	Found in replaceable bearings	Wears well. Has bright copper color	Replaceable Easily dented or broken.	Usually cheaper to replace than repair
Babbit	Serves as lining for cast iron bearings.	Lead color. Easily cut.	Wears well. Melts with heat	Cheap to replace in small bearings

Only high carbon steels can be tempered. Tool steel contains 0.5 to 1.5 per cent carbon and it can be hardened by heating to redness and quenching rapidly in water. Tool steels are the so-called carbon steels and nearly all edge tools are made of this metal.

Steels with approximately 0.5 per cent carbon are mild or low carbon steels. They cannot be hardened by normal heat treatment, except to be superficially case hardened. Case hardening is a means of converting the surface layer of mild steel or even cast or wrought iron, into carbon steel, leaving the inner part of the metal soft and tough. The advantage over solid high carbon steel is because the hardened outer portion withstands heavy wear or abrasion without the inner part becoming brittle. Case hardening is not a suitable treatment for tools which require grinding and sharpening. Case hardening is carried out by heating the mild steel in contact with charcoal while being protected from the oxidising effect of air. The metal absorbs carbon on its surface to a depth depending upon the length of time it is heated.

When carbon steel is heated to 750°C and kept there for a period, it is in a hardenable state. If cooled slowly in the air, it returns to its original state. If cooled rapidly, however, from above the hardening temperature, it remains hardened even when cold. The hardening heat is a bright cherry-red (up to 800°C). Such steel should never be heated to the yellow-red heat or to anything approaching white heat as the metal will be burned and be useless.

If steel is to be annealed, it must be heated to a bright cherry-red and then cooled slowly. Annealing removes stresses in metal and it is less likely to crack. Hardening of tools and steels should always start from the annealed state and heat should be applied gradually. The metal to be hardened should be heated uniformly and there should not be a distinctive line between red hot and black hot.

When quenching steel, it should not be removed from the liquid (water, brine, oil) until it is cold. Quenching is an essential operation in tempering with regard to high carbon steels or case hardening of mild or low carbon steels. Coolants are kept at room temperature to ensure a shock impact between the glowing cherry-red of the metal and the coolants. The rate of cooling of the metal depends upon the boiling point of the coolant. Water boils at 100°C and cools steel towards its core the fastest. Brine boils at approximately 107°C and cools the core a little more slowly. Oil (old motor oil) or fat has the highest boiling point, approximately 150°C , cooling the steel towards the core the slowest. The importance of the rate of cooling is that the more slowly hot steel cools, the softer its core becomes. The

inside softness makes tool steel tough and keeps it from breaking. The outer hardness of the treated steel penetrates deepest when quenched in water and least in the slowest cooling oil or fat.

In tempering a hard brittle steel to a specific hardness, it is necessary to reheat it. As steel heats its shiny surface changes colour and each colour change indicates a change in steel hardness. The colour of steel is very important as it is an indication of the temperature of the steel. Traditionally a blacksmith works indoors or in a relatively dark area because it is easier to observe the colour of steel when it is being heated.

If a piece of steel is of unknown origin, it should be tested for temperability. If a sample of the metal is held against a power grinder, it will give off sparks. The rule of thumb is that mild steel gives off a dull spark, while high carbon steel will produce a brilliant sharply exploding spark. Another simple test is to heat a sample of the metal in a charcoal fire until it is cherry-red, then quench it in water which is at room temperature. The metal should look pearl grey in colour. If the metal is put in a vice and a sharp file tried against it, if the file slides off, the steel is of high carbon quality.

Bright		
220°C		
Pale Yellow		
220°C		
Pale Straw	Razors	
232°C		
Middle Straw	Brace bits for wood	
245°C		
Dark Straw	Drills and punches, chisels, knife blades	
260°C		
Purple	Cold chisels, axes circular saws	
279°C		
Blue	Saws for wood, springs	
298°C		
Green Gray to Black		
315°C		

Forges and bellows

A forge is an open hearth in which the blacksmith builds a fire and heats his metal. The heat softens metal, making it into a plastic medium which is easy to work with. The fire also changes the crystalline structure of the metal causing changes in its physical properties.

What is required in a forge is a cavity in which a fire can be built and into which air can be injected to control the rate

of combustion. The hearth of the forge can be made of clay, built on a stand of wood or metal. It may be made from an old truck brake drum, from a section of culvert pipe, or an old heavy gauge 170 litre oil or gasoline drum.

A bellows or blower is required to supply air to the base of the hearth. An old forge blower is ideal, otherwise look for an old car fan which can be operated off a 12 volt battery, an old hair dryer, blower, or the like.

Bellows were the original means of supplying air to forges and they come in many different forms. The basis of all bellows is the one-way valve which permits the bellows to be filled with air but prevents the air from escaping (Fig. 165). This one-way valve is little more than a hole covered with a piece of flexible leather or rubber.

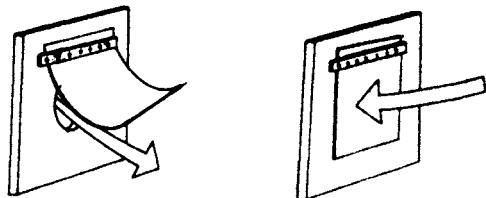


Fig. 165 - One-way valve

A general layout of a hand operated bellows is given in Fig. 166. For large forges the bottom board may be fixed in position at the forge, with the upper board only being moveable.

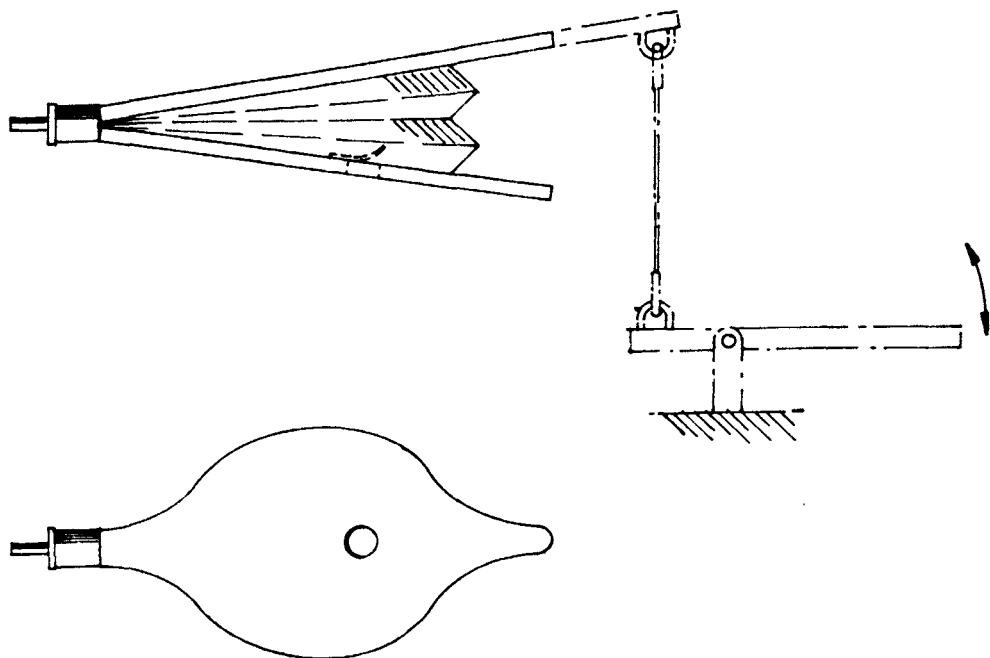


Fig. 166 - Hand operated bellows

In this instance, the handle is extended to give added leverage to the bellows. The sides of the bellows are made of leather or heavy rubber (old truck inner tube) cemented and tacked along the edge of the top and bottom of the bellows to make it air tight.

Another variation of the bellows is to operate it by a hand lever. Pulling down on the lever raises the bottom of the bellows. This closes the one-way valve and forces the air out of the nozzle. When the lever is released, the bottom of the bellows drops, the one-way valve opens and air flows into the bellows. The neck of the bellows into which the steel nozzle (a length of pipe) is fitted is made of a round piece of wood. It is fastened with hinges to the top and bottom of the bellows and usually covered with leather or rubber to make it air tight.

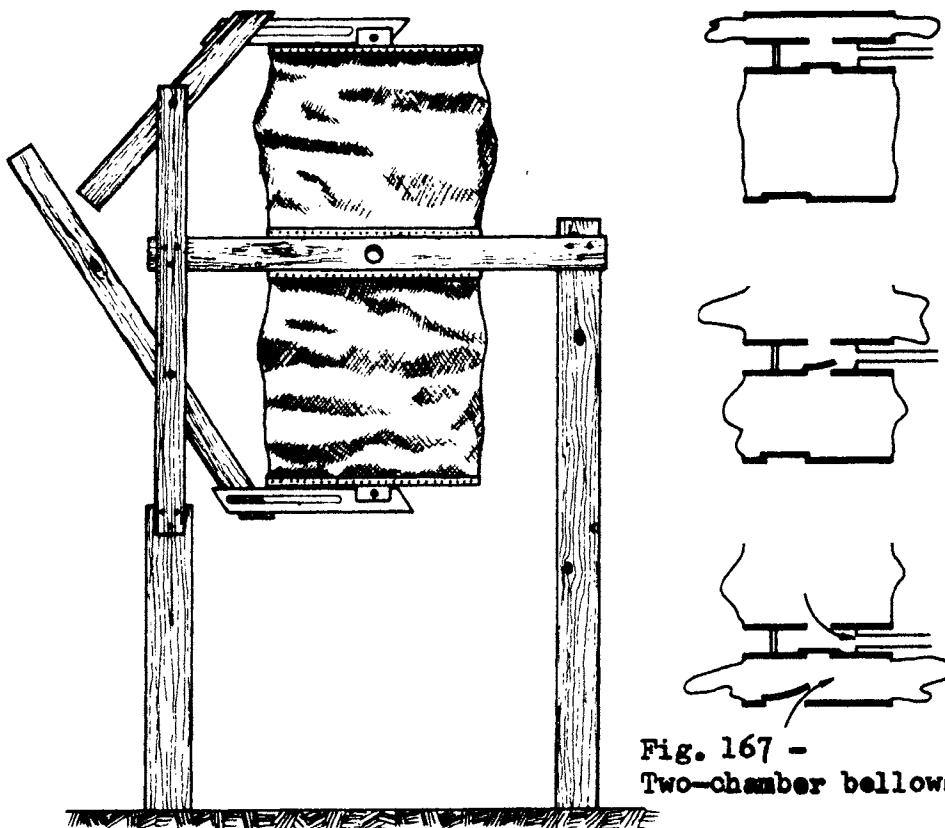


Fig. 167 -
Two-chamber bellows

The bellows as described can only produce an intermittent supply of air to the forge. The air comes in spurts. If a continuous flow of air is required, a double chambered bellows is required, with one chamber discharging through the nozzle pipe while the other chamber is filling with air. The bellows as shown in Fig. 167 may be divided into a two-chamber bellows by the addition of a centre wooden diaphragm with a one-way valve into the upper chamber. This means that the bottom board of the

bellows will have a one-way valve into the lower chamber from the exterior and the only way air can get into the upper chamber is from the lower one. A stone or light weight on top of the upper bellows board will keep pressure on the air in the upper chamber, forcing the one-way valve closed so that the only exit from it is through the nozzle to the fire.

Anvils

An anvil should be of a height that the blacksmith can just place his fingers on top of it when standing upright beside it. Ideally an anvil should be heavy, weighing perhaps 70 kg and securely anchored to the upper end of a heavy log sunk at least one metre into the ground (Fig. 168).

A very useful small anvil can be made from a length of steel railroad track by shaping it to the conventional design (Fig. 169). Such an anvil is not intended to replace a regular, heavy anvil, but will prove very useful for light work. Because of its light weight, it is readily portable.

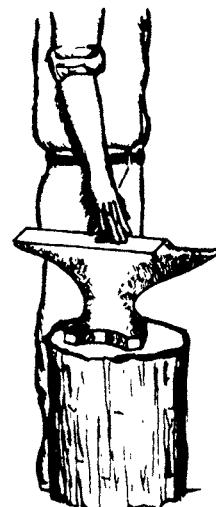


Fig. 168 - Suitably installed anvil

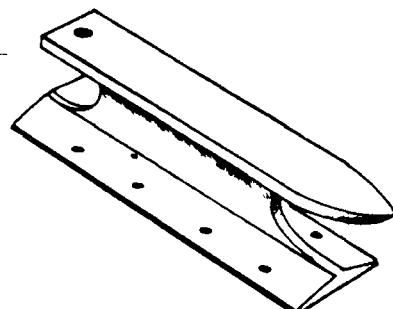
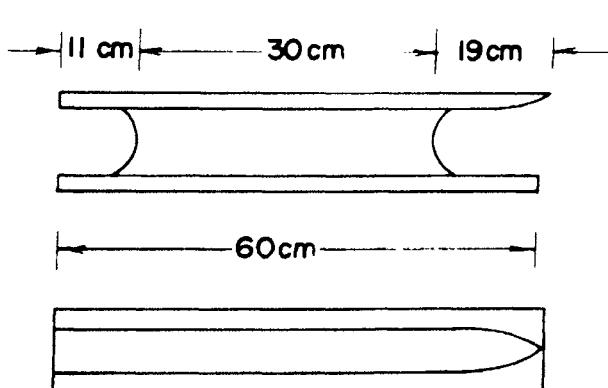
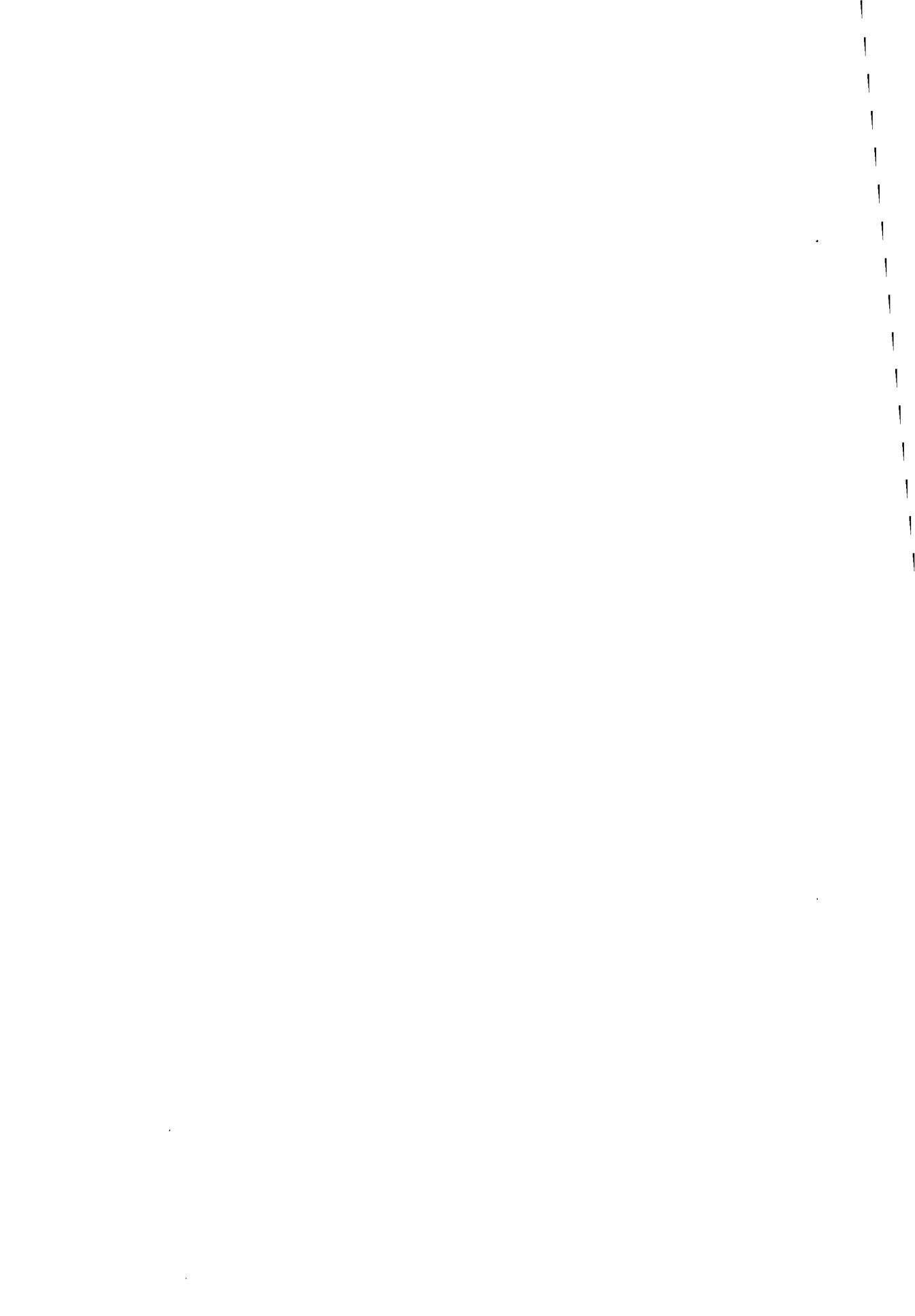


Fig. 169 - Small anvil from railroad track



Stake driver

MISCELLANEOUS

It sometimes occurs that long thin stakes are required to be driven into the ground. They cannot be driven from the top as they are too tall and springy. One means of driving such material into the ground requires a wedge which can be fastened at waist height or lower to such a stake with a piece of chain and, by tapping this wedge, the stake can be driven into the ground. A suitable wedge may be fabricated from a piece of steel, hollow, tapered and concave on one side. It should be approximately 20 cm long and about 8 cm wide. There may be ribbing on the concave surface which assists in holding the wedge onto the stake.

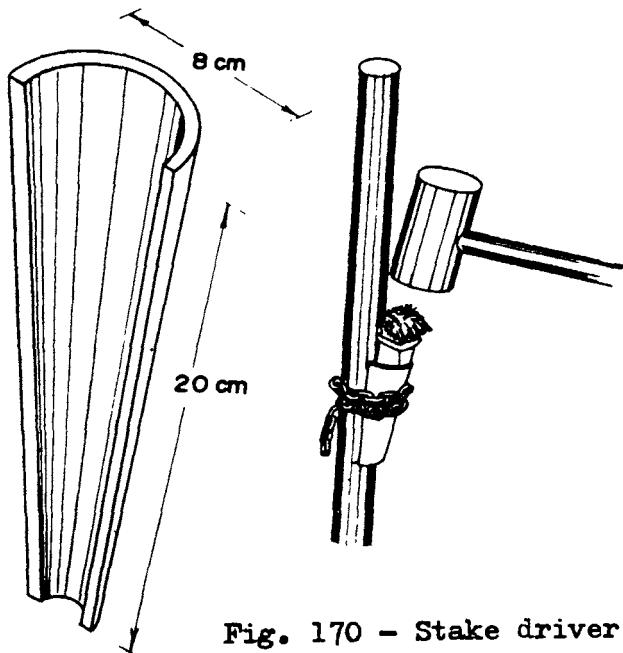


Fig. 170 - Stake driver

A wooden wedge, 16 cm long and reinforced with a metal ring at the top to prevent splitting, is fitted into the metal socket. A chain of 120 cm long is wound around the stake and wedge and is fastened or tied in place. If the use of such a device is sporadic, the owner may be able to use a 100 per cent wooden wedge with the same results. However, such wedges tend to be destroyed much more rapidly than if the iron elements are included.

Post driver

To drive posts which are of sufficient diameter to withstand pounding on the upper end, a simple post driver, usable by one or two men, can be made from a length of pipe. A piece of heavy walled pipe approximately 15 cm in diameter and 75 cm in length is capped at one end. This can be done by threading the end of the pipe and screwing a cap on it, or by welding a plate securely across the top. On each side of the pipe an iron bar 2.5-3 cm in diameter is welded to form handles. By using the piston principle, the driver is raised and dropped on the top of the post.

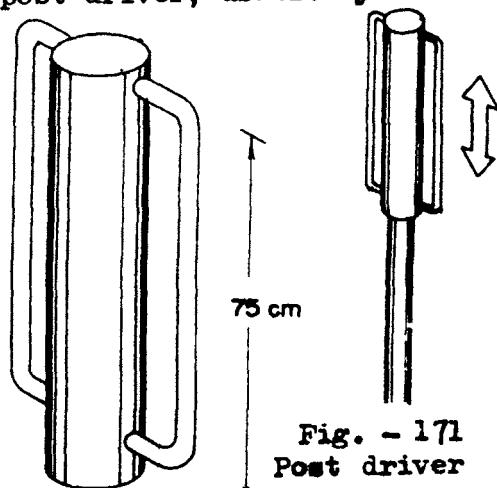


Fig. - 171
Post driver

Metal plate chain link

If a chain breaks while working in the forest, or if two chains have to be joined together in a hurry, two pieces of metal and two bolts can provide a substitute link. The plates should be drilled at both ends for the bolts which should fit snugly in the links of the chain. It would be a good plan to carry such a spare link wherever chains are being used (Fig. 172).

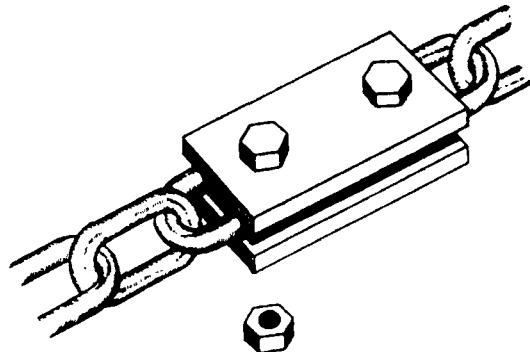


Fig. 172 - Metal plate chain link

Handling of large rocks

Rocks are often required in forest operations to fill timber cribs for bridge abutments or piers. They may be available on the site or it may be necessary to load them on carts or trucks for transport to the site.

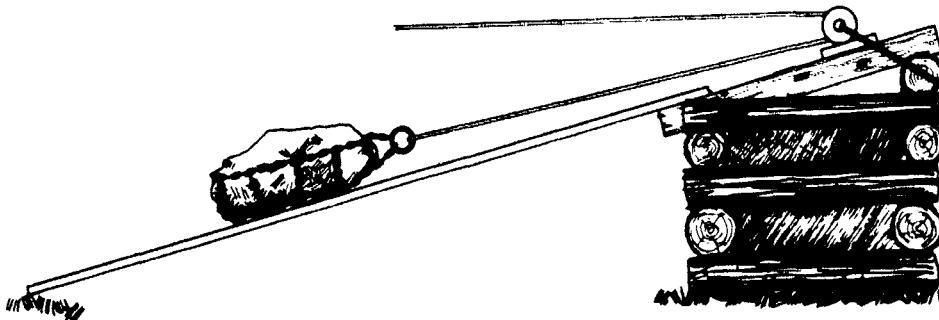


Fig. 173 - Handling large rocks with old truck tyre chain

Rocks that are too heavy and unwieldy to handle by hand may be handled as shown, by means of an old truck tyre chain, with the two ends fastened to a 7.5 cm iron ring. The old truck tyre chain is used as a sling, the iron ring acts as a swivel. Using a rope and pulley block the rocks can be pulled up skids or a plank by means of animal power or by hand (Fig. 173).

Chainsaw method for cutting boards (Fig. 174)

A plank 5 cm thick and 25 cm wide is fastened with spikes to the upper surface of a log. A piece of angle iron 2.5 cm to the side is nailed or bolted in an inverted position along one edge of the plank. It serves as a guide for a simple attachment to a chainsaw. The saw is kept in a position so that its blade is at 90 degrees to the plank. The chainsaw is pushed manually along the plank and the saw will cut the log into boards. The plank on which the saw travels must be relocated and respiked for each new board, but this requires little time and effort and permits an accurate measurement of board thickness.

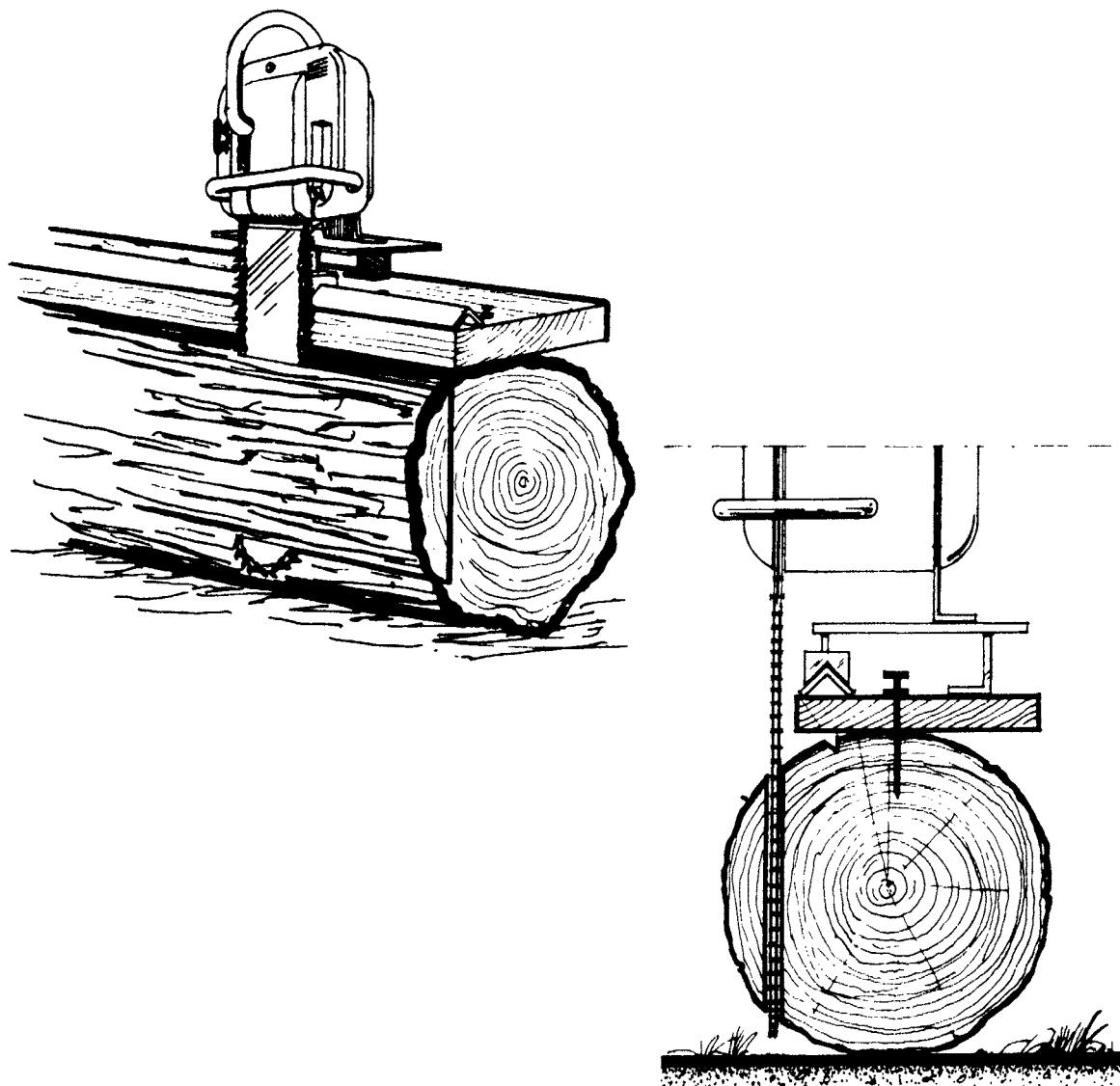


Fig. 174 - Chainsaw method for cutting boards

Pulling stumps

A stump puller shaped like a large mallet and with the measurements given, increases one's pulling power by a factor of 6. The dimensions can be varied depending upon the local situation (Fig. 175).

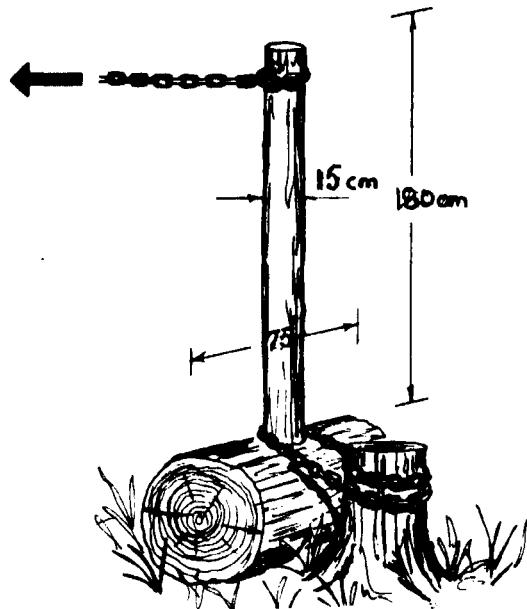


Fig. 175 - Stump puller

When pulling a stump, the earth may be dug away around the roots and the roots may be chopped away as they are exposed to reduce the effort required in the removal.

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