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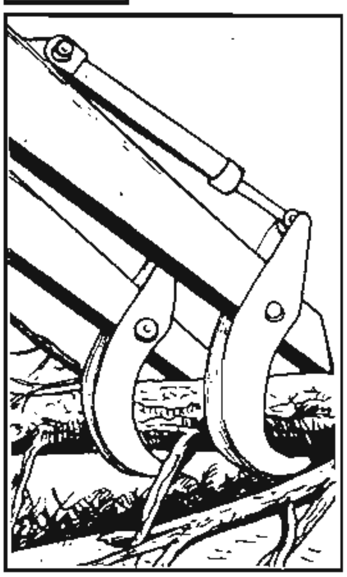
LOGGING REFERENCE MANUAL




Vol.1

W. ZAREMBA

LOGGING REFERENCE MANUAL

by
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Vol.1 - TIMBER PREPARATION SKIDDING BY ANIMALS AND TRACTORS

G.P.-S (L)

PREFACE

In South Africa, as in other countries which draw their timber supplies largely from man-made forests, the traditional forestry practices developed in the naturally forested countries of Europe and North America have had to be modified to suit local conditions, and through the years local practices have been evolved in partically all spheres of operation, based on research, evolved by trial and error} or sometimes arrived at merely by the application of common sense.

Exploitation of the timber resource is one of the fields in which local practices have been established by drawing on the most suitable techniques from established timber-growing countries and modifying them to suit local conditions, and these local practices are set out in the Logging Reference Manual in a form which will enable a forest manager with little or no previous experience of exploitation to apply well-tried principles and techniques to his own particular conditions.

This Manual gives details of systems that have proved themselves at various stages in the development of exploitation practices in South Africa. Brief mention is also made of certain systems that have been tried but found impracticable or uneconomic under the conditions obtaining at State plantations.

Although some of the information is dated or even obsolete, the Manual with its comprehensive coverage is in great demand in its present form. The Department is convinced that the South African logging fraternity would prefer to have access to the Manual now rather than wait until it can be completely revised and updated. Apart from minor alterations and metrication of the imperial units used in the original edition, the manual is published as compiled in 1965. This should be kept in mind, especially in so far as the cost figures are concerned.

INTRODUCTORY REMARKS

This manual was originally written as an aid to instruction at the College for Foresters at Saasveld, and is aimed at acquainting students with the practical application of logging methods and equipment used in state plantations for timber preparation, extraction and transportation, including the simplified methods of forestry road planning and construction. The manual may also prove useful as a work of reference for practising foresters.

A considerable number of illustrations is included in the manual to serve the following purposes:

(i) to shorten the written description by showing equipment or operations at a glance (There is a saying "A good illustration is worth a 1 000 words")

(ii) to illustrate the equipment and its application

(iii) to minimise the boredom of reading a poorly illustrated technical publication.

This manual differs from other publications in that the users of equipment are supplied also with information on the accessories of logging units, the conditions under which the equipment can be most efficiently used, as well as output, costs and labour requirements. The advantages and disadvantages of various types of equipment are also discussed. In virtually every case drawings are given, illustrating the practical application of the equipment under Departmental field conditions. Although much has previously been written concerning individual logging operations or equipment, this manual is unique in that it covers the full sphere of logging activities from beginning to end in sequence, and often in great detail.

In the absence of specific costing research most of the data given in the manual were accumulated by the Exploitation Section over a period of years. Since the establishment of a work study section, however, the matter has been given more attention and the resultant data and findings circulated with instructions that they be applied throughout the Department. The efficiency figures and data referring to timber exploitation have been incorporated in the manual.

With regard to the illustrations: some were taken or adapted from existing publications, others drawn from photographs primarily taken by members of the Exploitation Section, and many are originals.

As regards the written part of the manual, a great amount of up-to-date professional literature was consulted to supplement knowledge gained by experience and practice.

Taken as a whole, some technical forestry personnel dealing with exploitation, although having a general knowledge of operations and equipment, are often ignorant of the important finer details, or know little about the use and functions of some of the more modern and up-to-date equipment used. The Logging Reference Manual is designed to remedy this shortcoming.

W. ZAREMBA

PRETORIA
MARCH 1976

GLOSSARY

CAMBIUM

A sheath of generative cells between the wood (xylem) and the bark (phloem).

CONIFER

A tree belonging to the order Coniferae, usually evergreen, with cones and needle-shaped leaves and producing wood commercially known as "softwood".

CROOK

An abrupt bend in a pole or log, considered as a defect.

FOREST

An indigenous, naturally established wood. (Refer plantation).

HARDWOOD

Timber derived from one of the botanical group of trees that have broad leaves.

NORMS

The time or quantity which is statistically most frequent.

PLANTATION

An artificially established wood, usually of exotic species in Africa.

PRESSURE WOOD

Wood that is formed on the side of the tree that is constantly under compressive forces, e.g. lower side of branches, leaning and crooked trees.

RAKER

A tooth on a saw which cleans out the kerf.

SEASONING

The process of drying poles, logs or timber.

SNAG

A standing dead tree of 6 m or more. (If it is shorter than 6 m, it is a stub).

SNIPE

(verb) Round an end off to prevent it from fouling.

SNUBBING

A method of preventing logs from rolling.

SPAR TREE

A tree that is debranched and topped, to be rigged and used as a boom for highlead operation.

SPIRALITY

The tendency for the grain to run at an angle to the longitudinal axis of the pole, log or tree.

SWEEP

A gradual bend in a log or pole, considered as a defect.

TASK WORK

A standard of production that is established by observation over a period of time, the workers no longer working to time, but working until the set production is reached.

UNDERCUT

A notch cut in a tree to govern direction of fall and to prevent splitting.

YARDING

Extract timber by means of wire rope (cables).

GLOSSARY

BABBITT's METAL

A metal alloy containing a large proportion of lead (± 50%).

"BOXY" FOOT

When the inner part of the hoof (sole) is overgrown and is level with the wall.

CHOKER

A chain or cable so fastened that it tightens on its load as it is pulled.

CO-EFFICIENT OF ADHESION

A factor expressing the relationship between the tractive force of the wheels or tracks and the mass of the vehicle.

COLD-SHUT LINKS

An emergency repair link for chain.

DOLLY ARCH

This is a frame-mounted fair leader on wheels, attached to the tractor winch shaft, which, when unloaded, can be lifted off the ground, and gives a lift to logs when loaded.

DRAWBAR KILOWATT

Kilowatt available at the drawbar, after the transmission train, generator, water pump and other accessories have used kilowatt to function.

DRAWBAR PULL

The tractive effort exerted, in given circumstances by a tractor towing another item.

DYNAMOMETER

A machine for measuring brake kilowatt of a motor.

FAIR LEADER

A device containing sheaves or rollers, used to guide a moving cable so that it will be drummed evenly.

FREE-SPOOLING DRUM

A drum that can be disengaged from the motor by means of a clutch, and can then be freely rotated in either direction.

GRAB HOOK

A hook used with chain so designed that it can fit over any link.

GROUSERS

A ridge or cleat across a track shoe that improves its grip on the ground.

HANDSPARS

A light, sturdy pole which is used as a lever to roll logs.

HANG-UPS

1. To fell a tree so that it lodges against another tree instead of falling to the ground.

2. In skidding, to get a log stuck behind an obstruction.

HEARTWOOD

The inner core of the tree consisting of non-living cells and usually darker in colour than the sapwood.

HIGHLEAD

A system of timber extraction by means of winches and wire rope, the wire rope being passed through a pulley on top of a spar tree or boom to give a certain amount of lift to the logs.

INTEGRAL ARCH

A fair leader mounted on a frame fitted to the tractor chassis or winch shaft, the winch cable passing through it and being used to give a lift to the logs.

LINE GUARD

An optional safety device on a block to protect and keep the cable passing over the sheave.

LINE HOOK

A hook attached to the loose end of a winch cable. With a tractor - usually swivelling.

LOG SWINGING

Removal of skidded logs from landing (usually highlead) to the roadside or other depot.

LOGGING ARCH

Auxilliary equipment, either as a sulky drawn by the tractor, or integral part of the tractor, to give a certain amount of lift to the heads of the towed logs.

LOGGING PAN

A steel plate with a curved up front used for log skidding with towing tractor.

OVERWINDING DRUM

A rope or cable wound and attached to a drum in such a way that it stretches from the top of a drum to the load.

PEAVY HOOKS

A stout lever 1,5-2,1 m long, fitted with a socket and spike and a curved steel hook that works on a bolt; used in handling (rolling) logs.

RACK TRACKS

Tracks or rails with suitably placed holes for a sprocket or drive gear to engage, thus affording better traction.

ROLLING RESISTANCE

The amount of pull required to overcome a mass to be moved and expressed in kilograms per ton.

SAPWOOD

Living wood of pale colour.

SIDEWINDERS

Logs lying on a slope so that they roll easily if knocked slightly.

SIWASH

To haul logs so that they scrape against or sideswipe stumps and trees.

SKID SPARS

Logs or poles used to form a skidway for other logs or poles.

SKYLINE

A cable suspended between the head spar tree and the tail tree in cableway logging, on which the trolley travels.

SLIP PATH

A path along which timber can be skidded without obstruction. On steep slopes they may be excavated with suitable gradient.

SNATCH BLOCK

A pulley block with a hinged bridge (or shackle) or side, to allow a cable to be placed in the pulley groove.

SPLIT LINK

An emergency repair link used with chain.

SULKY

An arch with fair leader, mounted on wheels and towed behind a tractor, to give logs a lift.

SWINGING

Refer "Log swinging".

SWINGLES

The bar to which mule (horse) traces are attached.

TRACES

The twisted link chain that passes from the collar or breast plate of a mule or horse harness to the swingle.

TRACKS

One of a pair of roller chains used to support and propel a machine (crawler tractor).

UNDERWINDING DRUM

A rope or cable wound and attached to a drum in such a way that it stretches from the bottom of the drum to the load.

WHEELER

The back mule of a pair in tandem.

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INTRODUCTION

Logging in South Africa, prior to the turn of the century, was strictly limited to extracting hardwood timber from the country's indigenous forests. The advent of the industrial age soon showed, however, that the local timber resources were hopelessly inadequate to meet the growing need for timber products and the establishment of man-made plantations became necessary. The limited usefulness of indigenous timbers for general purposes, coupled with an increasing demand for protection of the country's natural resources, caused logging operations in the forests to come to a virtual standstill. At the same time the afforestation of suitable areas with artificial plantations created the need for a specialised approach to logging in order to extract the timber from the new plantations. The conventional European or American logging methods had only a limited application and had to be partly adapted to suit local conditions, as the country is not well supplied with natural waterways for timber transport or a ground cover of firm snow during the winter months to aid transportation or extraction operations by sled. Thus the lot fell to the South African forester to drag timber for extraction over the rough, uneven ground by brute force.

GEOGRAPHICAL SITUATION OF THE PLANTED AREA

By 1961 the planted area of State plantations comprised some 273 568 hectares, of which approximately 105 218 hectares were located in the Transvaal, i.e. the northern and north-eastern parts of the country. Approximately 24 280 hectares were located in the south-east, and the balance along the southern coastal regions from Durban to Cape Town.

Substantial groups of plantations forming planted blocks of substantial size can only be found in the Eastern Transvaal and Zululand, and to a limited extent in Natal and the Northern Transvaal, but for the remaining areas large gaps often occur between groups of plantations, and even between individual plantations themselves. This scattered location of the planted area severely limits effective planning, management and extensive use of mechanical equipment.

SIZES OF PLANTATIONS

At the time of writing the total planted area was split into 198 area units ranging in size from 10 ha to over 4000 ha, with a distribution as shown in Table 1.

TABLE 1 - Plantation sizes (State and S. A. B. T.)

Size hectares	No. of plantations
10 - 40	3
41 - 80	4
81 - 200	10
201 - 400	29
401 - 2 000	89
2 001 - 4 000	57
4 000 and over	6
Total:	198

AGE DISTRIBUTION OF TREES IN THE PLANTED AREA

A 35 year rotation is commonly applied to exotic species in South African plantations on average sites. Table 2 (a) and (b) show the distribution of age classes in the planted area (1961), from which can be deduced that 12 years is the average age, considering the planted area as a whole.

TABLE 2 (a) - Age distribution (State and private)

Age class years	Total coniferous area hectares	Percentage
0 - 5	122 242	27,4
6 - 10	135 700	30,5
11 - 15	80 986	18,2
16 - 20	23 192	5,2
21 and over	83 272	18,7
Total	445 392	100

TABLE 2 (b) - Age distribution (State and S.A.B.T.)

Age class years	Total *Eucalyptus saligna* areas hectares	Percentage
0 - 5	66 974	57,1
6 - 10	37 715	32,2
11 - 15	7 983	6,8
16 - 20	1 761	1,5
21 and over	2 811	2,4
Total	117 244	100

YIELD OF SPECIES PLANTED

With regard to yield, the planted conifers can be subdivided into three groups, viz fast-growing, medium-fast-growing and slow-growing species.

(a) Fast-growing species: *Pinus patula*, *Pinus radiata*.
(b) Medium-fast-growing species: *Pinus elliottii*, *Pinus taeda*, *Pinus pinaster* (Portuguese strain).
(c) Slow-growing species: *Pinus pinaster*, *Pinus palustris*, *Pinus canariensis*.

Table 3 indicates the average yield per acre for each group in addition to the subdivision into log sizes per group.

TOPOGRAPHY

Topography varies considerably throughout the planted area and ranges from flat to undulating with occasional steep mountain slopes. Virtually the whole area, with a few exceptions such as excessively steep, inaccessible areas and marshes, is nevertheless accessible for log-towing means such as tractors and animals. The most difficult, rocky, inaccessible areas produce poor yields and are costly to extract.

SURFACE

Terrain is generally firm throughout the country with the exception of limited portions of Zululand

TABLE 3 - Yield of species planted

A. Fast-growing

Age	Stems/hectare		Average DBH	Average height	Volume per hectare		
	Before thinning	After thinning			8-17cm	17-26cm	26cm +
yr			cm	m	m^3	m^3	m^3
0	1 310	-					
6	1 310	741					
15	741	494	17,8	17,7	35	3	
25	494	272	25,4	24,4	31	70	3
35	272	0	35,6	28,7	24	133	168

B. Medium-fast-growing species

0	1 310	-					
7	1 310	741					
15	741	494	15,2	15,2	21		
20	494	296	21,1	19,8	77	28	
35	296	0	30,5	24,4	42	105	49

C. Slow-growing species

0	1 310						
8	1 310	741					
13	741	494	12,7	11,0	10		
18	494	247	16,5	13,7	19		
35	247	0	25,4	19,8	45	56	

where marshes occur in places. The surface is generally smooth and free from undue obstructions, but stony ground with scattered boulders and rocky outcrops sometimes occurs on steep mountain slopes.

CLIMATE

The climate is fairly temperate and all forestry operations can be continued throughout the year. Humidity is moderate except for the hot, humid plains of Zululand. Temperatures vary from 2° to 38° celsius for most of the area.

The Forestry Department plantations are situated in three distinct zones, differentiated according to rainfall:

(a) Western Cape - winter rainfall.
(b) Cape Midlands - constant (all-year) rainfall.
(c) Remaining areas to the north and south-east - summer rainfall.

The rainy seasons do not affect logging operations to any serious degree and logging operations can continue uninterrupted throughout the year with the exception of brief periods when heavy downpours of rain occur. Wherever possible logging operations are concentrated along all-weather roads and on areas where the surface is less affected by rain during these periods of heavy rainfall.

LABOUR

Labour is still fairly abundant in South Africa, apart from the Western Cape, and in certain cases this may tend to curb mechanisation for economic reasons. High labour costs in the Cape Midlands and the scarcity of labour in the Western Cape do, however, tend to stimulate mechanisation.

The adaptability of Bantu labourers to new techniques is slow, but not necessarily a retarding factor in the use of mechanised operations.

EXPLOITATION

Logging presents problems not met with in any other industry. It is the most costly factor in forestry operations. Success depends mainly (apart from road location and the espacement of roads) on the proper selection of slipping or skidding means and routes, and log disposal along the roads in convenient places for loading. A well-planned harvesting road system is so laid out that the roads "tap" the timbered area and keep skidding distances down to the practical minimum.

A sound working knowledge of methods and equipment which can be employed in harvesting operations is of vital importance. A study of harvesting principles and practices in forestry is therefore, essential.

THE EARLY STAGES OF LOGGING

Prior to the introduction of mechanisation in logging, the timber harvested was generally of small size and areas yielding mature timber comparatively small. Trees were generally felled by men using axes and cross-cut or bow saws, dependent on the size of the trees. In order to move timber from stump to the roadside, men carried the smaller logs while teams of oxen or mules were usually used to slip the larger ones. Yokes, simple harnesses and trek chains were universally used with the animals for log slipping.

TABLE 4 - Timber yield and logging equipment distribution (1961)

Region	Planted area	Volume			Log slipping			Power saws	Cranes		Highlead	
		Thinning	Clearfelling	Total	Oxen	Mules	Tractors		Self propelled	On lorries	On lorries	On tractors
	ha	m^3	m^3	m^3								
N. Tvl. F.D.	13 678	52 723	75 439	128 162	131	61	11	14	1	1	1	
S.A.B.T.	4 160	7 782	1 330	9 112								
E. Tvl. F.D.	59 038	127 972	113 200	241 172	271	194	28	24	5	1	-	1
S. Tvl. F.D.	27 439	68 404	87 764	156 168	102	27	7	14	2			
S.A.B.T.	1 367	1 132	4 245	5 377								
W. Cape F.D.	18 393	30 609	34 025	64 634	3	113	5	13			1	1
S. Cape F.D.	47 430	101 031	144 981	246 012	6	262	25	15	1		2	2
E. Cape F.D.	15 435	17 829	28 753	46 582	60	67	6	6				
S.A.B.T.	8 242	-	-	-								
Transkei F.D.	154	-	-	-								
S.A.B.T.	22 035	45 195	4 047	49 242	94	26		3				
Natal F.D.	13 383	15 565	97 635	113 200	24	86	10	13	2			
S.A.B.T.	12 089	8 490	1 415	9 905	82	4						
Zululand F.D.	30 351	30 833	44 544	75 377	227	9				1		
S.A.B.T.	6 733	-	-	-								
Saasveld	1 342	-	-	-								
Total	281 269	507 565	637 378	1 144 943	1 000	849	92	102	11	3	4	4

F.D. = Forest Department

S.A.B.T. = South African Bantu Trust

For debarking, axes, draw-knives or vineyard spades were commonly used. Roads were, as a rule, constructed by hand labour.

FACTORS CAUSING THE PROMOTION OF MECHANISATION

The following factors brought about the introduction and increased use of mechanisation in logging:

(i) The increased size of timber.
(ii) The larger areas of mature yield to be extracted.
(iii) Acceleration of all logging operations. Fires particularly necessitated the speedy extraction of burnt timber.
(iv) Mechanical equipment is less dependent on terrain and surface conditions.
(v) Mechanical equipment is less dependent on weather conditions.

PRESENT CONDITIONS

At present mechanical and manual logging methods are employed side by side, depending on local conditions. Felling and log preparation are only partially mechanised, power saws being used in conjunction with hand-saws. The former are mainly used where large volumes of timber are to be exploited or for trees of large diameter.

Timber extraction from stump to roadside is also partly mechanised, crawler tractors being used in conjunction with mules and oxen. High-lead units and cableways are used primarily for difficult, steep and inaccessible terrain, irrespective of the log sizes. Tractors are generally employed on easier terrain for slipping large logs. Mules and oxen are mainly used for slipping logs of smaller diameter from thinnings, dependent on the terrain, but teams of animals are sometimes used for extracting large logs on downgrades in small, isolated plantations.

Table 4 shows the timber yield for each region as well as the tools used at present for log preparation and extraction.

The transportation of logs is fully mechanised, chiefly 7000 - 10 000 kg lorries being used to transport logs to the sawmills. Loading is partially mechanised, but in the majority of small, isolated plantations logs are loaded manually.

FINAL REMARKS AND CONCLUSIONS

The mechanisation of logging operations has in many ways affected the forestry industry and working conditions for the men involved, eg.:

1. Machines reduce the back-breaking strain of men engaged in logging.
2. The work can be carried out more expeditiously.
3. Labour has been considerably reduced.
4. The type of machine used demands more skilled men as operators.
5. Maintenance of the machines also requires specially trained staff and workshop establishments.

From the above it will be evident that due to the introduction of advanced mechanisation in logging, this important operation now demands a higher degree of skill and efficiency from the personnel employed than in the past.

FLOW PROCESS OF THE TIMBER-LOGGING OPERATIONS

The attached flow-process chart (Fig 1) illustrates methods of exploitation employed departmentally. The flow process in plantations is as follows:

Felling
Debranching
Cross-cutting at the stump
Load assembling (for small timber)
Skidding or slipping the logs
Stacking at the roadside
Loading the trucks (lorries)
Transportation by road, rail or cableway
Off-loading at the destination
Debarking (where most convenient).

ROADS

Several attempts have already been made to mechanise logging means in order to reduce the length of roads to be constructed for timber transportation, but it has been found that a well-planned system of roads provides the best access to the planted area, besides serving admirably for fire protection purposes.

A general guide has been established for road densities, to serve as a rough basis for road planning where one-side skidding is to be done to roads located on slopes:

(1) First quality sites - 10 - 11 ha/km.
(2) Second quality sites - 12,5 - 15 ha/km.
(3) Third and poorer quality sites - 17,5 - 20 ha/km.

For flat, mild or easily accessible country the above figures may be as much as doubled, with a maximum of twice the given area served per kilometre of road.

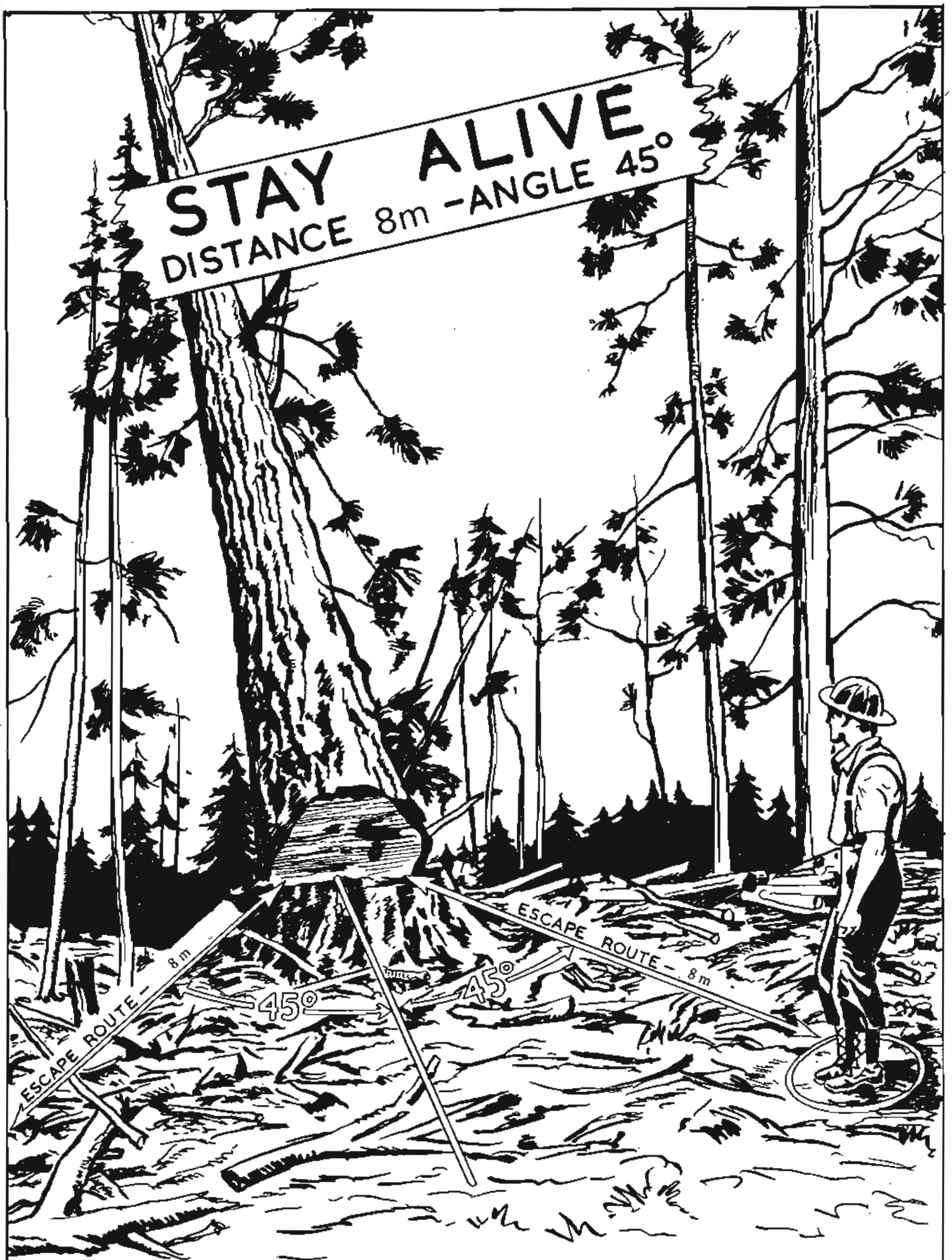
Table 5 shows the approximate area of each region, the approximate length of existing roads (1961), and their relationship to planted area.

TABLE 5 - Data of road length and areas served

Region	Planted area	Existing roads	Average area served by one kilometre of road
	ha	km	ha
Northern Tvl.	18 000	1 160	15
Eastern Tvl.	59 000	2 760	21
Southern Tvl.	29 000	1 155	25
Western Cape	18 000	740	24
Midlands	47 000	2 500	19
Saasveld	1 400	48	29
Eastern Cape	16 000	880	18
Natal	26 000	777	34
Zululand	37 000	820	45

Note: An estimated 2 780 km of road are still required to complete the road scheme for the Department's present plantation areas

SAWLOG PREPARATION


STAY ALIVE
DISTANCE 8m -ANGLE 45°
ESCAPE ROUTE — 8 m
45°
45°
ESCAPE ROUTE — 8 m

1 GENERAL

A. ORGANISATION OF FELLING

The felling sequence of compartments is laid down by the working plan, provided that this is not upset by unexpected damage due to fire, hail, windfalls, etc. A further factor which can interfere with the planned order of felling is the timber market, unfavourable markets often causing thinnings to be carried forward for several years.

The planning of felling in each compartment will depend to a large extent on local conditions, road location and slope. If more than one team of labourers is at work in the same compartment the teams should be so located as not to interfere with each other. The area may then be divided into strips and strip felling resorted to, each team working a separate strip. In this case strips should not be less than two tree lengths in width for safety reasons. Trees should be felled for the full width of the strip, starting from the road or bottom of the compartment if the latter is located on a slope. If only one strip is worked at a time all operations, i.e. felling and cross-cutting, should be completed before another adjacent strip is commenced. If more than one team is working, another strip can be cut simultaneously, provided that a similar strip width of standing trees is left as an interval between two worked strips.

If the above arrangement is found to be inconvenient, two strips can be worked side by side, provided that one team works at a safe interval of at least two tree lengths behind the other for safety purposes, the area then being cleared in stepped strips.

TWO NON-STANDARD METHODS

(a) STRIP FELLING METHOD FOR CLEARFELLINGS

(1) One of the problems which occurs, particularly in P. patula clearfellings, is that the crowns and branches of felled trees considerably hinder the skidding of sawlogs. Some boles are so covered over with crowns and branches that they must virtually be chopped free. The tractor driver also finds it necessary to climb over the litter with his tractor, although he cannot be sure that he is not climbing over stumps or rocks which could damage the tractor.

(2) To eliminate this problem it is desirable that logs be skidded through standing trees where there is not yet an accumulation of branches from felled trees. Although this may not always be possible under all conditions, it should be practicable in most plantations.

(3) The method to be adopted is briefly as follows and depends chiefly on most trees in the compartment having the same felling direction. On slopes trees are usually felled towards the lower side, and on flats they are felled in the direction of the prevailing winds, or in the direction of lean, if any.

(4) Compartments are divided into sections so that there is more than one working front. Each working front must be long enough so that two rows of trees in the front provide at least sufficient sawlogs to occupy the tractor for one day. Felling in the compartment is commenced from one flank and two rows of trees, with a width of approximately 6 m are felled. The trees fall more or less over each other, with their boles lying comparatively free so that cross-cutting presents no difficulties. On the second day a strip is felled through the compartment, parallel to the first, also 6 m in width, with the crowns of the trees in the same direction as those of the first front. Tractors now skid logs felled during the first day, skidding being done through the standing trees to the road. On the third day the fellers again fell two rows of trees on the first front, which has now had all the first day's logs skidded out, so that logs from the felled trees will again be accessible to the tractor, without its having to negotiate stacked litter. On the third day the tractor skids from the strip which was felled on the second day. This procedure is repeated, and the fellers and skidders are never in each others' way. Eventually it is only the logs from trees which stood where the 2nd day's crowns fell which have to be skidded through branches. Lorries usually drive where the tractors are skidding, and so they are also out of the way of falling trees.

NOTE : FLANK FELLING INCREASES THE SKIDDING DISTANCE

(b) TWO-STAGE FELLING OPERATION

At times two-stage felling may be resorted to in order to simplify timber extraction. During the first stage, 50% of the trees is removed, and after the felled timber has been extracted the balance of the trees is felled and extracted. This procedure is adopted to keep debris on the forest floor to the minimum and facilitate wheel tractor movement. The debris is stacked in heaps when the first stage of the operation has been completed, and approximately 150 stems per hectare are left standing.

Only large logs are skidded by tractor, and the balance is slipped by mules.

Timber preparation consists of the following: felling, debranching, cross-cutting, and sometimes pre-stacking for slipping in the compartment.

As soon as the felling area has been selected and the necessary labour strength and equipment have been ascertained and are available, the operation may commence.

Trees should be felled in the direction of the skidding operation so as to simplify the latter, unless the configuration of the terrain or surface conditions make this impossible or undesirable.

The labourers usually work in teams and the team strengths depend on local conditions and tools used. The organisation of teams and their respective duties are dealt with under the sections relating to the axe, hand-saw and power chain saws.

If the felling and cross-cutting are done by separate teams, the cross-cutters should work at a safe distance from the fellers, and if the operation is carried out on a steep slope, the cross-cutters should work out of line of trees which may slide down from the top. Skidding (by tractor and animals) and hauling operations (by lorries) should be so organised as not to be subject to danger from felled trees or cross-cut logs which may slide or roll down from above.

B. FELLING OF TREES

(a) DIRECTION OF FELLING

(1) Avoid felling trees among obstacles which can impede work and extraction. When felling, trees should be so located as not to cause inconvenience or inaccessibility.

(2) Avoid causing "hang-ups" (lodging one tree into another).

(3) When selecting the direction of fall, the lean of the tree and eccentricity of the crown must be considered.

(4) Felling against a considerable lean is impossible and only a slight deviation of the fall from the direction of lean can be achieved.

(5) Felling against a strong wind is dangerous.

(6) Felling trees up a steep slope is dangerous, as they may shoot back or slide down.

(7) When felling a tree where the ground conditions are rough and broken, the tree must be so felled as to minimise breakages.

(8) Obstacles around the base of the tree must be removed if possible, if they will in any way hinder the work.

(9) The general rule with regard to the felling direction is to fell into an area free of trees (fire-belt, previously clearfelled area, etc.) where possible, away from standing timber into which the feller is advancing. This method has the advantage of safety, in addition to shortening the skidding distance.

(b) TIMBER LOSSES IN FELLING

A high percentage of timber wastage is incurred during exploitation and particularly during clearfelling operations where the bigger trees tend to break more easily than the small trees felled when thinning.

(1) This matter has been investigated and the following salient features have emerged. The figures are expressed as percentages of the volume of utilisable timber.

0,4%	lost due to fitting in length specifications
0,5%	lost due to tearing of butt logs
1,7%	lost due to breakage
1,5%	lost due to 10 cm length tolerance
95,9%	actually utilised and invoiced
100,0%	

(2) Each of the "lost volume" items is dealt with in turn.

(i) Length specification

This loss is probably unavoidable, particularly near the thin end of the tree, but foresters are requested to ensure that the selection of the last few lengths is made in such a way that the minimum loss accrues.

(ii) Butt log tear

This can be reduced by ensuring that the correct felling technique is applied at all times. Apart from the loss to the plantations, serious losses are incurred by sawmills when butt logs with concealed tear damage are sawn.

(iii) Broken trees

The figure of 1,7% loss due to broken trees is a serious matter and calls for urgent attention. The following steps should, to a large extent help to eliminate this difficulty:

- Care should be taken that trees, if not felled in the same direction, should at least not be allowed to fall across trees already on the ground.
- Instead of felling all trees from one side of the compartment, to rather do a 50% thinning and then to fell the remaining 50%.

Note : The Eastern Transvaal Region supplies annually some 250 000 m^3 of sawlogs from clearfellings. If it is possible to reduce losses from broken trees by 1% this could represent a monetary gain of R16 000 per annum.

(iv) Length tolerance

The possibility of reducing the length tolerance below 10 cm is being further investigated by the Work Study section, particularly in respect of sawlogs supplied to State sawmills. If sawlogs are cut square with the axis of the tree it is possible that the reduced tolerance to be decided upon could involve the plantations concerned in a further gain of some R6 000 per annum.

(c) PRINCIPAL CAUSES OF TIMBER BREAKAGE IN FELLING

(Fig. P 1 - refer to numbers).

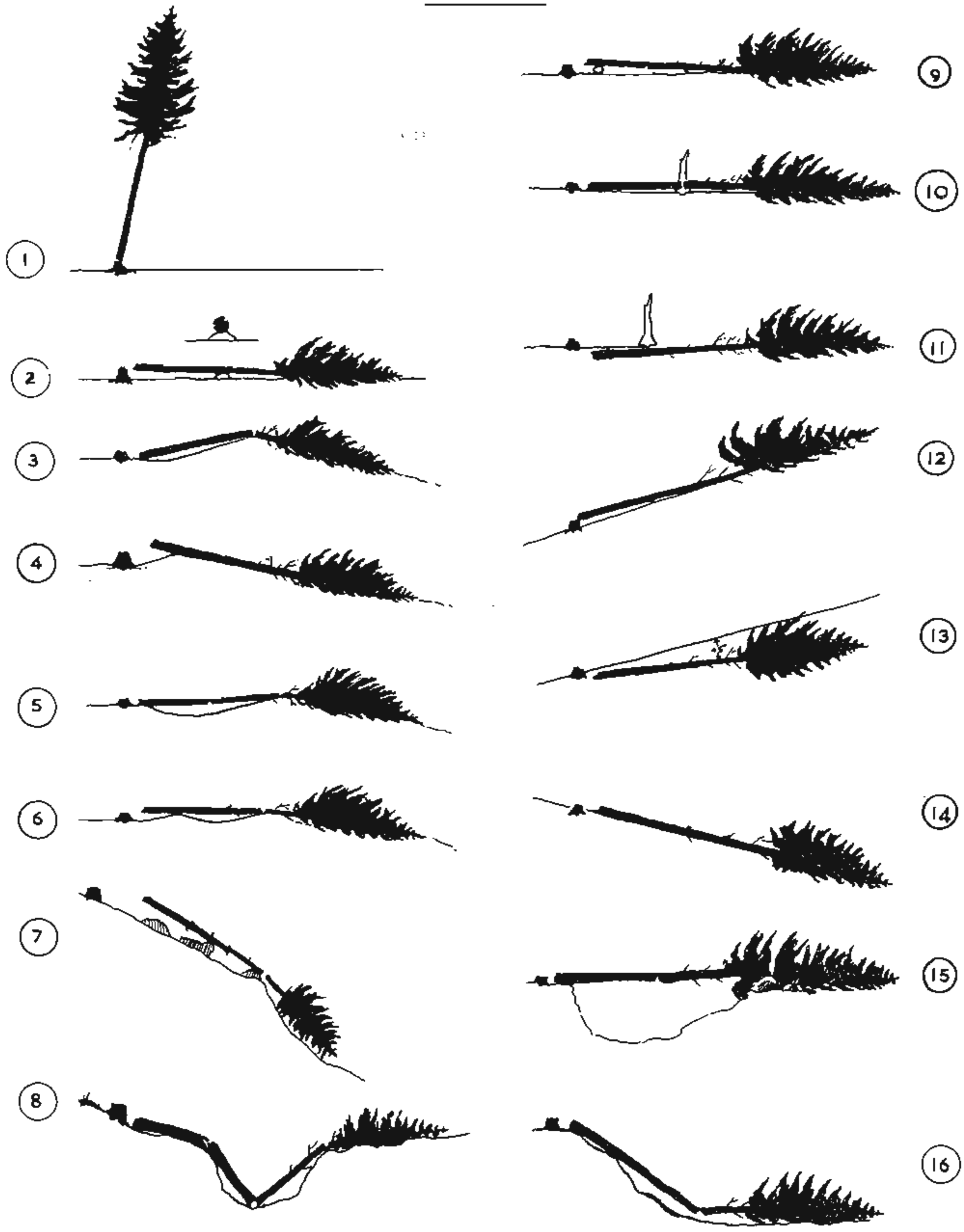
(1) The ideal condition for felling is level, spongy ground.

(2) Dropping trees squarely on rocks or stumps, unless relatively close to the stump of the falling tree, will shatter the trunk at the point of contact with the rock or stump. This particularly applies to Eucalyptus species.

(3) Dropping the tree across a ridge about half the tree length away from the stump, so that the butt is not supported, will break the tree at the ridge.

FIG. P.1

PRINCIPAL CAUSES OF TIMBER BREAKAGES.



DAMAGE TO TIMBER DUE TO FAULTY UNDERCUTTING OR NO UNDERCUTS

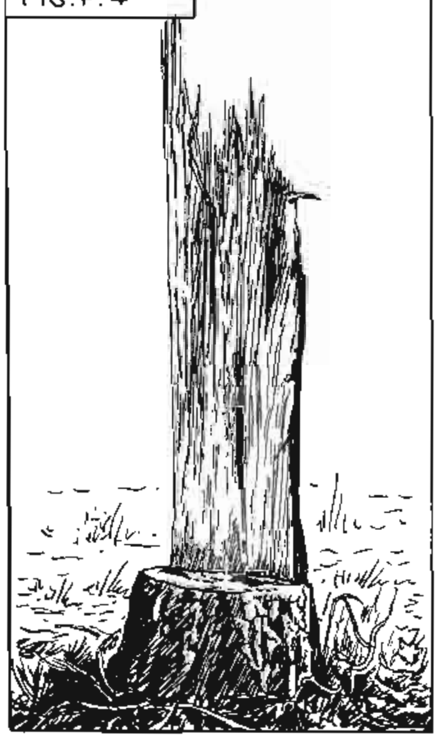
FIG. P. 2.

BUTT SPLIT-LOG STILL ATTACHED TO STUMP

FIG. P. 3

STUMP SPLINTERS.

FIG. P. 4



STUMP SNAG.

(4) Dropping the tree across a ridge or log 3 to 10 metres from the stump will generally not cause breakages.

(5) Dropping the tree across a hollow and over a ridge more than 2/3 the tree length from the stump will usually break the tree, both over the hollow and at the ridge.

(6) A tree may be dropped over two ridges, the first near the stump and the second as much as 2/3 the tree length from the stump without it breaking at the first ridge, but breaking at the second.

(7) A tree, unless small, felled downhill onto rocks or over a drop will usually suffer multiple breakage.

(8) A tree felled across a donga or streambed approximately halfway along its length will often break at the point of contact with the edges of the depression and again at the middle if the timber is large and soft. With small trees and soft soil the break may only occur at the middle.

(9) Hanging trees on stumps or large rocks near the stump of the falling tree may be sufficient to break the bole near the centre of its length.

(10) Trees striking leaning trees or snags near the ground, where their momentum is at its greatest, may break at the point of contact.

(11) Trees striking leaning trees or snags near to the stump will usually have their butts deflected and suffer no breakages.

(12) Trees thrown uphill sometimes have their butts hung up on their stumps, which may cause breakages near the butt in large trees.

(13) On moderate or uniform slopes throwing trees at an angle of 45° to the direct uphill falling direction appears to give the best results.

(14) Throwing trees downhill often causes breakages near the tops, but the butts never hang up on the stump, and so trunk breakages seldom occur.

(15) Large trees standing on the edges of dongas or streams may be broken at their middles and near their tops if the gap which they have to bridge is wide.

(16) Trees thrown downhill, across a depression, usually break near the middle of their length.

Note : Large or tall trees are more subject to breakages than small trees.

(d) FELLING OPERATION

The operation may be subdivided as follows:

(1) Approach to the tree

This involves gathering and carrying the tools and walking to the tree.

(2) Preparatory steps to felling

The tools are placed conveniently and the felling direction decided. Obstacles around the base of the tree which might interfere with felling are cleared and any snags (dead trees with dry branches) in the line of felling removed for safety reasons.

(3) Undercutting (first or front cut)

Undercuts are fully dealt with under the relevant sections of the chapters on the axe, hand-saw and power saw.

The undercut is often made by axe and as low as possible. The lower surface of the undercut is usually close to the horizontal and the upper cut slopes at an angle of 40 to 45°.

Sometimes the horizontal surface of the undercut is made by saw (bow saw or felling saw) and the sloping cut by axe. This is particularly effective for inexperienced labourers. If power saws are used the undercut is made by the saw alone.

Labourers working on task-work try to avoid the undercut entirely and simply fell the trees by sawing right through. This is only practicable with trees of small diameter, when one of the workers can push the tree in the desired direction as the cut nears its end. When this habit is extended to larger trees, however, it finally leads to damage to the saw and splitting of the tree. Fig. P 2 shows a split butt log still attached to the stump, which must be cut free with a hatchet. This type of damage results when no undercut is made in medium or large trees.

Correct undercutting is important as poor undercutting habits cause damage and wastage in the butt end logs. Fig. P 3 shows stump splinters which were pulled from a high quality butt log, caused by too shallow an undercut and a sloping back cut which went below the undercut. Fig. P 4 shows a badly split tree due to incorrect undercutting. Had the sawyers made the standard 1/5 to 1/3 diameter undercut instead of only two or three light cuts with the axe, the wastage could have been avoided.

(4) Felling cut (back or final cut)

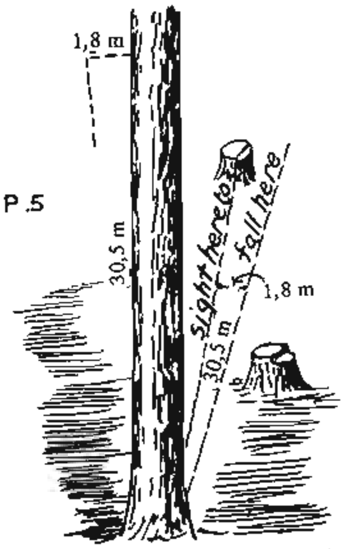
Felling is completed by the felling cut, which is usually made from the opposite side to the undercut. The felling cut is sawn horizontally and should be located 1 to 2 cm higher than the undercut.

(5) Sawing

Sawing while felling the tree is usually done in an uncomfortable stooped body position. When using the bow saw the labourer has to exert forward pressure on the blade to keep the frame in the right position to the cut, besides exerting the normal pull-and-push pressure on the saw. The demand for low stumps necessitates assuming a position close to the ground, and it is obvious that no fully convenient position is possible. With long felling saws, however, the situation is not quite so bad, as the sawyers can sway their bodies to assist sawing.

FELLING — DIRECTING THE FALL TO AVOID DAMAGE TO THE TREE.

FIG. P.5



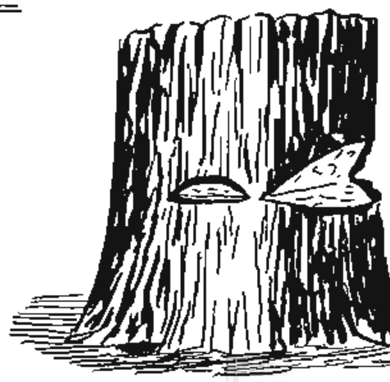


FIG. P.6

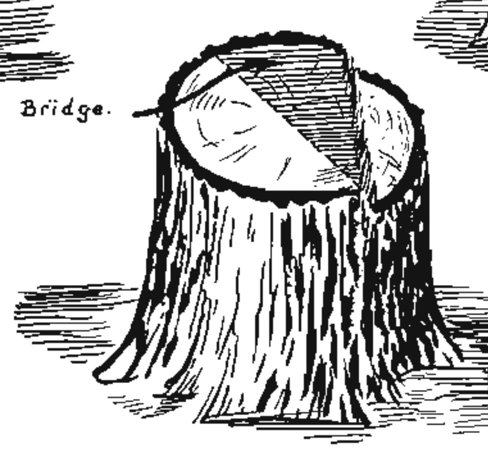
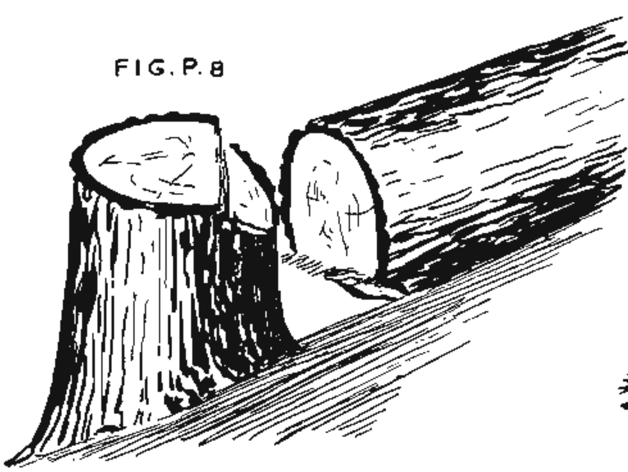


FIG. P.7

FIG. P.8



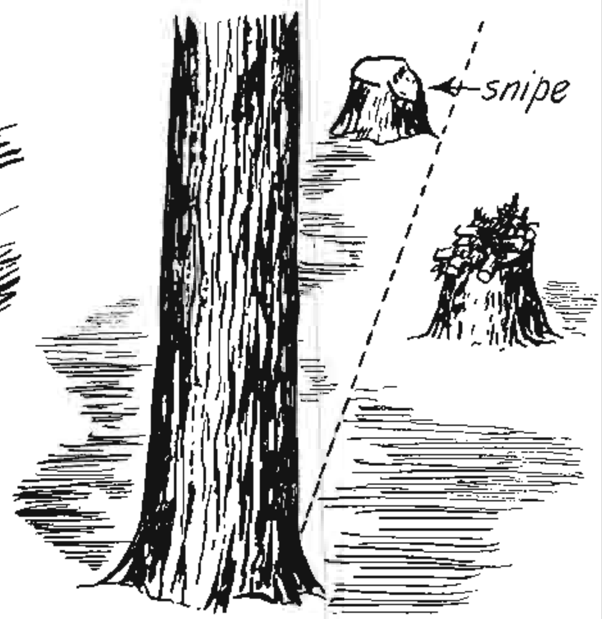


FIG. P.9

DIRECTING THE FALL OF A TREE IN A DESIRED DIRECTION.

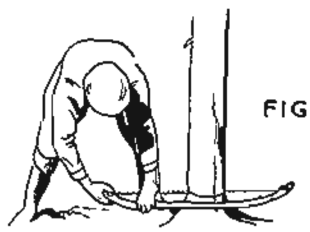


FIG. P.10

SAWING.

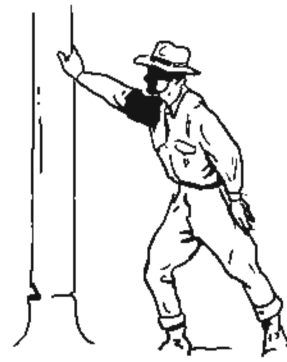


FIG. P.11

PUSHING OVER BY HAND (SMALL TREES)

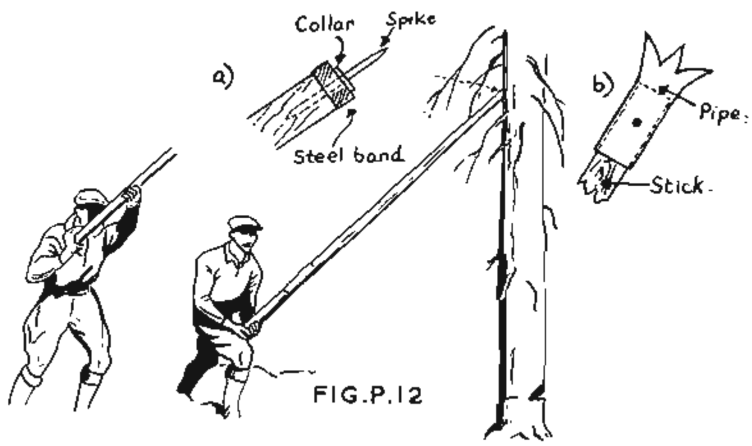


FIG. P.12

THE USE OF PUSH STICKS. (MEDIUM TREES.)

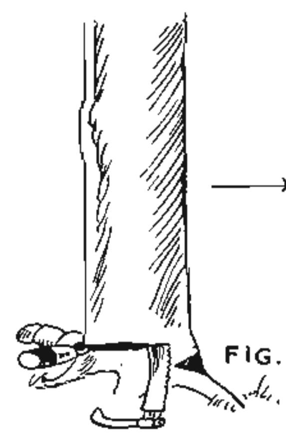


FIG. P.13

THE USE OF WEDGES. (LARGE TREES)

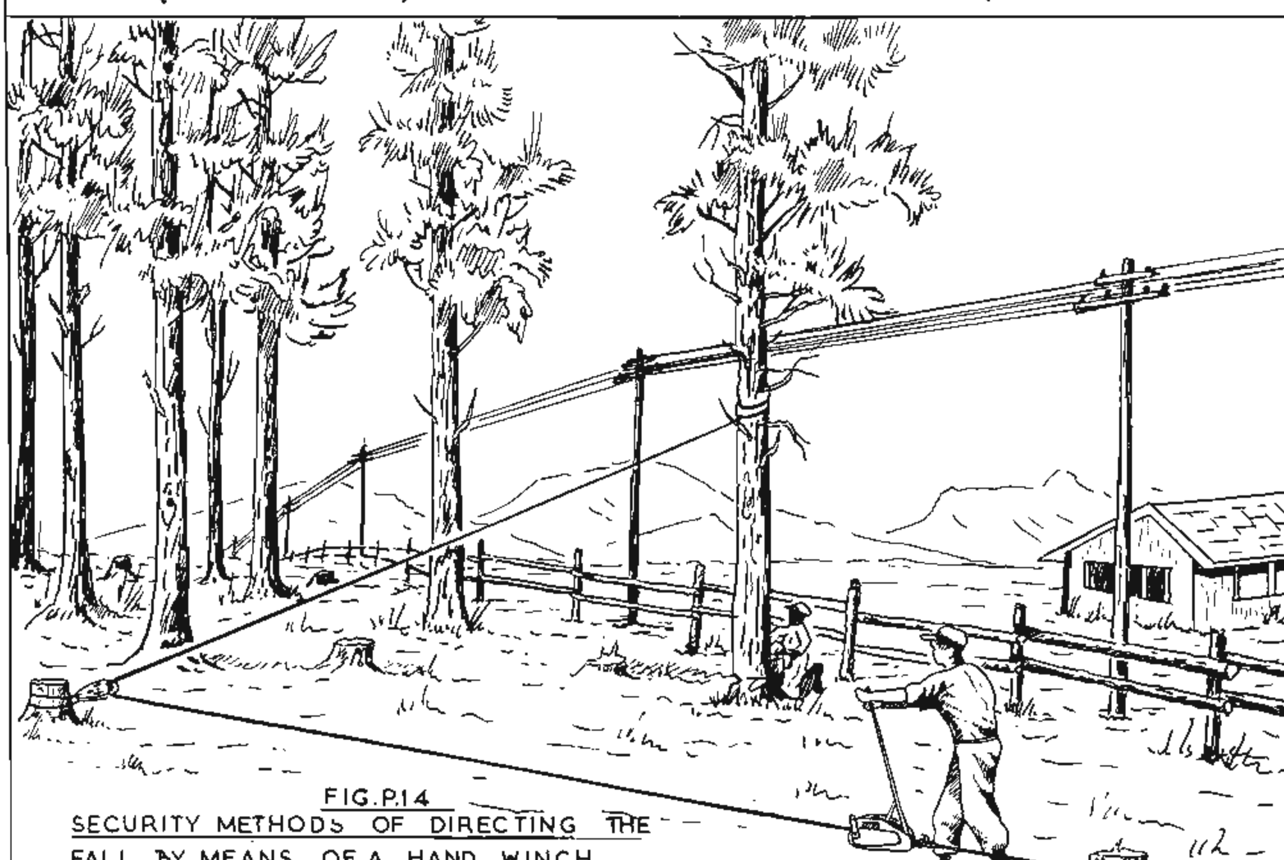


FIG. P.14

SECURITY METHODS OF DIRECTING THE FALL BY MEANS OF A HAND WINCH.

A partial remedy is for the sawyers to stand with their legs as far apart as possible, as this decreases the amount of bending required. In South Africa, felling is sometimes done in the kneeling or seated position, which is slower but more comfortable.

(6) Use of the "bridge" in felling

The "bridge" is a narrow piece of wood left uncut between the undercut and the felling cut, which breaks off by itself when the tree begins to fall. The bridge acts as a hinge to steer the falling tree in the right direction. If the bridge is of uniform width, the tree should fall at right angles to the undercut line, but if one side of the bridge is left wider than the other, (Fig. P 7) it will serve to pull the tree towards the wider side. This type of bridge is used for directing the fall of leaning trees. If the bridge is too wide it sometimes breaks off or tears out of the butt end of the tree to form splinters or "whiskers", or may even cause the tree to split.

(7) Forward lean

In order to avoid splitting a tree with forward lean when felling, the normal undercut is made and side notches are cut in both sides of the tree adjacent to the undercut, as shown in Fig. P 6. The back cuts are then made diagonally, first from the one side and then from the other, to relieve pressure, leaving the hinge and a triangle of uncut wood. If the triangle is cut through quickly, the tree should fall without splintering.

(8) Preventing damage to the falling tree

Fig. P 5 and P 9 show how a tree can be felled among obstacles so as to avoid damage. The tree can be deviated from its normal direction of fall, which would land it on one of the stumps, by the unsymmetrical hinge (Fig. P 7) or side notching (Fig. P 6), and as a safety precaution the left hand stump can be "sniped" to allow the falling tree to slip over it, or it can be cushioned with sticks and branches, as shown for the right hand stump (Fig. P 9). These precautions would be taken only when usually valuable logs were being felled.

(9) Pushing the tree over

Under normal conditions the tree will start to lean to fall as the felling cut nears completion (Fig. P 10). When the mass of the tree is evenly distributed above the stump or slightly to the opposite side of the intended direction of fall, the tree may require a slight push to fell it in the right direction.

Small trees can usually be pushed over by hand (Fig. P 11) or by using a long push stick. A push stick may be a sapling of 3 to 5 metres long with a slight taper, having a top diameter of about 5 cm. A sharpened, round iron spike (9 mm x 17 cm) is fitted into the centre of the top end and secured to prevent it from sinking into the wooden head by a metal 'collar' at its middle (Fig. P 12a). A steel band may be fitted around the top end of the stick to prevent splitting, and can be secured in place by a nail driven into the stick. If a small hole is drilled through the lower half of the iron spike, the same nail can be used for securing this in position.

An alternative practice is to use a short piece of iron piping, 5 cm inner diameter and about 20 - 25 cm long, which is fitted over the top end of the stick. The top of the pipe above the end of the stick should previously have been flattened and sharpened in the form of a three-pronged spike, as illustrated in Fig. P 12b. This arrangement is necessary to ensure a grip on the tree while pushing.

The maximum pushing forces of a man of average physique are as follows:

By hand:	50 kg
By push stick:	100 kg

In the case of a push stick, a stick of 4 m long was used and the push was exerted at an angle of 45° to the trunk of the tree. The point of application of the push stick was 3,3 m above the ground. Two methods of holding the stick are shown in Fig. P 12.

Wedges are used to push over large-sized trees in felling, as shown in Fig. P 13. Wedges serve the following purposes:

(i) To free the saw blade from a pinched tree or to prevent pinching. Saw pinching may be caused by an unfavourable lean, eccentric crown, wind, or by poor cutting.

(ii) To "trigger" the initial push to make the tree fall in the desired direction.

(iii) Wedges may be used effectively in a combined action with the "bridge" for controlling the direction of fall.

For commercially grown trees under Departmental conditions, wedges of 20 - 25 cm long by 8 cm wide and 4 cm thick at the head have proved quite satisfactory.

Wooden wedges are generally preferred for wedging but they are not always available due to lack of suitable material for their manufacture on the spot; so many mild steel wedges are found in use in the plantations. Some regions use nylon wedges with power saws with good effect, while soft metal wedges are also available for use mostly with power saws.

Lifting jacks have recently been introduced for directing the fall of large trees with heavy leans. The use of lifting jacks is illustrated under the section relating to felling by power saw.

Wire pullers or hand winches can also be used for directing the fall of trees, as shown in Fig. P 14, where a "Tirfor" puller is being used to direct the fall of a tree away from a fence, telephone line or house.

(10) Signals

Fellers must be taught to give a signal when a tree is about to fall in order to warn other labourers who may be in the vicinity. The signal usually takes the form of a shout of warning. In the case of power saws, a signal must be used which can be heard above the noise of the saw engine, and it is advisable for sawyers to close off the throttle of the machine well before the tree falls, warn any workers in the vicinity (a whistle with a piercing sound may be used), and then complete the felling cut.

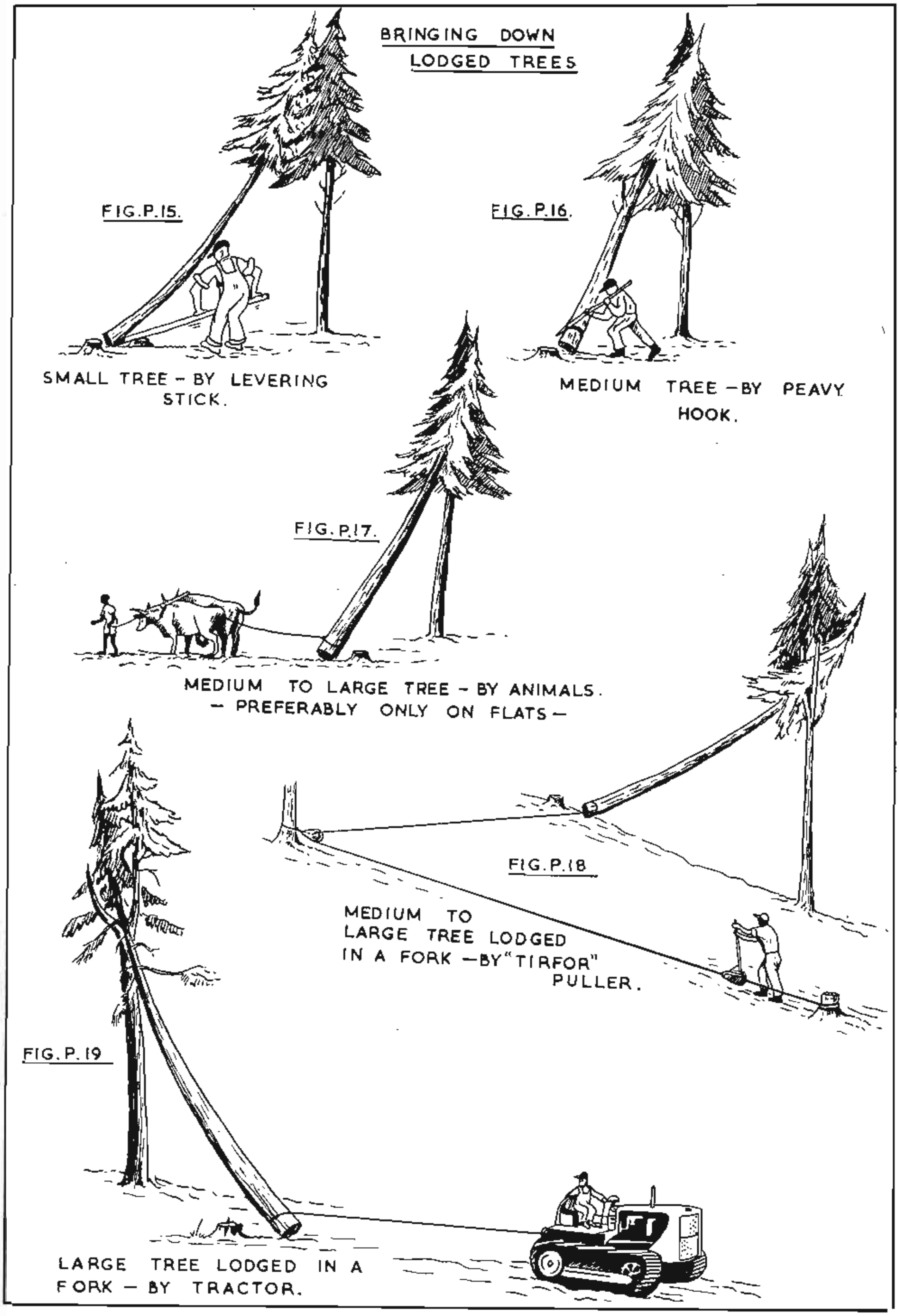

BRINGING DOWN LODGED TREES
FIG. P.15.
SMALL TREE – BY LEVERING STICK.
FIG. P.16.
MEDIUM TREE – BY PEAVY HOOK.
FIG. P.17.
MEDIUM TO LARGE TREE – BY ANIMALS.
– PREFERABLY ONLY ON FLATS –
FIG. P.18
MEDIUM TO LARGE TREE LODGED IN A FORK – BY "TIRFOR" PULLER.
FIG. P.19
LARGE TREE LODGED IN A FORK – BY TRACTOR.

FIG. P. 20.

STACKING OF BRUSH.

FIG. P.21.

SLASH STACKING IN THINNINGS

FIG. P.22

SLASH STACKING IN CLEARFELLINGS

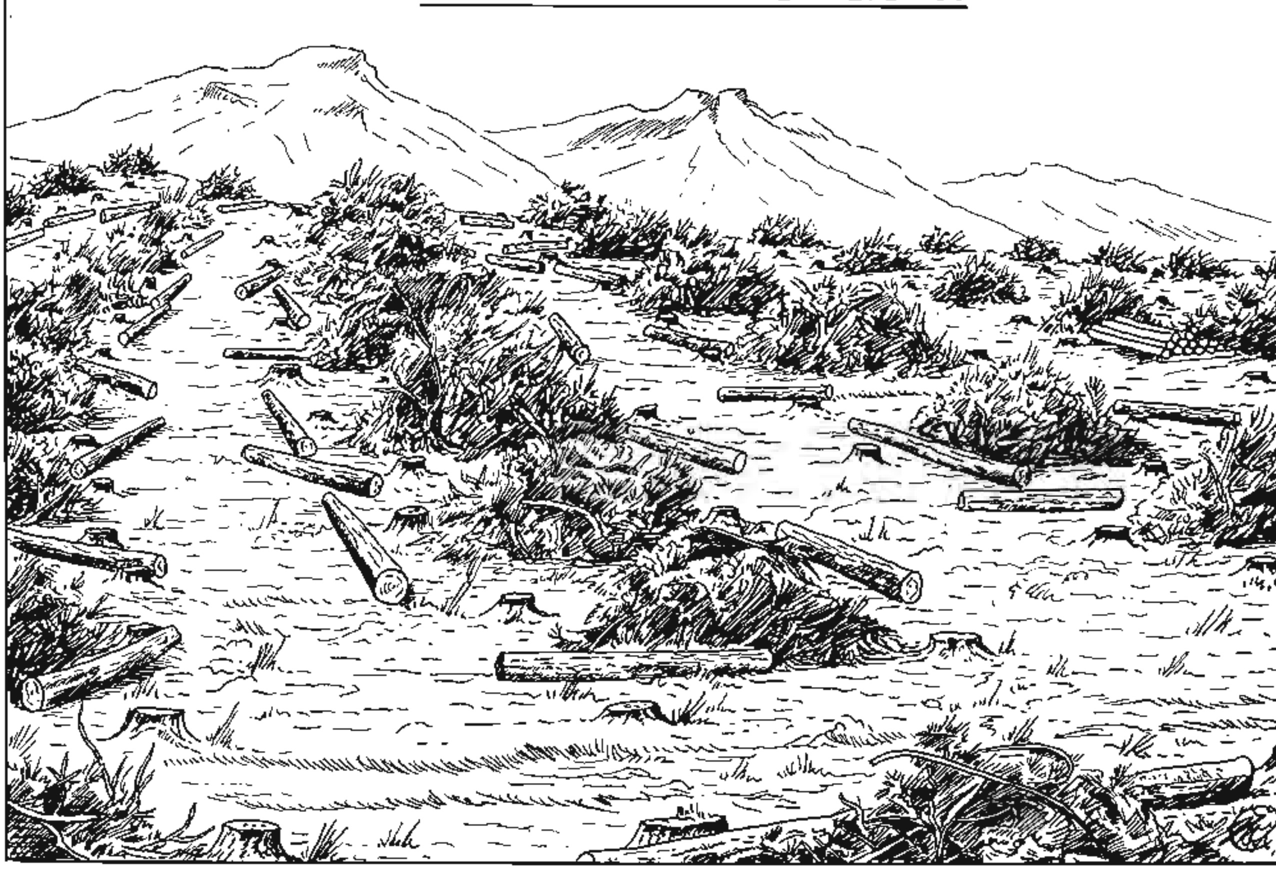
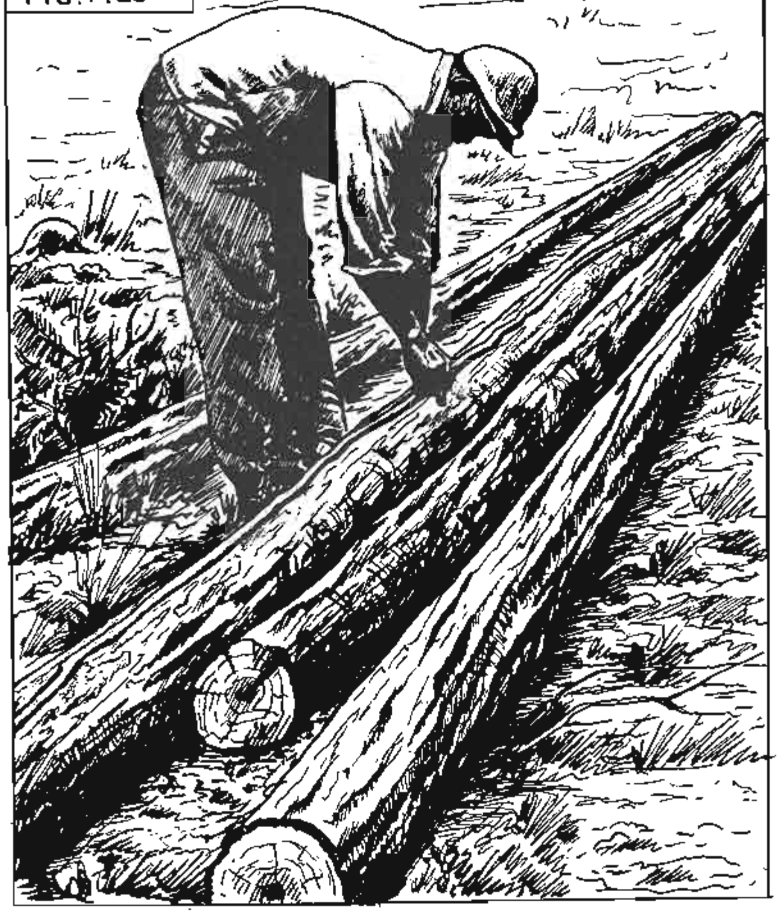


FIG. P. 23



MARKING AND MEASURING INTO LOGS.

FIG. P. 24

CROSSCUTTING POLES BY ONE-MAN BOW-SAW.

(11) Removal of the saw

When the final cut is completed and the tree begins to lean the saw must be quickly removed by the feller(s) in order to prevent damage to the tool. The feller then steps back and to one side of the stump for safety. As the tree falls it usually moves a short distance off the stump in the direction of fall.

If the falling tree strikes an obstacle, such as another tree, or the undercut has been made too high, or the felling cut too low or slopes out, the tree may be pushed back. If the tree is felled up a steep slope it is more likely to slide sharply back as it strikes the ground.

If any strain exists in the tree due to lean or abnormal development of the crown on one side, and this strain is not released when sawing, the tree can split at the butt when it is felled. As the butt split is released it may cause serious injury to the feller(s), and it is thus essential that he should plan an escape route in advance (see frontispiece). He must be alert for any signs of splitting so that he can step back at any time.

(12) "Hang-ups"

The predetermined direction of fall can be upset by gusts of wind, irregularities of the crown, an incorrect undercut or final cut, causing the tree to swing aside and "hang-up" or lodge in another tree. When this occurs the tree must be dislodged. With small trees this can often be done by shaking the tree by hand or by levering the butt aside with a hand spar (Fig. P 15). With larger trees the butt can be levered aside with a peavy hook (Fig. P 16). If the size of the tree makes the use of these methods impractical, animals can be used as shown in Fig. P 17, or wire pullers ("Tirfor" type) can be effectively employed for pulling the tree free (Fig. P 18). Tractors can also be used, but only in extreme cases as the costs do not justify their use (Fig. P 19). On no account should the feller climb up a lodged tree in an attempt to dislodge it.

As the final stage of felling, when the tree has been felled, the cutter must see that the butt is completely disconnected from the stump and that the shape of the butt is regular. If the butt is pointed, it must be squared before the logs can be marked for cross-cutting.

C. DEBRANCHING

Debranching is fully dealt with under "The Axe", as this is the tool used for the operation. It is essential that the branches should be cut off flush with the trunk, cutting with the angle of "hang" of the branch, and not against this angle. Debranching usually proceeds from the butt end of the tree to the top, branches only being removed up to the end of the merchantable timber.

The opportunity to knock off dead, brittle branches by using the axe as a hammer seldom occurs in South Africa as pruning to maintain a reasonably small knotty core involves removing branches before they die.

If one team of labourers works in the full sequence of felling, debranching and cross-cutting, they may be justified in leaving the debranching of the underside of the tree until later. Cross-cutting efficiency may be gained through the elevation of the trunk supported on the lower branches. When cross-cutting has been completed the logs can be rolled over and the underside branches easily removed from above. This operation is sometimes done at the roadside stacking deck, as the branches assist choking for skidding.

No uniformity in the method of debranching can be laid down due to the many variables involved, such as the thickness of the branches, their brittleness, attachment to the trunk, form and condition of their bases, and their position in relation to the debrancher.

One safety precaution must be observed while debranching - the cutter must stand on the side of the trunk opposite to the branches that he is cutting. Heavy branches must be cut with the axe held firmly in both hands, while small branches, which may be held aside, may be cut while holding the axe in one hand, although this method is inaccurate.

The parts of the tree with unmerchantable timber need not be debranched, unless they interfere with access to the merchantable parts of the boles.

Slashed branches derived from trees with heavy crowns usually litter the felling area and must be stacked at suitable intervals for access to the logs by the log-towing equipment. Stacking of branches is usually done at the same time as debranching. As the branches are cut off they are stacked by the debranchers (Fig. P 20). In thinnings slash should be stacked in rows along every alternate row, with occasional intervals (Fig. P 21), but it can be stacked in piles in clearfelling (Fig. P 22). Where skidding is done by highlead, orderly stacking of slash will be unnecessary, as it does not interfere with the skidding operation. Heavy tree tops may be cut into two or three sections for easier stacking.

D. MARKING THE BOLES INTO LOGS

In Departmental plantations cross-cutting is done at the stump, or more frequently tree-lengths are slipped to the roadside and cross-cut there. Marking the boles into logs is done by specially assigned men, as the cross-cutters are not permitted to mark the boles into logs themselves.

Log measuring is done with a marked stick or lath 3 - 4 m long, with a mark for every 10 cm, starting from 1 m. The lath is laid on the trunk and the marker marks the logs as shown in Fig. P 23. The mark itself is usually made with a hatchet or pruning saw. When the bole has been marked it may be cross-cut (Fig. P 24).

Marking boles into logs is controlled by crookedness (crook), spirality, rot, sweep, knots, etc., as well as the market demand for specified timber dimensions for certain species. Special Departmental instructions have been issued on log-making.

The classification of logs is done according to Departmental instructions, which affect the sorting and stacking at the roadside, where logs are stacked according to the dimensions required, and sometimes according to the species if certain timber is to be directed to different destinations.

The instructions for marking boles into logs and poles are given below in an abbreviated form.

(a) SUMMARY OF SPECIFICATIONS FOR SAWLOGS

(1) Short sawlogs

Class a: 2,0 - 3,5 m long with thin end underbark diameter 13,0 - 17,9 cm
Class b1: 2,0 - 3,5 m long with thin end underbark diameter 18,0 - 25,9 cm
Class c1: 2,0 - 3,5 m long with thin end underbark diameter 26,0 - 33,9 cm
Class d1: 2,0 - 3,5 m long with thin end underbark diameter 34,0 cm and over

(2) Long sawlogs

Class b2: 3,5 m and over with thin end underbark diameter 18,0 - 25,9 cm
Class c2: 3,5 m and over with thin end underbark diameter 26,0 - 33,9 cm
Class d2: 3,5 m and over with thin end underbark diameter 34,0 cm and over

I. All Pinus species

(1) Short sawlogs

The following defects are not permissible:

(i) Sweep and crook more than:

For 13 - 15 cm top under-bark diameter - 12 mm
For 17 - 20 cm top under-bark diameter - 24 mm
For 23 - 25 cm top under-bark diameter - 38 mm
For 27 - 30 cm top under-bark diameter - 50 mm
For 32 - 35 cm top under-bark diameter - 63 mm
For 38 cm and over top under-bark diameter .... - 76 mm

Sweep and crook are measured on the convex side of the log, except when the tree falls with its convex side towards the ground, in which case the concave side is measured.

(ii) Short logs - knots

A knot cluster (a group of knots in any 38 cm of the stem length) of which the sum of the diameters of knots 12 mm and over in diameter is equal to or more than the over-bark diameter of the stem just above the knot cluster.

Note : Knot diameters are always measured at right angles to the longitudinal axis of the stem.

In 1,90 m and 2,20 m logs - two or more clusters not allowed.
In 2,50 m and 2,80 m logs - three or more clusters not allowed.

(iii) Large knots

In Class a + b1 logs: any knot of 7,5 cm and more in diameter is not allowed.

In Class c1+d1 logs:

(a) Any knot 9 cm and more in diameter, or
(b) In any 38 cm of the trunk length:
  (i) a 7,5 - 9 cm knot plus another of 5 cm or more;
  (ii) a 7,5 - 9 cm knot plus 3 or more others of over 4 cm.

In P. pseudostrobus and P. montezumae species with regular branch whorls of thick branches, short logs may be prepared which are not permissible according to (ii) and (iii) mentioned above, provided that there is at least 80 cm between any two short log knot clusters, or between any defects which are not permitted according to (iii).

(2) Long sawlogs

The following defects are not allowed:

(i) Eccentricity

The shortest radius on the one side of the pith may not be equal to or less than one third of the longest diameter at either end of the log.

(ii) Sweep and crook

For 18 - 22 cm top diameter under-bark - 20 mm
For 23 - 25 cm top diameter under-bark - 25 mm
For 26 - 30 cm top diameter under-bark - 40 mm
For 31 - 35 cm top diameter under-bark - 50 mm
For 36 - 40 cm top diameter under-bark - 60 mm
For 41 cm and over top diameter under-bark .... - 76 mm

(iii) Any long sawlog knot cluster (a cluster of knots within 38 cm of stem length) of which the sum of knot diameters of knots of 12 mm and over, is equal to or more than 3/4 (75%) of the over-bark diameter of the stem just above the cluster.

(iv) Large knots

In Class b2 and c2 logs	In Class d logs
a. Any knot 6 cm and more in diameter	a. Any knot 8 cm and more in diameter
In any 38 cm of the stem length	
b. 3 or more knots 5-6 cm diameter	b (i) A 6 cm to 8 cm knot plus one of 5 cm or more (ii) A 6 cm to 8 cm knot plus 3 of more than 4,0 cm each (iii) 4 or more knots each of 5 - 6 cm or more

II Cypress species

(1) Short sawlogs

The following defects are not permitted:

(i) Bends and crooks - see a I 1 (i)
(ii) a. any knot of 5 cm or more in diameter
b. 3 or more knots each of 4 cm or more in diameter in any 30 cm of stem length.

(2) Long sawlogs

The following defects are not allowed:

(i) Eccentricity: See a I(2) (i).
(ii) Sweep and crook: See a I(2) (ii).
(iii) Any knots 3 cm and more in diameter.

(b) SUMMARY OF SPECIFICATIONS FOR POLES

(1) Poles must be debarked.

(2) Poles must be debranched flush with the bole surface.

(3) Inherent and post-impregnation defects.

(i) Sapwood - No pole shall have sapwood with a radial width of less than 15 mm in the case of hardwoods and 20 mm in the case of softwoods. Sapwood shall not be removed to such an extent that the depth of penetration of preservative or strength of the pole is adversely influenced.

(ii) Decay - Neither decay nor live fungal fruiting bodies shall be present in any pole.

(iii) Gum veins (kino) - A pole shall not contain gum veins within the first 25 mm of its wood when measured radially from the periphery of the pole.

(iv) Gum and resin pockets and resin scars -

• No gum or resin pockets or scars shall be present in the lower 2 metres of the pole.

• A maximum of 3 gum or resin pockets or scars may be present in the portion of the pole 2 metres away from the butt provided that the average diameter of any gum or resin pocket or scar does not exceed 1/3 diameter of the pole measured at the point where the gum or resin pocket or scar occurs, and provided that the penetration of preservative is not impeded.

(v) Insect damage -

Poles shall be free from insect damage with the following exceptions:

• Scoring and/or chanelling, up to a depth of 3 mm, of the surface of a pole shall not be classified as insect damage.

• A maximum of 5 barkborer holes (Cerambycidae) shall be allowed in any 1 metre length of a pole provided that the holes shall be tightly plugged with an acceptable creosote impregnated wooden dowel after treatment.

• A maximum of 20 pinhole borer holes (ambrosia) shall be allowed in any 1 metre length of a pole.

(vi) Ring shakes -

• Top: Tops of poles shall be free from ring shakes.

• Butt: One complete ring shake at the butt of a pole shall be allowed provided it is situated at least 50 mm from the periphery of a pole when measured radially.

When a ring shake at the butt of a pole does not extend across the diameter it will be allowed provided that it is situated at least 40 mm from the periphery of the pole when measured radially.

(vii) Spiral grain - Spirality of grain shall not exceed one complete turn in any 5 m length of pole and pro rata for longer and shorter lengths except that in pine species used for telephone carrier routes, spirality shall not exceed one turn in the overall length of the pole.

(viii) Post-impregnation defects - Post-impregnation defects shall not be present.

(ix) Maximum permissible defects

1	2
Description of defect	Maximum
Checks	
(a) End checks: Number (1) Top	3
(2) Butt	4
Length* (1) Top	4 x diam.
(2) Butt	6 x diam.
Width (1) In poles of top diam. not exceeding 13 cm: Top and butt	1/10 diam.
(2) In poles of top diam. exceeding 13 cm: Top ...	13 mm
Butt ...	20 mm
Sum of widths	
(1) In poles of top diam. not exceeding 13 cm: Top	25 mm
Butt	45 mm
(2) In poles of top diam. exceeding 13 cm: Top ...	30 mm
Butt ...	70 mm
(b) Surface checks	
Number++	Not limited
Individual length*	8 x diam.
Individual width	20 mm
Crook + and sweep ‡	
Telephone poles	12,5 L§ mm
Low voltage distribution poles ..	16,7 L§ mm
Knots and knot holes	
(1) Individual knots and knot holes	1/6 girth
(2) Clusters of knots in worst 150 mm of length	1/3 girth

* The length of the check over the distance for which its width is greater than 3 mm, but in the lower third of the length of the pole, the length of the check over the distance for which its width is greater than 6 mm

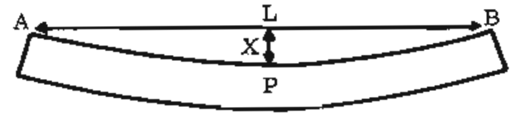
\+ No reverse crook shall be allowed

++ Provided that where 3 or more checks occur together at any cross-section, the sum of their lengths shall not exceed half the length of the pole

‡ Reverse sweep shall be allowed, provided that a straight line connecting the mid-point at the ground line with the mid-point at the top does not at any intermediate point pass through the face.

(x) Ordinary sweep shall not exceed 12,45 L mm between any two points L m apart along the same line of the pole, where L is 2 m or more in length.

Example: Say L = 2 m: 12,45 mm x 2 m = 2,5 cm in 2 m.



x = the deviation in cm from the straight line between two points A and B, which are along the same line of the pole P.
L= the distance in metres between points A and B mentioned.
P= The pole that has deviated from the straight.

(xi) In double or reverse sweep a straight line connecting the midpoint at the ground line with the midpoint at the top shall not at any intermediate points pass through the surface of the pole.

(xii) Occlusion swelling shall not be removed from poles of the genus Eucalyptus where such removal will result in the exposure of cavities, or of heartwood. In all hardwoods no sapwood shall be removed from that portion of the pole which is to be in the ground, or along one fifth of the overall length of the pole, as measured from its butt end. Butt swelling shall be admissible in all species.

(xiii) Standard dimensions of poles - Measure the diameter, length, and squareness of ends of poles as follows:

- Diameter: Measure the diameter to the nearest 1 mm using a diameter tape and to the nearest 3 mm using a measuring tape.

- Length: Measure the length to the nearest 10 mm.

- Squareness of ends: Measure the squareness of ends to the nearest degree.

(xiv) Tolerances on dimensions - Length

- Telephone poles - When measured the length of telephone poles shall be as given in Table P.1 or as specified by purchaser subject to a tolerance of ± 75 mm.

- Low voltage distribution poles - When measured the length of low voltage distribution poles shall be as given in Table P.1 or as agreed upon between purchaser and supplier, subject to the following tolerances:

TABLE P.1 - Standard dimensions of creosoted telephone and transmission poles

Length, m	Top diamter, cm	
	min	max
5,5	8,5	10,5
	11,0	13,0
6,5	8,5	10,5
	11,0	13,0
7,5	8,5	10,5
	11,0	13,0
	13,5	15,5
8,0	11,0	13,0
	13,5	15,5
	16,0	18,0
8,5	11,0	13,0
	13,5	15,5
	16,0	18,0
9,25	11,0	13,0
	13,5	15,5
	16,0	18,0
10,75	11,0	13,0
	13,5	15,5
	16,0	18,0
	18,5	20,5
12,25	11,0	13,0
	13,5	15,5
	16,0	18,0
	18,5	20,5
	21,0	23,0
13,75	13,5	15,5
	16,0	18,0
	18,5	20,5
	21,0	23,0
14,75	13,5	15,5
	16,0	18,0
	18,5	20,5
	21,0	23,0
15,25	13,5	15,5
	16,0	18,0
	18,5	20,5
16,75	13,5	15,5
	16,0	18,0
	18,5	20,5
18,25	13,5	15,5
	16,0	18,0
	18,5	20,5
21,50	13,5	15,5
	16,0	18,0
	18,5	20,5

Plus: 50 mm for every 3 m of pole and pro rata for shorter lengths;
Minus: 75 mm on the total length of the pole.

Diameter - When measured using a diameter tape, the top diameters of poles shall be as given in Table P.1 or as specified by the purchaser, subject to the following tolerances:

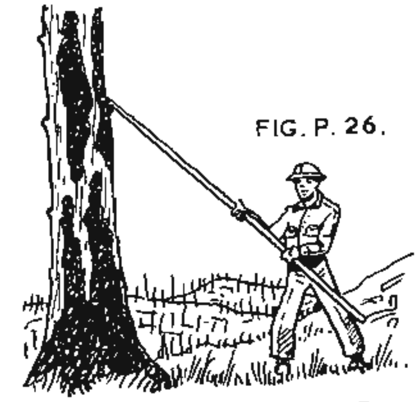
- diameter class 8,5 cm to 10,5 cm: plus 25 mm. No minus tolerance shall be allowed;

- diameter classes above 11,0 cm plus or minus 25 mm.

FIG.P.25.

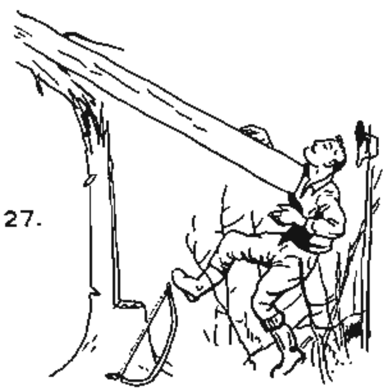
CHECK FOR LEAN AND HANG-UP LIMBS BEFORE FELLING.

FIG. P. 26.



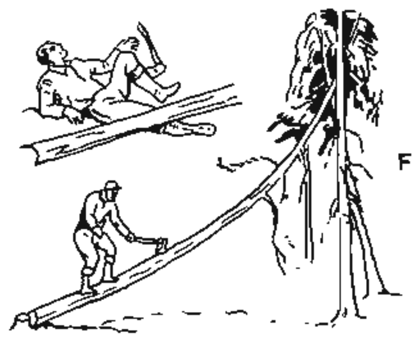
LOOSE BARK SHOULD BE REMOVED BEFORE FELLING SNAGS.

FIG. P. 27.



POOR UNDERCUTTING INCREASES THE DANGER OF BUTT SPLIT IN TREES WITH A HEAVY LEAN OR STUMP ROT.

FIG.P. 28

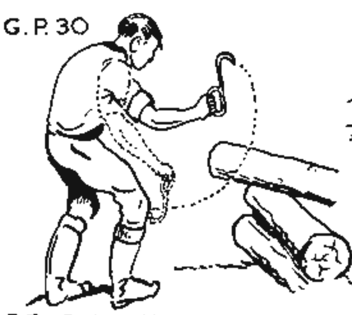


IT IS DANGEROUS TO SHAKE A LODGED TREE DOWN BY CLIMBING ON IT.

FIG.P.29

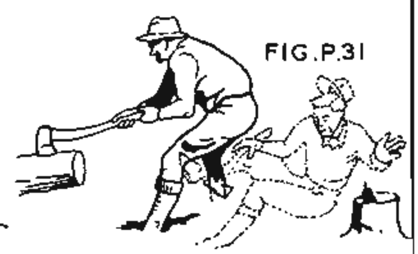
CUTTER'S HAND TOO CLOSE TO SAW, AND LOG CAN DROP ONTO FOOT WHEN CUT THROUGH.

FIG.P.30



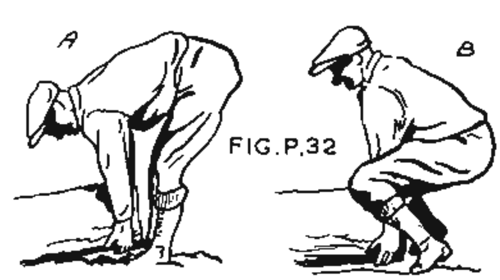
BE CAREFUL NOT TO GET PULPHOOK IN LEG INSTEAD OF LOG.

FIG.P.31



USING AN AXE IN PLACE OF A PULP-HOOK IS UNSAFE.

FIG.P.32



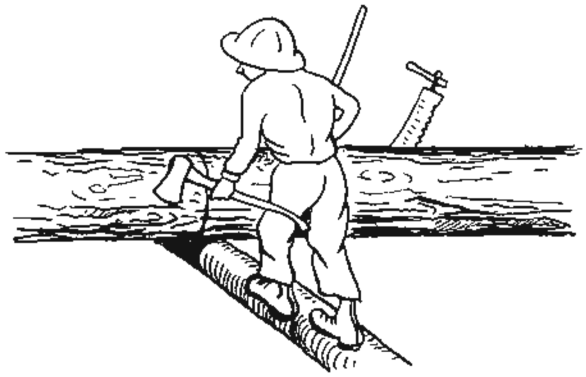
(B) CORRECT, AND (A) INCORRECT WAY TO LIFT HEAVY WOOD.

SAFETY IN FELLING, CROSS-CUTTING AND HANDLING TIMBER

FIG. P.33

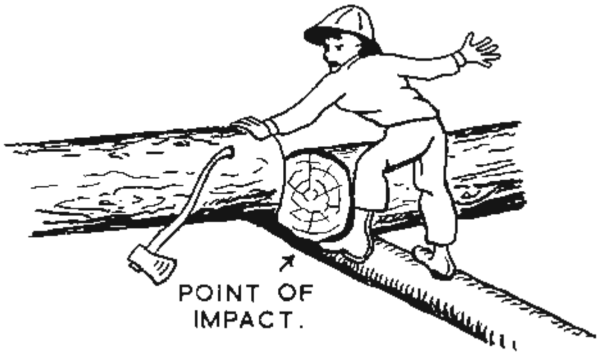
DEBRANCHER KILLED WHEN HIS HEAD WAS CRUSHED BY A LARGE LOG THAT HE TRIED TO ROLL ON A STEEP SLOPE WITH A PEAVY HOOK TO EXPOSE THE UNDERSIDE FOR KNOTTING. HIS FEET SLIPPED AND THE LOG ROLLED OVER HIM.

FIG. P. 34



THE CROSSCUTTER HAD FINISHED CROSSCUTTING A LOG, LYING ON A 15 cm SAPLING. HE LEANED OVER TO GET HIS MEASURING STICK AND SAW · · · · · · ·

· · · · THE TOP LOG ROLLED, TRAPPING AND SQUEEZING THE CROSSCUTTERS LEFT FOOT. HE WAS WEARING SAFETY SHOES AND SO ESCAPED INJURY.



E. SEQUENCE OF THE LOG PREPARATION OPERATION

(a) Because one man marks the boles into logs for a number of teams working with bow or cross-cut saws, he is not always available on the spot for each working team. This in itself predetermines the working method in felling, debranching and cross-cutting, and one of the following alternatives can be followed:

(1) The felling crew fells the trees and debranches them, stacking the branches which they remove. In this case work proceeds without interruption. When the boles have been marked into logs they are cross-cut by special teams.

(2) The felling crew fells the trees, debranches them, and stacks the branches, then cross-cuts the trees after they have been marked by a marker. In this case it frequently occurs that cutters are delayed before they can start cross-cutting, as they have sometimes to wait for the marker.

(b) When power saws are used, one man is included in the team to mark the bole into logs as soon as the tree has been felled and debranched. Several procedures may be followed:

(1) <u>One power saw working in the compartment</u>

(i) Trees are felled by the power saw during the whole day, then debranched and immediately marked into logs, which are cross-cut on the following day. This method is practicable when only 220 - 250 trees are to be clearfelled per hectare.

(ii) A number of trees is felled and as soon as they have been debranched their boles are marked into logs, after which cross-cutting proceeds immediately with the same saw. This method is preferred if the stand is dense.

(2) <u>Two power saws work in the same compartment</u>

One saw is responsible for felling only, debranching and marking being done by a special team, while the second saw cross-cuts the marked boles into logs.

After a few days of this type of operation the cross-cutters usually begin to lag behind the fellers. If this is the case, the fellers must help with cross-cutting for a short while until all the felled trees have been cross-cut before the operation can commence in the usual manner again.

<u>Note</u> : The sawing teams, debranching team and marker must all work at a safe distance from each other so as not to be injured by falling trees or rolling logs, if the slope is steep. This method is used when the production of a large volume of timber is required

F. CROSS-CUTTING

(a) THE CROSS-CUTTING OPERATION

The cross-cutting operation consists of:

(1) nearing the tool (picking it up and preparing for use);

(2) cross-cutting;

(3) occasional pinching of the saw;

(4) squaring the butt if necessary; and

(5) walking between cuts or from bole to bole. If spare saws or blades are kept handy sharpening delays can be minimised or avoided.

The stance of the labourer when cross-cutting is easier and more convenient than is the case for felling. Elevation of the boles above the ground is of great importance for speedy cross-cutting. For this reason it is sometimes convenient that cross-cutting and debranching advance together. If trees are not too heavy they may be felled across other previously felled trees, or across the logs of previously cross-cut boles in order to give some elevation for cross-cutting. Stability of the boles is another important factor in cross-cutting. Sometimes boles are not adequately supported from underneath. Small trees can be shifted to a more convenient or firmer position or stabilised by hand while sawing, while larger trees can often be propped from beneath. Overhang of one end of the tree without support from below may cause longitudinal splitting, which can be avoided by propping this end.

Occasionally a tree is encountered with a diameter larger than the space between the blade and frame of the bow saw, which prevents cutting the bole right through. This can be overcome by chopping a notch with the axe to permit the saw frame to pass below the surface of the bole, or else the cut can be made partially from above and partially from below if the bole is raised or suspended. If large diameter trees predominate, cross-cut or power saws must be used in preference to bow saws.

(b) SAW PINCHING IN CROSS-CUTTING

Hardpoint bow saw blades 19 mm wide, with scriber and raker toothing, are used for cross-cutting small and medium diameter trees in Departmental plantations. These thin and narrow blades, if well set and tensioned, are hardly ever subject to pinching. If a sagging tree is encountered, which is a frequent cause of pinching, the bole should first be cross-cut elsewhere if possible, leaving the sagging portion to be dealt with at the end. This often solves the difficulty, as the sagging portion often drops to the ground when other logs are cut from the bole. If this does not solve the problem, wedges must be used to keep the saw from pinching.

(c) SAFETY IN TIMBER PREPARATION

Figures P 25 to P 34 illustrate hazards, accidents, and safety precautions which should be taken during timber preparation in felling, cross-cutting and handling timber.

THE AXE

IN

TIMBER

PREPARATION

THE AXE

The axe is used in logging operations for felling trees in first thinnings, or for preparing the undercut when hand-saws are used for felling trees of medium or large diameter. It is also used for clearing the area around the base of the trees to be felled of branches and saplings, and for removing bark from around the base of trees when hand-saws are to be employed. Hatchets are used for marking trees for thinnings or logs for cross-cutting.

A. THE AXE HEAD

(a) MATERIAL

Axes can be made in two different ways. Previously the most usual method was to insert a piece of hard steel for the bit or edge and the main body of the head was made from fairly soft steel (Fig. A 1). Nowadays, however, axes are mainly made out of good steel throughout, being shaped from solid steel as shown in Fig. A 2.

The ideal steel for axe heads should have a carbon content of about 0,8%, it should be malleable amenable to hardening, i.e. by heating up to about 800°C and quenching and possibly tempering by reheating to 200 or 300°C, the final product having a good hardness in combination with a certain toughness. The present tendency is to specially temper the bit more than the rest of the head. Axe head steel should be as even as possible and hard without being brittle.

(b) MASS

Axe heads vary in mass from 1,1 kg to as much as 3,2 kg. For pulpwood preparation of softwood timber, heads of from 1,1 - 1,6 kg are suitable; for general preparation of medium-sized timber, heads of from 1,6 - 2,3 kg and for the preparation of hardwood timber or for large-sized trees, heads with a greater mass are more suitable. It is essential that the cutter choose an axe most suited to his own muscular forces and the timber that is to be treated. An axe that is too large for the worker causes unnecessary strain and spoils his aim and efficiency.

(c) SHAPE OF THE BIT AND GRINDING

The felling axe should have a thin, sharp and durable bit in order to cut efficiently into the wood. As the felling axe must also be designed as a chip-producing tool, it must also have a suitable thickness behind the bit, making it capable of breaking up the chips. A thin, sharp bit cuts well but is easily blunted. For an efficient chip breaker and to avoid the axe getting stuck in the wood, a certain rounding of the sides of the bit is required. Through this the bit will also be thicker and stronger. The rounding should be less pronounced for softwood than for hardwood. Fig. A 3 illustrates suitable bit designs considering the hardness of the timber.

Felling axes are all manufactured with curved edge lines. It is important that this curve line is maintained unchanged when grinding. The curve line should coincide with a circular bow with the centre in or slightly outside the centre of gravity of the axe, through which the stability of the axe in various regards is guaranteed, as well as the chip-breaking quality at different hit points of the edge (see Fig. A 4).

An unsymmetrical, as well as a too sharply curved edge line, means that the axe slides easily, through which the risk of accidents is considerably increased (see Fig. A 5).

(d) DESIGNS

Hundreds of designs for axe heads exist, in many cases different localities having developed their own designs. Two main types stand out, however, the double-bitted axe and the single-bitted or "pole-axe."

(i) DOUBLE-BITTED AXE

This axe has two cutting edges opposite each other, both in line with the handle, and is the specialised tool that belongs only in the hands of a professional axeman. It is, however, a dual purpose axe, as it is actually two axes in one, the woodsman grinding each of the two blades to different thicknesses for different purposes. One is thinly ground for clean, fast chopping, the other ground thicker for working round knots, roots or near the ground where a slip may mean a nick.

The full-sized double-bitted axe has a 1,6 - 1,8 kg head and a 90 cm handle (Fig. A 6), but most workers usually favour the lighter and smaller "cruiser" axe (Fig. A 7), which has all the advantages of the larger double-bitted axe, but none of its unwieldiness. This axe has a 1,1 - 1,4 kg head and 70 cm handle.

Of the various designs of double-bitted axes, the Michigan and Pennsylvania or Western are preferred (Fig. A 8).

The disadvantages of the double-bitted axe are that it cannot be used for hammering (driving wedges) and it is dangerous to both handle and carry. The head must be muzzled in a sheath at all times when not in use. In most parts of the world this axe is being replaced by the pole-axe and in South Africa it is hardly, if ever, encountered. All the remaining information in this manual will consequently only refer to pole-axes.

(ii) THE POLE-AXE

The pole-axe is a general purpose axe which can be used for chopping, splitting or hammering. This axe has a hammer surface opposite the cutting edge, the hammer surface being called the "butt" or "pole", hence the name. Fig. A 9 illustrates the head of a pole axe with the nomenclature of the various parts.

In South Africa the conception of an axe, even today, is a 2,3 - 2,5 kg pole-axe, due, no doubt, to the demand that grew up before the days of

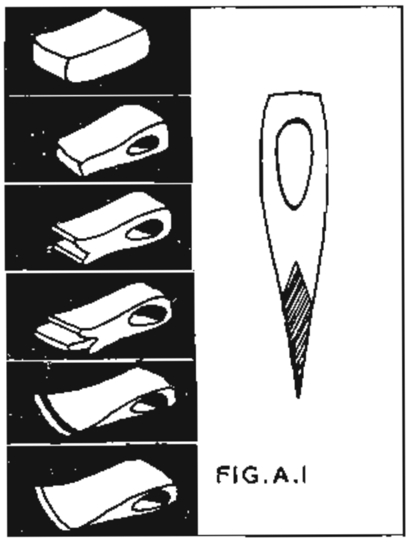


FIG.A.I

MANUFACTURE OF AXE WITH INSERTED STEEL FOR BIT.

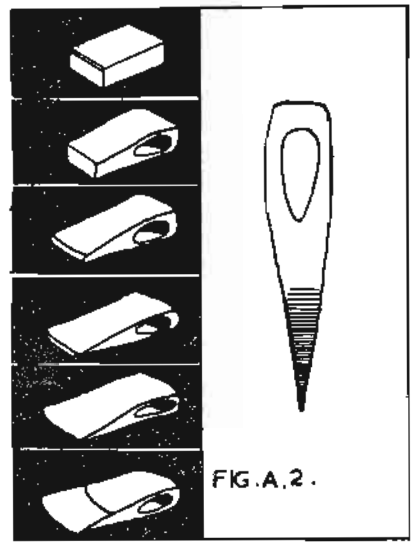
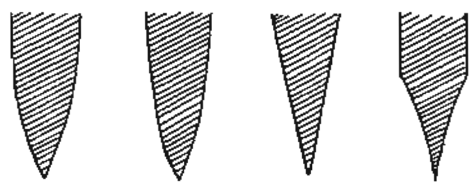


FIG.A.2.

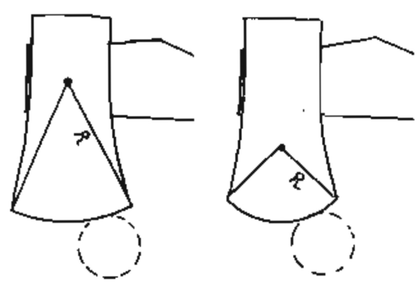
MANUFACTURE OF SOLID STEEL AXE HEAD.

FIG. A.3.

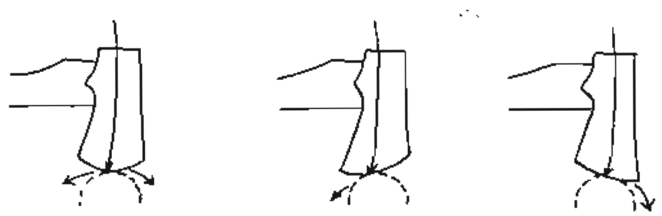


HARDWOOD - SOFTWOOD - SPLIT-TING BADLY GROUND.

FIG.A.4.



TWO TYPES OF CURVED LINES. FOR BITS.



SHARPLY BENT EDGE LINE. UNSYMMETRICAL EDGE LINES.

FIG. A.5.

HEAD AND BIT

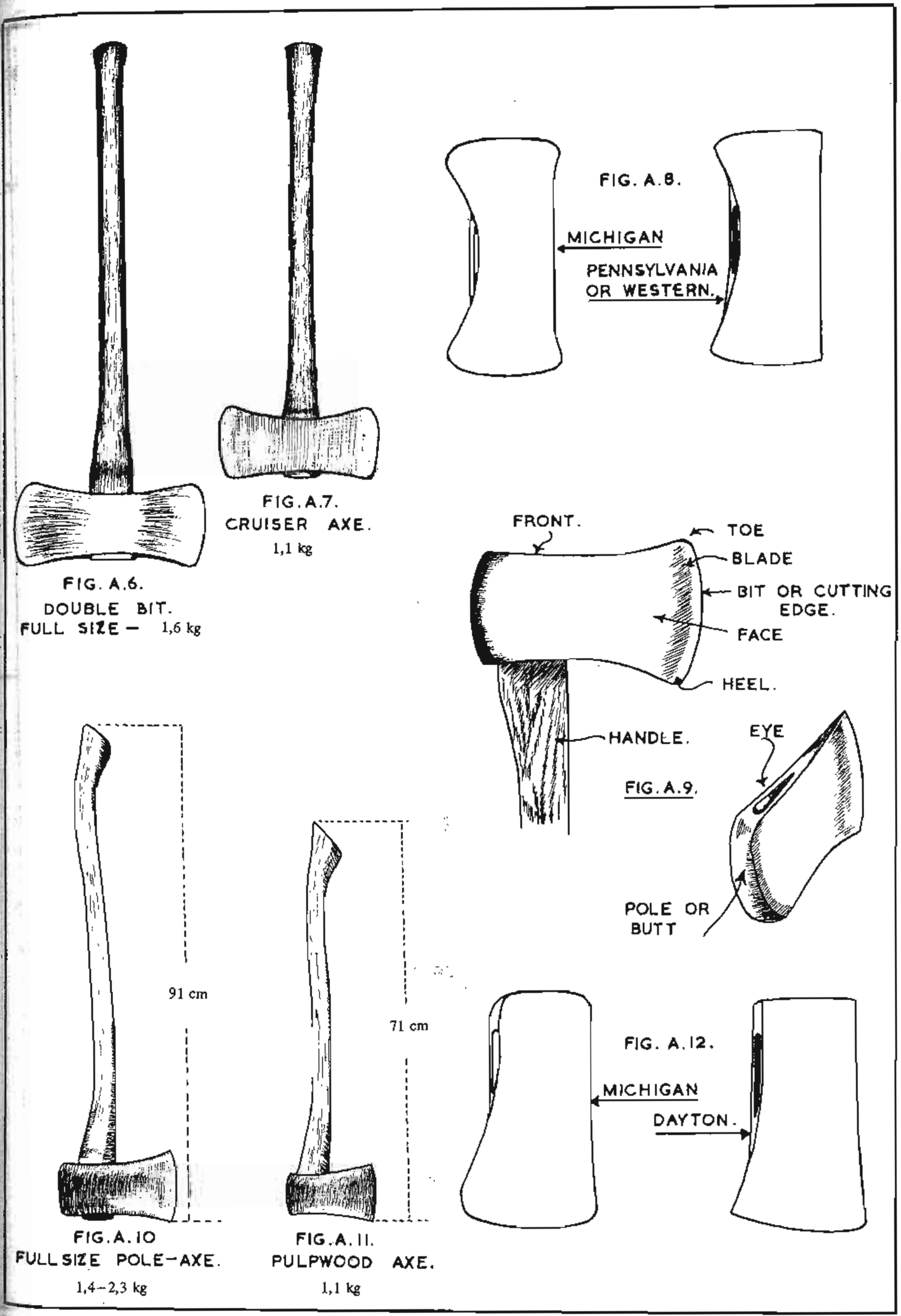


FIG. A.6.
DOUBLE BIT.
FULL SIZE — 1,6 kg
FIG. A.7.
CRUISER AXE.
1,1 kg
FIG. A.8.
MICHIGAN
PENNSYLVANIA OR WESTERN.
FRONT.
TOE
BLADE
BIT OR CUTTING EDGE.
FACE
HEEL.
HANDLE.
EYE
FIG. A.9.
POLE OR BUTT
91 cm
71 cm
FIG. A.10
FULL SIZE POLE-AXE.
1,4–2,3 kg
FIG. A.11.
PULPWOOD AXE.
1,1 kg
FIG. A.12.
MICHIGAN
DAYTON.

TYPES OF AXE

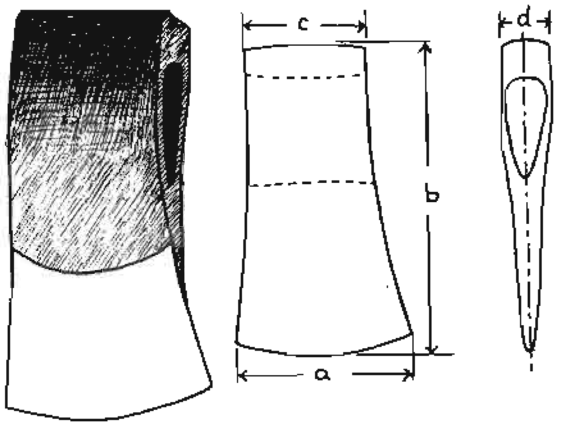


FIG. A.13a.

AXE HEAD.

YANKEE PATTERN.

SPECIAL ANALYSIS STEEL.
PRETESTED FOR SHOCK.
HEAT TREATED AND TEMPERED.
CARBON CONTENT. ± 0,8%

MASS kg	MEASUREMENTS IN cm			
	a.	b.	c.	d.
1,4	11	18	8	3
1,6	11	19	8	3
1,8	12	20	8	3
2,0	13	21	8	3
2,3	13	21	8	3
2,5	14	21	9	3

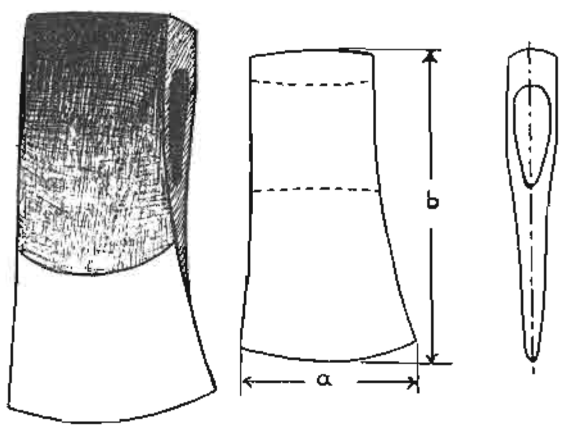


FIG. A.13. b.

AXE PATTERN – HATCHETS.

YANKEE PATTERN.

SPECIAL ANALYSIS CAST STEEL.
PRETESTED FOR SHOCK.
HEAT TREATED AND TEMPERED.
CARBON CONTENT ± 0,8%

MASS OF HEAD. kg	0,7	0,8	0,9	1,0
LENGTH OF HANDLE (cm)	38	39	42	44
LENGTH OF AXE (b) APPROX(cm)	15	15,5	15,9	16,5
LENGTH OF CUT (a) APPROX(cm)	7,9	8,6	8.9	10,2

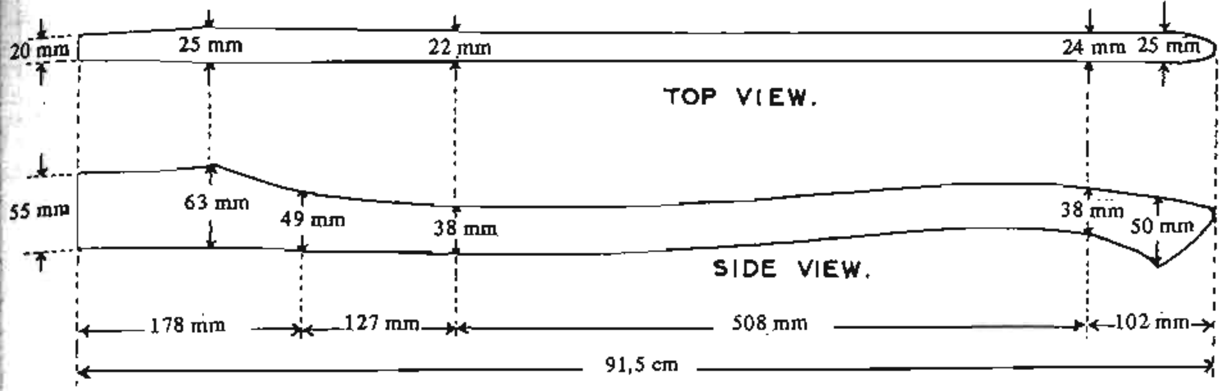


FIG. A. 14 a.

HICKORY AXE HANDLE FOR 2 kg AXE.

DENSITY: NOT MORE THAN 16 GROWTH RINGS PER 25,4 mm.

FIBRES: RUN ALONG WHOLE LENGTH OF HANDLE.

WOOD: FREE OF KNOTS OR DEFECTS, PARTICULARLY IN UPPER HALF OF HANDLE.

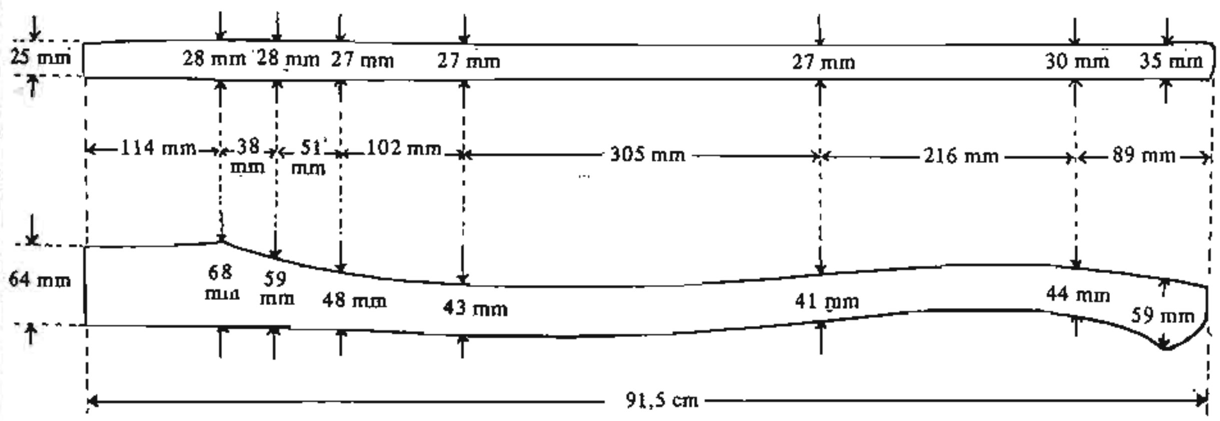


FIG. A. 14. b.

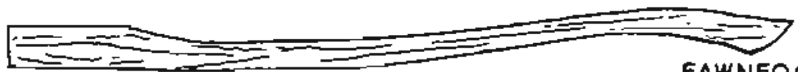
AXE HANDLE FOR 2 kg HEAD:—SOUTH AFRICAN TIMBER.

SPECIFICATIONS AS PER. S.A.B.S. 573 — 1958.

FIG. A.15.

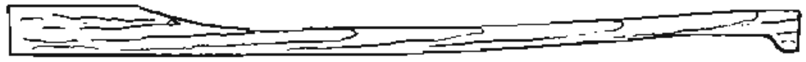
SWELL END.

a. DOUBLE BITTED AXE HANDLE.



FRONT END. BELLY. FAWNFOOT.

b. POLE-AXE HANDLE.



c. PULPWOOD AXE HANDLE. BLUNT END.

d. SCROLL END.

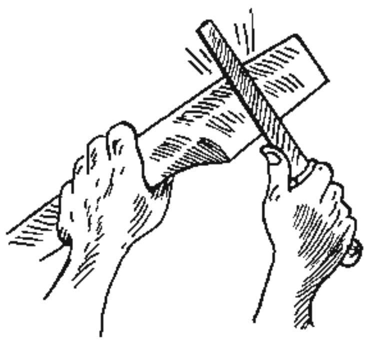


FIG. A. 17.
SHAPING HANDLE TO FIT HEAD.

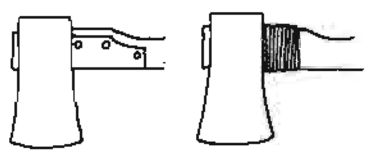


FIG. A. 16
REINFORCED AXE HANDLES.

RIGHT WRONG.

FIG. A. 18.
HEAD WELL DOWN.

FIG. A. 19.
ALIGNING THE AXE.

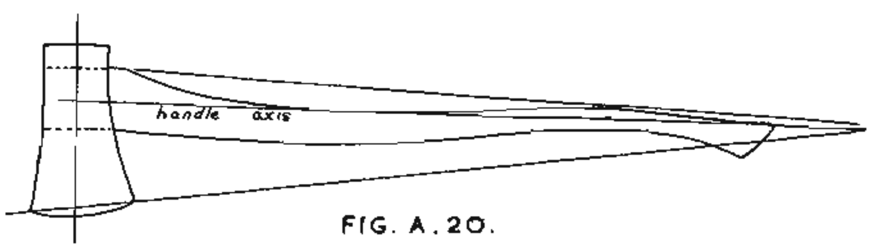


FIG. A. 20.
THE "HANG" OF THE AXE.

AXE HANDLES AND FITTING

exotics for an axe capable of chopping and splitting our close-grained hardwoods. Large pole-axes range in mass from 1,4 - 2,3 kg, most woodsmen preferring a 1,6 - 1,8 kg axe with a 90 cm handle, which has great enough mass for most uses (Fig A 10). Axes with a great mass are mainly used for splitting firewood or chopping big timber.

In the vast pulpwood areas of the United States and Canada, where trees seldom run over 30 cm in diameter at the butt, no one thinks of using an axe with a greater mass than 1,1 kg with a 70 cm handle (Fig. A 11). This class of axe is usually catalogued by manufacturers as the pulpwood axe, three-quarter axe or boy's axe. Many woodsmen use this axe in preference to the axe with a greater mass, particularly for thinnings or small undercuts, as it is more versatile and lends greater accuracy.

In pole-axes the Michigan pattern is the most widely used and is generally accepted in South Africa, with the Dayton and Yankee patterns next in demand, although a combination of these two patterns is also popular (see Fig. A 12).

Fig. A 13a shows the "Yankee" axe head at present used in the Department, with specifications and masses indicated, while Fig. A 13b shows details of the hatchet head preferred for general use.

B. THE HANDLE

(a) DESCRIPTION

Pole-axe handles are generally curved, whereas those used on double-bitted axes are straight. The shape of the handle plays an important role, pole-axe handles being curved to ensure a convenient and steady handgrip when cutting, which affects swing and precision. Fig. A 14a illustrates a hickory pole-axe handle with specifications, and Fig. A 14b an axe handle made from locally grown timber. Fig. A 15 illustrates a straight handle, a handle with a regular curve, and a handle with slightly less curve favoured by the pulpwood workers in England.

The handle consists of three main parts: the front end to which the head is fixed; the belly or curved main portion of the handle, and the knob at the end (Fig. A 15a). The knob is to prevent the hand from sliding off the handle and should fit conveniently into the hand. The usual shape of the knob is the "fawn foot" (Fig. A 15b) followed by the less common "scroll-end" (Fig. A 15d), "swell-end" (Fig. A 15a) or even rounded or blunt knobs (Fig. A 15c).

The quality of an axe handle is important as poor handles are difficult to control and are not dependable. Of the imported handles, white hickory is the world's favourite for axe handles. Tests have shown that so long as the wood has the proper density (not more than 16 growth rings per 2,5 cm) it makes little difference if it is white or brown (red) hickory. In the best handles, the rings are parallel to the blade and run through the centre lengths of the handle. White ash is also frequently used. Essential qualities are that the fibres run along the whole length of the handle and the wood must be free of knots or any other defects, particularly in the upper half of the handle.

Of the South African grown timbers, none has quite as high a shock strength mass ratio as hickory. On the other hand, if carefully graded and selected, several local woods are suitable for axe handles:

Hickory class	Ash class	
White ironwood	E. maculata	Over 640 kg per m^3 @ 15 % moisture content
Assegai	E. microcorys	do
Black ironwood	E. diversicolor	Over 720 kg per m^3 @ 15 % moisture content

Heartwood near the centre of the tree must be avoided due to its brash characteristics rendering it useless as a handle.

Reinforced handles, as illustrated in Fig. A 16, cannot be recommended for the following reasons:

(1) Risk of breaks in the handle behind the rivets.

(2) Chips and twigs can collect between the reinforcing iron and wood.

(3) Reinforcing adds mass to the axe and impairs balance.

Reinforcements are used to protect the underside of the handle behind the head, but are only necessary for unskilled workers. The able worker can do more to protect his axe than can reinforcements.

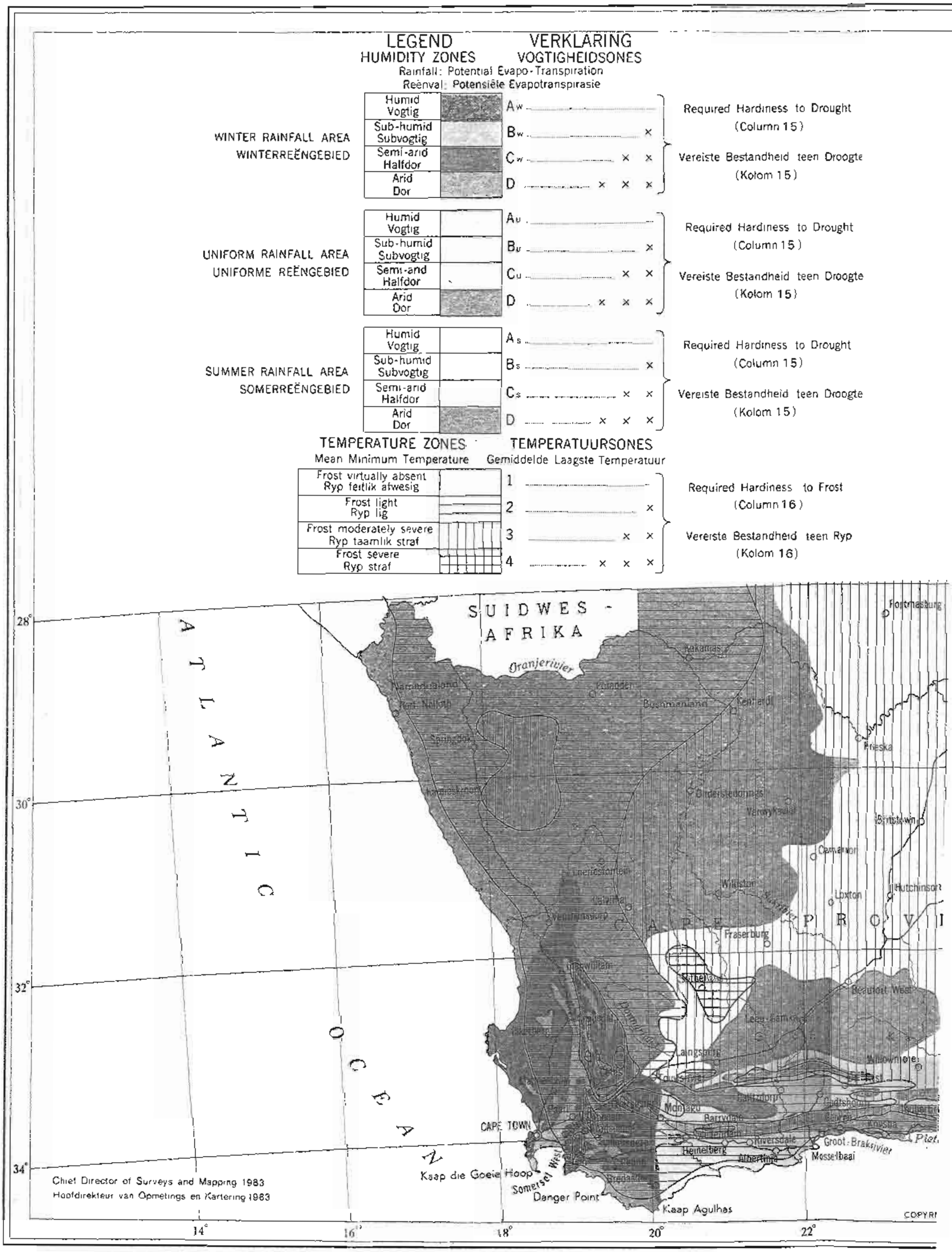
(b) LENGTH OF THE HANDLE

The length of the handle must be adjusted to suit the mass of the head and the physical abilities of the axeman. The most suitable length is perhaps 838 mm, but to be perfect an axe handle must fit the individual user. A rule which seems to work in practice is that the length of the handle from the grip to the shoulder should equal the length of the user's arm from armpit to tip of fingers.

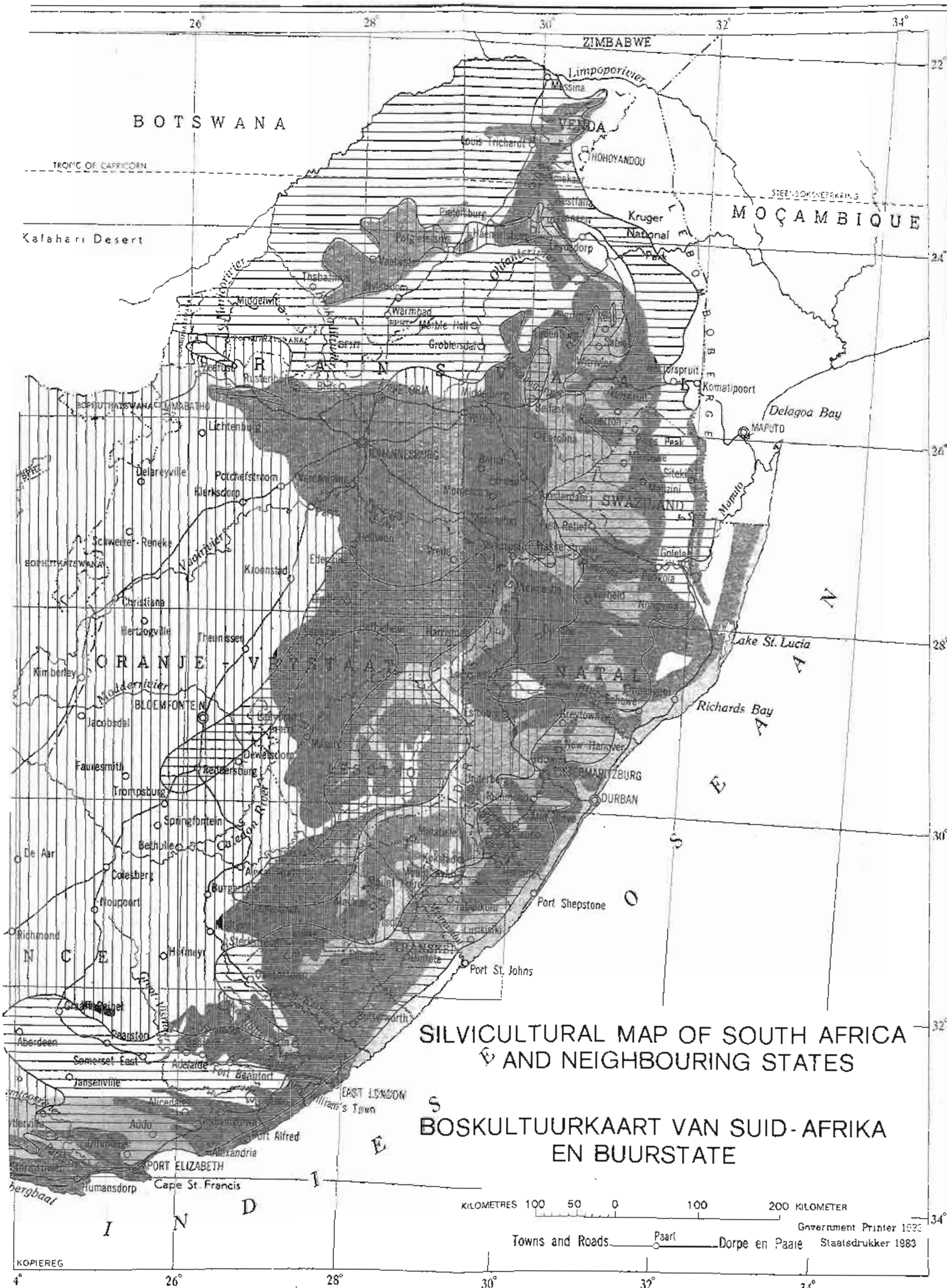
For different masses of head the following lengths of handles are suitable:

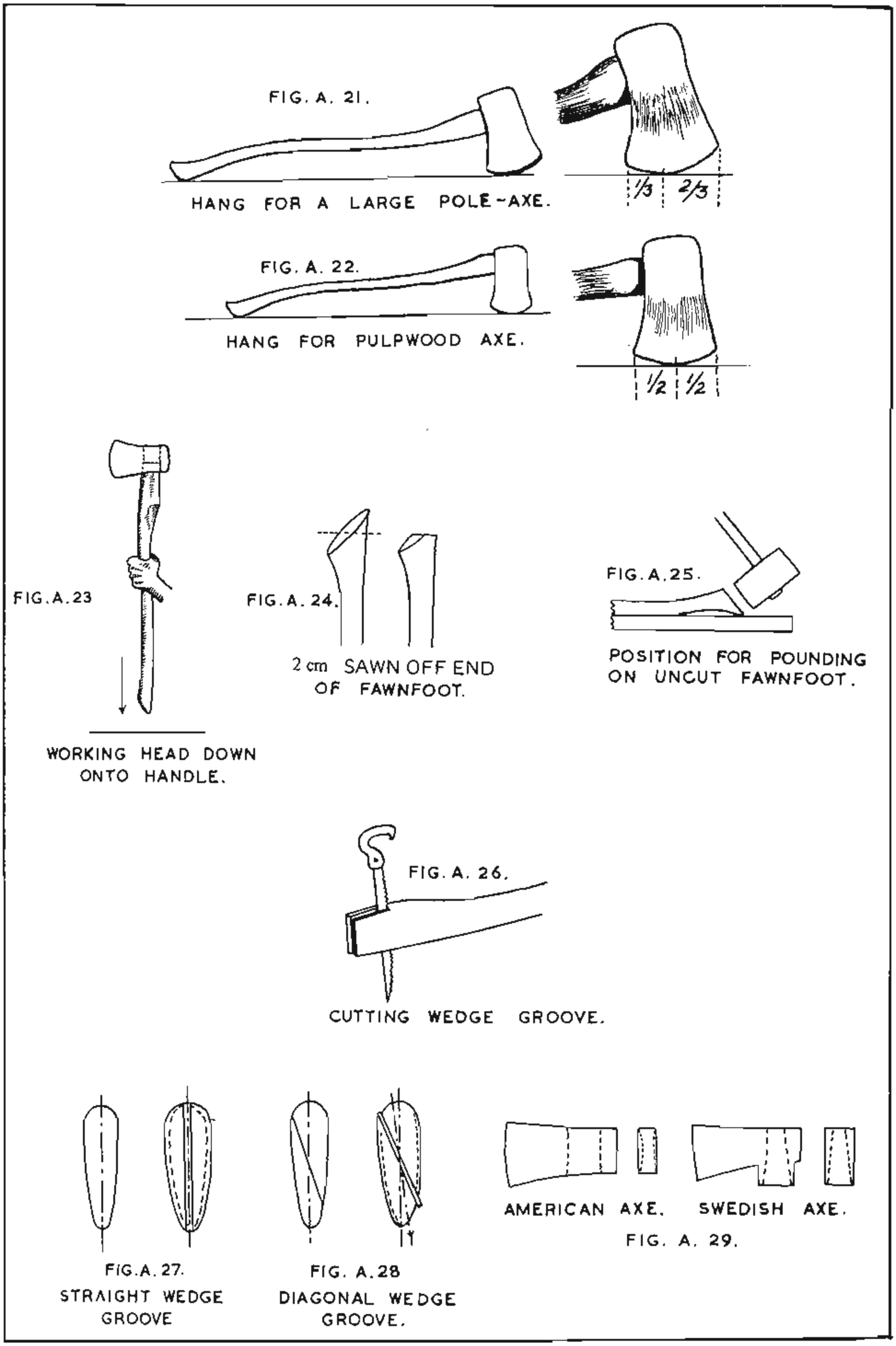
0,8 - 1,1 kg	-	66 cm
1,1 - 1,4 kg	-	66 - 71 cm
1,4 - 1,7 kg	-	71 - 76 cm
1,8 - 2,3 kg	-	76 - 81 cm
2,3 kg and over	-	81 - 90 cm

An axe handle should be absolutely smooth so that it will slip in the hand with the utmost ease. A rough or "furred" handle can be smoothed by soaking it in hot water until the grain stands out, allowing it to dry, and then sanding it down until smooth. After that it should be given repeated coats of linseed oil. Warped or rough handles lead to inaccuracy and increase the accident hazard. To prevent a handle from warping the axe should be laid flat on its side when not in use.



LEGEND
VERKLARING
HUMIDITY ZONES
VOGTIGHEIDSONES
Rainfall: Potential Evapo-Transpiration
Reënval: Potensiële Evapotranspirasie
WINTER RAINFALL AREA
WINTERREËNGEBIED
UNIFORM RAINFALL AREA
UNIFORME REËNGEBIED
SUMMER RAINFALL AREA
SOMERREËNGEBIED
Humid
Vogtig
Sub-humid
Subvogtig
Semi-arid
Halfdor
Arid
Dor
Aw
Bw ×
Cw × ×
D × × ×
Au
Bu ×
Cu × ×
As
Bs ×
Cs × ×
Required Hardiness to Drought
(Column 15)
Vereiste Bestandheid teen Droogte
(Kolom 15)
TEMPERATURE ZONES
TEMPERATUURSONES
Mean Minimum Temperature
Gemiddelde Laagste Temperatuur
Frost virtually absent
Ryp feitlik afwesig
Frost light
Ryp lig
Frost moderately severe
Ryp taamlik straf
Frost severe
Ryp straf
1
2 ×
3 × ×
4 × × ×
Required Hardiness to Frost
(Column 16)
Vereiste Bestandheid teen Ryp
(Kolom 16)
SUIDWES-AFRIKA
Oranjerivier
ATLANTIC OCEAN
CAPE PROVI
Namakwaland
Port Nolloth
Springbok
Bushmanland
Kenhardt
Prieska
Pofadder
Kakamas
Brandvlei
Britstown
Carnarvon
Williston
Loxton
Hutchinson
Fraserburg
Beaufort West
Laingsburg
Montagu
Barrydale
Heidelberg
Riversdale
Albertinia
Mosselbaai
Groot-Brakrivier
Knysna
Oudtshoorn
Calitzdorp
Willowmore
CAPE TOWN
Kaap die Goeie Hoop
Somerset West
Danger Point
Kaap Agulhas
Bredasdorp
Chief Director of Surveys and Mapping 1983
Hoofdirekteur van Opmetings en Kartering 1983
28°
30°
32°
34°
14°
16°
18°
20°
22°
COPYRI


SILVICULTURAL MAP OF SOUTH AFRICA AND NEIGHBOURING STATES
BOSKULTUURKAART VAN SUID-AFRIKA EN BUURSTATE
ZIMBABWE
BOTSWANA
MOÇAMBIQUE
SWAZILAND
NATAL
VENDA
TRANSKEI
Kalahari Desert
Kruger National Park
Delagoa Bay
Lake St. Lucia
Richards Bay
DURBAN
PIETERMARITZBURG
JOHANNESBURG
PRETORIA
BLOEMFONTEIN
Kimberley
EAST LONDON
PORT ELIZABETH
Port Shepstone
Port St. Johns
Cape St. Francis
Komatipoort
MAPUTO
Limpoporivier
KILOMETRES 100 50 0 100 200 KILOMETER
Towns and Roads Paarl Dorpe en Paaie
Government Printer 1983
Staatsdrukker 1983
KOPIEREG



ASSEMBLING THE AXE AND HANDLE

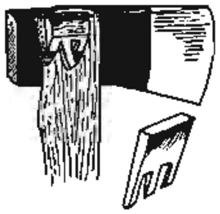


FIG. A. 30.
"HANDLE WEDGE LOCK"
IRON WEDGE.

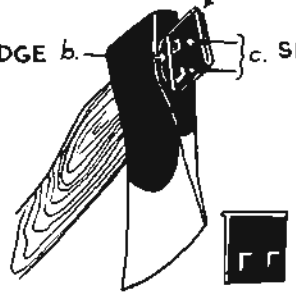


FIG. A.31

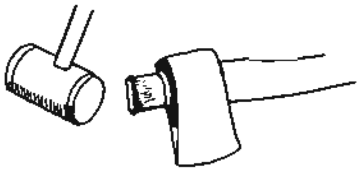
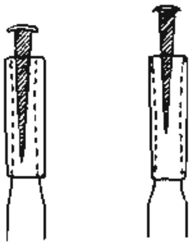


FIG. A. 32.
DRIVING THE WEDGE.

FIG. A. 33.



DEPTH OF WEDGE.

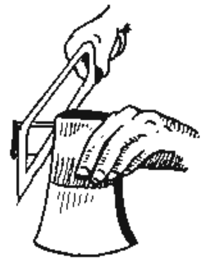
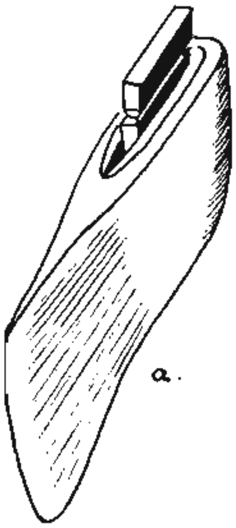


FIG. A. 34.

SAW OFF EXCESS
OF WEDGE.



A GROOVED HANDLE WEDGE.

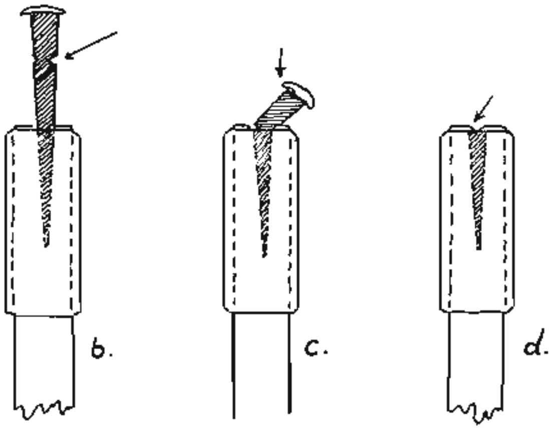


FIG. A. 35.

WEDGING WITH A GROOVED WEDGE.

WEDGING THE HANDLE

(c) FITTING OF HANDLE TO THE HEAD

The front end of the handle must first be shaped to fit the eye of the blade, using a draw-knife and wood rasp as illustrated in Fig. A 17. The number of transverse fibres decide the durability of the handle and care should be taken not to damage these when shaping. The upper rough side of the handle can be shaped with a knife, whereas the lower side, with transverse fibres, must be left untouched. Shaping on the side must be tapered off towards the back of the handle. The common sharp edges and steps near the rear mouth of the axe eye must be carefully filed off so that shaping will be even at all points, or else "short" shaping will be the beginning of breaks.

Fitting of the handle to the eye must be done with precision. A fine trick to get the sharpened handle end into the axe eye more easily is to grease the wood with boiled potato, or similar.

When fitted the head must be well down on the shoulder of the handle (Fig. A 18) and the head and handle must be in a straight line (Fig. A 19).

(d) THE HANG OF THE AXE

The hang of an axe is a matter of axe pattern and individual preference. The axe head should generally be "hung" at such an angle that the extension of a straight line from the cutting edge passes through the free end of the handle as shown in Fig. A 20. Most axemen who use the large pole axe prefer the head so that when the axe is placed on edge on a flat surface, contact with the flat surface is made about $^2/3$ of the way down the blade when the end of the handle touches the same surface, as in Fig. A 21. This will give the head a slight underposition. In this way the axe gives the best possible response when cutting, i.e. the moving lines of the centre of gravity and the hitting points, the middle of the edge, are coinciding, in which way there will be no lateral forces forcing the axe out of its original direction. The pulpwood axe is usually hung so that the middle of the blade and the end of the handle touch the flat surface (Fig. A 22).

(e) HANGING A NEW HANDLE

When assembling, the best way to get the head well down on the handle is to hold the handle upright, with the head on top. Then tap the handle on some firm surface so that the head works down under its own mass (Fig. A 23). Alternatively, first saw off about 2 cm from the end of the fawnfoot to provide a blunt surface (Fig. A 24). Split the other end to receive a wedge, then drive the split end into the eye of the axe by pounding on the blunt end of the fawnfoot. Cutting off a section of the fawnfoot can be avoided if pounding is done as illustrated in Fig. A 25. When the handle has been inserted the hang and alignment must be checked.

The handle is secured in the correct position in relation to the head by means of a wedge which is driven into the front end of the handle.

(f) WEDGING

Before the handle is inserted into the head eye a wedge slit must first be made in its end. This slit may be made with a thin bladed back saw (Fig. A 26) or by careful splitting, which is preferable, as the wedge is gripped more firmly. Axe handles are often provided with a wedge groove.

Diagonal wedging has no particular advantages, and there is a risk of warping if the wedge is driven too deeply. Fig. A 27 illustrates a straight wedge groove, even pressure and an unchanged handle position, while Fig. A 28 illustrates diagonal wedging, uneven pressure, and the risk of warping. Consequently axe handles with diagonal wedging should be avoided.

Fig. A 29 illustrates axe handle holds for American and Swedish axes. In American axes the handle is somewhat narrower in the middle of the axe, being slightly broader at the end to secure wedging.

Wedging must be done carefully to prevent accidents. The wedge should be sawn from a piece of seasoned, straight-grained hardwood. Wooden wedges fit more tightly and are safer than other types. Fig. A 30 illustrates an iron wedge of the so-called "handle-wedge-lock" type, while Fig. A 31 shows a wooden wedge with,

(a) a flange over the wood,

(b) the handle wedge itself of wood, and

(c) knobs against the handle for secure wedging.

Small iron wedges with rifling are available which partly hold the previously driven wooden wedge and partly secure its wedging.

Assemble the axe as previously described, checking its hang and alignment, then drive the wedge in using a wooden mallet (Fig. A 32). If glue is available the wedge should be dipped in glue before it is driven in. The wedge should stop slightly behind the middle of the head (Fig. A 33), and the excess be sawn off as shown in Fig. A 34.

A wedge will stick better if a groove is cut round it when partially driven, as in Fig. A 35 a and b. Continue driving the wedge until the groove disappears in the end of the handle. When the wedge is broken off it will break at the groove as in Fig. A 35c. The handle can then be flattened over the wedge by hammering with a mallet (Fig. A 35d) to firmly secure it, or the handle can be soaked in water so that the end swells over the wedge.

After fitting a new handle it should be smoothed down with a piece of broken glass or fine sandpaper to suit the individual grip.

Every axe will need rewedging at some time. This is merely a matter of picking out the old, loose wedge and cutting and fitting a thicker one in its place. Steel wedges can be pulled out by means of tongs, narrow-nosed pliers, or a screwdriver. Tests of hang and alignment should always be applied when an axe has been rewedged.

A loose axe head can sometimes be temporarily tightened by soaking the handle and head in water, or better still, in linseed oil.

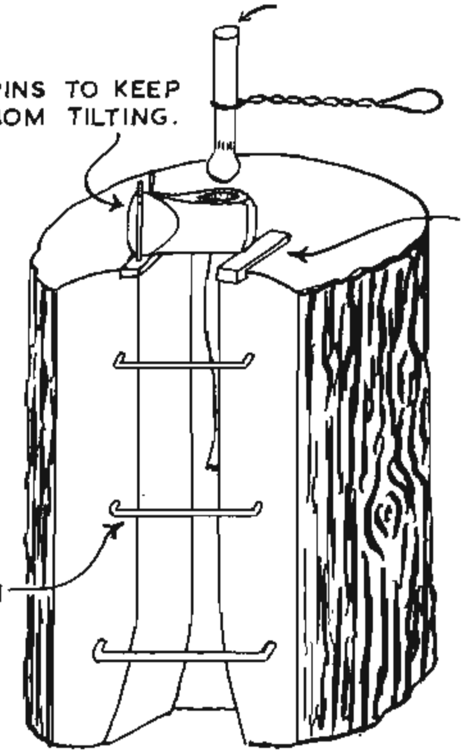


FIG. A. 37.
DEVICE FOR REMOVING HANDLES FOR USE AT LARGE CENTRES.

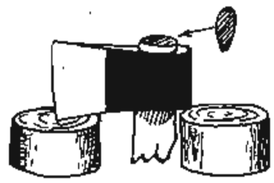


FIG. A. 36.
REMOVING A BROKEN HANDLE.

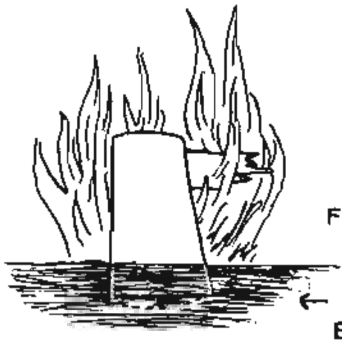


FIG. A. 38.
BURNING OUT A BROKEN HANDLE.

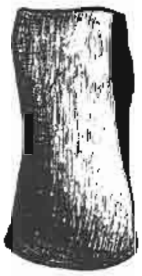


FIG. A. 39
DEFORMED AXE HEAD.

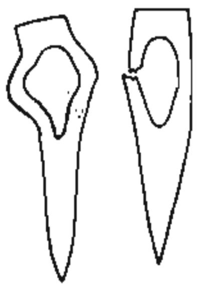


FIG. A. 40
DAMAGE DUE TO USE AS WEDGES.

FIG. A. 41
FAULTY WORKMANSHIP.

FIG. A. 42.
FAULTY MANUFACTURE.

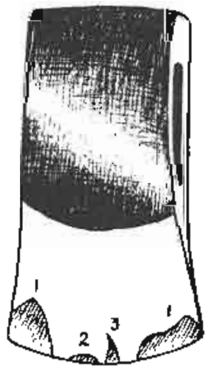


FIG. A. 43.
BREAKS IN THE CUTTING EDGE.

REMOVING BROKEN HANDLES. DAMAGE TO THE AXE HEAD AND BIT

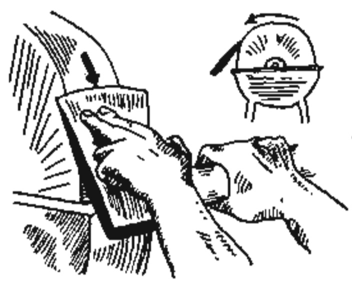


FIG. A.44.

TURN GRINDSTONE TOWARDS AXE.

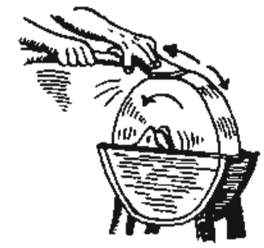


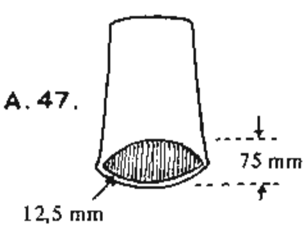
FIG. A.45.

MOVE AXE BACK AND FORTH.

FIG. A. 46.

HOLD BLADE CROSSWISE TO STONE.

FIG. A. 47.



FAN-SHAPED EFFECT.

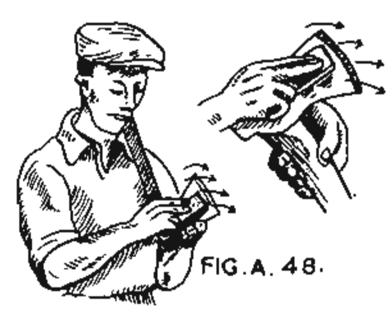


FIG. A. 48.

HONE WITH A CIRCULAR MOTION OF THE WHETSTONE.

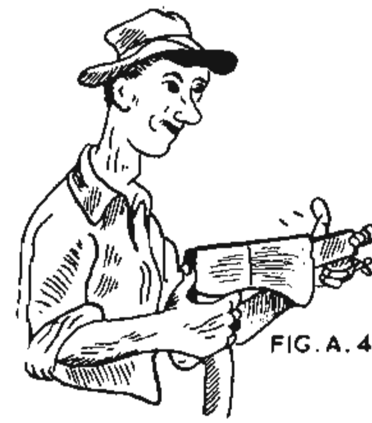


FIG. A. 49.

DON'T LET FINGERS OVERLAP END OF WHETSTONE

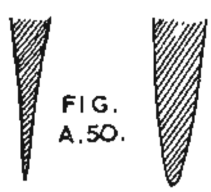


FIG. A.50.

(a) TOO THIN. (b) TOO THICK.

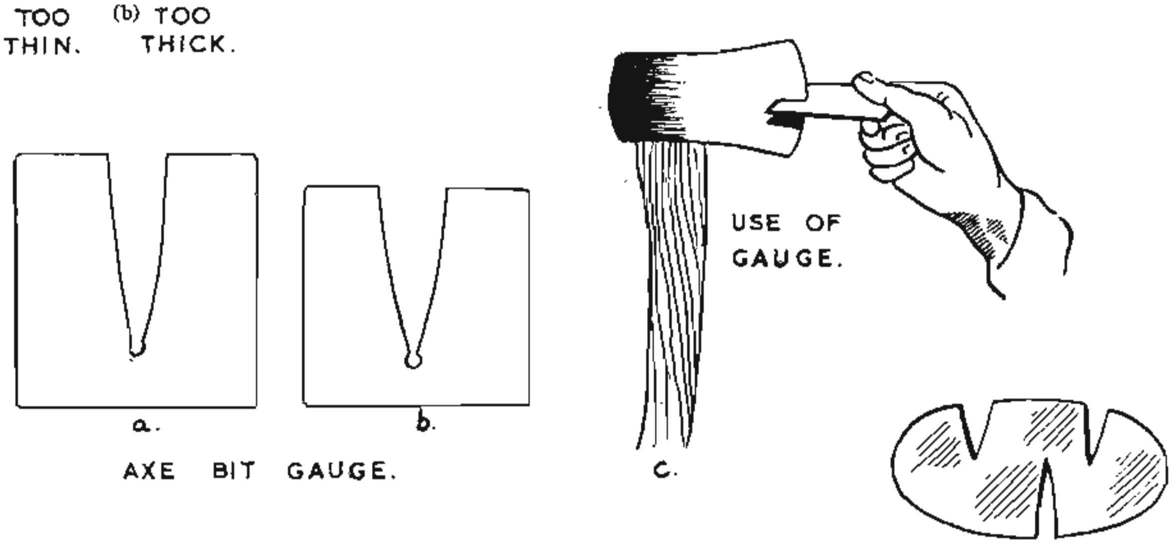


FIG. A.51.

SHARPENING

(g) REMOVAL OF A BROKEN HANDLE

Saw off the stub of the handle just below the head with a hack-saw and drive it back with a steel bar and hammer. Fig. A 36 illustrates a suitable way of removing a broken handle. Saw off some pieces about 2 cm thick from the broken handle with a somewhat similar section to the axe eye. With some strong blows with a wooden mallet on the wood pieces, even a very tight handle can be driven out.

A useful device for use at large centres consists of a hardwood block with a great mass, 1 m long, which enables a full length handle to be removed without damaging it (Fig. A 37). The wedge for driving out the handle is made of mild steel and shaped so that it is slightly smaller than the eye of the axe. It is about 10 cm long below the handle.

A broken handle may also be burned out, but this should only be resorted to if no other means is available, as the cutting edge may be annealed or retempered, causing it to loose its strength and sharpness. The handle stub may only be burned out if the blade is buried in wet earth, as in Fig. A 38.

C. DAMAGE TO THE AXE

(a) DAMAGE TO THE AXE HEAD

If axes are used for general purposes other than cutting (e.g. as a wedge, sledge, turning hook, etc.) they will sooner or later become deformed. Fig. A 39 shows an axe that has become generally deformed through misuse, while Fig. A 40 shows an axe that has become damaged through being used as a wedge.

The cutting edge of an axe often becomes deformed, either due to faulty manufacture or due to faulty workmanship. Fig. A 41 shows an axe which has become deformed due to faulty workmanship, while Fig. A 42 shows damage to a faulty axe. If breaks in the cutting edge are sharp they are generally due to defective material or manufacture. Such breaks are caused by cracks resulting from shrinkage after the steel has hardened (cooled), and there is often a dark part in the break surface showing the grains of ashes, where breaks or unevenness have existed in the material. Any manufacturer of warranted axes will replace an axe that develops such breaks. Breaks in the cutting edge with curved edges are due to careless application or accidents. Sharp, wedge-shaped breaks are often due to incorrect grinding or sharpening. Fig. A 43 illustrates breaks in the bit caused by:

(1) faulty manufacture,

(2) careless treatment, and

(3) incorrect sharpening.

(b) SAFETY PRECAUTIONS

(1) Never let the edge touch the ground - even a pebble may chip it. An axe is not a mattock or a pick.

(2) Don't chop any kind of knot unnecessarily - chop round it if possible.

(3) Never use a cold or frosted axe, as the steel becomes very brittle at low temperatures. First warm it to blood heat by rubbing with a coat or placing near a fire.

D. SHARPENING THE AXE

Dull axes are dangerous - instead of cutting they tend to glance off. If the axe is in good shape it will only be necessary to sharpen the cutting edge, but it is generally advisable to trim the blade down proportionally or else the cutting edge will eventually become stubby and dangerous.

Note : The bits of axes as issued by the manufacturers are usually slightly too thick and require some grinding by the axeman before use

(a) POINTS TO REMEMBER

(1) Use a grinding stone and whetstone. Avoid the use of a file as this leaves marks which form the beginning of breaks, from which pieces can easily be broken off.

(2) Avoid any heating of the head through friction, as this may spoil the temper of the bit.

(3) Never use an emery wheel or cloth.

(4) Keep the grindstone wet and rotate it slowly.

(5) Turn the grindstone towards the axe (Fig. A 44) and move the latter back and forth while grinding so as to obtain a smoothly tapering edge (Fig. A 45). If the grindstone is turned away from the axe, the stone will cut more slowly and create a bigger beard on the cutting edge.

(6) Hold the blade of the axe crosswise on the stone so that the stone will stroke it gently at right angles to the cutting edge (Fig. A 46).

(7) Be careful not to alter the original "bow" line of the bevel.

(b) SHARPENING PROCEDURE

(1) First grind the flat surface of the blade from a point about 1 cm from the cutting edge and for a distance of 8 cm from the cutting edge at its middle point. Aim at a fan-shaped effect (Fig. A 47).

(2) Then grind the bit or cutting edge to a point 1 cm back from it in such a manner as to secure a rounded finish. The aim should be to shape the cutting edge like a long thin wedge - not chisel-shaped.

(3) Hone the edge with a whetstone, using a circular motion from the toe to the heel (Fig. A 48). Start on the rough side of the stone to remove the burr and finish with the fine side. Don't let the fingers overlap the edge of the stone (Fig. A 49). Make sure that all scratches are removed with the whetstone.

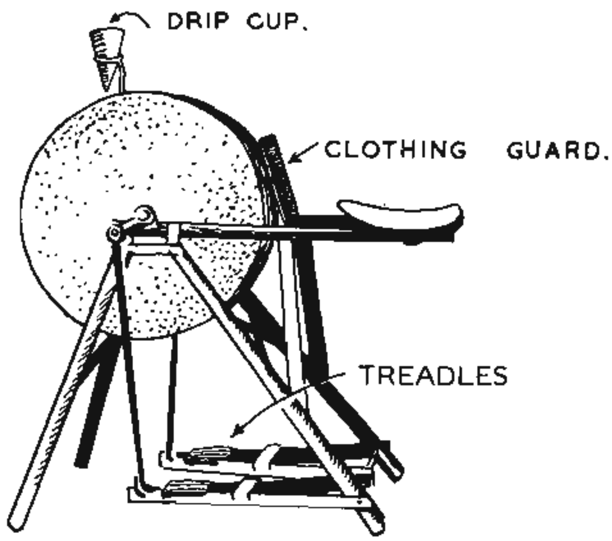


FIG. A.52.

FOOT OPERATED GRINDING STONE.

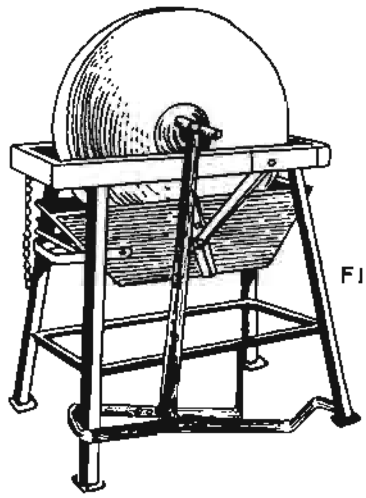


FIG. A.53.

GRINDING STONE WITH WATER TROUGH THAT CAN BE LOWERED.

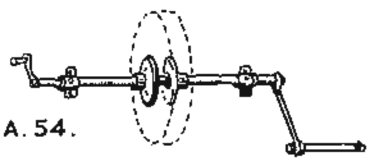
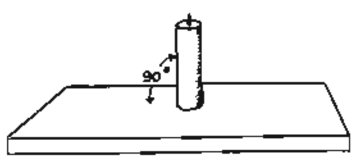


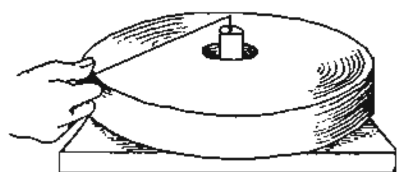
FIG. A.54.

GRINDING-STONE AXLE.



a.

CENTRE BOARD.



b.

CENTRING THE STONE.

FIG. A.55.

(4) Repeat for the other side.

(5) Give both sides the same attention so that the edge will remain parallel with the shaft.

An axe can easily be ground too thin, and, particularly if given a concave grind, it may break under ordinary conditions of chopping, or may tend to bind in the wood (Fig. A 50a). However, one finds more frequently that the axe is too thick due to the bevel of the cutting edge only having received attention without the blade having been thinned correspondingly (Fig. A 50b).

The taper of the blade will vary with the axe pattern and purpose for which the axe is to be used (Fig. A 3). The only safe method of maintaining the correct taper is to use an axe bit gauge, made from a sheet of scrap metal with a slot in it to the exact thickness of the blade. Fig. A 51 illustrates actual gauge sizes for hardwoods and softwoods as well as showing the use of the gauge. By slipping it over the edge of the axe one can tell at a glance whether the bit is too thin or too thick.

A good axeman hones his axe with a whetstone daily after use and grinds it at least twice weekly.

(c) GRINDING STONES

Grinding stones are required when axes have become badly blunted. Their advantage lies in their ability to quickly restore the shape of the edge with relatively good sharpness. The edge must, however, be fine-sharpened with a whetstone.

Grinding stones may either be cast from sand with binding agents or cut from natural sandstones. The present tendency with greater mechanisation is to the former and at present the Department employs a "Norton A 46 M.Y.G." machine grinding wheel cast from specially selected abrasives and water cooled by means of a drip feed. This type of wheel is generally used for sharpening precision tools, but may also be used for axes, provided that it is kept cool and rotated slowly. Natural grinding stones are often preferred by the woodsman if they are available. The latter stones are cut and shaped in the quarries. The qualities of a natural stone cannot be standardised, but when ordering it is usually sufficient to state the use to which the stone is to be put in order to get the correct stone for the job.

(d) GRINDING CHARACTERISTICS OF A GOOD GRINDING STONE

A rough stone has better abrasive qualities than a fine one, but does not produce an equally fine edge. For grinding forestry tools fine or medium-rough sandstones of relatively soft consistencies are recommended. One way to judge by eye if the hardness of the stone is suitable is the following:

Take a sample piece out of the side of the stone - not larger than can be held between two fingers. Rub it against a moistened axe blade. A stone of the right composition will leave a heavily muddied grinding paste.

Grinding-stones should have a diameter of approximately 50 cm and a width of between 8 and 10 cm. A larger width will, as a rule, not be used when grinding, which means that the stone will become uneven.

(e) MOUNTING AND MAINTENANCE

The grinding stone should be mounted on a steady stand and preferably under a roof. If left in the open it may weather until it has an eccentric shape which makes grinding impossible. The same thing will apply if the stone is left to dry by removing the water from the trough, or it is left standing in the water for too long. The latter problem can be solved by mounting the assembly so that either the stone can be raised from the trough or the trough can be lowered below the stone. In any event the stone should be periodically moistened when not in use and should be so mounted that it is kept wet when in use.

(f) STANDS

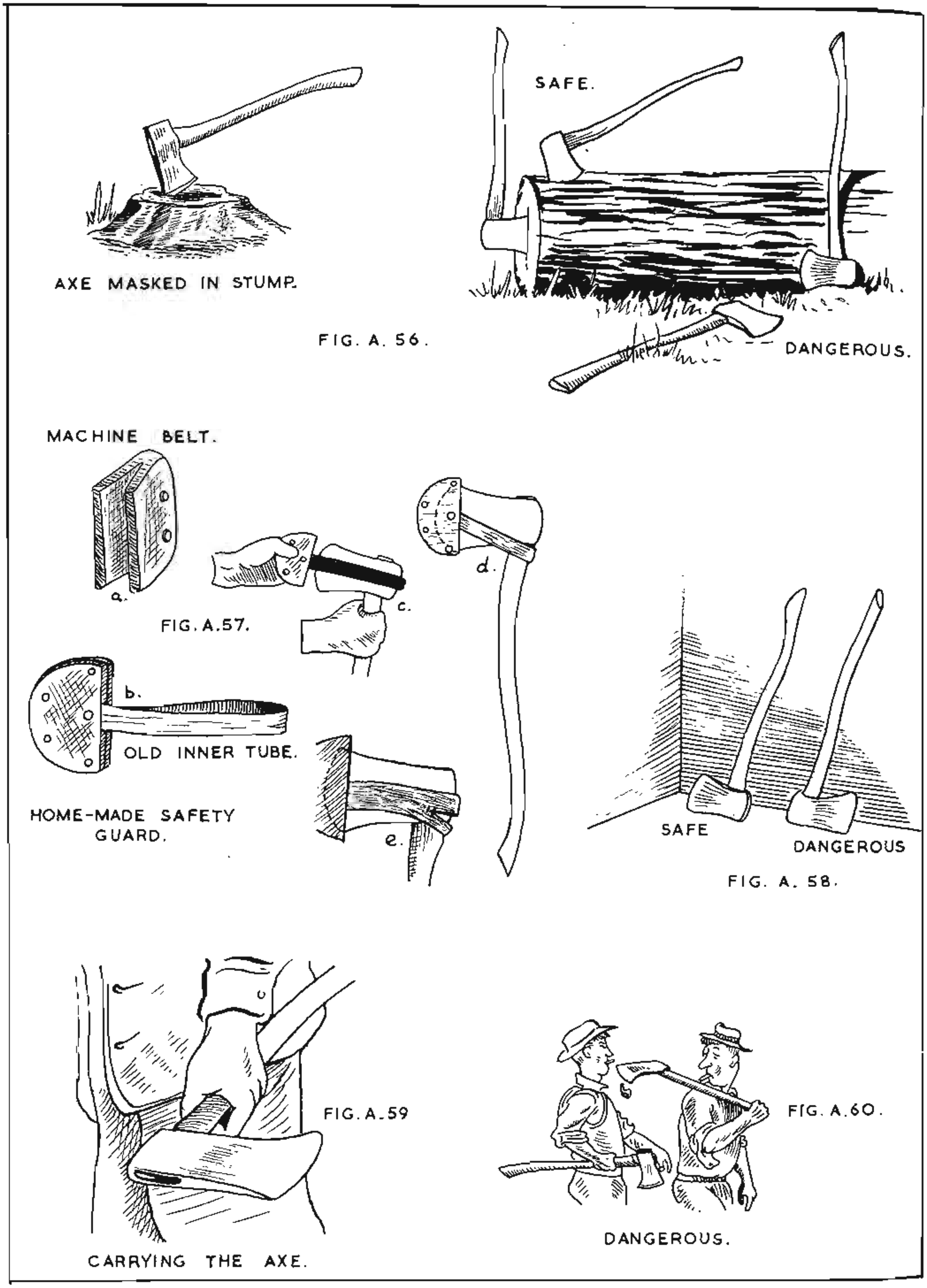
These may be made either from wood or iron. Hand or foot operated stands are available on the market at a cost of approximately R20, including the stone. Foot operated grinding stones demand less space and have the additional advantage that they can be operated by one man (Fig. A 52). Stands can either be fitted with water troughs (Fig. A 53) or drip cups (Fig. A 52), although the former are generally preferred.

When mounting a grindstone it is essential to see that the grinding axle is borne horizontally and passes through the centre of the stone (Fig. A 54). If wedging of the axle is necessary it should be done with great care to preserve perfectly horizontal mounting.

Wedging can be avoided if the grinding-stone is centred and mounted as illustrated in Fig. A 55. The size of the centre board should be in proportion to that of the stone, and the measurements of the pin according to the axle of the grinding stone. The pin must stand at right angles to the board. Place the stone on the board with the pin through the centre hole. Attach a string to the nail fastened to the centre of the pin and centre the stone with the aid of this device as shown in Fig. A 55. The empty space between the pin and the stone is filled with cement mortar. Let the stone lie untouched for a few days, after which it can be mounted and should fit exactly on the axle.

E. SAFETY FIRST

A number of accidents is caused by stumbling over or falling on a carelessly placed axe. The woodsman should be careful where he lays his axe down and remember where it is. A pole-axe can be safely "masked" by sticking it into a log or stump as in Fig. A 56. The woodsman should never lay his axe down or lean it in the woods as a falling butt or branch striking the axe may send it flying through the air.



SAFETY PRECAUTIONS

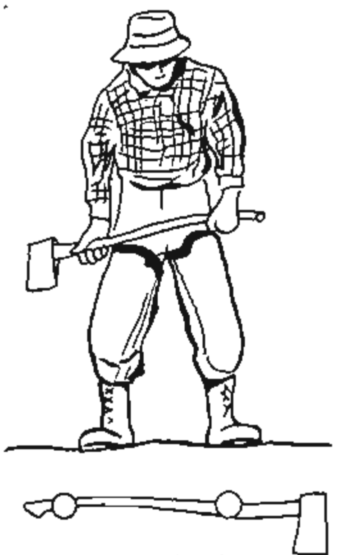


FIG. A.61.
HOLDING THE AXE.

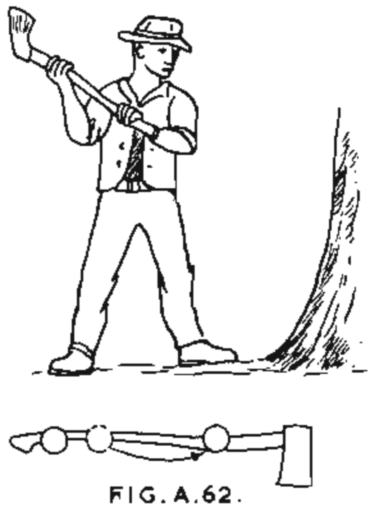


FIG. A.62.
THE UPSTROKE.

FIG. A.63.
THE DOWNSTROKE.

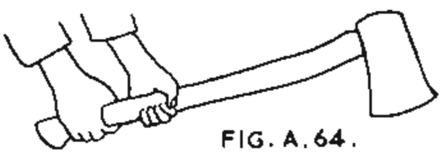


FIG. A.64.
TWO-HANDED SWING.

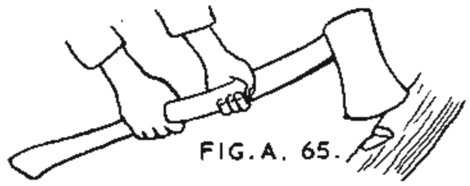


FIG. A. 65.
TWO-HANDED CHOKED GRIP.

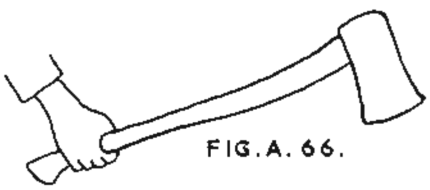


FIG. A. 66.
ONE-HANDED END SWING.

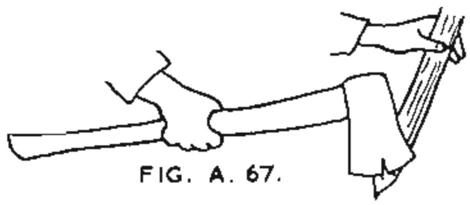


FIG. A. 67.
ONE-HANDED FULL SWING.

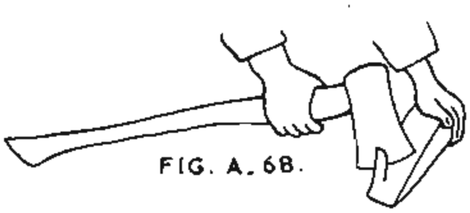


FIG. A. 68.
ONE-HANDED CHOKED GRIP.

VARIOUS GRIPS ON THE HANDLE

FIG. A.69.

THE FOREHAND SWING.

FIG. A.70.

THE BACKHAND SWING.

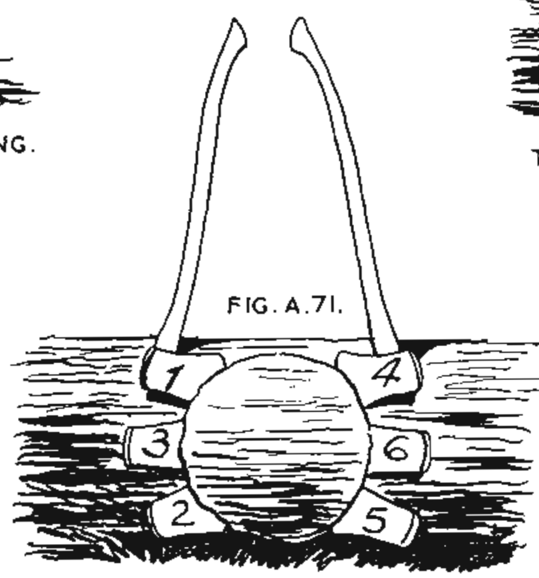


FIG. A.71.

HIGH, LOW AND IN THE MIDDLE.

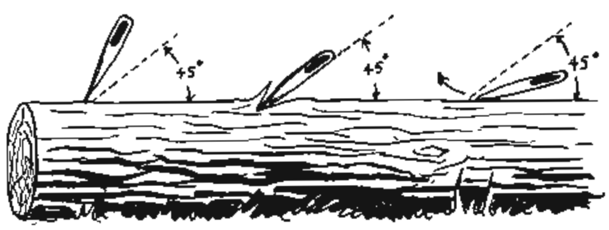


FIG. A.72. ANGLE OF STROKE.

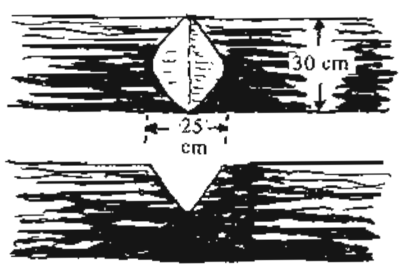


FIG. A.73.
CORRECT WIDTH OF "V"

FIG. A.74.
NOTCH FOR A TREE OVER 30 cm

FIG. A.75.
NOTCH FOR A "BIG ONE".

CHOPPING

Fig. A 57 illustrates an easy-to-make safety guard which protects the cutting edge of the axe and prevents accidents. The guard is cut from an old machine belt, partially split to accommodate the edge of the axe, and fastened with harness rivets. A loop is fashioned from a strip of old inner tube about 4 - 5 cm wide and its two ends are rivetted to the two sides of the guard. When finished the distance from the top of the guard to the top of the loop should be from 5 - 7 cm shorter than the length of the axe head for which it is to be used. Fig. A 57c, d and e shows how the guard is fitted onto the axe and the loop secured behind the axe head against the handle.

If an axe is to be left indoors, it should be placed in a corner, either standing or lying down, with the edge facing inwards (Fig. A 58).

It is safer to carry the axe in one hand at its point of balance near the head with the cutting edge towards the outside (Fig. A 59), than over the shoulder, especially in rough country. If the worker strips or stumbles the axe can be thrown away easily and naturally. If carried over the shoulder it may be dangerous to other workers (Fig. A 60).

F. USE OF THE AXE

Axemen use their axes for approximately 30% (less with mechanical means) of the actual working time. Half of the work with an axe is debranching time, the remainder being for undercutting and removing obstacles.

To become an expert at chopping takes time and experience, but the fundamentals are clear. Efficiency is achieved by using the correct grips, accuracy of aim, proper allocation of force, adequate swinging space, proper tempo of work and by having a reasonably good footing.

(a) GRIP

(1) Holding the axe (Fig. A 61)

Grasp the axe with the left hand just above the knob at the end of the handle and support it with the right hand about three-quarters of the way up the handle. With the axe held this way, crosswise in front of the body, one is ready to start chopping.

(2) Upward swing

The axe is raised up behind the shoulder with the hands in the position described in (1). Fig. A 62 shows the changing grip if the axe is to be swung up from below, with the right hand sliding down the handle towards the axe head.

(3) Downward swing (Fig. A 63)

On the downward stroke, which is performed with a natural easy swinging motion, the right hand slides along the handle until both hands are together at the end of the handle when the stroke ends. The left hand always remains stationary while the right hand slides back and forth, guiding the axe in its stroke. Grips (2) and (3) require the maximum working space.

(4) Two hand swing (Fig. A 64)

Both hands are kept near the knob at all times. Less accurate, less safe, and more strenuous than the previous grips.

(5) Two-handed choked grip (Fig. A 65)

For careful and delicate work such as notching logs or some debranching, the two-handed choked grip is used with both hands near the centre of the handle. Considerably less powerful but well controlled strokes. Practical when working space is limited.

(6) One-handed end swing (Fig. A 66)

One hand is held on the handle near the end, the other being free. Poor aim and control, and dangerous.

(7) One-handed full swing (Fig. A 67)

One hand only, near the middle of the handle. Less powerful strokes than with the preceding grip, but more accurate and safe. This grip is used for splitting wood, cutting coppice and sharpening pegs.

(8) One-handed choked grip (Fig. A 68)

One hand held close to the axe head. For very light work only.

(b) CHOPPING

A good axeman at work is loose and relaxed in every muscle. Every blow lands where it is intended and with the proper force. There is no shock on the hands and muscles. The axe should not be forced, but should cut with its own mass.

No axeman is worthy of the name until he can make left and right handed cuts with equal accuracy. Should the worker not be able to do this, however, he must make use of the backhand swing to supplement the forehand swing (Fig. A 69). In this case the axe is raised over the right shoulder as before, but the body is leaned well over to the left, as shown in Fig. A 70.

When chopping a log, the best position is to stand on it, provided that the log is large enough to furnish a footing. If it is slippery, footholds must be roughed up on it. A log is chopped by cutting a V on opposite sides so that the two ultimately meet. Of course, if the log is small enough to be rolled over the chopper can stand on one side and chop a V in the top of it, then roll it over and finish the other side. If it cannot be rolled he has no choice but to mount the log as described.

The sequence for good chopping is first three forehand strokes and then three backhand strokes, following the sequence as in Fig. A 71, high, low and in the middle. There is a good reason for this: not until the wood has been cut at the top and bottom can the big centre chip be thrown out. If the middle stroke is made first the axe will bind and freeze in the solid wood. The top and bottom strokes should be made so that the top and bottom corners of the axe respectively extend above and below the log.

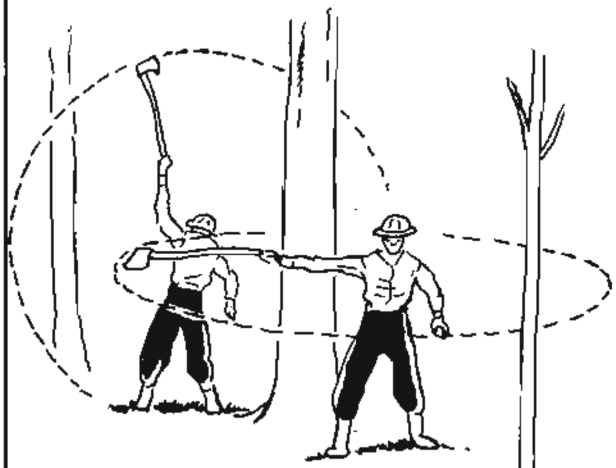


FIG. A.76.
ALL CLEAR FOR FELLING.

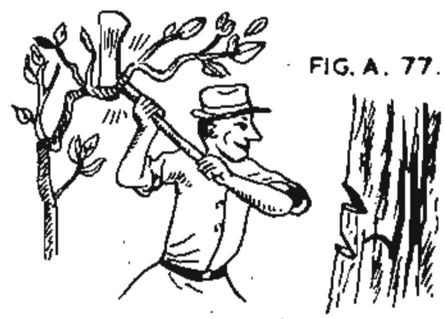


FIG. A. 77.

DANGER — A HOLD UP.

FIG. A.78.

USING THE AXE AS A PLUMB.

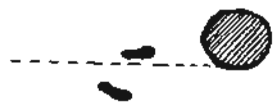


FIG. A. 79.

CORRECT STANCE BEFORE COMMENCING FELLING.

START OF LOW HORIZONTAL CUT.

END OF THE LOW HORIZONTAL CUT.

FIG. A.80.

FELLING

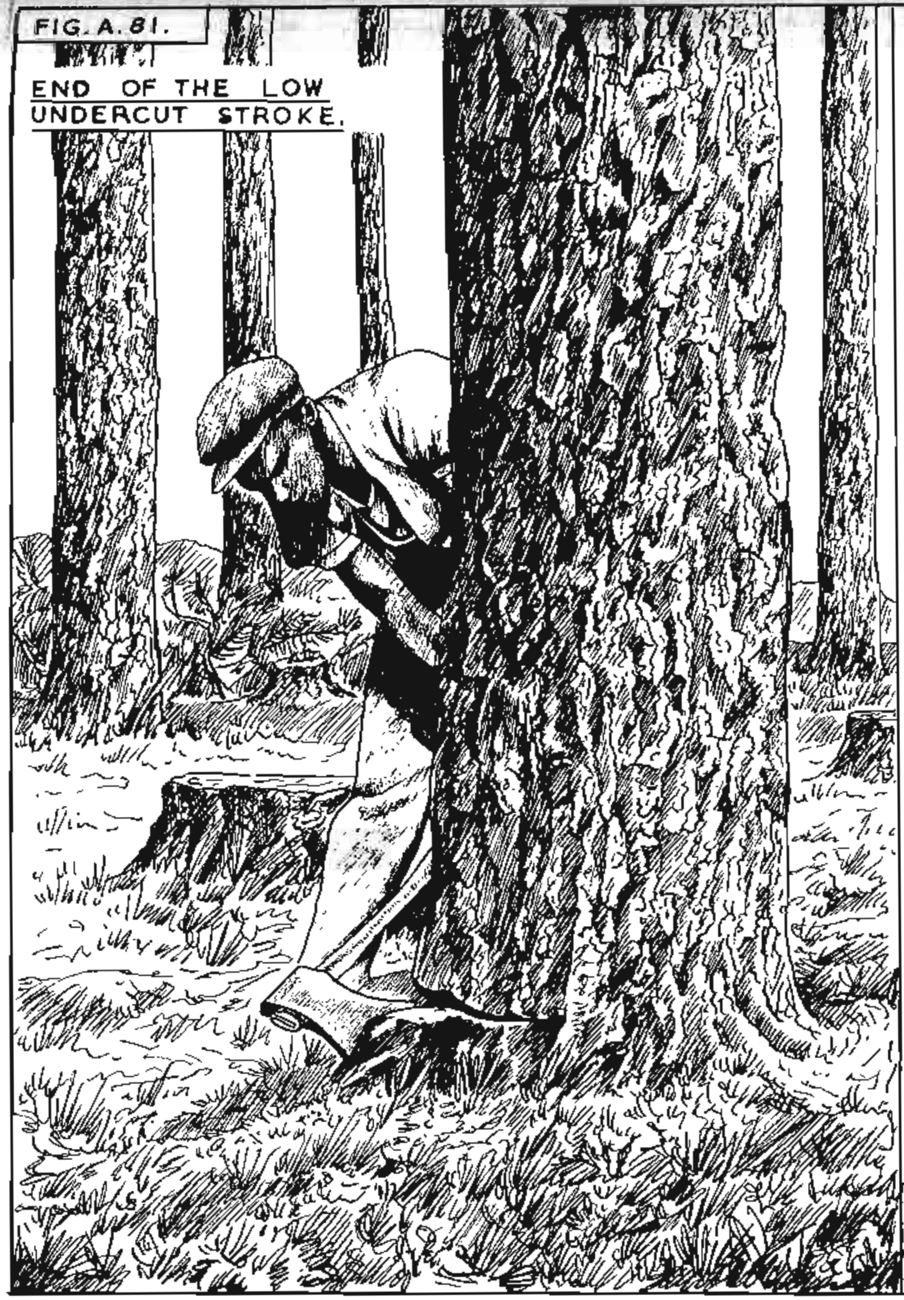


FIG. A.81.

END OF THE LOW UNDERCUT STROKE.

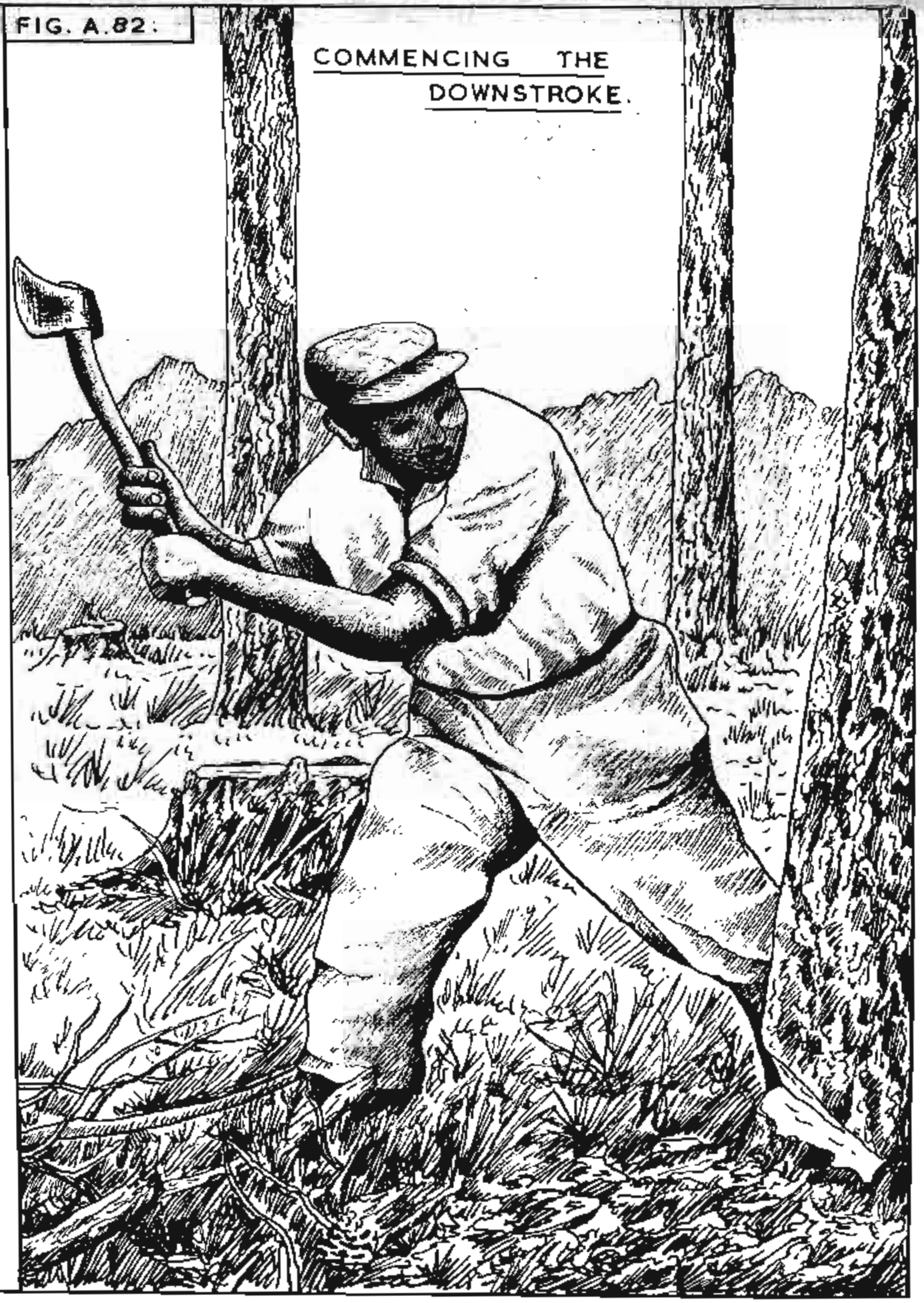


FIG. A.82.

COMMENCING THE DOWNSTROKE.

FIG. A.83.

NOTCHING FROM A KNEELING POSITION.

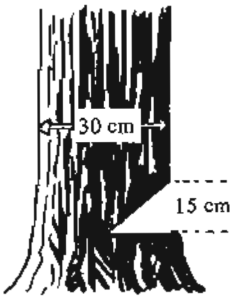
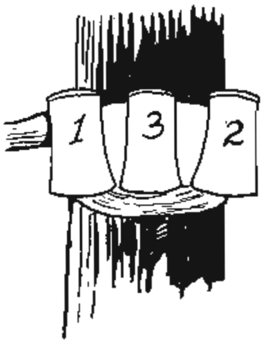


FIG. A.84.
THE UNDERCUT.

FIG. A.85.
THE FELLING CUT.

FIG. A.86.
THE BRIDGE ACTS AS A HINGE.

FIG. A.87.



NEAR, FAR AND IN THE MIDDLE.

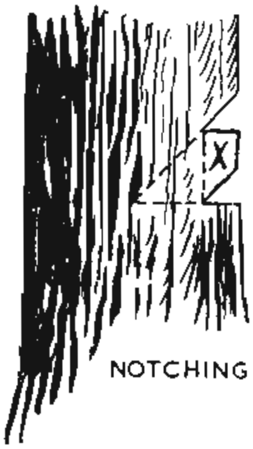


FIG. A.88.

NOTCHING A BIG ONE.

FIG. A. 89.

TWO-MAN TEAM PREPARING THE UNDERCUT AND FELLING CUT SIMULTANEOUSLY.

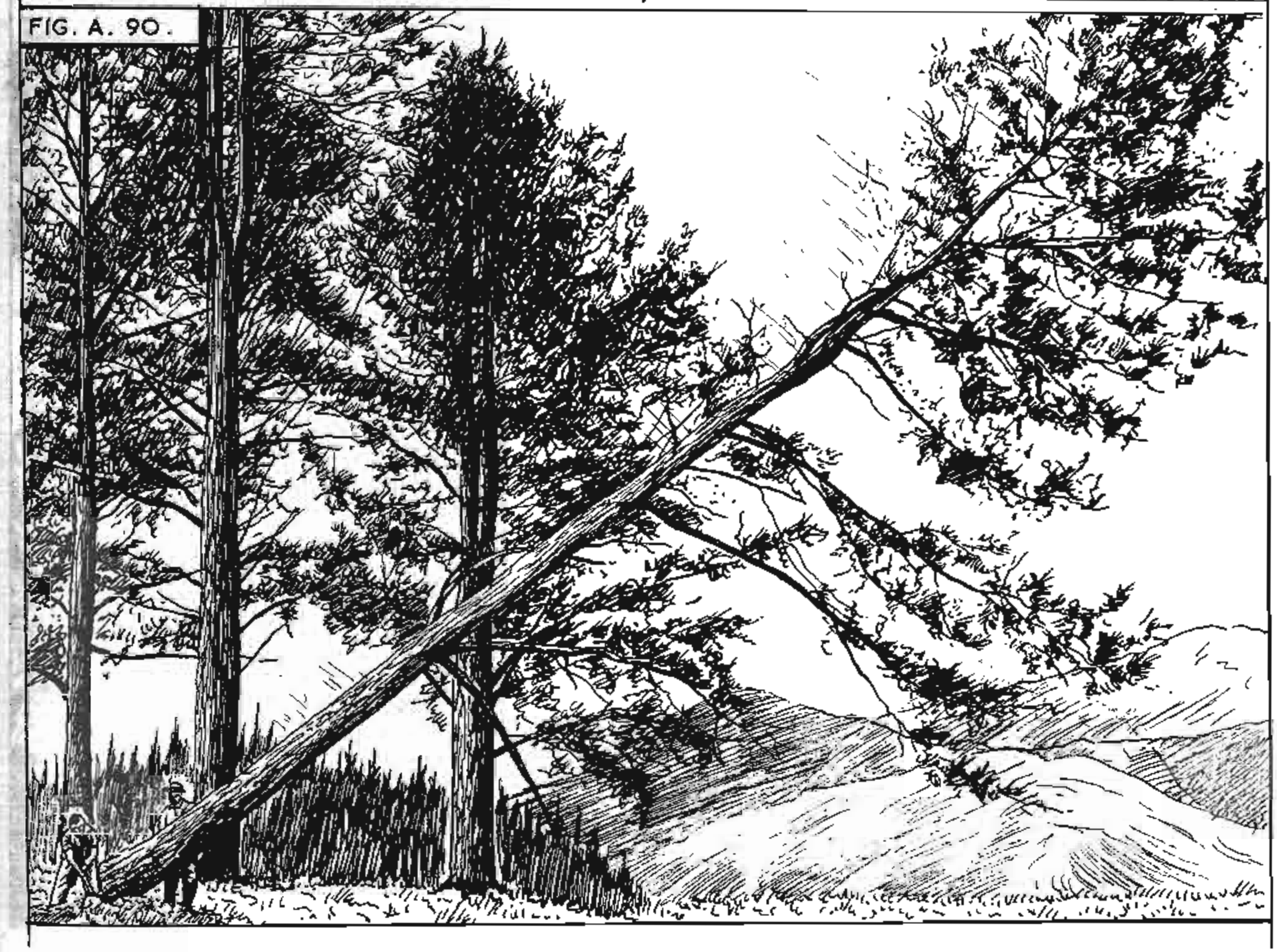


FIG. A. 90.

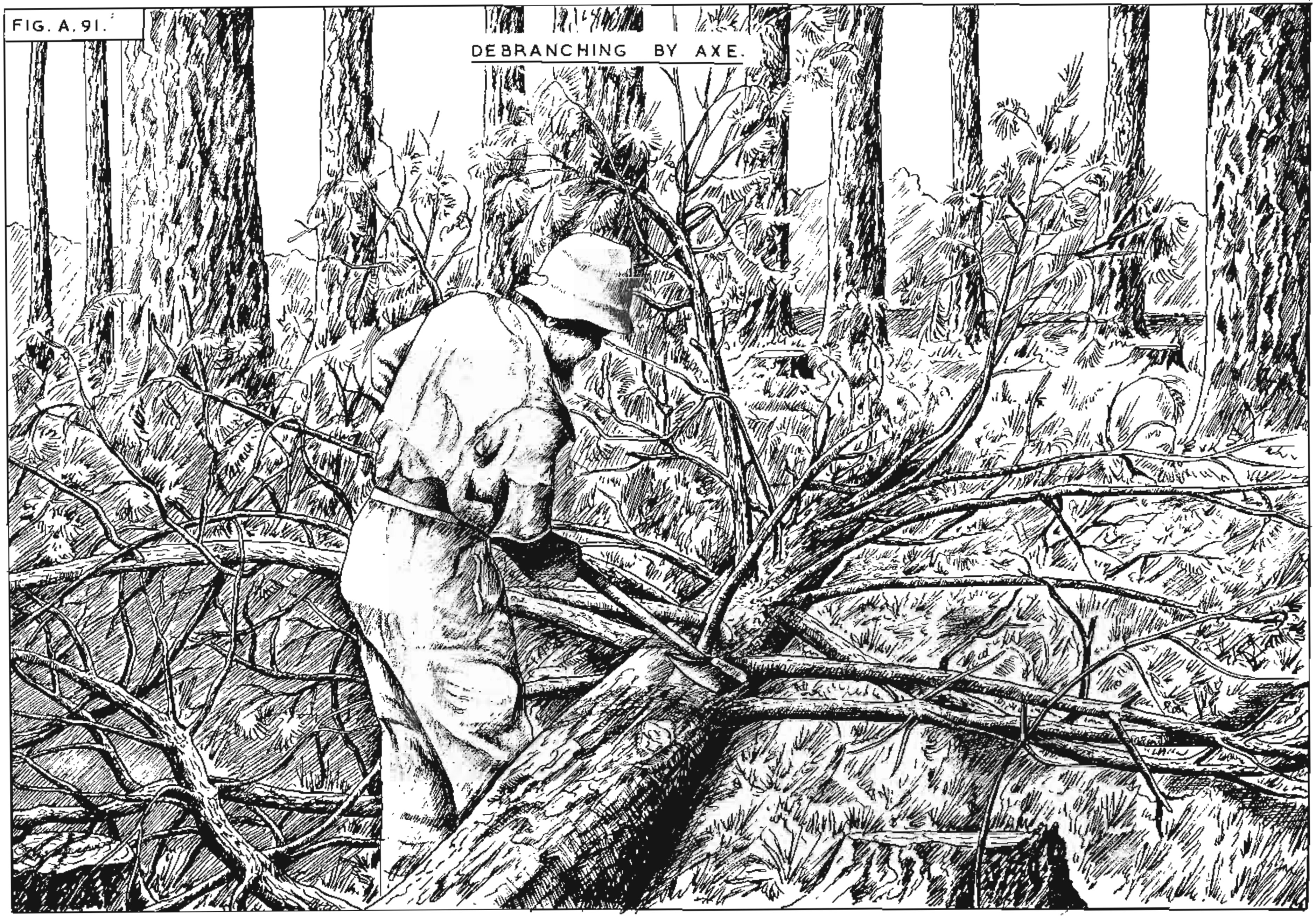


FIG. A.91.

DEBRANCHING BY AXE.

FIG. A. 92.

DEBRANCH FROM FAR SIDE.

FIG. A. 93

NEVER DEBRANCH FROM NEAR SIDE.

FIG. A. 94.

ASTRIDE THE LOG – DANGEROUS.

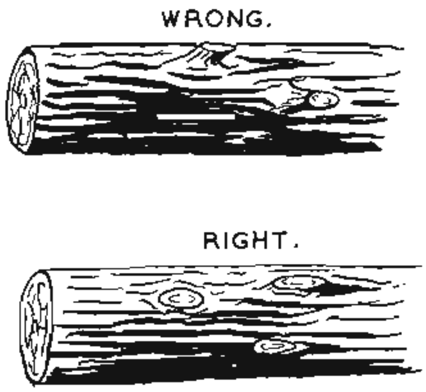


FIG. A. 95.
CUT OFF BRANCHES CLEANLY.

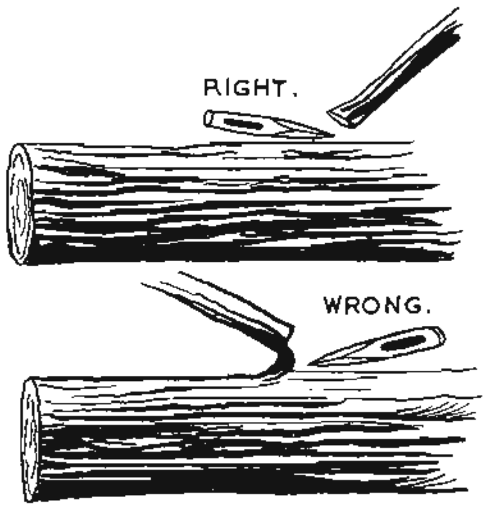


FIG. A. 96.

DEBRANCHING

This is to prevent the axe from binding. After the wood has been cut at the top and bottom, the middle blow will loosen the chip easily and the axe will be freed. It is the last stroke of the series, No. 6 in the drawing, that throws the chip to the ground. In practice several strokes may be needed in addition, but the high-low sequence should be followed regardless until the notch is completed.

When chopping logs, the axe should always strike at an angle of 45°. Sriking at a greater angle is ineffective and striking at too small an angle is dangerous as the axe may glance off (Fig. A 72).

The width of the V should be the same as the width of the log. This is slightly wider than necessary, but it is an easy rule to remember. Actually a 30 cm log requires only a 25 cm V width (Fig. A 73). For a log over 30 cm, commence by chopping the 25 cm V as for a 30 cm log and enlarge by knocking off chips from the side. A large log will require knocking off chips from both sides. See Fig. A 74 and 75 for details.

(c) FELLING BY AXE

Never start felling until you are sure that there are no branches or undergrowth which can be struck as the axe is swung. Fig. A 76 illustrates a method of being sure that the area is free from obstructions. Many bad cuts are received from an axe which has been deflected by some small branch or twig. (Fig. A 77).

Decide in which direction the tree must fall. If the tree has a slight lean, the direction of the lean can be determined by using an axe as a plumb as shown in Fig. A 78. First cut the front notch or undercut on the fall-direction side of the tree. Fig. A 79 shows the correct stance to be adopted for felling. In notching a tree three basic strokes are used: the upstroke, the downstroke and the low horizontal cut, the former two having been previously described. The latter cut is the most difficult to master. For it the legs should be spaced well apart and the axe swung so that the hand at the grip is brought down to a point between the legs and the cut, as shown in Fig. A 80. A popular rule is that the back of the hand should be "low enough to brush the bootlaces." The guiding hand is used to ensure that at the moment of impact the axe is neither deflected up or down from the level. Fig. A 81 and 82 show an axeman completing a low undercut stroke and raising the axe before a top downward stroke.

When notching the undercut the axeman may also assume a kneeling position as in Fig. A 83. This is a useful position if the tree is to be felled at or close to the ground level.

The downward axe stroke should strike the tree at a 45° angle, while the lower cut is horizontal. The undercut should be more or less half the width of the tree in depth, if the tree is to be felled with the axe alone (Fig. A 84).

Next cut the back notch directly opposite the first and a few centimetres higher. This is the felling notch shown in Fig. A 85. The small section between the undercut and the felling notch is known as the bridge, which serves as a hinge to direct the fall of the tree (Fig. A 86).

In chopping notches the sequence is "near, far and in the middle" (Fig. A 87). The first stroke is on the near side, the second on the far side and the third, or as many as may be necessary, in the middle, always working from the sides inwards. First chop the top edge of the notch in this way and then the bottom. It is the bottom strokes that remove the chips and so the axe should be twisted with each stroke to loosen the chips.

Fig. A 88 illustrates how a particularly large tree can be notched. Two small notches are first made and the piece marked "X" is knocked out. The main notch is then completed.

Trees should always be felled as low as possible.

As the tree starts to fall, step back and to one side at an angle of approximately 45° opposite to the direction of fall. Do not stand directly behind a falling tree as it may kick back, and don't run away. If the tree swings it is far easier to keep clear of it by moving round the stump.

Fig. A 89 and 90 illustrate a two-man team felling by axe, one making the undercut while the other prepares the felling cut simultaneously. This method is no longer in general use, except in felling competitions.

(d) DEBRANCHING BY AXE

Debranching requires the greatest percentage of time of all the operations for which the axe is employed, and is at the same time responsible for about 30% of all accidents associated with cutting. Efficient debranching will not only increase the workers' output but also decrease the accident ratio for axe work, and the following points should be observed and followed:

(1) Work from the butt end of the log, cutting off branches as shown in Fig. A 91. For heavy branches hanging down it is better to proceed in the opposite direction.

(2) Always debranch from the far side of the log as in Fig. A 92. Fig. A 93 and 94 show the dangers of debranching from the near side of the log or standing astride the log.

(3) If the log is large, trim off the top branches first and then clean the sides. If the log can then be rolled, remove the remaining branches. With smaller logs it is advisable to debranch the whole bole, working from one end.

(4) The whole tree should preferably be debranched before cross-cutting commences, particularly if heavily branched.

(5) Only debranch merchantable timber and do not waste time debranching the top end beyond the merchantable timber mark.

(6) Branches should be cut off cleanly at their base to eliminate the need for subsequent knotting (Fig. A 95). Axe strokes must be with the angle of the branch and not against it, as in Fig. 96. Avoid repetition of blows and waste of effort through

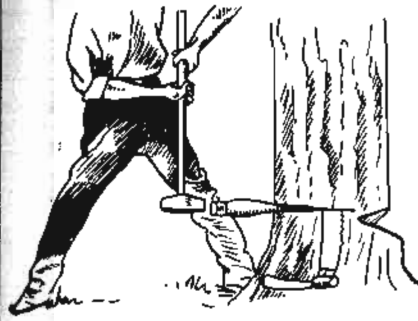


FIG.A.97

USE OF WEDGES IN FELLING.

FIG.A.98.

SPLITTING LOGS WITH WEDGES.

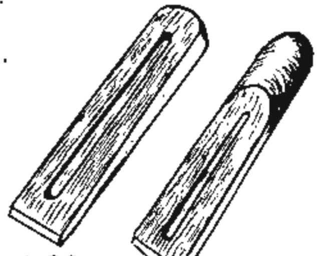


FIG.A.99.

SPLITTING WEDGES.

FIG.A.100

MICHIGAN OR WOODED TYPE WEDGE.

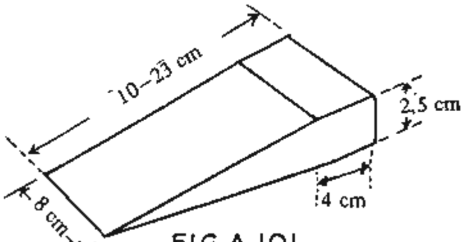


FIG.A.101.

FELLING WEDGE.

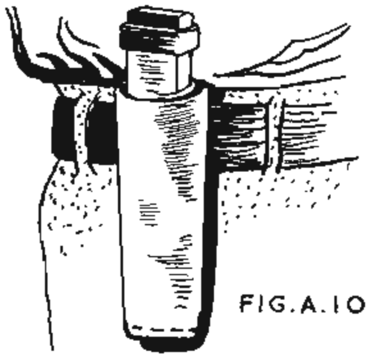


FIG.A.102.

WEDGE SHEATH.

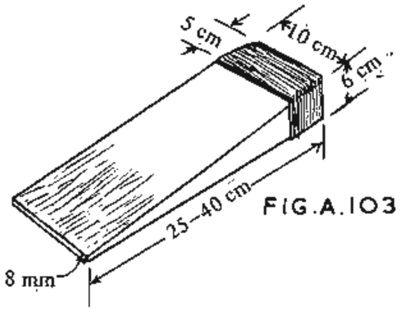


FIG.A.103.

WOODEN WEDGE WITH IRONBAND.

FIG.A.104.

ALUMINIUM WEDGE.

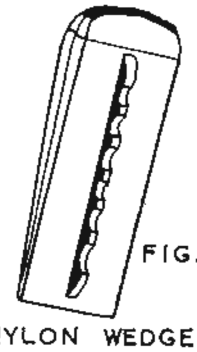


FIG.A.105

NYLON WEDGE.

CHAIN-SAW WEDGES

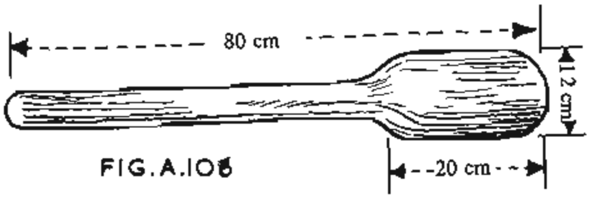


FIG.A.106

WOODEN MAUL.

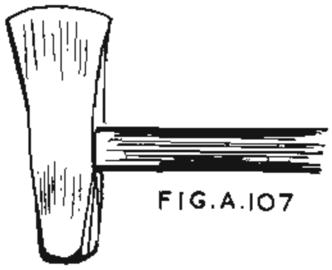


FIG.A.107

STEEL WOODCHOPPERS MAUL

WEDGES

poor planning, inaccuracy of aim and improper force of strokes. One proper axe blow per 2 - 3 cm usually suffices for most cases.

(7) Avoid wide sweeps of the axe along the trunk to cut off several branches at a time, unless the branches are very small and close together. A full force axe stroke should only be used when the resistance of the branches requires it and safety permits.

(8) Use both hands with the axe at all times. One-handed grips may be used, provided that they are only used for very light debranching. It is dangerous to grip the axe in one hand while holding back a branch with the other, or holding a measuring stick or saw.

(9) Dead branches of evergreens may be knocked off with the butt end of the axe, but must be knocked off cleanly. Hard, brittle branches may dull the axe if chopped.

(10) Fallen branches which may be in the way of cross-cutters must be removed. If heavy tops must be moved, they must be cut in two.

G. WEDGES

(a) USE OF THE WEDGE FOR FELLING

(1) Only wooden wedges may be driven by using the back of an axe.

(2) Never use an axe as a wedge.

(3) Never drive an axe with another axe.

(4) It is preferable to use a wooden wedge of seasoned hardwood.

(5) Wedges should be 10 - 15 cm long, but in certain cases wedges up to 30 cm long are used.

(b) WEDGES AND THEIR USES

The primary function of a wedge is to force timber apart. Wedges serve three main functions in logging.

(1) In felling trees (Fig. A 97). A wedge is forced into the cut behind the saw to prevent the tree pinching the saw; to throw the tree in the desired direction and to hasten the fall. With the skilful use of wedges, it is possible to throw a tree having a lean of up to 3 or 4 degrees, in the opposite direction to the lean. If the lean is greater it is possible to throw such trees either to the right or the left of the direction of lean.

(2) In cross-cutting trees. It will often occur that the log rests on both ends with no support under the point where the cut is to be made. As the saw cuts deeper, the tree will sag and force the two sides of the cut together, pinching the saw. By driving in a wedge or two, it is possible to hold the cut open until the tree is cut in two.

(3) In splitting logs (Fig. A 98). Wedges are driven in to start the split and force it open.

Special wedges are available for each of the above uses but the splitting wedge can serve for all purposes (Fig. A 99). Wooden or polythene wedges are, however, preferred for timber preparation as they are light to carry and can be driven by an axe. A steel wedge is heavy and must be driven by a sledge, which is also heavy and a further burden to carry.

Of the felling wedges, the Michigan wooded type illustrated in Fig. A 100 is the most popular. This is a hollow steel wedge with a piece of hardwood inserted in the centre. It is the only steel wedge which may be driven with an axe. Wooden wedges can be made on the spot from dry hardwood. They should be made from a limb of suitable thickness, at least 10 cm long, and must taper evenly on both sides (Fig. A 101). Green wedges can be hardened by heating them over a fire to dry them, being cautious not to char them. Woodsmen can carry their wedges in a belt sheath (Fig. A 102). It is better to drive a wooden wedge with a wooden maul than with a sledge hammer. Wooden wedges that are sawn appear to hold better than wedges which are hewn.

Metal wedges should be made of untempered steel. Although the metal wedge is a sturdy article it does mushroom. A wedge in this condition is highly dangerous. Many eyes have been lost from flying particles of steel. Steel wedges should be driven with sledges, or steel mauls. Heavy metal wedges should never be used with power chain saws. Fig. A 103, 104, 105 show three types of wedges for use with power chain saws, one a wooden wedge with an iron band around the head (A 103) the second a light metal (aluminium) wedge (A 104) and the third a nylon wedge (A 105). The best wedge to use with power chain saws is a polythene or wooden wedge, 12 - 15 cm long, so that it will not be necessary to get the fingers near the moving chain at any time when the wedge is being driven into the cut. The front edge of the chain saw wedge should be thick enough to engage the sides of the kerf just as soon as it is inserted.

Cross-cutting wedges can also be of polythene, nylon, wood or steel, but are usually shorter than felling wedges.

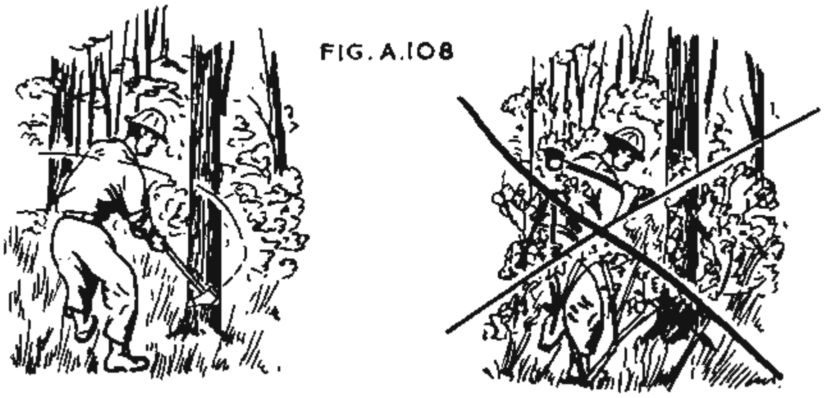
(c) DRIVING THE WEDGE

(1) Never drive a steel wedge with an axe and never drive an axe with another axe or sledge. An axe should never be used as a wedge - it is a cutting tool, but may be used for driving wooden wedges.

(2) A wooden maul as shown in Fig. A 106 is best suited for driving wedges. It should be made of a suitably tough piece of hardwood. Find a sapling 12 - 15 cm through at butt and cut it off at ground level or a little below, for the wood is toughest there. This butt end is to be used for the big end of the maul.

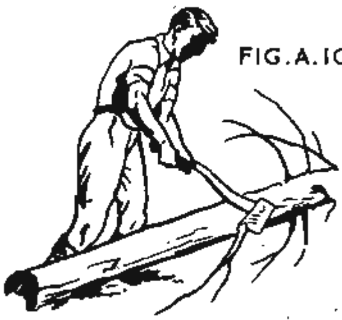
(3) For regular use a steel maul is preferable because the wooden ones get battered quickly. A blacksmith's sledge will do, but a wood-chopper's maul is ideal, as it is a combination of a wedge and maul (Fig. A 107).

FIG. A.108



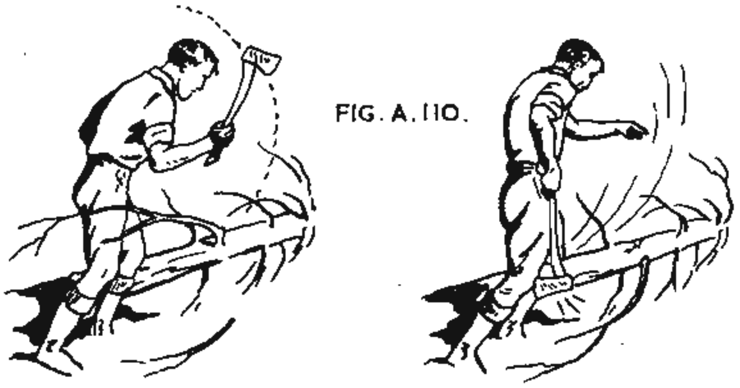
ENSURE A FREE SWING OF THE AXE BEFORE COMMENCING FELLING.

FIG. A.109



BRANCH FROM FAR SIDE OF THE TREE.

FIG. A.110.



HOLDING THE AXE BY THE END OF THE HANDLE WITH ONE HAND AND SWINGING TOWARDS YOUR-SELF IS DANGEROUS.

FIG. A.111.

IN KNOTTING IT IS DANGEROUS TO HOLD AN AXE AT THE END OF THE HANDLE WITH ONE HAND, TO EXPOSE FINGERS OF THE OTHER HAND, AND TO TRY TO REACH ON THE INSIDE INSTEAD OF TURNING THE POLE.

FIG. A.112

UNSAFE WAY TO CARRY TOOLS — A STUMBLE WILL CAUSE ALMOST CERTAIN INJURY.

AXE SAFETY

H. SAFETY IN CUTTING

(a) SOME PERSONAL FAULTS WHICH HAVE CAUSED ACCIDENTS TO AXEMEN

Cutting accidents represent approximately 45% of all wood accidents, of which the axe causes almost 25%. Of these, 30% of the accidents occur during debranching. The following are some faults which have caused accidents:

(1) Failure to observe dead limbs or stubs while felling.

(2) Neglecting to remove brush sufficiently when preparing to fell a tree. The axe catches in it and is deflected onto the axeman's feet or legs (Fig. A 108).

(3) Leaving axe carelessly lying about while working nearby with other tools.

(4) Using the axe to push over partially cut small trees.

(5) Using the axe as a hook to pull the butt of a lodged tree from the stump. The axe slips and cuts the knee or leg.

(6) In cutting small trees or rotten logs (obstacles), striking too hard with the axe which goes clear through and strikes the foot.

(7) Lack of care when cutting small brush or branches held in one hand while using the axe with the other. Handle of axe catches, deflecting blade onto wrist or fingers (Fig. A 110).

(8) Chopping of limbs with feet in poor positions where glancing axe may strike them (Fig. A 110).

(9) Careless handling of measuring pole when using axe with one hand to mark log for cross-cutting. Axe descends on thumb extended at the end of the pole.

(10) Failure to anticipate and protect self against sudden upward movement of bent limb or "springers" when cutting.

(11) Using axe driven into end of pole as a means of pulling it to pile or stack. Sudden freeing of axe causes man to fall, or axe strikes his foot or leg.

(12) Failure to observe overhanging branches when swinging the axe.

(13) Trimming upright log or pole with hand on top end, allowing axe to strike hand (Fig. A 111).

(14) Carrying axe carelessly while walking where footing is insecure (Fig. A 112).

(b) BRANCHING (Fig. A 109, 110)

(1) When the branches are thick and the woodsman not sufficiently careful, the axe will be deflected and strike him on the knee or leg.

(2) Where the branches are light, a heavy blow will cause the axe to go through the branch and cut him on the knee if he is standing behind the branch.

(3) The practice of holding a branch in one hand and swinging the axe with the other is dangerous. Accidents from this source are due to the fact that the worker has improper control over the axe, which catches his clothing or in a branch, is deflected, and hits him on the hand or leg.

(4) In knotting it is dangerous to hold an axe at the end of the handle with one hand, to expose fingers of the other hand, and to try to reach on the inside instead of turning the pole (Fig. A 111).

(c) CAUSES OF ACCIDENTS DUE TO THE AXE

(1) An improperly sharpened axe, causing the axe to glance.

(2) A badly hung axe with the head out of line.

(3) A loose head.

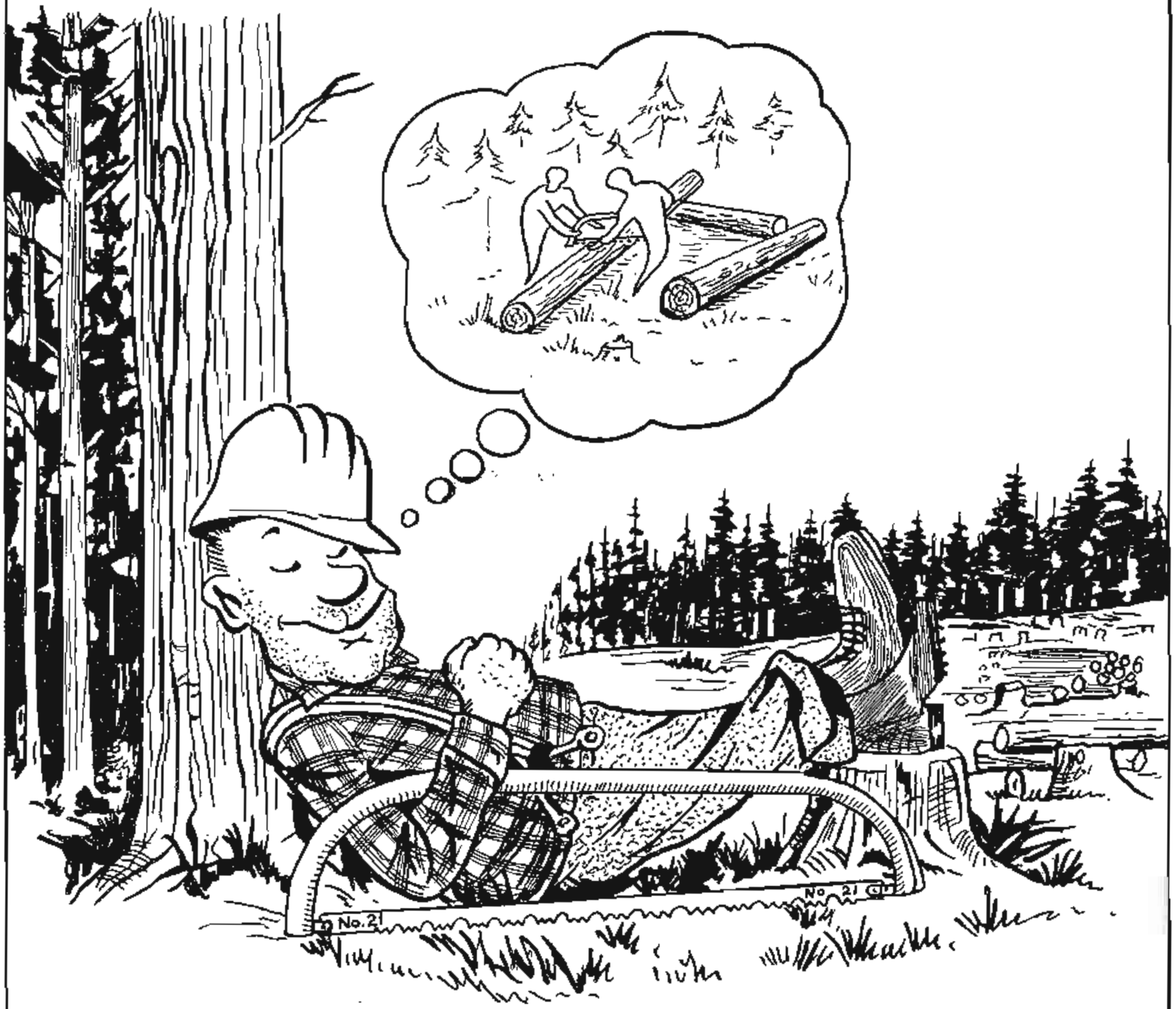
(4) Poor quality or shape of the axe handle.

(5) The use of the axe to replace a screwdriver when tightening saw blades.

(6) Lack of care in carrying the axe through the bush.

(7) In cold weather an axe handle covered with gum tends to become slippery, causing the axe to fly out of the axeman's hands while working.

HANDSAWS FOR SAWLOG PREPARATION



A. INTRODUCTION

The saw is a cutting tool used for the preparation of timber, i.e. felling, cross-cutting, topping and (seldom) debranching. The following are the main types of saws used in Departmental plantations:

(i) Bow saw
(ii) Two-man cross-cut saw
(iii) One-man cross-cut saw

Besides their basic blade shape, saws are usually distinguished by their tooth pattern, many various types of tooth pattern being used.

B. SAW TOOTHING

The task of the saw teeth during the sawing process is as follows:

1. To cut off the fibres
2. To break away the fibres that have been cut off
3. To carry the sawdust or cut-off fibres out of the kerf

Two main types of toothing are distinguishable, viz "peg" toothing and "raker" toothing, as illustrated in Fig. S.1 and S.2. Each tooth of the peg-toothed saw performs all three of the tasks listed above, and the saw is suitable for green or dry wood. The peg toothing is symmetrical and the teeth are sometimes placed in groups of varying tooth distance to reduce vibration and provide more space between the teeth for sawdust removal. The chips from peg-toothed saws are roughly granulated in shape as illustrated in Fig. S.9.

Raker-toothed saws, on the other hand, have two types of teeth; the cutters, which cut off the fibres, and the rakers, which break up the fibres and carry them out of the kerf. (See Fig. S.8).

Raker toothing is most suitable for green wood cutting. Fig. S.6 illustrates how the saw should be rocked slightly while sawing to accelerate cutting, and at the same time working fewer teeth into the wood, which makes sawing easier. The chips produced by the raker saws are in the form of long shavings, as in Fig. S.10.

Fig. S. 7 illustrates the various component parts of the peg-toothed saws, while Fig. S. 8 shows the detailed parts of a raker-toothed saw.

Apart from raker and peg toothing, "tiger" peg-toothed saws are also available, as shown in Fig. S. 4. In this case the front edges of the teeth are almost at right angles to the back of the saw blade, and feed themselves into the wood. "Tiger" toothing is usually associated with one-man cross-cut saws.

C. DESCRIPTION OF SAW

(a) BOW SAWS

(1) Toothing

Conventional bow saws may have either peg- or raker-toothed blades, as shown in Fig. S.3. Sharpening bow saw blades, particularly raker-toothed blades, has always been a problem due to the precision and accuracy required in adjusting the height of the rakers in relation to the cutting teeth. This problem has been overcome to a certain extent by the invention and introduction of a specially designed blade with so-called "hard-point" teeth. This saw because of its cheapness, can be thrown away when it becomes blunted, and replaced with a new one. The manufacturers claim that by a special process of hardening the resistance of the tooth points to wear is increased to more than three times the normal, when compared with the ordinary bow saw blade i.e. the hard-point blade will cut about three times as much wood as the conventional blade, without refiling. This leads to the conclusion that it will pay the user to switch over to the razor blade principle - use a new blade instead of refiling the old one.

After a prolonged period of observation of felling and cross-cutting tests, Sandvik No. 21 and No. 99 bow saw blades were selected for use in plantations for cutting trees of up to 25-30 cm diameter. Finally, however, the Sandvik No. 21 hardpoint raker-toothed saw blade was selected exclusively for felling and cross-cutting small or medium-sized trees. (See Fig. S.5).

The following information is of value regarding the use of the hardpoint saw:

There are two main forces which make the saw cut - the push-pull force and the feeding force, which presses the blade into the wood. The feeding force is concentrated on only two cutters in the hardpoint blade saw, and these are consequently pressed deeper into the wood, resulting in faster cutting.

The distance between the rakers is small, consequently there is a large number of them on the blade. Sawdust is efficiently removed from the kerf with reduced friction.

(2) Blades

In general the development of hand saw blades proceeded gradually all over the world, but the invention and introduction of the hardpoint blade can be considered a remarkable step forward.

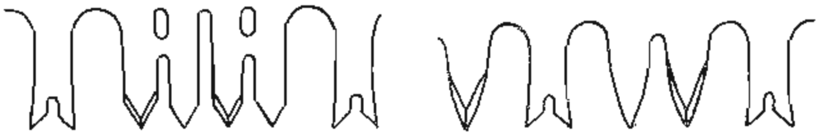
In sawing, the power used depends to a large extent on the quantity of wood (sawdust) removed and the friction of the blade sides within the kerf. Bow saws are used, where possible, as their blades are thin and narrow, and therefore have the great advantage over other types of saws, that they are less subject to pinching.

Bow-saw blades may be thin and narrow because of the tension given by the frame, but the

FIG. S.1

PEG-TOOTHED CROSSCUT SAWS.

FIG. S.2.

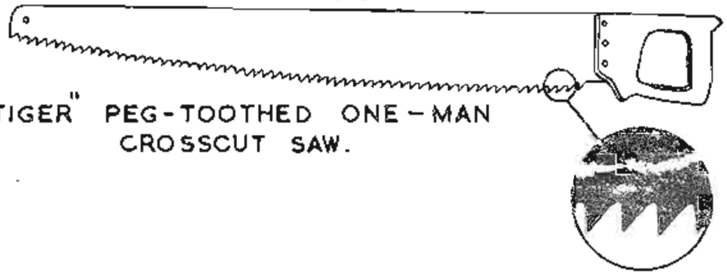


RAKER-TOOTHED CROSSCUT SAWS.

FIG. S.3.

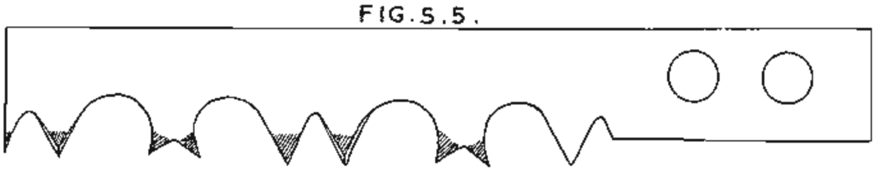
CONVENTIONAL BOW-SAW BLADES.

FIG. S.4.

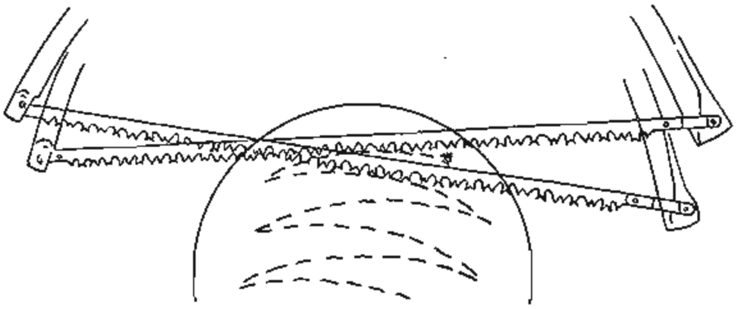


"TIGER" PEG-TOOTHED ONE-MAN CROSSCUT SAW.

FIG. S.5.



HARDPOINT RAKER-TOOTHED BOW-SAW BLADE

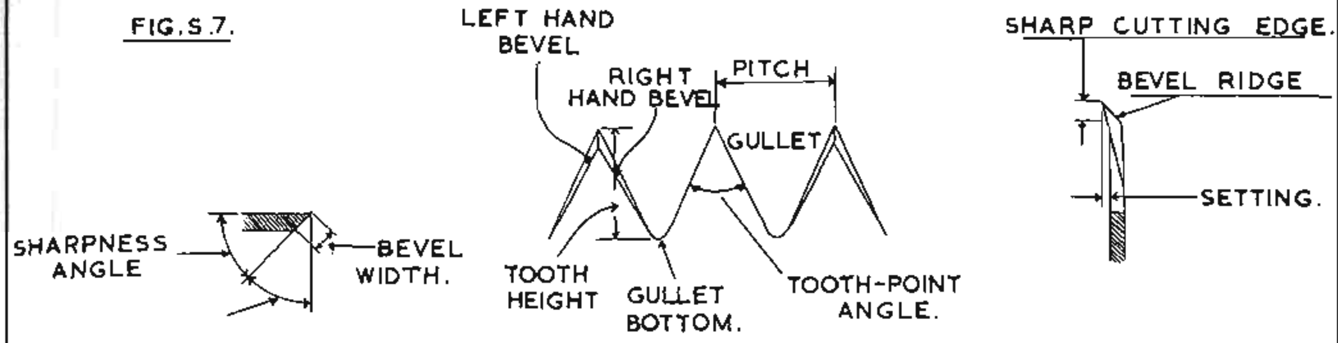


FIGS.6. ROCKING SAWING MOVEMENT FOR RAKER-TOOTHED SAWS.

VARIOUS TYPES OF SAW TEETH

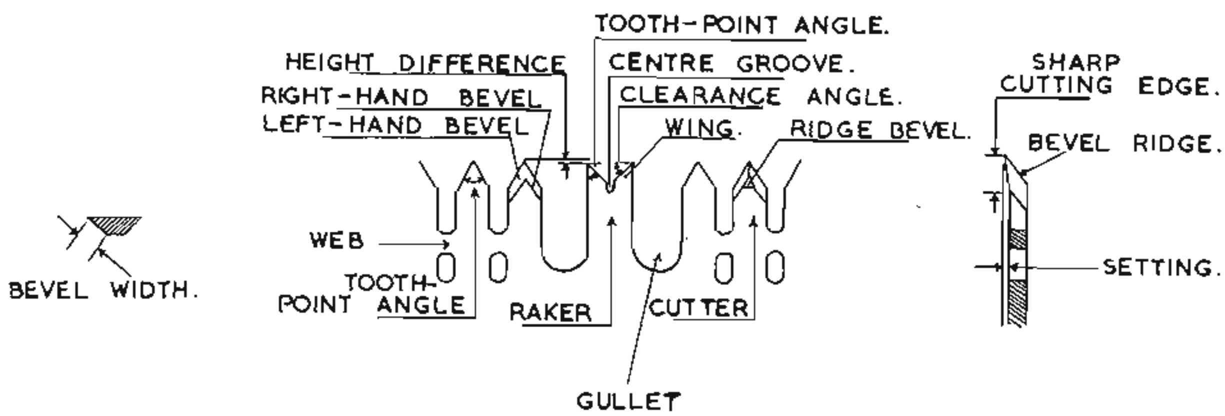
PEG TOOTHING.

FIG.S 7.



RAKER TOOTHING.

FIG.S. 8 .



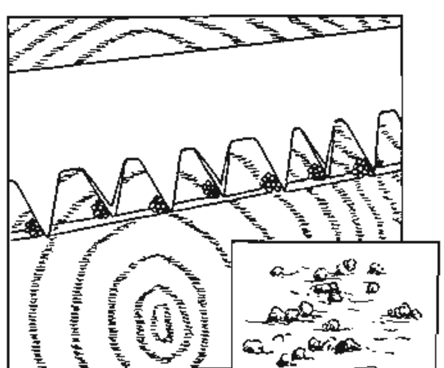


FIG.S. 9

WORKING METHOD AND SAW-DUST OF PEG TOOTHING.

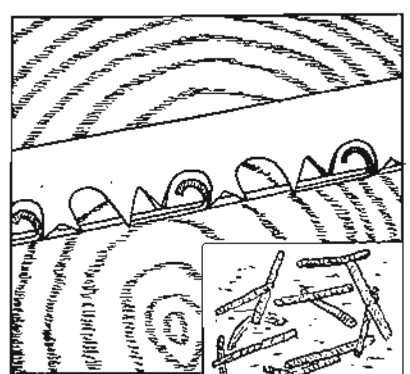
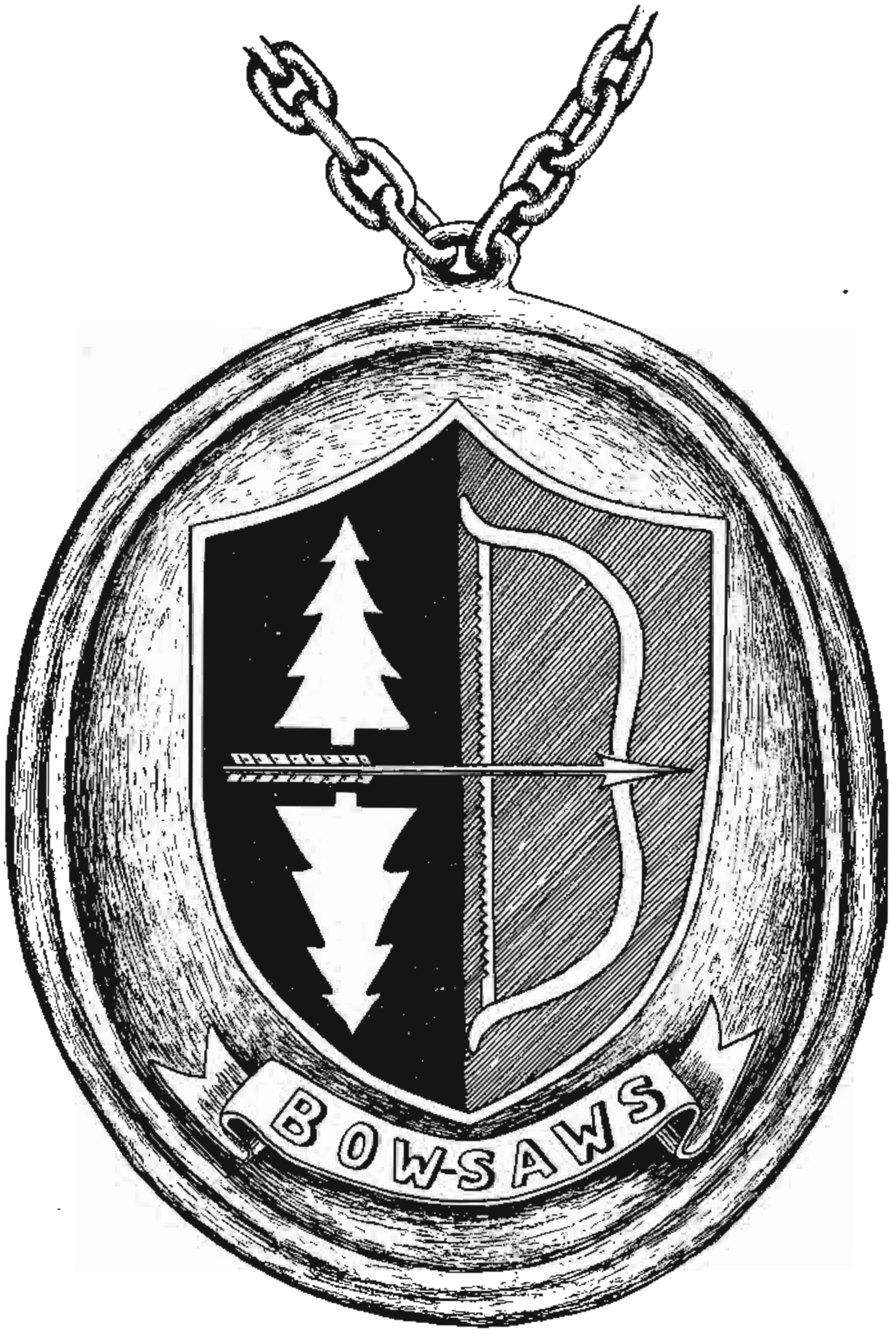


FIG.S.10.

WORKING METHOD AND SAW-DUST OF RAKER TOOTHING.

TOOTH DETAILS AND CUTTING ACTION


BOWSAWS

tooth line must, of necessity, be straight. A curved tooth line is advantageous as fewer teeth are engaged in sawing, but this effect can be obtained with the bow saw by gently rocking the saw while sawing, as previously described. The narrow width of the saw, 19 to 25 mm, reduces friction and eliminates binding. Hardpoint saws in the 19 mm width are available in lengths of 91, 100 and 107 cm. For heavier work, hardpoint saws are available in 25 mm widths in lengths of 107 and 122 cm.

(3) Maintenance tools for the hardpoint blade

The blades are delivered with a set for medium-hard wood, so the setting must be adjusted, i.e. increased for softwood and reduced for hardwood.

Saw-set pliers, for hardpoint saws (Fig. S. 25) are specially designed for bow-saw blades. They are applied from the back of the blade and will thus not damage the sharp tooth points.

After adjusting the set, the blade may cut a little crookedly. This can be corrected by honing the side that pulls out. Any hard and fine-grained whetstone (Fig. S. 26) with a smooth, flat surface will do. The same stone may be used for touching up the hardpoint blade, when it begins to dull. The blade must be uniformly honed on both sides. This will reduce the setting slightly and the blade must be reset.

Sawyers should be given a few spare blades to keep handy in the event of one becoming blunt or damaged during the day.

(4) Frames

The main part of the bow-saw frame consists of a single piece of seamless tube, or else of two pieces telescoping one into the other, thus making the saw adjustable. A blade-fastening device is fitted to each end of the frame (Fig. S.11). Blade holders must be in line and clamped tight and flat to prevent the blade from twisting.

One end of the frame is equipped with a tensioning lever by means of which tension can be applied to the blade after it has been secured in the frame. (Fig. S. 11a,c).

Bow-saw frames must comply with the following requirements:

(i) High tensioning ability in order to stiffen the blade, which is thin and narrow.

(ii) Good balance and low mass to facilitate easy handling while sawing.

(iii) They must be easily adjustable to keep the blade flat and straight, thus preventing crooked cutting.

Frame design with wide bends, made from oval section seamless tubing of high quality steel solves the problems of saw mass. It has a small mass and is easy to handle with comfortable grips; thus reducing fatigue.

Tensioning of the sawblade is achieved by a lever with an eccentric fitting, having a large movement, which enables the strength and elasticity of the frame to be fully utilised.

Three types of frames are available:

(i) Unsymmetrical and non-adjustable

(ii) Symmetrical and non-adjustable

(iii) Symmetrical and adjustable

Non-adjustable frames are made from a single piece of tubing and have a smaller mass than the adjustable frames. There are two types of non-adjustable frames:

(a) With an unsymmetrical shape, the lower bend being near the handle, as in Fig. S. 18. The maximum cutting depth at the handle is approximately 22 cm up to the 91 cm length, 25 cm for the 100 cm length and 30 cm for the 107 cm length.

(b) With symmetrical bends, as in Fig. S.19. These frames are available in lengths of 76, 91, 100, 107, and 122 cm, with a cutting depth of 30 cm for all lengths.

The adjustable frame is made in two halves, the middle ends of which telescope into each other. These frames are available in two sizes, one for 91 to 107 cm blades and the other for 107 to 122 cm blades with cutting depths of 27,5 and 30 cm.

Adjustable frames have the following advantages over non-adjustable frames:

(i) They permit the use of blades of different lengths

(ii) They give greater tension due to the double tubes at the point of telescoping, which prevent the frame from arching.

The locking device at the frame telescopic joint consists of a wedge principle lock, shown in Fig. S. 12, in the shape of a conical ring around the thinner inner tube. When the frame is to be locked in position, this ring is pushed over the larger tube, thus locking the two tubes as illustrated. The lock can easily be loosened at any time by giving it a light blow with the back of an axe.

(b) TWO-MAN CROSS-CUT SAWS

The two-man cross-cut saw has a wide, thick blade, to the ends of which two handles are rigidly attached to pull the saw back and forth when sawing. This saw is used for the felling and cross-cutting of large and medium-sized trees, and is available in lengths 1,36 ; 1,5 ; 1,68 ; 1,8 ; 2,1 and 2,4 m. The saws are heavily taper ground with a uniform thickness along the tooth line. The tooth line is curved, making the saw cut faster. The back of the saw (opposite the tooth line) may be flat (Fig. S.15), hollow (Fig. S. 16) or "salmon-backed" (arched) (Fig. S. 17).

Hollow-backed cross-cut saws have the advantage that the saw has a smaller mass and is narrower. This greatly reduces the risk of binding and makes it possible to use the felling wedge at an early stage of sawing.

Cross-cut saws may have either peg or raker toothing. Peg-toothed cross-cut saws range in length from 1,4 to 3,1 m. Raker-toothed saws commonly have four cutters to each raker.

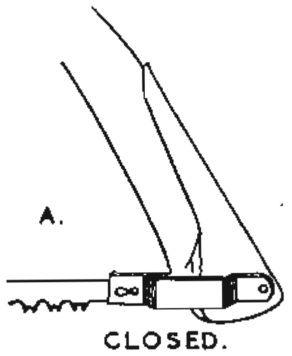
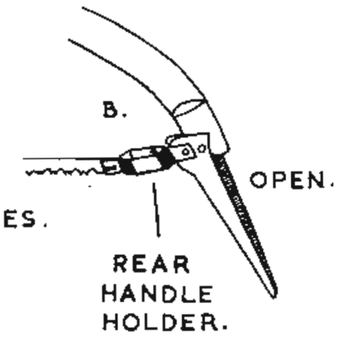
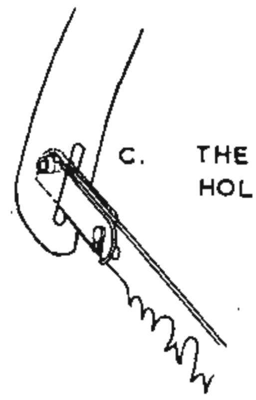


FIG.S.11

TENSION LEVER AND BLADE HOLDERS ON BOW-SAW FRAMES.





THE FRONT END BLADE HOLDER CLAMPS THE BLADE.

FIG.S.12.

TELESCOPIC CONNECTION AND CONICAL LOCK FOR ADJUSTABLE BOW–SAW FRAME.

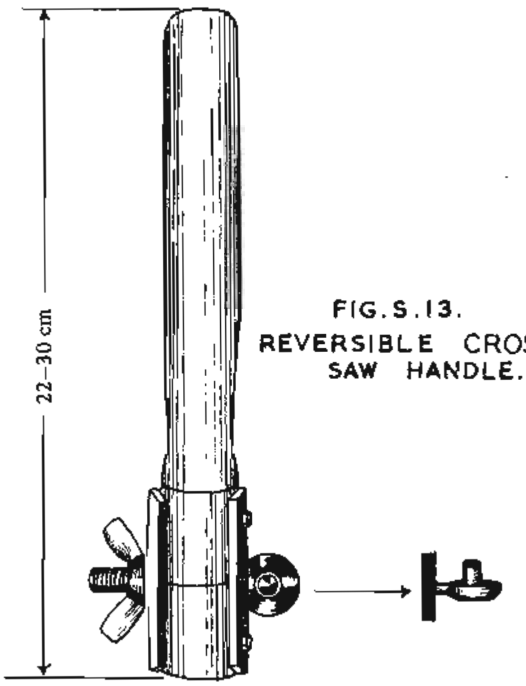


FIG.S.13.
REVERSIBLE CROSSCUT SAW HANDLE.

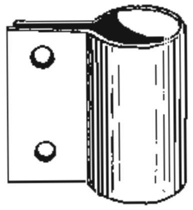
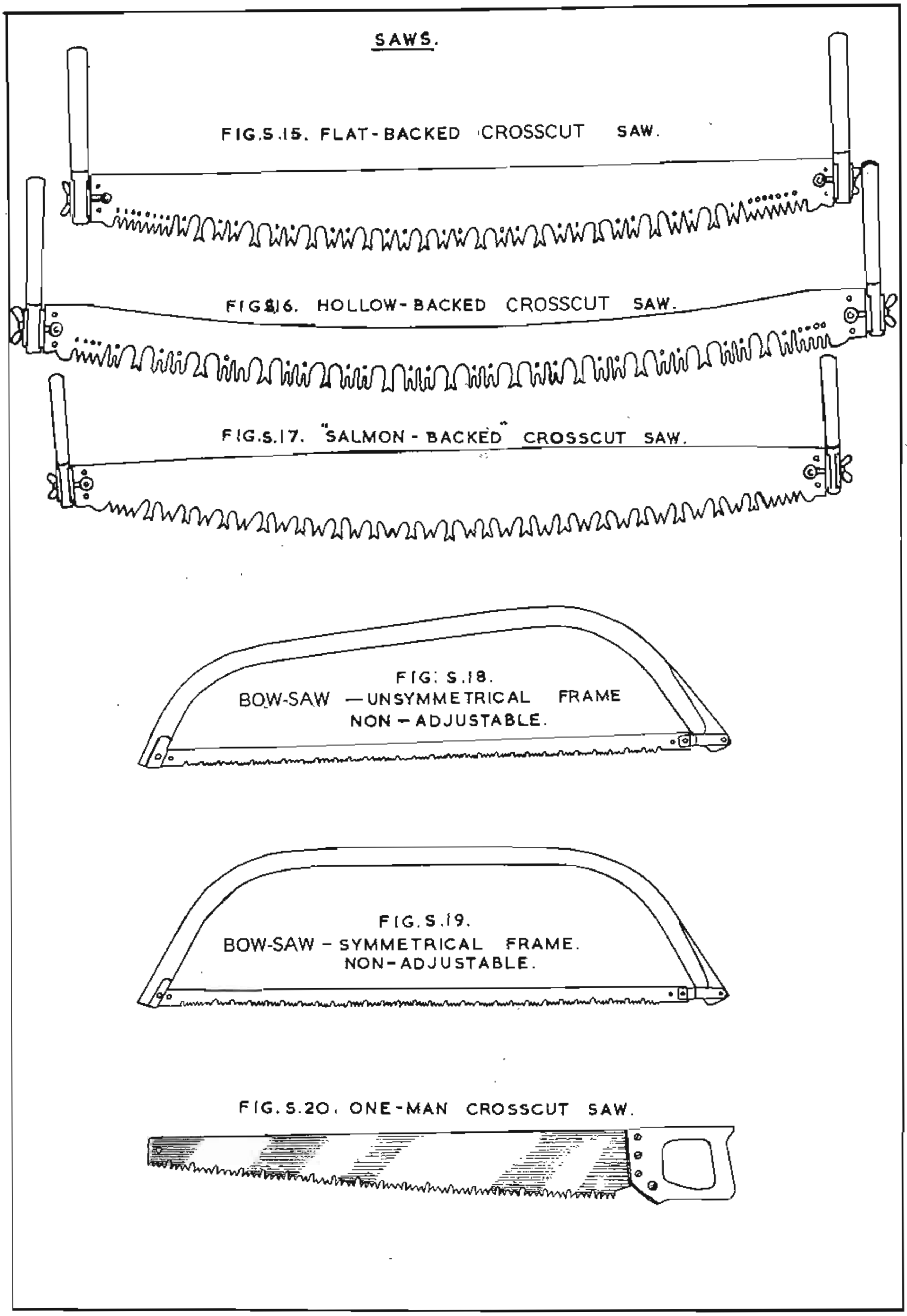


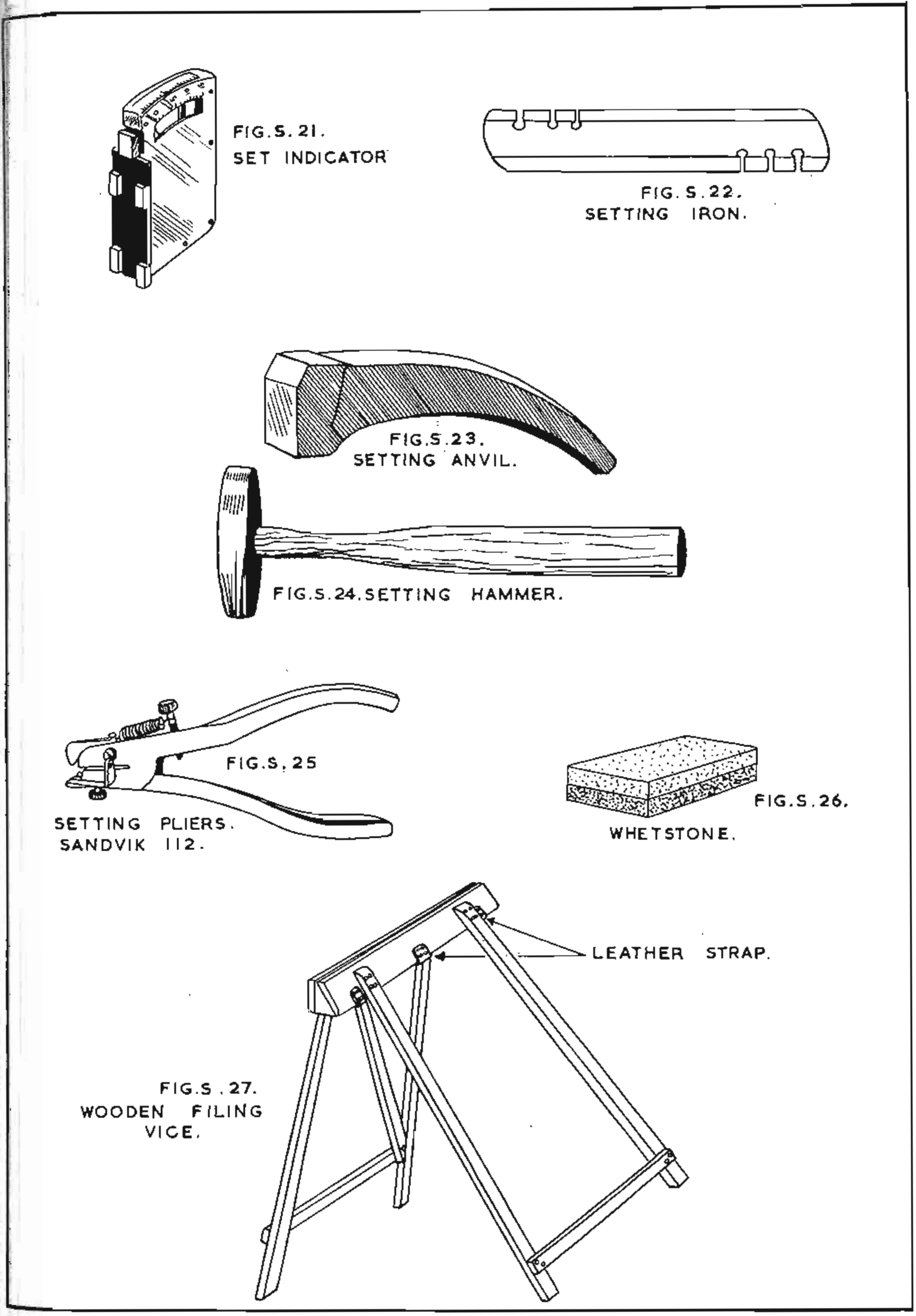
FIG.S.14.

CROSSCUT SAW HANDLE HOLDER WITH TWO BOLTS AND WING NUTS.

SAW HANDLES



VARIOUS TYPES OF HAND SAWS



SETTING TOOLS

FIG. S.28. STEPS OF TRIMMING A PEG-TOOTHED SAW.

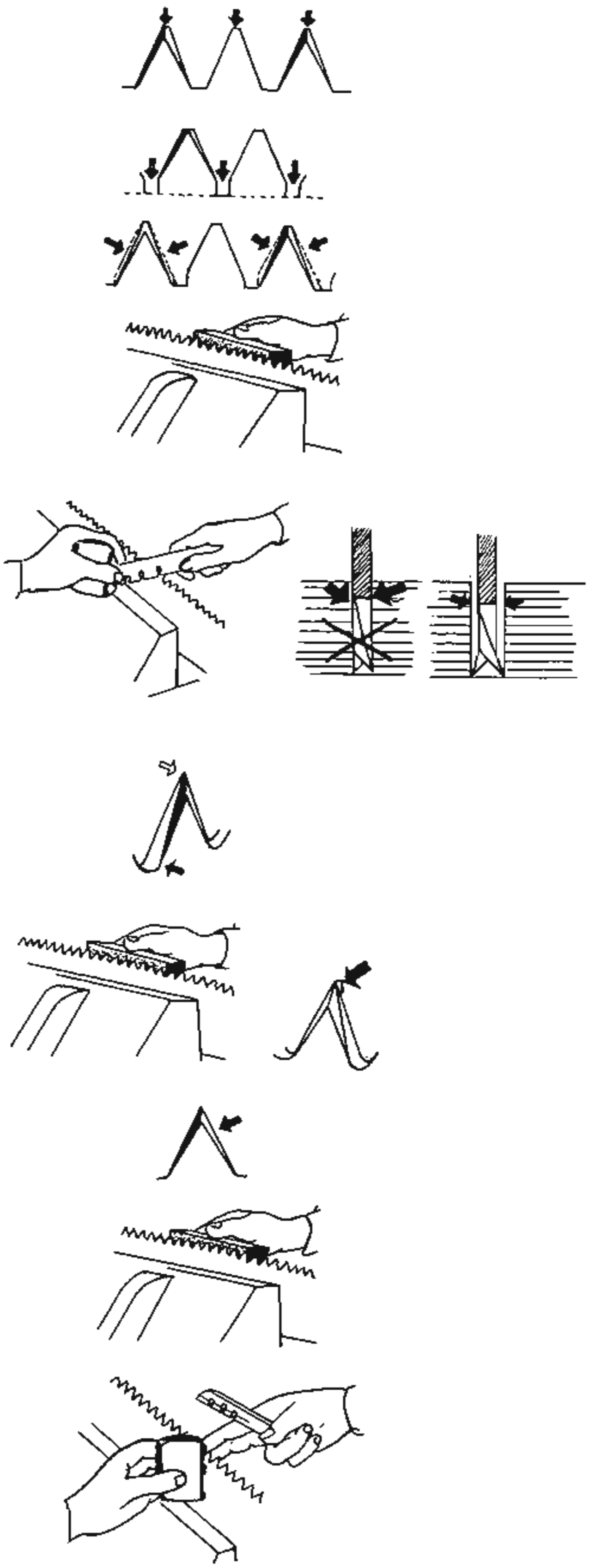
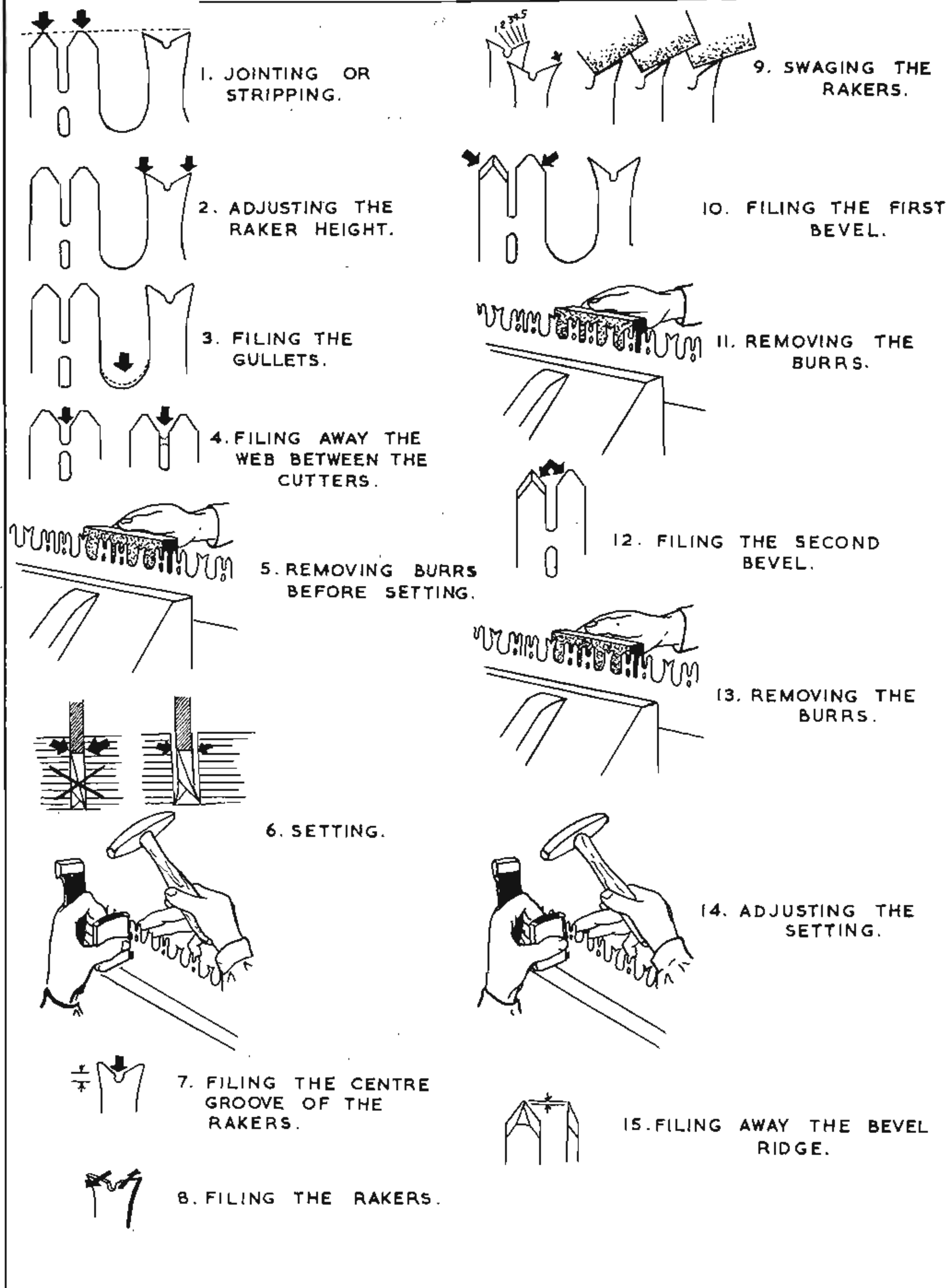


FIG.S.29 STEPS IN TRIMMING A RAKER-TOOTHED SAW.



Cross-cut saws like bow saws, are supplied already sharpened and set. This does not mean, however, that the setting and height difference between the raker and cutting teeth is suitable for any kind of wood. The user has to adjust the setting, height difference and bevel filing to suit the saw to the specific kinds of wood.

Fig. S. 13 illustrates the handle and handle fitting for cross-cut saws. Handles which can be bolted onto the saw may be used, as in Fig. S. 14, but reversible handles are preferred, particularly as they can be quickly detached, which may be necessary if the saw is to be pulled through a kerf or cut instead of being withdrawn in the usual manner.

(c) ONE-MAN CROSS-CUT SAW

The one-man raker-toothed cross-cut saw (Fig. S.20) is a felling saw, heavily taper ground and with a curved tooth line. The saw used in Departmental plantations is generally short, being 60 to 110 cm in length. In the Department these saws are primarily used for "topping" spar trees, or for other odd jobs.

Apart from raker-toothed blades, the saws are also available with "tiger"-toothed blades (Fig. S. 4). The "tiger" saw is 116 cm long, has a curved tooth line, and is comparatively wide.

The one-man saw usually has a typical "carpenters saw" handle at one end, but a supplementary handle, called a "point" handle, may be attached at the other end of the saw, to make it a two-man saw if necessary.

In the early days of logging this saw was used largely for cross-cutting logs, but in present day logging it has been replaced with the more versatile bow saw.

D. SHARPENING THE SAW TEETH

After continual use the saw blade blunts and must be resharpened, which requires a skilled technique. Only a few of the many men employed in sawing are sufficiently trained to do resharpening more or less correctly. The problem is solved to a certain extent by establishing a workshop where the saws can be "doctored" by a man experienced in the trade. This is, of course, only possible if the operation is large enough to warrant the expense of a specially trained man to do the job.

The introduction of the hardpoint bow-saw blade has virtually eliminated sharpening of bow-saw blades, but where conventional blades are still used the appropriate sharpening procedure for the particular type of toothing must be followed.

(a) MAINTENANCE HINTS

(1) Place for filing: The light should be good and even.
(2) Clean the saw with soft steel wool dipped in paraffin.
(3) The saw blade must be straight, flat and without any defects. Defects must be corrected or adjusted.
(4) Steady filing is essential. The blade should be held firmly without vibration or wobble. A saw holder or wooden filing vice as shown in Fig.S.27 should be used.

When a saw holder is used in the woods, a convenient working place can be provided by cutting off a tree at about breast height above the ground. A notch is cut into the top of the stump with the saw, and the holder is wedged into the kerf.

(5) The saw holder should be placed at a convenient height - at the level of the filer's elbow, or slightly higher.
(6) The files should be kept clean - use a wire brush or piece of charcoal for rubbing (rubling).
(7) Make a couple of cuts in softwood before starting the refiled saw in hardwood.
(8) Rub the saw blade lightly with an oily cloth to prevent rusting and reduce friction against the wood when sawing.

(b) SHARPENING PROCEDURE

It is not within the scope of this manual to give a full description of the sharpening and maintenance of the saw, as any saw distributor will willingly supply the buyer with a detailed instruction booklet on the sharpening and maintenance of the saw.

The process of sharpening peg and raker toothing is shown graphically in Fig.S.28 and S.29 respectively. Brief explanations of the various sharpening terms are given below.

(c) TOOLS USED FOR RESHARPENING

Twenty centimetre single cut, smooth, flat file; setting pliers, (Fig.S.25) or setting iron (Fig.S.22); setting indicator (Fig.S.21); setting anvil and hammer (Fig.S.23,24); whetstone (Fig.S.26); fine, smooth, flat file.

(d) EXPLANATION OF TERMS

(1) Peg-toothed saw

Jointing (Stripping) - All the tooth points must lie on the same line. A tooth which is too long will make the saw jump, a tooth which is too short will not reach into the cut.

Deepening the gullets - The gullets must be deepened to give the teeth correct and uniform length and width.

Shaping the teeth - Shaping is required to obtain the correct tooth angle. When shaping, the jointing flats must be adjusted to uniform size for bevel filing.

Removing burrs - When the file is used, burrs or "wire edge" are formed. Light use of the whetstone is sufficient to remove burrs. This is particularly important before setting is done.

Setting - The teeth are bent alternately to the right and left. This is done to provide a saw kerf wider than the saw width, to prevent the saw from binding or running heavily.

Filing the bevels - Oblique bevel filing should be used. The first bevel should be filed on that side of the tooth which you find most difficult, filing the second bevel on the easiest side to bring the tooth to a sharp point. The second bevel should be as similar in shape to the first as possible.

(2) Raker-toothed saws

Jointing - Jointing should take off the points of the teeth at right angles to the surface of the saw, so that the teeth set on the one side have the same height as those on the other. All cutter points should lie on the same line, as for peg toothing.

Adjusting raker height - A cutter group of a raker-toothed saw has only to cut off the fibres, whereas the raker will loosen them and remove them from the kerf. To prevent the raker from striking fibres which are not yet cut, they must be slightly shorter than the cutters. Softwood requires a larger height difference between the rakers and cutters. For adjusting the difference in height a Sandvik 120 gauge is used.

Height difference:
Approximately 0,2 mm hardwood
Approximately 0,4 mm softwood.

The height difference is correct if, with cross-cut saws, the chips are from 10 to 15 cm long, with the edges cleanly cut.

Filing the gullets - If the gullets at the rakers are too shallow the sawdust will clog them, making the saw run heavily and cut badly. When required the gullets must be deepened to prevent the chips packing and make them fall out automatically when sawing. Larger gullets are needed for softwood than for hardwood.

Filing away the web between the cutters - When the cutters become too short they are difficult to set. The web between the cutters should then be filed away. The reason for having the web at all is to stiffen the cutters while they are still long.

Note: This does not apply to some types of saw blades.

Removing burrs - As for peg-toothed saws.

Setting - The saw should be set as previously described. The last group of cutters in the row should not be set. Raker teeth are not set. The setting hammer, setting anvil and setting indicator are used. Pliers or setting irons cannot be used for setting.

Setting for hardwoods:
At the most 0,2 mm to each side
Setting for softwoods:
At the most 0,3 mm to each side

Filing the centre groove of the rakers - The groove in the centre of the middle of the raker is filed down to make both wings of equal width. By making the groove about 5 mm deep the operation need not be repeated at the next three or four trimmings. A 20 cm single-cut, smooth, flat file with round edges is used for filing the centre groove.

Note: This does not apply to some types of blades

Filing the rakers - The raker edges must be filed at right angles to the saw blade and with sufficient clearance. The wings are best filed with a slope of about 30 to 40 degrees (tooth point angle 50-60 degrees).

Swaging the rakers - The raker wings are bent slightly outward (longitudinally) by gently tapping with the hammer as illustrated. The rakers are swaged to work more like chisels, and not merely scrape off the chips. The saw will then cut more easily and smoothly. Swaging should be just sufficient for the "bent edge" to be felt by the finger run up the edge of the raker.

Normal swaging will shorten the rakers about 0,1 mm. This fact is to be remembered when the height of the rakers is adjusted.

Filing bevels - The task of the cutters is to cut off the fibres, but not to remove the sawdust. The cutters are filed with full bevels, which should be as wide as possible. The bevel width is limited by the tooth points becoming thin and brittle in hardwood. The 20 cm file is used.

When filing wide bevels, large burrs will form at the tooth point, and these may be tapped off with the file handle between strokes.

The tooth point angle should be about 75 degrees for softwood and 80 degrees for hardwood.

The second bevel should bring the tooth to a sharp point, which should lie just at the original level of the jointing flat. The individual cutting depth of the teeth is less than 3 to 0,8 mm below the tooth point.

E. DEFECTIVE SAWING

Despite a saw having been resharpened or trimmed, its performance may not be satisfactory. When examined the following defects may be found:

(a) THE SAW CUTS CROOKEDLY

(1) Larger setting on one side (the saw runs to this side).

(2) Teeth are higher on one side of the blade because of incorrect jointing or filing (the saw pulls to this side).

(3) Point angle or bevel width may not be the same on both sides of the blade.

(4) The frame is twisted or gives insufficient tension.

(b) SAWING IS HEAVY

(1) Too little set for softwood or too much set for hardwood.

(2) The saw is rusty or coated with resin.

(3) Too heavy honing has been applied to correct crooked cutting and has resulted in a marked loss of ability.

(4) Large burrs are left on the tooth points.

(5) The saw is badly straightened and tensioned. (If the filing and setting are correct the saw should be turned over to an expert for adjustment.)

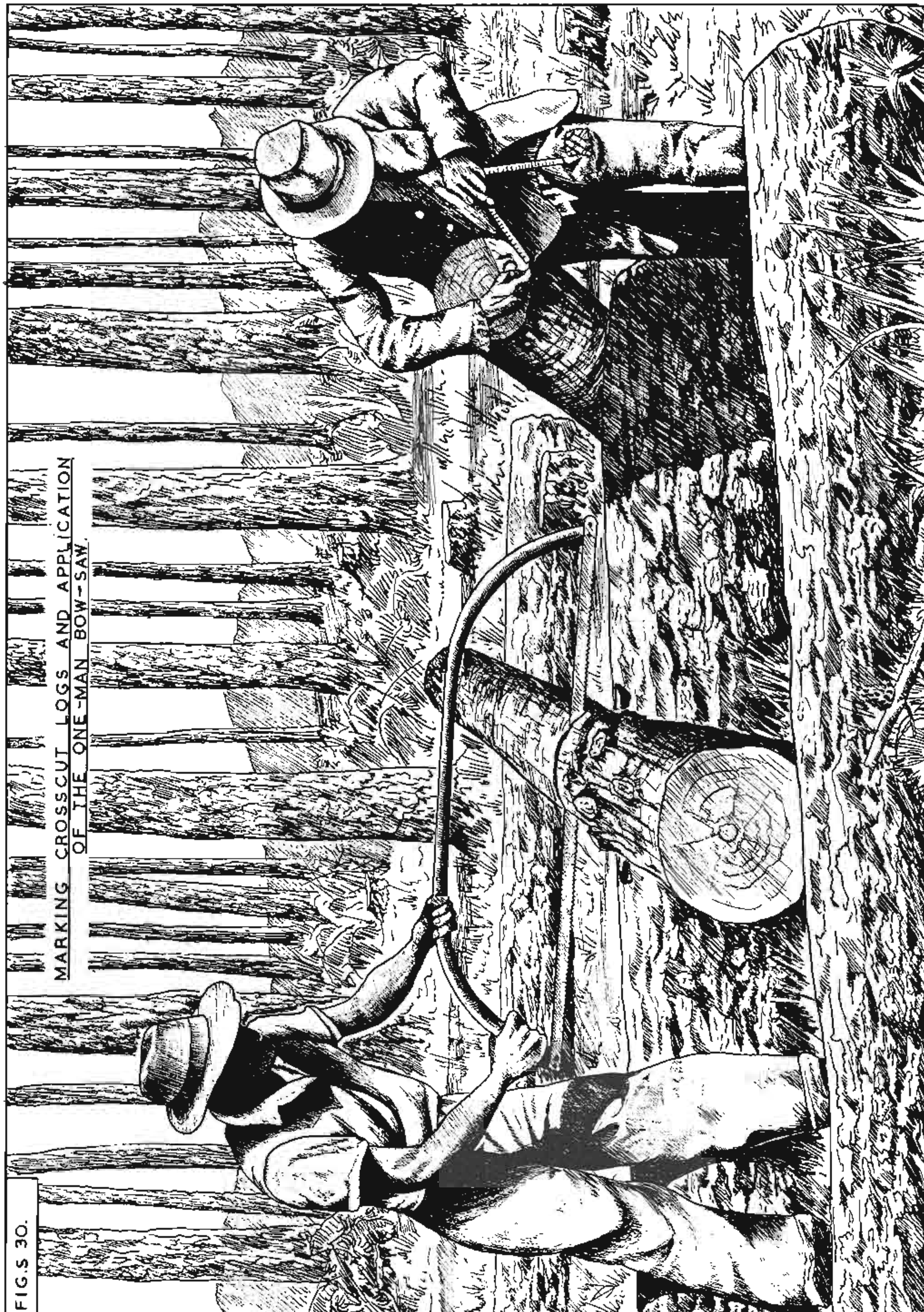


FIG.S 30.

MARKING CROSSCUT LOGS AND APPLICATION OF THE ONE-MAN BOW-SAW.

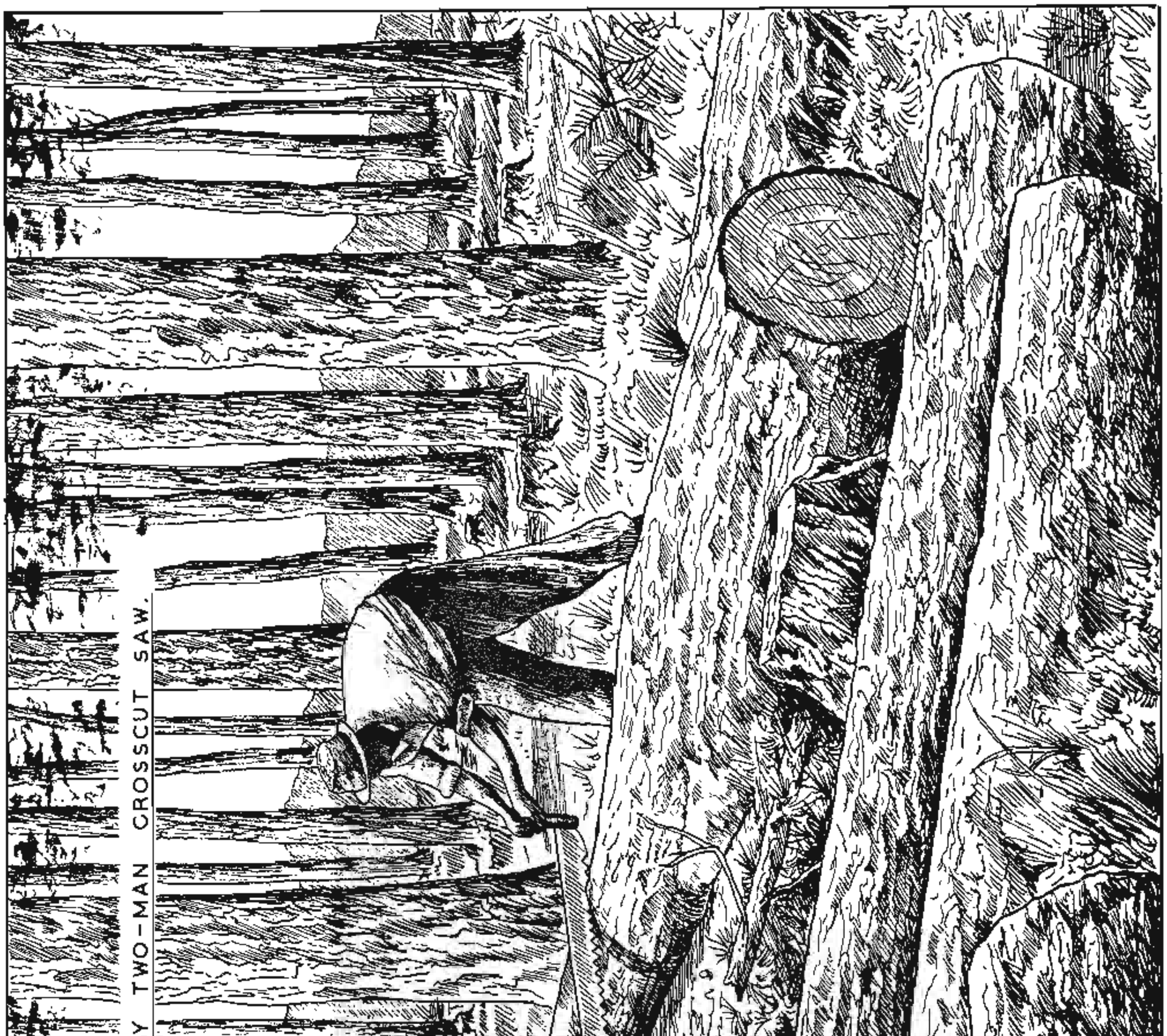
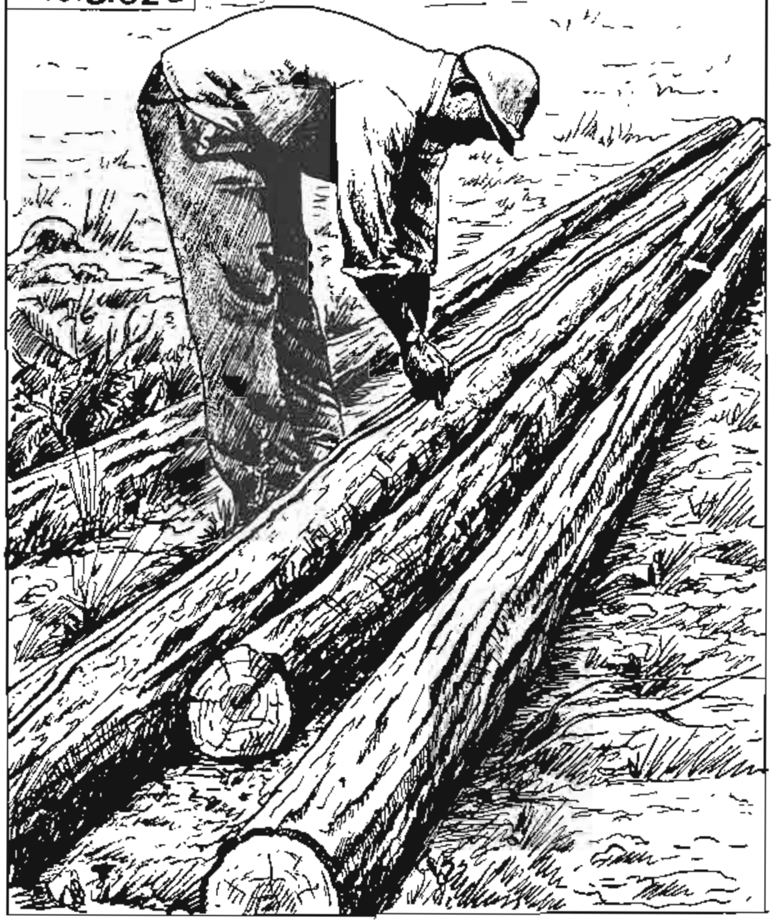


FIG. S. 31.

CROSSCUTTING BY TWO-MAN CROSSCUT SAW.

FIG. S.32 a



MARKING AND MEASURING INTO LOGS.

FIG. S.32 b

CROSSCUTTING POLES BY ONE-MAN BOW-SAW.

(c) THE SAW RUNS EASILY BUT CUTS BADLY

(1) The teeth are too blunt (too narrow bevels or too large point angles).

(2) The gullets are too small, making the sawdust clog.

(3) The teeth are not filed to a sharp point.

(4) (Tiger toothing). The front edges of the teeth lean too far backwards.

(d) THE SAW CUTS ROUGHLY AND JUMPS IN THE KERF

(1) Occasional teeth are too high.

(2) The setting is uneven.

(3) (Tiger toothing). The front edges of the teeth are too upright or even lean forward.

(4) The raker teeth are too high.

Note: If some of the blades or frames prove defective upon delivery, they should be returned to the distributor for replacement

2. USE OF HAND-SAWS

Efficient sawing requires the use of long, powerful and properly timed strokes. Where possible the working position should be comfortable and there should be reasonable freedom from obstacles.

Saw strokes should preferably be the full length of the blade, particularly with short saws. This is desirable both from the point of view of the muscular effort employed and the fact that long strokes keep the saw in good working condition much longer. With short strokes the section of the blade most used dulls quickly and the set of the teeth on that section becomes less than the rest of the blade, which increases the saw resistance.

Muscular exertion need not be strenuous but should be reasonably steady throughout both forward and backward strokes, if somewhat greater on the first, and more relaxed when the stroke is about to be reversed. Not only the arms, but also the swing of the body should be used, movements being even and not jerky.

The saw should be "rocked" on each stroke, that is, be so directed that on a forward stroke its free end gradually dips down to come 2 to 4 cm below the level on which it would have been without the rocking movement. Sawdust clears easier with this method, less teeth being engaged in the wood, and sawing is also easier. Less downward pressure is needed on the saw. Similar to this is "sawing continually at a corner": sawing with straight strokes, but slightly changing at frequent intervals the angle at which they are directed. In sawing large-sized wood this practice can be advantageously combined with rocking of the saw.

It is vital that the blade is not bent or deflected, and should be kept as straight as possible. Bending the saw leads to greater sawing resistance and often pinching.

The best tempo of work for a cutter of average physique making long strokes with a 90 to 100 cm bow saw is about 60 to 65 double strokes per minute. With cross-cut saws the tempo is slightly slower.

A. CROSS-CUTTING WITH THE TWO-MAN CROSS-CUT SAW (Fig. S. 30, 31, 32).

(1) Elevate the log if possible so that the end is free, by placing a prop slightly back from where the cut is to be made (Fig. S.30). This will prevent pinching. If the log is large, pinching can be prevented by driving a wedge into the kerf as sawing proceeds.

(2) Remove thick bark from the point where the cut is to be made. Thick bark is hard and dulls the saw.

(3) Squirt paraffin on the saw for lubrication.

(4) Take a good stance with the feet well apart.

(5) Pull the saw towards you with long, even strokes. Do not push it back - that is your partner's job, and pushing buckles the blade. On the backward stroke relax your grip and thrust out your arms in the rhythm of the sawing.

(6) Do not wrestle the saw to force it downwards - use just enough force to keep the saw in the wood.

(7) Keep the saw straight, to cut a straight, even kerf.

(8) When the saw begins to pinch, drive in a wedge. When the cut is nearly through the saw will pinch anyway, so long strokes become impossible. Then take short, quick strokes, 30 cm or so in length, until the log drops.

B. FELLING WITH A SAW

(1) First chop a notch or undercut by axe, approximately one third the width of the tree, and as low as possible. The bottom of the undercut may be sawn and the top cut away with the axe.

(2) Start sawing directly opposite the undercut and 2 to 5 cm higher than its lower surface. Hold the saw level with the ground. This will ensure a flat stump.

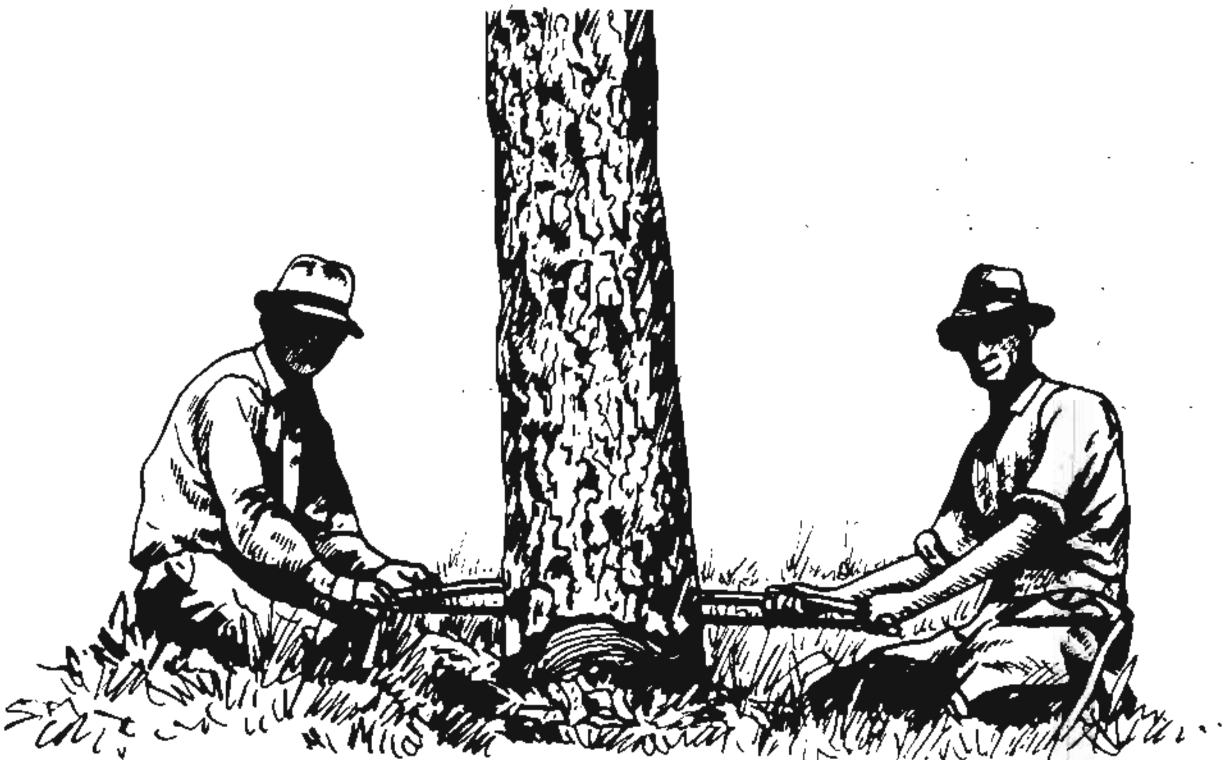
(3) Keep the cutting edge of the saw even with the undercut. When two men are sawing, this can be accomplished by each man calling out as the sawing progresses, the number of centimetres between the saw and the undercut on his side. When one calls his number the other answers with his, and if one is further away than the other the saw must be adjusted.

(4) To avoid pinching the saw must be absolutely straight. In big or leaning trees where pinching can be expected, a wedge should be driven into the kerf as soon as possible.

(5) Just as the tree starts to fall, the saw must be withdrawn from the kerf.

FIG. S. 33

APPLICATION OF THE TWO-MAN FELLING SAW



FELLING BY TWO MAN BOW SAW — SEATED POSITION.

Fig.s. 34.

FD.854.

C. POSITION FOR FELLING

(1) With two-man cross-cut saws, the sawyers should stand facing away from the direction in which the saw is cutting, far enough back so that the saw can be pulled across in front of the sawyer's body. In this position the saw is forced into the tree as it is pulled. One of the logger's hands grips the saw handle, the other is placed loosely in the corner between the handle and the saw to force it into the tree (Fig. S. 33).

(2) If the above position is assumed, one can bend down so as to cut the tree low, or, for relief, can drop on one knee.

(3) An alternative position is for the two sawyers to assume a seated position, facing each other, or half facing the direction of the cut, as in Fig. S. 34. In this position a half-kneeling stance may also be assumed. Such a position permits the sawyers to cut the tree closer to the ground, but limits the stroke length of the saw to a certain extent. It is, however, most effective for use with bow saws or short cross-cut saws, as it is more comfortable and results in less strain on the sawyers.

3. PREPARATION OF SOFTWOOD SAWLOGS BY HAND-SAWS

A. TASK-WORK NORMS

Task-work has been introduced in order to achieve a uniform system for controlling timber production, and is based on allowed time norms (tabulated), especially drawn up for that purpose.

The number of labourers and their duties are detailed. Taskwork norms in timber preparation are based on the diameter of the tree or log actually cut, consequently one is unable to trace the timber volume of converted boles and logs from this table, unless the number of logs and their length for each diameter class is known. The species covered by the task norms chart (table) are the following: (For preparation with bow, felling and cross-cut saw).

Pinus canariensis, *P. elliottii*, *P. patula*, *P. palustris*, *P. pinaster*, *P. pseudostrobus*, *P. radiata*, *P. roxburghii* and *P. taeda*.

TABLE S. 1: Allowed times for felling and debranching of trees

Thick end diameter 1st log(cm)	Allowed times in minutes for two labourers per tree						
	P. pin	P. pat P. tae P. can	P. ell	P. pseud	P. rox	P. rad	P. pal
13,5	3	2	2	3	3	3	1
15	3	3	2	3	4	3	2
17	4	3	3	4	4	4	2
19	4	4	4	4	5	4	3
21	5	5	4	5	7	5	3
23	6	6	5	6	8	6	4
25	7	8	6	7	9	7	4
27	8	9	7	8	11	8	5
29	9	10	7	8	12	9	5
31	10	11	8	9	13	10	6
33	11	11	9	10	15	12	6
35	13	12	10	11	16	13	7
37	14	13	11	12	17	14	7
39	15	14	11	12	18	16	8
41	17	14	12	13	19	18	8
43	18	15	12	13	19	19	8
45	20	16	13	14	20	21	9
47	22	16	13	14	21	23	9
49	24	17	14	15	22	25	10
51	26	18	15	16	24	27	10
53	28	20	16	18	26	29	11
55	29	22	17	20	28	31	12
57	31	24	19	22	32	33	13
59	34	28	22	25	36	36	15
61	36	31	25	28	41	38	16
63	38	34	27	32	47	40	18
65	41	37	30	36	53	43	21
67	43	40	32	40	59	46	24
69	46	43	34	43	-	48	-
71	48	46	36	46	-	51	-
73	51	50	39	50	-	54	-
75	54	53	42	53	-	57	-

The following allowances must be made for slope:
- 0 - 15° The labourers must start on 0 minutes;
- 16 - 20° The labourers must start on 27 minutes;
- 21 - 30° The labourers must start on 54 minutes;
- 31 - 40° The labourers must start on 81 minutes;
- over 40° The labourers must start on 108 minutes.

Two types of tables are given for hand-saws:

S. 1. For felling and debranching trees
S. 2. For cross-cutting boles into logs

The given tasks were achieved under the following conditions:

(1) Bow saws were used for felling trees of up to 60 cm diameter, and for cross-cutting logs of up to 33 cm diameter. The felling saw was used for larger trees. Saws were sharpened by a trained man every day, and axes once every three days. Axes were used for the initial undercut.

(2) Stumps of felled trees were left not higher than 15 cm above the ground. Forest litter and slash were removed from around the tree before felling commenced. Boles, when felled, were debranched and the branches removed in order not to interfere with the work of the cross-cutters.

(3) Peavy hooks were used by the cross-cutters for rolling logs.

(4) Marking of boles into logs was done in advance so as not to keep the cross-cutters waiting.

(5) Fellers and cross-cutters were allotted to various parts of the compartment so as not to hinder each other, whether individually or in the group.

Note: Changed log classifications or crooked trees did not influence the labourers' tasks

This method can be used to simplify the overtime system if so desired.

TABLE S. 2: Allowed times for cross-cutting of logs

Thin end diameter of logs (cm)	Allowed time in minutes for two labourers per cut					
	P. rox	P. tae P. pat P. pseud P. pal	P. ell	P. rad	P. can	P. pin
13,5	1,0	0,9	0,9	1,3	1,4	1,2
15	1,1	1,0	0,9	1,5	1,6	1,3
17	1,2	1,1	1,0	1,7	1,8	1,4
19	1,3	1,2	1,1	2,0	2,1	1,6
21	1,6	1,4	1,2	2,3	2,6	1,9
23	1,8	1,6	1,4	2,7	3,0	2,2
25	2,0	1,8	1,6	3,2	3,4	2,4
27	2,4	2,0	1,8	3,6	4,0	2,8
29	2,6	2,3	2,1	4,2	4,8	3,3
31	3,2	2,6	2,4	5,0	5,5	3,8
33	3,8	3,1	2,8	5,8	6,6	4,4
35	4,7	3,6	3,3	6,8	7,8	5,2
37	5,5	4,2	3,8	8,0	9,0	6,2
39	6,6	4,8	4,4	9,2	10,7	7,0
41	7,6	5,5	5,1	10,8	12,3	7,9
43	9,0	6,4	5,9	12,3	14,6	9,0
45	10,3	7,4	6,8	14,2	17,0	10,3
47	11,9	8,4	7,8	16,4	19,9	11,9
49	13,6	9,7	8,9	17,4	23,0	13,6
51	15,2	10,8	9,9	18,4	25,8	15,2
53	16,9	12,1	11,0	20,7	28,9	16,9
55	18,6	13,5	12,2	22,2	32,1	18,6
57	20,8	15,2	13,6	26,1	35,7	20,8
59	23,3	17,2	15,4	29,2	-	23,3
61	26,2	19,2	17,2	32,0	-	26,2
63	29,5	21,1	19,1	35,4	-	29,5
65	-	23,3	-	39,2	-	-
67	-	25,4	-	43,0	-	-
69	-	27,5	-	46,7	-	-
71	-	-	-	50,0	-	-
73	-	-	-	54,4	-	-
75	-	-	-	58,8	-	-

The following allowances must be made for slope:
0 - 15° The labourers must start on 0 minutes;
16 - 20° The labourers must start on 27 minutes;
21 - 30° The labourers must start on 54 minutes;
31 - 40° The labourers must start on 81 minutes;
over 40° The labourers must start on 108 minutes.

B. TEAMS AND THEIR DUTIES

(a) Two alternative methods of team organisation were considered. In the first, felling and cross-cutting are done by the same labourers, who earn allowed times for both felling and cross-cutting. The second alternative is for felling and debranching to be done by one team and cross-cutting by another.

(b) Allowed times are applied to sawyers, as it is believed that the work of the other teams will equal that of the sawyers if the work is properly organised.

Table S.3 shows the average number of men required to prepare various volumes of timber per day in P. patula, P. elliottii, and P. taeda:

TABLE S. 3: Man-power required to prepare various volumes

Timber derived from:	Number of men required for the preparation of:				
	184 m^3/day	147 m^3/day	117 m^3/day	88 m^3/day	59 m^3/day
Clearfellings	21	17	15	11	7
3rd thinnings	30	25	21	15	10
2nd thinnings	55	47	35	27	18

Note: For costing purposes the foreman's wages and the cost of marking for thinnings must be added to the labour costs for bow or cross-cut saw.

(1) DUTIES OF THE TEAMS

Men per team: Teams 1 to 2 : one or 2 men
Teams 3 to 7 : one man

(i) Team

No. 1 Fell and debranch: Fell tree and cut butt end square, debranch to 13 cm at thin end and remove branches.

Equipment:
1 bow saw or two-man cross-cut saw per two labourers
2 axes - 2 kg each
Lumber crayons

No.2 Cross-cutting: Cross-cut the logs and roll them over to expose branches underneath in such position as to be accessible for final debranching.

Equipment:
1 bow saw or two-man cross-cut saw
1 large axe
Lumber crayons

No. 3 Marking the bole for cross-cutting: Mark according to local specifications.

Equipment:
Measuring stick
Hatchet or pruning saw

No.4 Tally for cross-cutters: (Tellers). Tally all the cross-cut logs for daily production sheets (form for felling and cross-cutting).

Equipment:
1 tally board with production sheets
1 pencil
1 steel rule
Lumber crayons

No.5 Tally for felling and debranching: Completion of daily production sheets for felling and cross-cutting.

Equipment:
As for Team No. 4

No.6 Removal of remainder of knots after cross-cutting:

Equipment:
1 axe - 2 kg

No.7 Transport of equipment: Transport all saws, axes, etc., for sharpening, and to assist Team No. 6.

(ii) Duties of the foreman

The foreman will supervise all labourers in their duties.

Equipment:
Hardpoint bow-saw blades
Axes - 2 kg recommended

C. CONTROL OF THE SCHEME

(a) FELLING AND DEBRANCHING

The thick end diameter of the bole is recorded, as the allowed time is based on this. Tellers, before recording, inspect the tree to see if it is correctly cut and debranched.

Each team of fellers is allotted a number which they must write on the thick end of the tree which they fell. The tellers cancel these numbers with a stroke while tallying.

The foreman must check the work of at least one team of two labourers each week. He should compare his production sheet with that of the teller at the end of the day.

(b) CROSS-CUTTING

Allowed times are based on the thin ends of logs, which must be tallied by the teller. The cross-cutters write their numbers on the thick ends of the logs, and these numbers must be crossed by the teller as he tallies the logs. The foreman must exercise a check in the same way as for felling and debranching.

(c) ALLOWED IDLE TIME

Idle time is allowed at a rate of 12 minutes per kilometre for moving from compartment to compartment, and when work is stopped for rain, the actual time not worked is permissible idle time. Idle time must be checked and approved by the forester before being granted.

D. TABLES FOR THE NORMS OF ALLOWED TIMES AND THEIR USE

Tables of allowed times for felling and cross-cutting to be applied as follows: All times were normalised and 20% rest time was allowed for sawing and chopping, while 12½% rest time was allowed for walking. An allowance of 10 per cent was made in the cross-cutting norms for cuts not yielding logs.

(a) USE OF THE TABLES

The production sheet data are completed and the logs listed in centimetre classes, after which the table for the required species is selected. The number of logs in each diameter class must then be multiplied by the allowed time, and the earned time for the various classes added together. The daily task is completed when the day time of 540 minutes has been earned.

(b) DAILY PRODUCTION SHEETS

Examples of daily production sheets for felling and debranching; cross-cutting; and felling, debranching and cross-cutting are given below:

Daily production sheets are completed by the teller and foreman. The slope is determined by the forester, which should be the approximate average if the area is broken. If areas with different slopes are worked, with substantial volumes on each slope, the volumes should be listed separately according to the slope.

The field forman must determine the time earned and ensure that the workers earn the time in the day. The completed production sheets are sent to the forester, who, if satisfied, books the labourers for the day. The foreman's calculation will be accepted if correct to 5%.

E. APPLICATION OF EFFICIENCY DATA

PREPARATION OF SAWLOGS

The following method must be applied:

(a) <u>A combination method of sawlog preparation</u>

One pair of labourers will fell, debranch and cross-cut the stem into logs, then roll the logs to remove knots.

<u>Daily production sheet - felling and debranching</u>

Date ________ Compt. No. ________ Species ________ Slope ________

Thick end diameter of stem (cm)	Team No. ____ Labourer 1. ____ 2. ____		Team No. ____ Labourer 1. ____ 2. ____		Team No. ____ Labourer 1. ____ 2. ____	
<u>Allowances for slope</u>						
13,5						
15						
17						
-						
73						
75						
	Total		Total		Total	

Teller ________ Foreman ________

<u>Daily production sheet - cross-cutting</u>

Date ________ Compt.No. ________ Species ________ Slope ________

Thick end diameter of log (cm)	Team No. ____ Labourer 1. ____ 2. ____		Team No. ____ Labourer 1. ____ 2. ____		Team No. ____ Labourer 1. ____ 2. ____	
<u>Allowances for slope</u>						
13,5						
15						
17						
-						
73						
75						
	Total		Total		Total	

Teller ________ Foreman ________

Daily production sheet : fell, debranch and cross-cut

Date: ____________ Compt. No. ____________ Species ____________

Slope ____________

Diameter of log or stem (cm)	Team No. ______		Labourer 1 ______ 2 ______		Team No. ______		Labourer 1 ______ 2 ______	
	No. of trees	Time	No. of trees	Time	No. of trees	Time	No. of trees	Time
13,5								
15								
17								
-								
-								
73								
75								
	Total		Total		Total		Total	

Time for felling and debranching ____________
Allowance for slope ____________
Total time earned ____________

Time for felling and debranching ____________
Allowance for slope ____________
Total time earned ____________

TELLER ____________

FOREMAN ____________

Idle time sheet

Section ____________ Date: ____________

Time		Time		Details of idle time
From	to	From	to	

SIGNATURE OF FOREMAN

SIGNATURE OF FORESTER

(b) Task-work based on allowed time per tree and tasks to be given in number of trees per day

The task is determined as follows:

(1) The trees felled on the first day in a new compartment are recorded on a "task determining chart".

(2) The data are converted into allowed times, using the tables.

(3) The total allowed time divided by the number of trees for which the time was earned gives the average time per tree.

(4) The average time per tree divided into the available time per day gives the number of trees to be felled per day.

(c) Work performance of labourers

There are 540 minutes in the working day, and the labourers must earn this time to earn 100% work performance. The work performance of a labourer must be expressed in a percentage of 540 minutes. This should not be less than 80%. No plantation should try to exceed 100% work performance.

(d) Control of work

(1) Each pair of labourers must receive a number, which they write on all the logs which they prepare.

(2) Actual measuring is done as in E (b) above, every second day the work is recorded on a task-determining chart and calculated. Task adjustments may be made if necessary.

(3) The forester must check the sheets and make them available for inspection if necessary.

(4) The foreman must check each pair of labourers' work daily and satisfy himself that it has been properly done.

Note: The above applies to the Eastern, Southern and Northern Transvaal Regions, Natal, Zululand and the Eastern Cape.

F. MEASUREMENT FOR THE DETERMINATION OF TASK WORK

The following table gives the work measurement for the determination of task work

Date: 5.8.60 Team No. 2. P. roxburghii Compt. A.18 Slope 2°.

Diameter of trees or logs (cm)	Number of trees		Time per tree	Allowed time min.	Number of logs		Time per log min.	Allowed time Total min.
13,5					~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~	25	1,0	25,0
15					~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 1	41	1,1	45,1
17	1111	4	5	16,0	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 11	42	1,2	50,4
19	1111	4	6	20,0	~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ ~~1111~~ 111	33	1,3	42,9
21	~~1111~~ ~~1111~~ 1	11	8	77,0	~~1111~~ 11	7	1,6	11,2
23	~~1111~~ ~~1111~~ ~~1111~~ 1	16	10	128,0	1111	4	1,8	7,2
25	~~1111~~	5	11	45,0				
27	11	2	13	22,0				
29	1	1	15	12,0				
31								
71								
73								
75								

Total felling and debranching time: 320,0	Total cross-cutting	181,8
Total fell and debranch.		320,0
Allowances for slope		
Allowed time for 43 trees		501,8
Average time per tree 501,8 ÷ 43		11,7
Number of trees per task 540 ÷ 11,7		46

APPENDIX S. 1

Tender specifications for bow-saw blades: Steel analysis: Item 1

Brand or make	Type of steel	Steel analysis								Price for 3000
		Carbon	Silicon	Manga-nese	Chrome	Nickel	P	S	Ph/s	
		%	%	%	%	%	%	%	%	R
Sandvik	Cold rolled Hardened Tempered	1,0	0,25	0,32	0,26	0,05				1 431
Jack	Tempered	1,0	0,25	0,32	0,26	0,05				891
Spear and Jackson	Tempered	1,0	0,25	0,32	0,26	0,05				1 280
Grorud	Swedish alloy spring steel	1,02	0,20	0,40			0,03	0,02		834
Gustav Doehl.	-	0,75	0,35	0,30					0,03	952
Abaca	Special crucible	0,80	0,25 0,40	0,60 0,75						810
Eia Pinetool	Raker instead of peg tooth									945

APPENDIX S. 2

SPECIFICATIONS

ADJUSTABLE BOW-SAW FRAMES SUITABLE FOR 107 cm BLADES

1. Frame to be manufactured from high tensile seamless oval tubing.

2. Length of each half not less than 82,5 cm, measured as the actual pipe length.

3. When a 107 cm blade is fitted and properly tensioned the back overlap on the bow frame should not be less than 14 cm.

4. When fitted with a 35 mm blade the cutting depth should be less than 28 cm.

5. Each end to be fitted with a link type blade holder, and one end also to be fitted with a tensioning device.

6. The locking device on the bow frame should be of the wedge type, consisting of two conical rings. The outer ring to fit over the inner ring, which should be split. The inner ring should be clamped onto the front half of the bow by the outer ring.

APPENDIX S.3

SOME EXAMPLES OF LOG PREPARATION OPERATIONS USING HAND-SAWS

OUTPUT AND COSTS

COSTS OF CLEARFELLING AND DELIVERY OF SAW TIMBER ON THE ROADSIDE

The following data regarding the output and cost in clearfellings are available from Jessievale plantation:

Period of observation: Financial year 1962/3.
Volume of sawlogs: 24 179 m^3
Species: P. patula, P. taeda, P. pseudostrobus
Nature of terrain: 2 652 m^3 were exploited on slopes of 15-20°; 21 527 m^3 were exploited on slopes of 0-15°.

The average age of the stands was 37 years and all the timber was delivered to the roadside.

Two-man cross-cut and bow-saws were used. Timber was extracted by mules and manual labour.

The work was done as prescribed by the work study section for clearfellings and thinnings, using bow saws and mules.

The following volumes of timber were extracted, according to log classes:

Class a.	518 m^3
" b. 1	1 861 m^3
" b. 2	3 610 m^3
" c. 1	1 899 m^3
" c. 2	7 213 m^3
" d. 1	2 431 m^3
" d. 2	6 647 m^3
	24 179 m^3

COSTS

Felling and log preparation costs

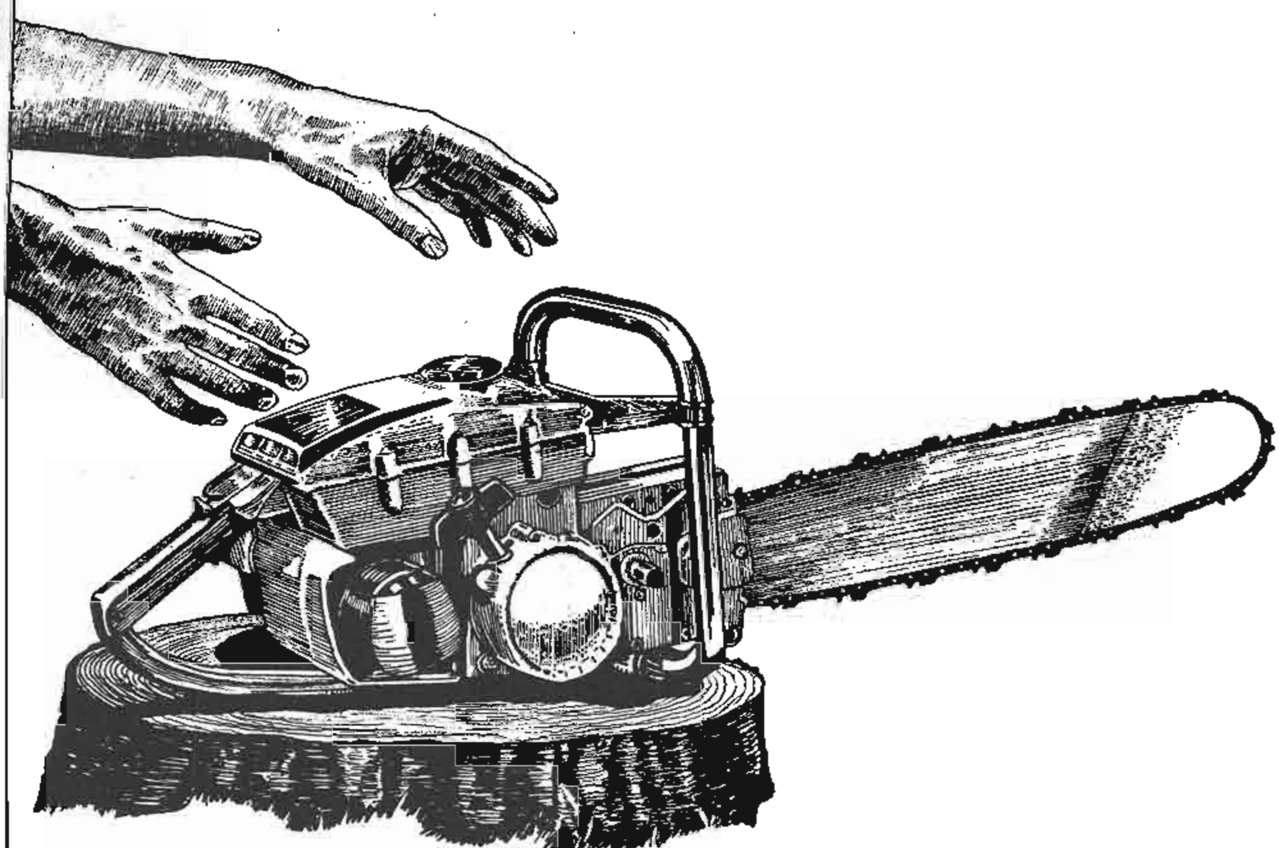
325 foreman units of supervision	R1 264,14
5 880 units of labour	3 560,22
Ration of 5 880 labourers @14c per unit	823,20
Purchase of saws (x)	19,30
Purchase of axes (x)	177,56
Transporting equipment to the field	24,44
Railage charges of saws and axes	7,91
Hire charges, mules (for pulling down hang-ups)	73,64
Total ...	R5 950,41

Note: 24 179 m^3 ÷ 6 205 = 3,9 m^3 per unit or 4,1 m^3 per unit if the foreman is excluded.
(x) Still in use after the period covering the observation

This operation included felling, debranching, cross-cutting, marking, tallying and stacking of branches. Ninety per cent of the stem was debranched to facilitate extraction of the remaining pulpwood.

Costs of clearfelling and preparation: 24,36 c/m^3.

POWER DRIVEN CHAIN SAWS



A. INTRODUCTION

Power chain saws can no longer be considered an innovation in logging. Their performance, disregarding costs, is spectacular, and whether we approve of them or not, they are here to stay. As long as a saw proves to have a small enough mass to handle and tough enough to do the job, it will be in demand by the woodcutters.

There are many makes of power saws on the market, most of which have proved themselves in use, but apart from the mechanical finish of the product, maintenance is the most important single factor involved. Efficient maintenance can only be achieved by a good distribution of agencies for a particular make of saw throughout the country, with a ready stock of spare parts and servicing tools, and the availability of assistance from the distributor's trained mechanics.

After numerous trials, the Forestry Department has finally selected two makes of power saws for use in plantations, the intention being to standardise on these makes for simplification of maintenance and operating technique until such time as a significantly better make becomes available.

B. DESCRIPTION (Fig. P.S. 1)

The power saw is a portable, mechanised tool for cutting wood by means of a driven saw chain. The saw itself is an endless chain held rigidly by a steel guide bar, with the teeth projecting from the outer side. The bar guides the chain by means of a groove along its outer edge, in which lugs (tangs) protruding from the inner side of the chain, run. The chain is driven by means of a sprocket geared to the engine. The saw is used in plantations for felling and cross-cutting trees, and on limited occasions for topping and debranching.

The complete unit consists of a case to which is attached the guide bar, around which the chain rotates. The case houses the engine, gears, starter, clutch and fuel and lubrication tanks. A modern power chain saw should answer to the following requirements:

(a) THE ENGINE

(i) The engine to be not less than 5 kW with a high torque. The machine must be able to work in a humid atmosphere with temperatures up to 38°C and at altitudes up to 1 800m above sea level.

(ii) The engine must be air cooled.

(iii) The engine should be provided with replaceable cylinders or liners.

(iv) The carburettor to be so arranged as to permit the engine to work in any position without changing the blade position in relation to the engine housing.

(v) Exhaust well positioned from the fire hazard point of view, so located as to direct fumes away from the operator's face or the ground, at the same time decreasing the sound of the working engine.

(vi) Oil mixed with the fuel to lubricate all bearings.

(vii) Ignition system to be well protected and able to withstand severe vibration.

(viii) Engine to be started by a recoil-type rope starter.

(ix) Cage-type needle roller bearings on crankshaft are desirable.

(x) Vibration or noise which could affect the operator, to be reduced to a minimum.

(b) CLUTCH

The unit should be fitted with an automatic centrifugal clutch which engages automatically when the engine reaches operating speed.

(c) GEARBOX

If a gear drive is specified, the engine is to be fitted with a reduction gearbox to increase the torque available on the teeth of the chain.

(d) GUIDE BAR

A guide bar and chain are included in the power-saw assembly. (Fig. P.S. 1 and 6).

(i) The function of the bar is to guide and support the chain.

(ii) The length of the bar depends on the purpose for which the saw is intended. Seventy one centimetre bars are usually used for one-man chain-saw operation, being suitable both for felling and cross-cutting plantation-size timber. Direct drive chain-saws with 61 cm long bars can be used for pulp and small-sized timber, while geared saws with 71 cm bars are suitable for felling and cross-cutting large-sized timber.

(iii) The guide bar is manufactured from the best quality steel, and the nose and rails are specially hardened to resist wear.

(iv) The bar should be adjustable to facilitate altering the chain tension as required.

(v) A "roller-nose" saw bar (Fig. P.S. 1) has been introduced which virtually eliminates the replacement of bar noses, and reduces drag of the chain on the bar by over 30%. Friction reduction causes the chain to slip over the bar surface with increased speed.

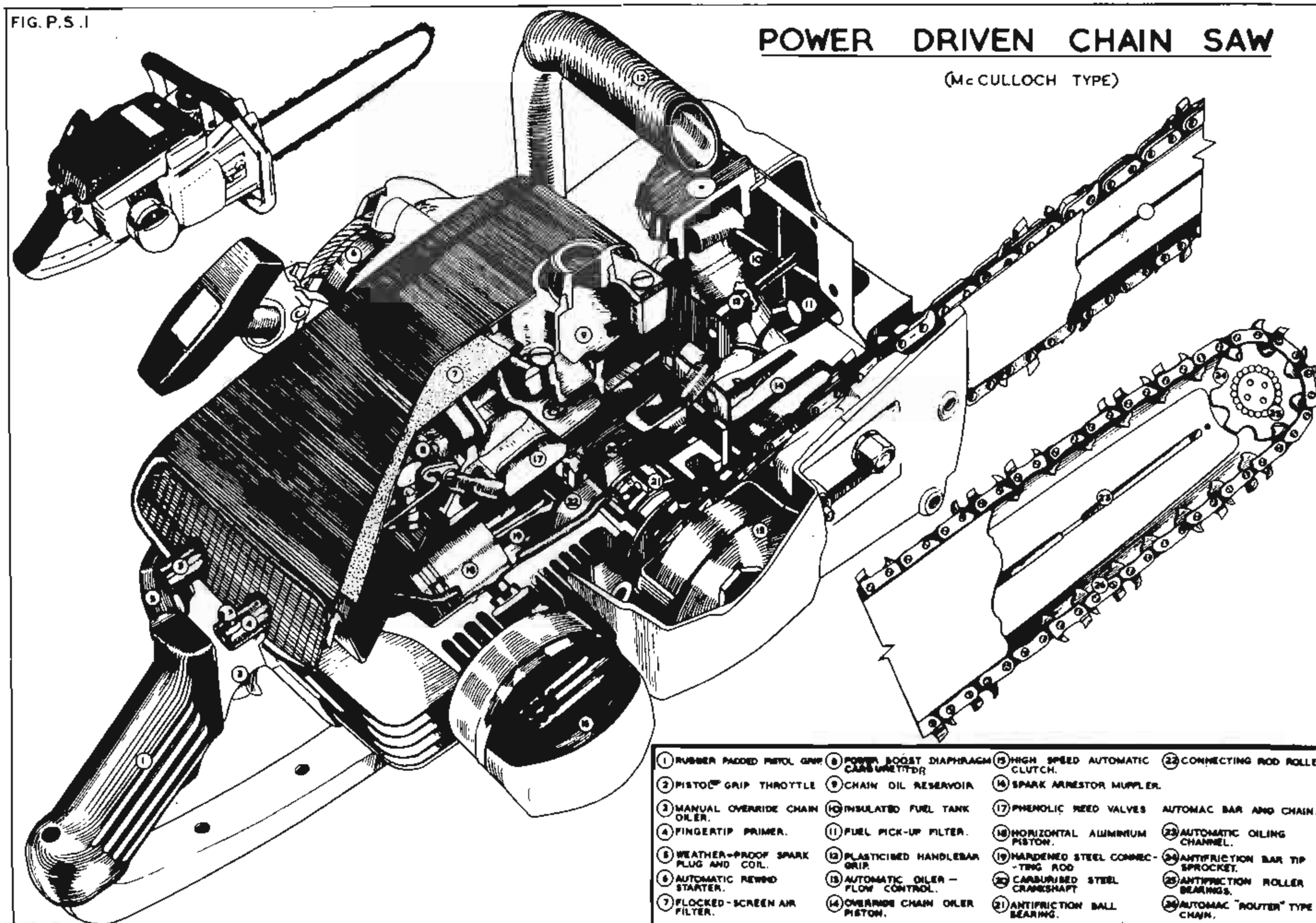
(e) SPROCKETS (Fig. P.S. 7)

(i) The sprocket drives the saw chain, and it is essential that the chain and sprocket be correctly matched. The tip of the sprocket tooth fits into the notch of the cutter and side link.

FIG. P.S. I

POWER DRIVEN CHAIN SAW

(McCULLOCH TYPE)



1. RUBBER PADDED PISTOL GRIP
2. PISTOL GRIP THROTTLE
3. MANUAL OVERRIDE CHAIN OILER.
4. FINGERTIP PRIMER.
5. WEATHER-PROOF SPARK PLUG AND COIL.
6. AUTOMATIC REWIND STARTER.
7. FLOCKED-SCREEN AIR FILTER.
8. POWER BOOST DIAPHRAGM CARBURETTOR
9. CHAIN OIL RESERVOIR
10. INSULATED FUEL TANK
11. FUEL PICK-UP FILTER.
12. PLASTICISED HANDLEBAR GRIP.
13. AUTOMATIC OILER — FLOW CONTROL.
14. OVERRIDE CHAIN OILER PISTON.
15. HIGH SPEED AUTOMATIC CLUTCH.
16. SPARK ARRESTOR MUFFLER.
17. PHENOLIC REED VALVES
18. HORIZONTAL ALUMINIUM PISTON.
19. HARDENED STEEL CONNEC--TING ROD
20. CARBURISED STEEL CRANKSHAFT
21. ANTIFRICTION BALL BEARING.
22. CONNECTING ROD ROLLER

AUTOMAC BAR AND CHAIN.

23. AUTOMATIC OILING CHANNEL.
24. ANTIFRICTION BAR TIP SPROCKET.
25. ANTIFRICTION ROLLER BEARINGS.
26. AUTOMAC "ROUTER" TYPE CHAIN.

PART NAMES FOR SAW CHAIN AND GUIDE BAR.

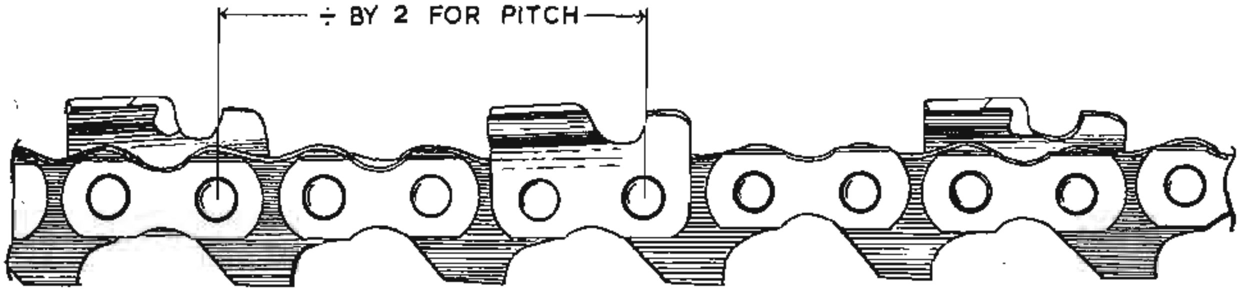


FIG.P.S.2 CHIPPER-TYPE SAW CHAIN.

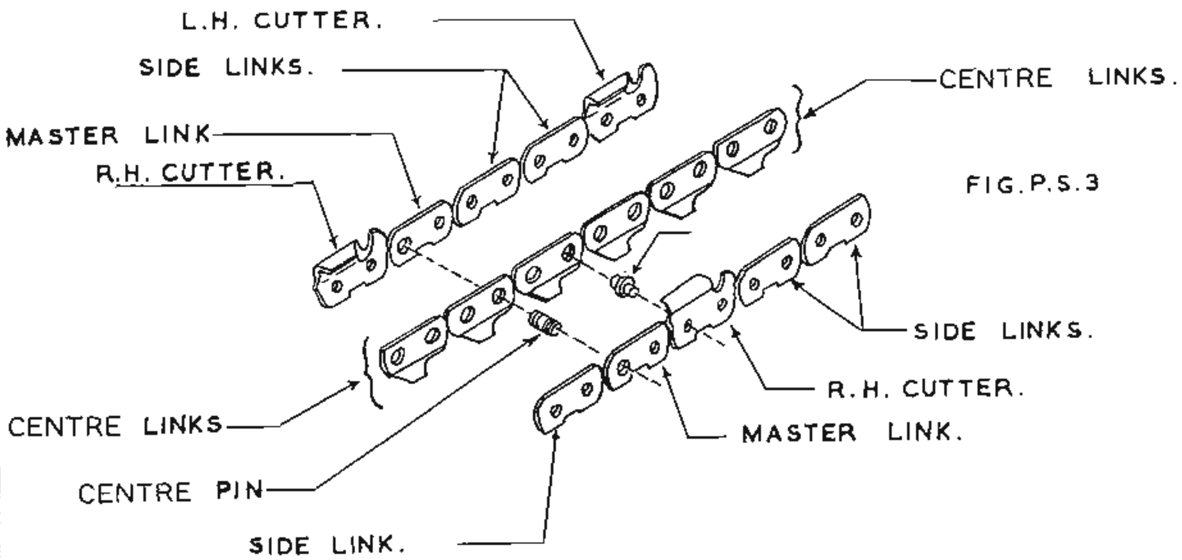


FIG.P.S.3

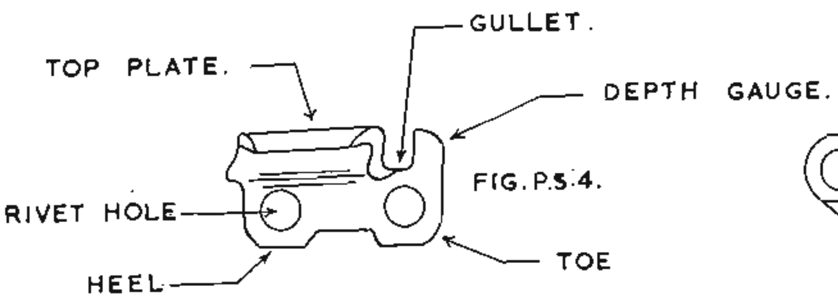
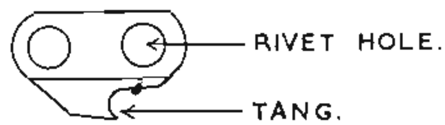


FIG.P.S.4.

FIG.P.S.5



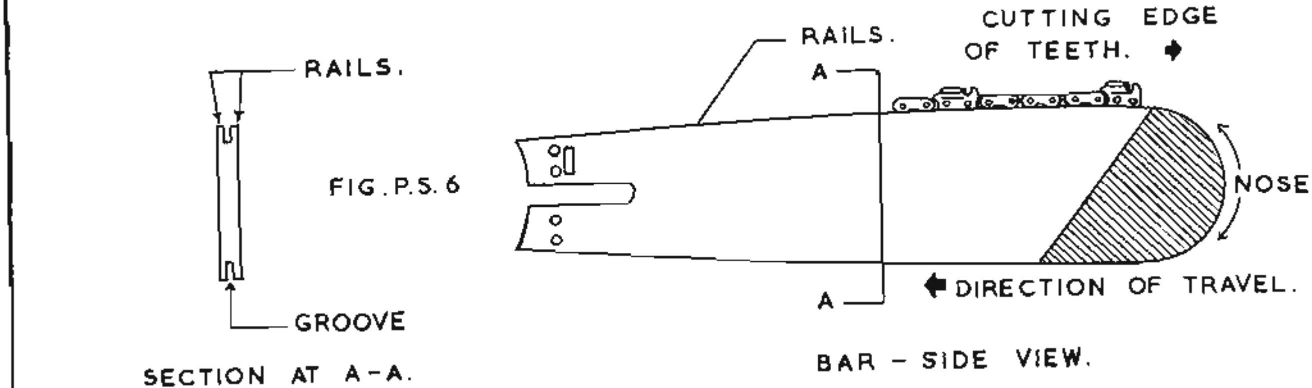


FIG.P.S.6

CHAIN SPROCKET AND BAR ENTRY.

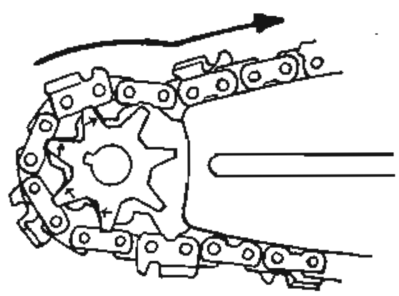


FIG. P.S. 7.

CORRECTLY MATCHED CHAIN, SPROCKET AND BAR COMBINATION.
NOTE POINTS OF DRIVING CONTACT.

FIG. P.S. 8.

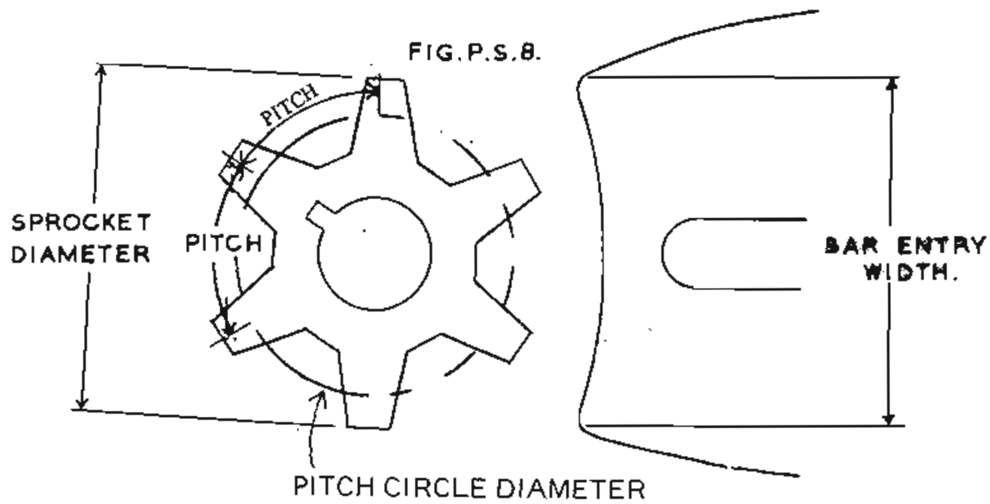
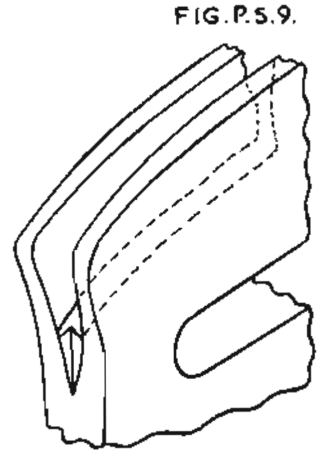


FIG. P.S. 9.



CORRECTLY FUNNELLED CHAIN ENTRY ONTO BAR.

(ii) A pitch of 13 mm is preferred for gear-driven machines and 10,3 mm for direct drive machines. The sprocket pitch is the distance between two adjacent teeth (Fig. P.S. 8), measured along the pitch circle.

(iii) The sprocket must have the correct diameter to suit the saw chain and guide bar. The sprocket diameter is the distance between two opposite teeth (Fig. P.S. 8). As the chain flows off the sprocket it has a tendency to continue moving in a circular path. At this point it must, however, straighten out and flow into the bar rails. For gear-driven saws a sprocket diameter of up to 3 mm less than the bar entry width is permitted. For direct drive saws the sprocket diameter must be slightly larger (up to 19 mm) than the bar entry width (Fig. P.S. 8 and 9).

(f) CHAINS

(i) Departmentally the preferred cutting chain is of the "chipper" design, with specially hardened cutting edges. (Fig. P.S. 2).

(ii) Fig. P.S. 3, 4 and 5 illustrate the various component parts of a saw chain, with a description of the teeth and links. The basis of the chain consists of a series of centre links, to each side of which are rivetted cutters (at alternate intervals) and side (or spacer) links. The advantage of the chipper chain is simplicity in construction, as the number of links is reduced to the necessary minimum, and it is quickly and easily sharpened.

(iii) The centre links (Fig. P.S. 5) serve to keep and guide the chain in the bar groove, while at the same time their "tangs" which travel in the groove, keep the groove clear of sawdust or dirt, and carry oil around the groove.

(iv) The cutter (Fig. P.S. 4) consists of the tooth itself, which actually cuts the wood, and the "depth gauge", which controls the 'bite' which the tooth takes.

(v) The chain pitch should be the same as the sprocket pitch, given in (ii) for sprockets. The chain pitch is the distance between two like rivets on like links, divided by two (Fig. P.S. 2).

(g) LUBRICATION

Chain lubrication is effected either manually or automatically from the tank (mounted on the saw case) and fed to the chain by way of the guide bar. A sight glass is provided on the oil tank.

(h) HANDLES (Fig. P.S. 1)

Handles are usually provided so as to be suitable for two positions of the machine (felling and cross-cutting).

(i) GENERAL

(i) No bolts or screws tapped into aluminium, or other non-ferrous alloy, are permitted anywhere on the saw.

(ii) A tool kit with spares is provided with each saw.

C. DIRECT-DRIVE AND GEARED SAWS

Direct-drive saws are lighter, safer and easier to operate than gear-driven saws, resulting in less operator fatigue and greater cutting efficiency. Direct-drive saws have, however, greater wear and replacement costs due to the high operating speeds. Chains on direct-drive saws require more accurate sharpening and maintenance and better trained operators than do the chains of geared saws.

Geared saws are preferred by the Department for cutting large trees, while direct-drive saws appear better for smaller-sized timber. Skilled operators can use direct-drive saws for both small and large trees, however.

D. INSTALLING A NEW CHAIN

Correct installation prolongs the useful life of the chain, and the following procedure should be followed:

(1) Soak the chain thoroughly in clean, SAE 30 oil for at least 5 minutes.

(2) The oil tank of the saw must be full and the oil pump in working condition.

(3) Make sure that the bar is straight with no cracks; that the bar groove is deep enough and clean, and that the bar rails are not pinched, spread or uneven.

(4) The sprocket must be of the correct size and design to fit the chain and in a good condition. It is advisable to fit a new sprocket with a new chain and a new sprocket should not be used with an old chain.

(5) Installation of the chain on the bar must be done strictly according to the manufacturer's instructions.

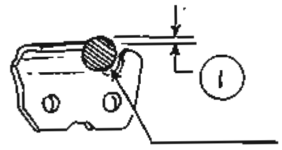
(6) Give the chain a moderate tension. Ideally there should be a distance of 9 - 12 mm from the bottom of the side links or cutter to the rail at the middle of the bottom half of the blade, for short bars. For long bars this distance can be from 12 - 19 mm. A practical rule is "loose enough to be pulled round by hand ...... tight enough to keep from jumping off the bar."

(7) Pull the chain round by hand, oiling with the oil pump.

(8) A new chain must be "broken in" before being put on the job. Run the saw at 1/3 throttle for two or three minutes oiling frequently. After a short stop, it should be run for a further 3 minutes at half throttle, the oil being pumped every 20 seconds or so.

(9) Stop the motor and re-tension the saw chain to the correct tightness. The chain wears and stretches in use and the greatest wear occurs during the first half hour of the operation, so frequent checking is required.

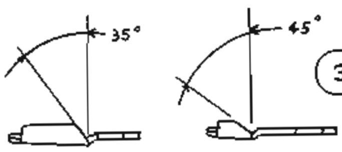
FIG. P.S. 10. CHAIN SHARPENING PROCEDURE.



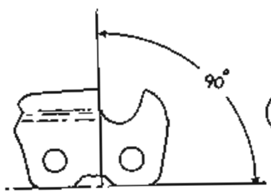
(1) 1/5 TO 1/10 OF FILE DIAMETER ABOVE TOP OF TOOTH

MEANS CORRECT TOP CUTTING EDGE.

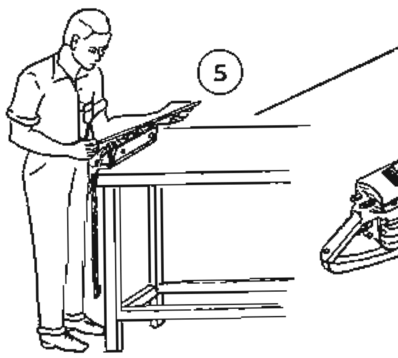
(2) HOLD FILE LEVEL WITH TOP PLATE.



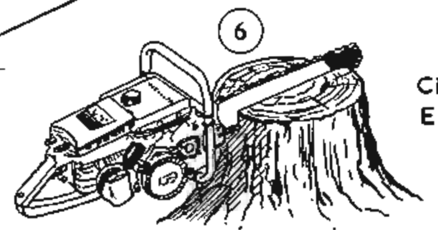
(3) TOP FILING ANGLE TO BE 35°.
IF CHAIN BINDS AFTER BEING FILED, INCREASE ANGLE TO ABOUT 45°, ABOUT HALFWAY BACK.



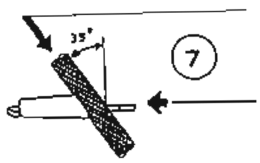
(4) CORRECT VERTICAL CUTTING EDGE.



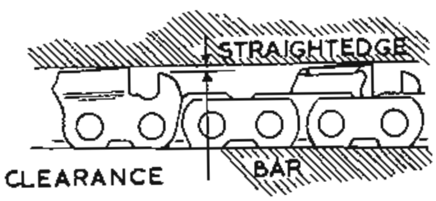
(5) FILING SAW CHAIN IN A VICE.



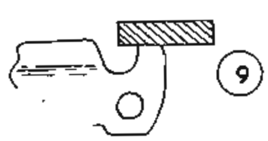
(6) CHAIN CUT INTO STUMP FOR EMERGENCY FILING IN THE WOODS.



(7) PUSH IN THIS DIRECTION.
CORRECT FILING STROKE.
PRESS IN THIS DIRECTION.



(8) USE STRAIGHTEDGE TO DETERMINE DEPTH-GAUGE SETTING.



(9) USE A FLAT FILE TO LOWER DEPTH GAUGES.

(10) ROUND OFF THE ANGLE.

SPECIAL DEVICES FOR USE WITH POWER CHAIN SAWS.

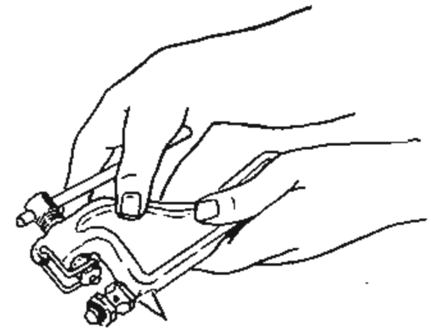
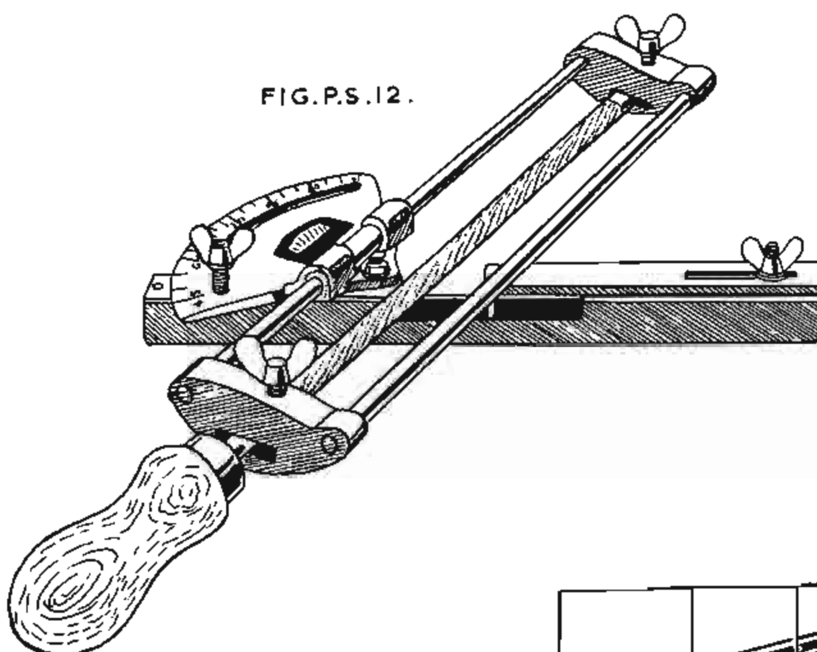


FIG. P.S. 11.

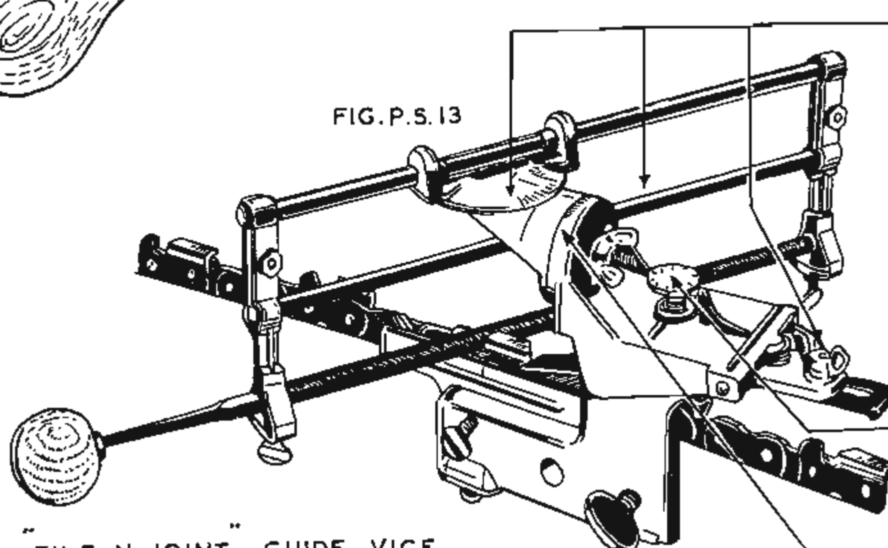
CHAIN BREAKER AND SPINNER FOR USE IN THE FIELD.

FIG. P.S. 12.



FILING DEVICE FOR SHARPENING ON THE JOB WITHOUT REMOVING THE CHAIN FROM THE BAR.

FIG. P.S. 13



"FILE-N-JOINT" GUIDE VICE FOR CHAIN SHARPENING.

(10) Make 5 or 6 light cuts in a log, oiling the chain between each cut and in the middle of the cut. Gradually increase the depth of the cut until the log is cut through. After about 10 minutes or so of this procedure the chain will be ready for service. Avoid accelerating to full speed.

E. CHAIN SHARPENING (Fig. P.S. 10)

(a) GENERAL

The "chipper chain" is simply constructed and is quick and easy to sharpen.

The saw chain must be correctly filed to do the sawing quickly and accurately. Blunt chain operation causes vibration and operator fatigue, as well as damage to the clutch drum, bearings, clutch shoes, bars and sprockets.

(1) Use the correct file of the right diameter according to the manufacturer's instructions. When filing, the file must be held at the correct angle to suit the bevel of the cutting link. One fifth to $1/10$ of the file diameter should extend above the top of the tooth (item 1), to give the correct hook.

(2) Hold the file level with the top cutting plate (item 2).

(3) The bevel angle of the cutting edge should be 35° for most types of cutting (item 3). If this proves unsatisfactory for certain cases and the chain begins to bind, this angle may be increased to 45°.

(4) The vertical cutting edge (item 4) should be 90° when all the rules set out above are observed.

(5) If possible the chain should only be sharpened when securely held in a vice (item 5), the latter being fastened to a work bench and set at waist height. If sharpening has to be done in the woods, the chain saw has to be cut into a stump (item 6) for about half the depth of the bar and the chain tightened to keep the cutter from swaying.

Note: Sharpening the chain on the bar, with the bar cut into a stump is not recommended, except in emergencies, as steel filings penetrate between the links of the chain and into the bar groove, causing rapid wear.

(6) A special chain-saw file, together with a holder guide, is used for sharpening the saw. Numerous makes of filing devices are available, two of which are shown in Fig. P.S. 12 and 13. The filing devices facilitate the correct positioning of the file in relation to the tooth being filed.

Apart from major sharpening, the teeth should be touched up after every few hours of sawing. The period between sharpenings will depend on the hardness of the wood being cut.

(b) PROCEDURE

(1) Use the correct file and hold it in the correct manner as set out above.

(2) Hold the file against the cutting face of the tooth, do not press down towards the gullet of the tooth (item 7).

(3) File slowly, applying pressure against the cutting edge of the tooth.

(4) Do not touch the cutting edge of the tooth on your return stroke or you will dull it.

(5) Repeat the forward stroke until the tooth is sharp.

(6) Compare the shape of a new cutter and correct the shape of the sharpened tooth if necessary. Make sure that there is a 90° cutting edge.

(7) File all the teeth on one side of the chain first.

(8) When finished, compare all the teeth you have filed to see that they are all of the same length.

(9) If filed with rapid strokes the teeth will have hard, brittle edges and dull the file. If you drag the file across the cutting edge on the return stroke you will dull the fine edge you have just made. If the file is not held horizontal, the bevel will be incorrect.

Rotate your file to make it last longer.

(c) DEPTH GAUGES

Depth-gauge setting is the distance between the top of the tooth and the top of the depth gauge. For all general work with the average power chain saw, a clearance of from 0,6 - 0,9mm is correct (item 8). Lower powered or direct-drive saws need less clearance, while higher powered or geared saws can do with greater clearance. Hardwoods require less clearance than do softwoods. Clearance can be measured with a straightedge or ruler and a set of feeler gauges (item 8, Fig. P.S. 10).

(d) SETTING DEPTH GAUGES

The correct height difference between the top of the cutter tooth and the top of the depth gauge must be maintained. This is done by filing the depth gauge with a flat file (item 9). Round off the angle with a flat file (item 10).

(e) CORRECTING A HOOK

The chain will cut roughly and dull quickly if the hook of the tooth is incorrectly filed. The hook can be corrected by either filing with the file handle held down slightly, or by using the next larger size file in place of the correct one.

Check the filing to make sure that a correct vertical cutting edge is obtained.

(f) AFTER SHARPENING

Clean the chain after filing with a solvent of paraffin to remove all filings, and soak in oil after cleaning to prevent rust forming and damaging the chain.

FIG.P.S.14. REPLACING DAMAGED CUTTERS.

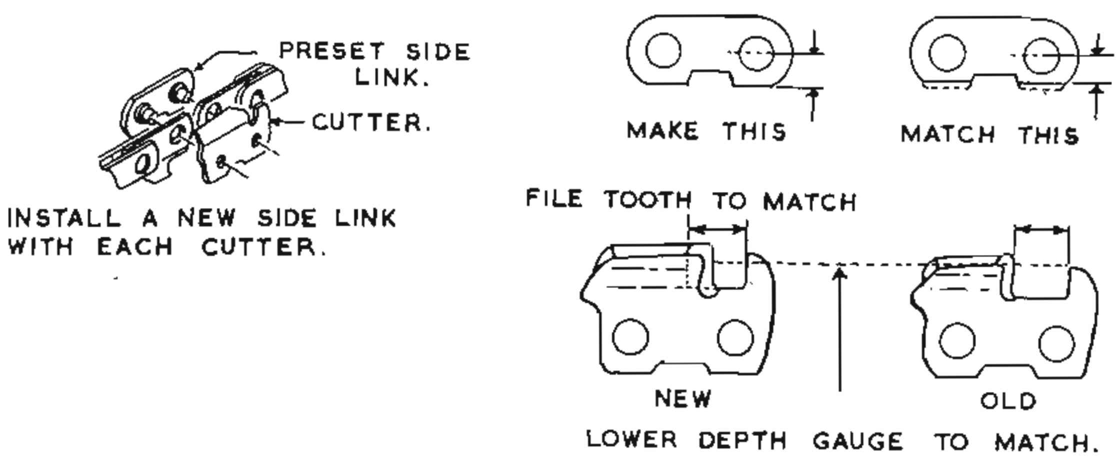


FIG.P.S.15. REPLACING DAMAGED SIDE LINKS.

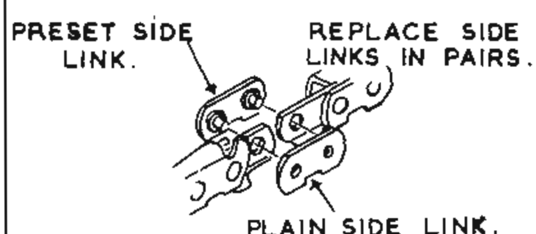


FIG.P.S.16. REPLACING DAMAGED CENTRE LINKS.

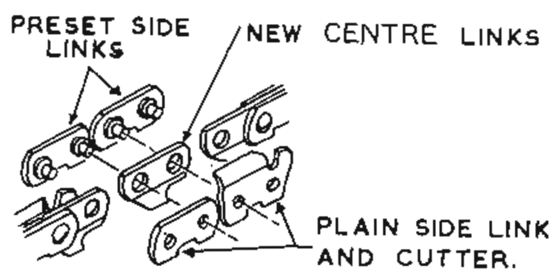


FIG.P.S.17. REPAIRING DAMAGED CENTRE LINKS.

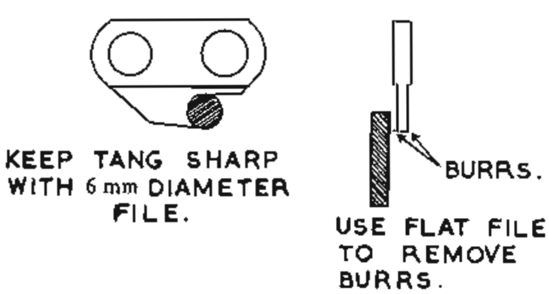


FIG.P.S.18. REPLACING DAMAGED MASTER LINK.

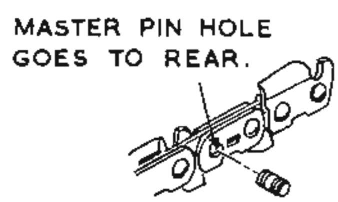


FIG.P.S.19. DAMAGE FROM ABRASION.

F. REPAIR OF THE CHAIN

A well-repaired chain is as strong as a new chain if the correct repairing procedure is followed. Rivets may be removed with a chain breaker (Fig. P.S. 11) or filed off with a flat file. If the rivets are filed off, the side and cutter links can easily be pried away from the centre links. The chain breaker usually punches the rivets through the side and centre links.

(a) REPLACING DAMAGED CUTTERS (Fig. P.S. 14)

(1) Remove the rivets and old cutter with its link. If a new cutter is installed, a new link with rivets is fitted.

(2) The bottoms of the cutter and side link are filed in order to correspond with the rest of the chain, if the latter is much used.

(3) If the preset side links are not used, care should be taken that the stamped sides of the new links face towards the outside of the chain, otherwise the joint will be too tight. The rivet spinner is used to form the rivet heads. When a new cutter has been installed in the chain, the tooth must be filed back to match the old teeth and the depth gauge lowered to the proper height.

(b) REPLACING DAMAGED SIDE LINKS (Fig. P.S. 15)

(1) Remove the rivets and side link.

(2) Rejoin the chain, using a preset and plain side link.

(3) The stamped side of the plain link (if used) must face towards the outside of the chain.

(4) Spin or lightly peen the rivets to form heads.

(c) REPLACING DAMAGED CENTRE LINKS (Fig. P.S. 16)

(1) Remove all four of the links attached to the damaged centre link.

(2) Install new centre link with preset side links and a plain side link and cutter.

(3) Hold the chain tightly together and spin or lightly peen the rivets to form heads.

(d) REPAIRING DAMAGED CENTRE LINKS (Fig. P.S. 17)

(1) Centre link tangs can be damaged by the bar and sprocket, and the first essential is to correct the cause of the damage.

(2) The tang must be kept sharp in order to keep the groove clean. A 6 mm diameter file is used for this purpose.

(3) The sides of the tang must be smoothed with a flat file to remove burrs.

(e) REPLACING DAMAGED MASTER LINK (Fig. P.S. 18)

These links are replaced in pairs. The larger of the two holes, the master pin hole, must face towards the rear of the chain to prevent damage to this hole by the sprocket teeth.

(f) DAMAGE FROM ABRASION (Fig. P.S. 19)

Cutting in sandy areas may cause wear or damage to the chain. In this case the teeth have to be filed back until the damaged part has been removed. All the teeth must be filed to the same length and the depth gauges properly lowered.

G. SAW MAINTENANCE

Eighty per cent of saw trouble can be traced to incorrect sharpening and insufficient maintenance, consequently correct saw-chain maintenance can be a major factor in reducing logging costs. The last half of the saw-chain cutter is the best half, and correct maintenance preserves the chain to utilise this cutting edge. Efficient maintenance reduces the replacement costs of motors, bars and sprockets to the minimum, and also reduces operator fatigue, while increasing the output.

Improved saw-chain maintenance practices have the following direct results:

(i) Wear and tear is reduced.
(ii) Sprockets last longer.
(iii) The life of the saw bar is extended.
(iv) More wood is cut with less fuel mixture.
(v) Chain problems are reduced.

Present day saws with their high running speeds of up to 69 km/hr. (1 160 m/minute or 19m/second) must be run tighter and checked more frequently than was previously necessary.

The time factor greatly hinders effective saw maintenance, but by reducing chatter and vibration to the minimum operator fatigue is also reduced, safety increased, and output and efficiency notably improved.

(a) GENERAL PREVENTIVE MAINTENANCE OF SAWS

(1) Follow the instruction manual for the operation and maintenance of the saw.

(2) Clean and inspect the saw regularly, paying particular attention to all controls.

(3) Be sure the air cleaner is clean at all times.

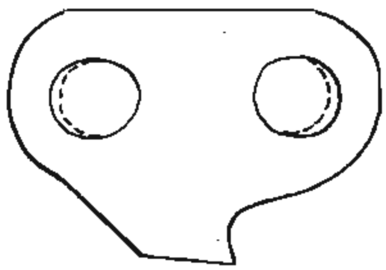
(4) Use the correct oil, ensure that the tank is clean and filled to the correct level.

(5) Keep the engine cooling system clean.

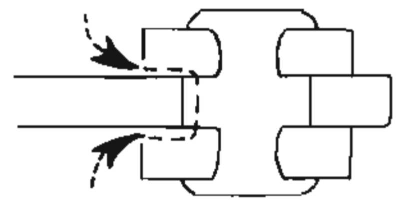
(6) Be sure that the exhaust muffler is in good condition and the exhaust ports are clean.

(7) Sharpen the chain to the manufacturer's specifications. Lubricate the chain well.

FIG.PS.20 LUBRICATION.

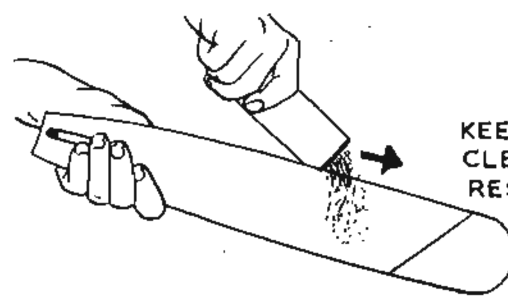


RIVET HOLE WEAR AS A RESULT OF INADEQUATE LUBRICATION.



DOTTED LINE INDICATES PATH THAT OIL MUST FOLLOW TO ENTER AND LUBRICATE THE CHAIN RIVET BEARINGS.

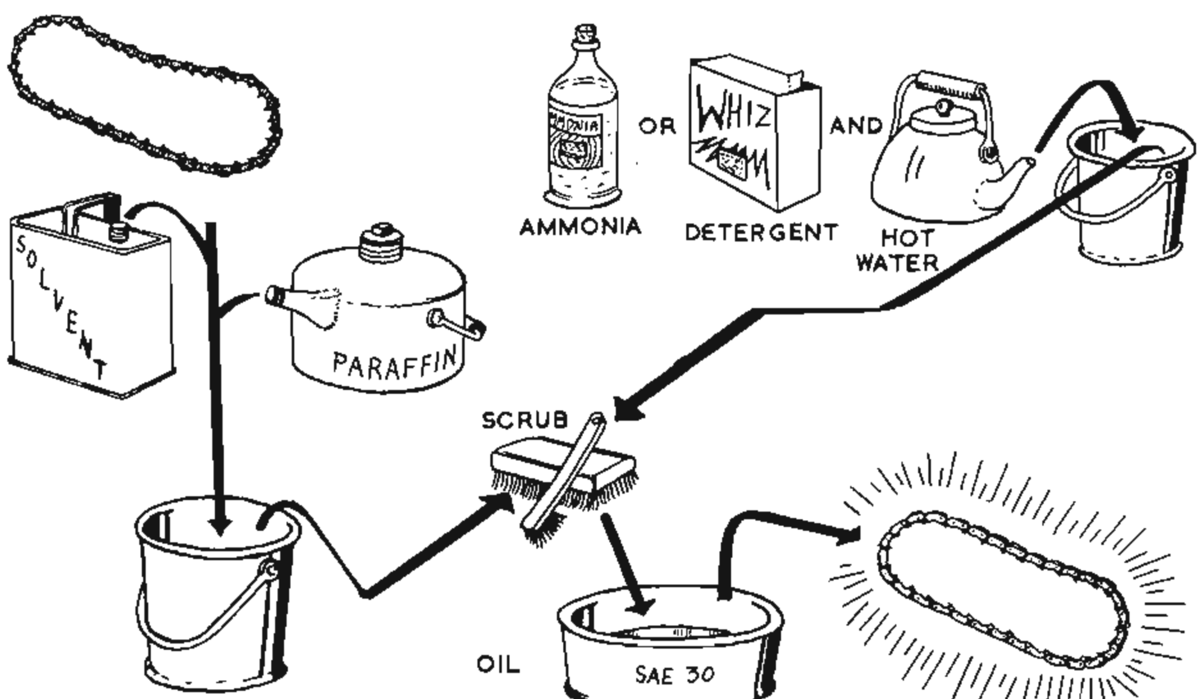
FIG.P.S.21.



KEEP THE BAR GROOVE CLEAN AND FREE OF RESIN AND SAWDUST.

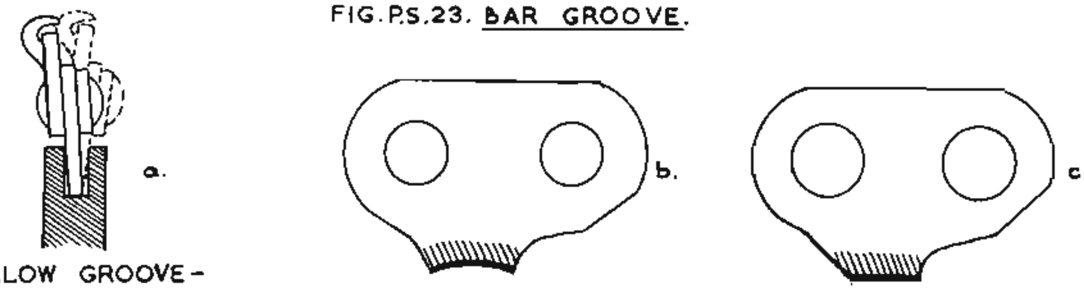
FIG.P.S.22.

TO CLEAN DIRTY CHAIN AND TO SOFTEN PITCH ON CHAIN



GUIDE BAR RAILS AND GROOVE

FIG. P.S.23. BAR GROOVE.

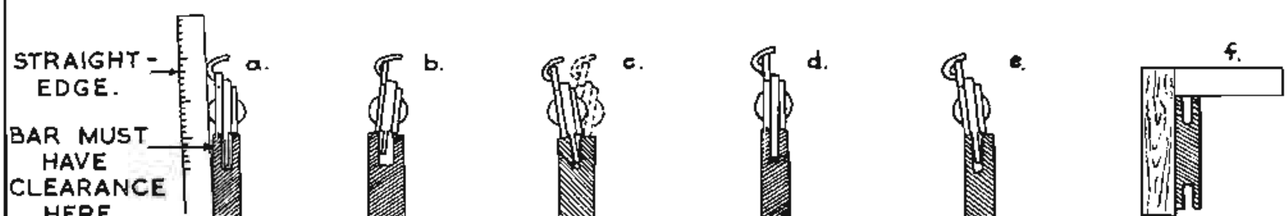


SHALLOW GROOVE - CHAIN WOBBLES AND CHATTERS.

SHALLOW BAR GROOVE AT TIP.

SHALLOW BAR GROOVE ALONG FLAT OF BAR.

FIG. P.S.24. BAR RAILS.



TESTING RAIL WIDTH.

UNEVEN RAILS

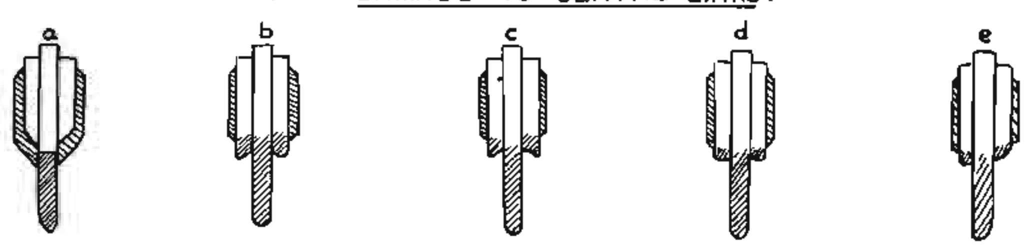
SPREAD RAILS

PINCHED RAILS

ONE RAIL NARROWER THAN OTHER.

CHECKING LEVEL OF RAILS.

FIG. P.S.25 DAMAGE TO CENTRE LINKS.



RAILS SPREAD.

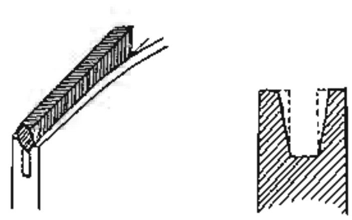
RAILS NOT FLAT AND TRUE.

RAILS NOT FLAT AND TRUE.

RAILS TOO THICK.

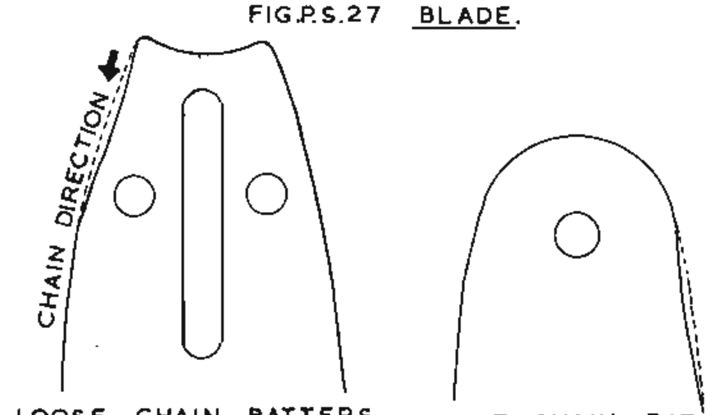
THIN, SOFT OR WORN RAIL ON ONE SIDE.

FIG. P.S.26. BAR ENTRY.



FILING FUNNELLED BAR ENTRY.

FIG. P.S.27 BLADE.



LOOSE CHAIN BATTERS BAR RAILS ON ENTRY.

LOOSE CHAIN BATTERS BAR RAILS BEHIND HARD TIPPING OF NOSE.

(8) Ensure that the petrol/oil is well mixed and that storage containers do not contain water which has condensed in the container.

(b) STRETCH

During sawing, friction causes wear and chain stretch. Stretch is a result of wear in the rivet holes and link rivets while the chain travels around the bar (Fig. P.S. 20). As there is a number of rivets and holes, even a small amount of wear in each can produce a substantial chain stretch with the result that the chain becomes "out of pitch" with the sprocket. This causes the chain to jerk and pound while moving around the bar. Preventive maintenance in this case consists of proper oiling and tensioning of the cutter chain.

(c) LUBRICATION (Fig. P.S. 20)

The correct oil for lubricating the chain is also important. The objectives of efficient lubrication are:

(i) To preserve the initial strength of the chain.
(ii) To prevent chain stretch.
(iii) To reduce wear and tear.

By applying oil the chain rivets and rails of the bars are lubricated. Frequent oiling may ensure adequate lubrication of the bar rails, but this does not necessarily mean that the chain rivets have sufficient protection.

(1) A large percentage of the oil is thrown off the end of the bar at high speeds.

(2) Sawdust accumulation in and around the bar may absorb much of the oil.

(3) The oil may be too heavy to flow into the chain parts, or too light to stick to the bearings.

Use SAE 30 oil for really hot weather.
Use SAE 20 oil for moderate temperatures.
Use SAE 10 oil for cold weather.

(d) EFFICIENT OILING METHODS

(1) Pump the chain oiler often while running at low speeds.

(2) Oil once per hour while pulling the chain through by hand.

(3) Keep sawdust from accumulating in the bar groove.

(4) Soak the chain in oil overnight.

Note: Running the chain at high speeds while pumping the oiler is both ineffective and wasteful

When sawing timber full of resin a solution of 50% oil and 50% paraffin should be used, and the oiler pumped twice as often as usual.

The cutting of wood full of sand is to be avoided, but if one is compelled to do so, the oil must be pumped onto the chain every two or three seconds, but even this will not entirely prevent the chain from wearing.

When sawing trees with heavy, tough bark, especially if the bark is full of sand, it is advisable to remove a strip of bark around the portion to be sawn. This can be done by axe.

(e) DIRTY CHAIN (Fig. P.S. 22)

A dirty chain wears faster and requires more power than a clean chain. A fibre brush, soaked in paraffin solvent, can be used to brush the chain and keep it clean. If the chain is covered with resin or pitch, it should be soaked in a solution of hot water and detergent or ammonia until the resin is softened and can be removed with the fibre brush. After cleaning, the chain should be soaked in oil to prevent rust and to lubricate it thoroughly.

(f) GUIDE BAR

Normal bar wear occurs along the nose and rails (Fig. P.S. 23 and 27). Such bars need to be re-tipped, re-grooved, and have their rails re-jointed. Re-tipping involves the application of hard surfacing material by welding and must be done by an expert. Bar wear conditions can be detected either by inspection of the bar or through analysis of the wear pattern of the chain. Fig. P.S. 25 shows the wear pattern of centre links, which can be used to determine the causes of wear.

Abnormal bar wear is due to poor maintenance or operating conditions of the saw chain. Regular inspection and maintenance of the chain will extend the life of the bar.

Application of the following suggestions will prolong the life of both bar and chain:

(1) Oil the chain frequently while cutting.

(2) File according to the manufacturer's specifications, removing as little metal as possible.

(3) Touch up the cutters often to keep them sharp.

(4) Tension the chain correctly and check it frequently.

(5) Turn the bar over after about every 40 hours of operation.

(6) Correct the bar entry periodically by funnelling it with a double bevel file in order to facilitate a smooth chain entry onto the bar (Fig. P.S. 26).

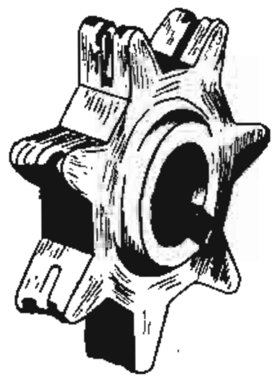
(7) Check the level of the bar rails with a carpenter's square. (Fig. P.S. 24f)

(8) By pulling a spare centre link around the bar one can determine whether the rails are correct or pinched. If there is no friction between the tang and the rails then the groove is usually wide enough.

(9) Spread bar rails can be checked by holding a straightedge across the bar and cutter, as illustrated in Fig. P.S. 24a. If there is no clearance between the straightedge and the bar, the bar rails are flared, or too wide apart. Normal clearance should be between 1,5 mm and 3 mm.

SPROCKETS.

FIG. P.S. 28.



GROOVED SPROCKET TEETH.

FIG. P.S. 29

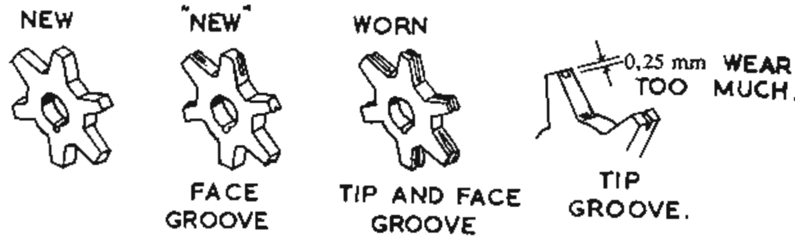
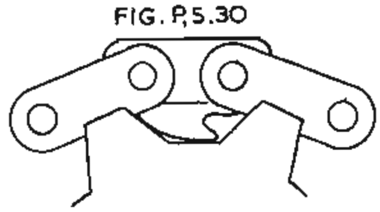
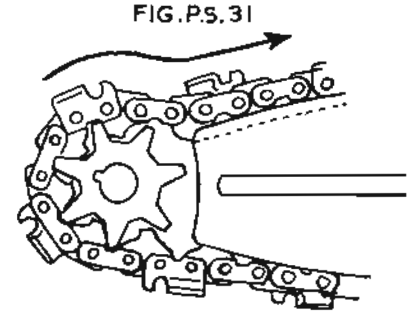


FIG. P.S. 30



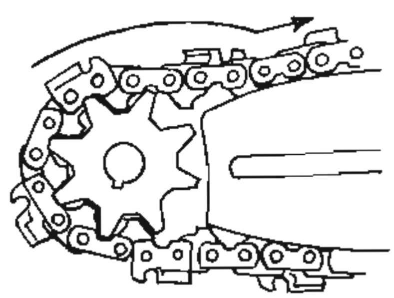
UNDERSIZED SPROCKET BENDS UP TANGS.

FIG. P.S. 31



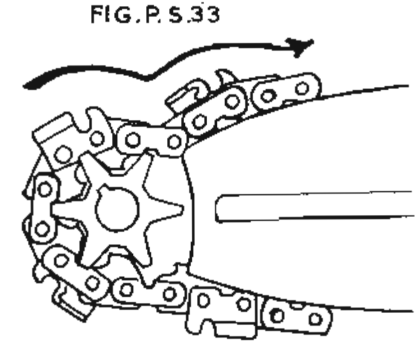
CHAIN FLOW PATTERN OF A CORRECTLY MATCHED CHAIN, BAR AND SPROCKET COMBINATION.

FIG. P.S. 32



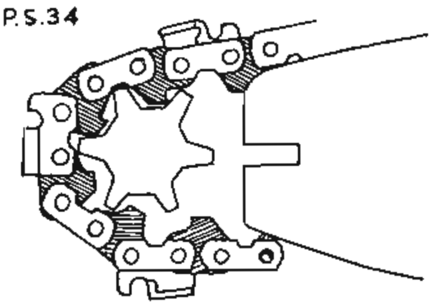
SPROCKET DIAMETER WIDER THAN BAR ENTRY.

FIG. P.S. 33



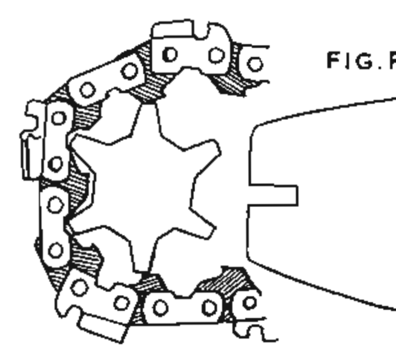
SPROCKET DIAMETER NARROWER THAN BAR ENTRY.

FIG. P.S. 34



DRIVING CONDITION WHEN SPROCKET PITCH IS TOO SMALL FOR CHAIN PITCH.

FIG. P.S. 35



DRIVING CONDITION WHEN SPROCKET PITCH IS TOO LARGE FOR CHAIN PITCH.

(10) Check the depth of the bar groove periodically. When mated with a new bar, the drive links of the saw chain clear the bottom of the groove by about 1,5 mm.

(11) Keep the blade and groove clean (Fig. P.S. 21).

(12) Avoid undercutting or boring with the chain, unless necessary.

(13) For roller nose bars, grease the roller hourly if possible.

(g) SPROCKETS

With a well-maintained saw the chain will retain its match with the sprocket until the cutters are entirely used up.

After the chain and sprocket have been used for some time, they will begin to show wear (Fig. P.S. 28); the chain pitch increases while the sprocket pitch decreases. The tips of worn sprocket teeth begin to show a groove (Fig. P.S. 29), which reduces the height of the tooth. Tooth height is measured from the bottom of the groove.

For correct preventive maintenance of sprockets the operator is recommended to:

(1) Adjust the chain tension frequently to keep it correct. Poor chain tension ruins sprockets.

(2) Install a new sprocket with a new chain. Do not run a new chain on a worn sprocket.

(3) Use a matched bar, chain and sprocket combination.

(h) SAW CHAIN TENSION

Correct tensioning practices will do much to prolong the life of the bar, chain and sprocket.

Recommended procedure for tensioning:

(1) Check and adjust the tension only when the bar and chain are cold. In operation the chain will heat, causing it to grow longer and looser.

(2) Loosen the bar adjusting nuts, holding the tip of the bar up.

(3) Adjust the tightener until the chain is fully tight. Back off the tightener screw 1/8 of a turn.

(4) Tighten the bar-adjusting nuts, squirt chain oiler three times.

(5) The operator should be able to pull the chain through by hand.

H. CAUSES OF WEAR AND DAMAGE

(a) BAR GROOVE

(1) Groove not deep enough (Fig P.S. 23)

The centre link tangs will ride on the bottom of the groove and the side links and cutters will not be properly supported on the bar rails. This will make the chain wobble and chatter.

(2) Groove is too deep (Points worn off tangs)

The tangs won't be able to keep the bar groove clean and the groove will fill up with a mixture of sawdust, resin and oil. This mixture will force the tangs away from the bottom of the groove, causing the chain to wobble and begin to tighten up. Its tension will have to be adjusted frequently.

(b) BAR RAILS

(1) Rails uneven (Fig. P.S. 24b)

Uneven rails will cause one side of the chain to ride higher than the other, causing the chain to lean over and bind in the cut. The rails will wear the centre link tang.

(2) Rails are spread (Fig. P.S. 24c)

Spread rails cause the chain to wobble from side to side and wear away the bottoms of the cutters and side links (Fig. P.S. 25a). The chain tension will slacken and need frequent adjusting.

(3) Pinched rails (Fig. P.S. 24d)

Pinched rails rub the sides of the centre link tangs, reducing the cutting power as the sides of the tangs wear away with the friction and finally break off.

(4) Rails not of the same thickness (Fig. P.S. 24e)

If one rail is narrower than the other a shelf will be worn into the bottoms of the side links and cutters and the chain will begin to lean to this side and bind in the cut.

(5) Rails on the bar nose damaged

Under use the rails on the bar nose wear down and the groove becomes shallow, causing the chain to be supported on the centre link tangs (Fig. P.S. 23b). The chain cuts roughly and heavy strain is placed on the drive links. Breakages generally occur. This condition will also cause the bar rails to spread, which will result in rough, uneven and "out of square" log ends.

(c) BAR ENTRY (Fig. P.S. 26)

The bar entry must be funnel shaped, or else the chain coming off the sprocket will strike the bar rails with the side links or cutters, breaking off their corners and ultimately causing the chain to break. If the tangs strike the bottom of the groove, their points will be broken off or blunted and the groove will fill up with resin, sawdust and oil.

(d) SPROCKETS

(1) The chain and sprockets wear, causing the chain to become over pitched, and the sprocket underpitched. The chain starts to chatter, reducing the cutting effect and requiring more power from the engine, which causes vibration.

(2) The sprocket is worn and grooves appear in the tips of the sprocket teeth. (Fig. P.S. 28). If grooves exceed 0,25 mm in depth, the sprocket and chain should be replaced (Fig. P.S. 29). A groove on the face of the sprocket is less important as it does not affect the pitch of the sprocket.

(3) A face groove can burr the back edges of the centre link tangs and gouge some of the metal away, which can eventually lead to breakage.

(4) A poorly mated sprocket (Fig. P.S. 34, 35) causes breakages in the chain. Worn sprockets are detected by observing the wear pattern developed in the drive links, or the extremely battered condition of the cutter and side link notches.

(5) An undersized sprocket (Fig. P.S. 30) with a pitch less than the chain pitch, will bend up the points of the centre link tangs because the tangs will bottom on the sprocket between the teeth.

(6) When the sprocket diameter is wider than the bar entry the chain will climb onto the guide-bar too high up on the guide rails where there is no funnel to guide the tangs into the bar groove (Fig. P.S. 32). The chain is inclined to jump off the bar, or "dive" into the bar, causing joints to tighten due to peening of the bottoms of the cutters and side links.

(7) When the sprocket diameter is smaller than the bar entry width (Fig. P.S. 33) the chain dips too much and must climb over the rear corners of the bar rail, damaging the rail and the front corners of the side links, cutters and tangs.

(8) Damage is similar to that caused when the bar is not of the correct size, and the right sprocket must be purchased to suit both the chain and the bar.

(e) TENSIONING

Poor tensioning causes:

(i) Rapid wear in the sprockets.
(ii) Excessive peening and bottom wear on cutters and side links.
(iii) Rough operation of the chain.
(iv) Loose chain peens the bar entry and rails.

If a chain is poorly tensioned and has dull cutters and low depth gauges, the cutters will only take small chips and there is excessive wear on the cutter heels. The cutting action is rough and there is extreme vibration, causing the cutters to dull even more.

If the chain is poorly tensioned with a high depth-gauge setting, the cutters move forward with little or no chips at all. There is rapid wear on the toe of the cutters and on the bar rails, as the chain snakes over the groove. This action spreads the bar rails.

I. HANDY TOOLS FOR USE WITH THE CHAIN SAW

(a) CHAIN BREAKER AND SPINNER (Fig. P.S. 11)

This tool is used for chain repair in the field. It is small, and easy to carry. The instrument punches out old rivets and spins or peens new rivet heads.

(b) THE FILE GUIDE (Fig. P.S. 12 and 13)

The file guide is used to file teeth with the correct angle and setting and correct depth-gauge height. It also indicates if the bar is deep enough for the saw chain.

(c) THE Mc CULLOCH DEPTH-GAUGE TOOL

This tool is used for setting the depth-gauge heights evenly throughout the entire chain, and also for checking the height of the cutter teeth and the correctness of the top filing angle.

J. ATTACHMENTS FOR POWER SAWS

(a) PLUNGE-CUT BOW SAW

Instead of the regular guide bar, this saw has a bow-type of blade. The plunge-cut bow is designed for pinchless cutting of small timber and may profitably be used for cross-cutting logs up to 25cm.

(b) CLEARING ATTACHMENT

This attachment is similar to the regular saw with the guide bar, except that the regular bar is replaced with a much longer frame-type of bar. It is primarily designed for cutting small timber which normally requires much stooping or squatting. The long blade permits the operator to do most jobs in a standing position. The attachment has been found unsuitable for debranching purposes as the axe is more convenient and cheaper.

(c) BUSHCUTTER ATTACHMENT

With this saw the regular blade is replaced by a 1,5m long arm, to the end of which is fitted a circular saw. The attachment is designed for clearing saplings and brush, making it easy for the operator to get under overhanging branches. A special harness, worn by the operator, evenly distributes the mass of the unit on both shoulders. In tests conducted by the Department, the Bushcutter was found to be dangerous and not as efficient as the axe.

Note: Althought the above attachments were found to be generally unsuitable for Departmental use, they may prove very useful where the conditions occur for which they were designed.

2. USE OF THE POWER CHAIN SAW

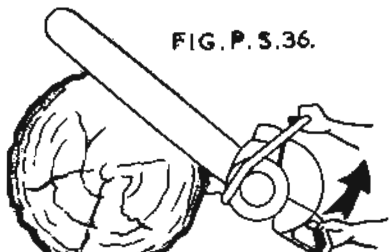
A. OPERATING THE SAW

The cutting movement with the straight-bladed saw, called the "pivot action", is as follows:

Place the spikes of the saw against the wood and open the engine throttle. When the saw reaches full speed pivot the saw on its spikes by pulling on the pistol grip until the chain engages wood (Fig. P.S. 36). Keep pulling on the pistol grip to pivot the blade through the wood. If the saw jams

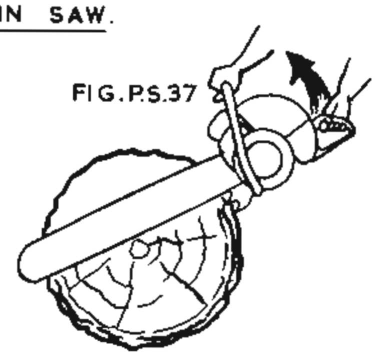
OPERATION OF POWER CHAIN SAW.

FIG. P. S. 36.



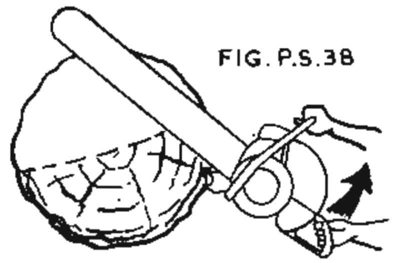
BEGINNING OF PIVOT CUT.

FIG. P.S. 37



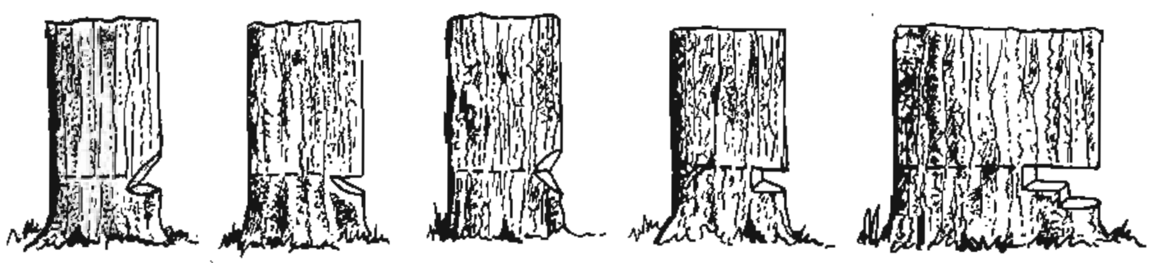
PULL ON PISTOL GRIP TO PIVOT BLADE THROUGH THE WOOD.

FIG. P.S. 38



AFTER FIRST CUT RE-ENGAGE SPIKES IN POSITION FOR SECOND PIVOT CUT.

FIG. P.S. 39 TYPES OF UNDERCUTS.



A. B. C. D. E.

A. COMMONLY USED UNDERCUT FOR SMALL TREES.
B. BUTT END OF LOG IS CUT SQUARE ACROSS.
C. VARIATION OF TYPE A.
D. HORIZONTAL CUT WITH BLOCK SPLIT OUT.
E. STEP TYPE FOR USE WITH LARGE TREES.

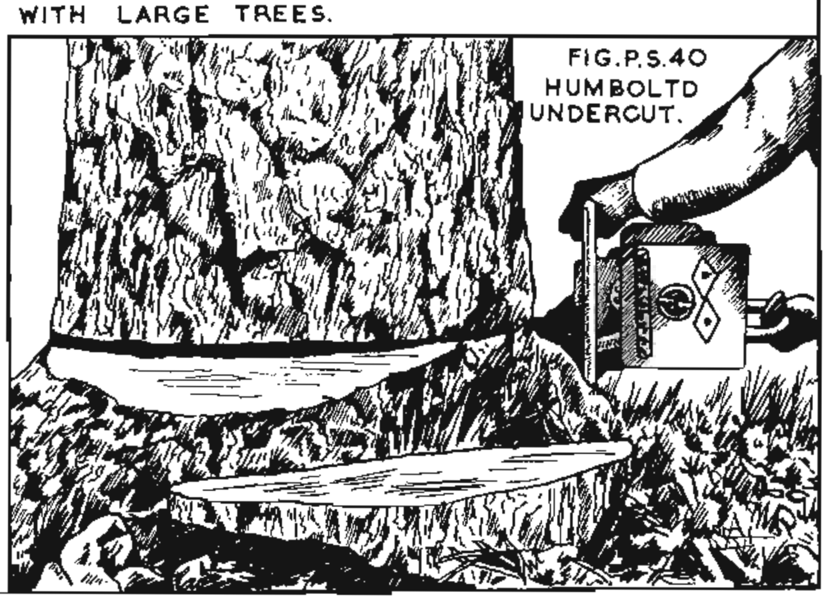


FIG. P.S. 40 HUMBOLTD UNDERCUT.

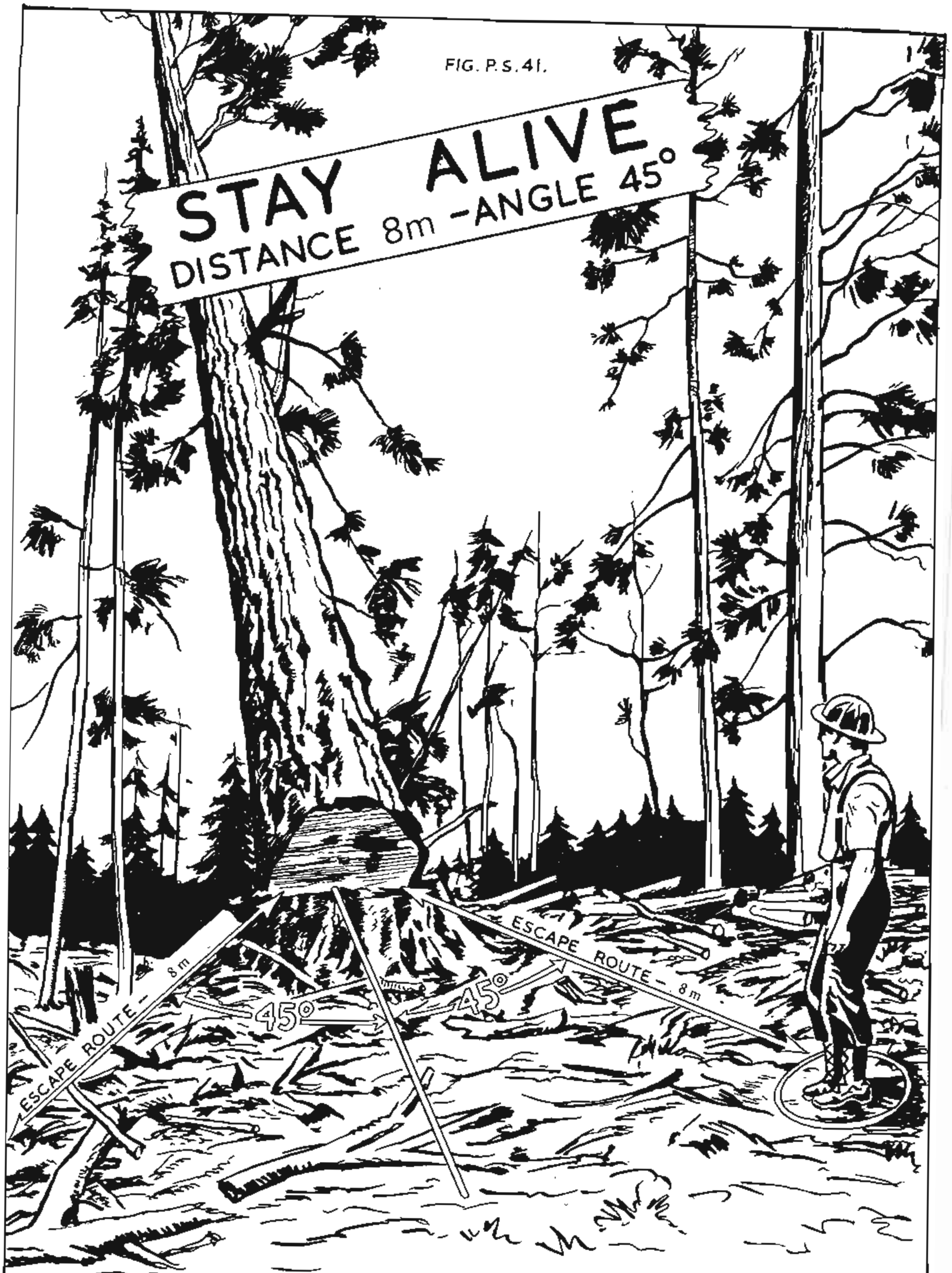
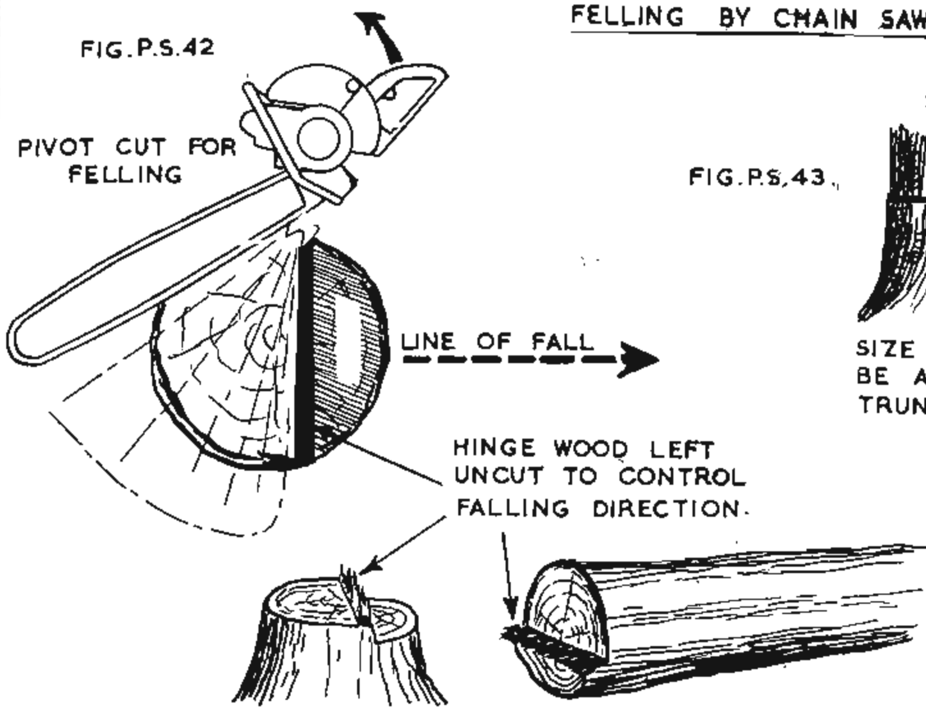


FIG. P.S. 41.
STAY ALIVE
DISTANCE 8m -ANGLE 45°
ESCAPE ROUTE – 8m
45°
45°
ESCAPE ROUTE – 8m

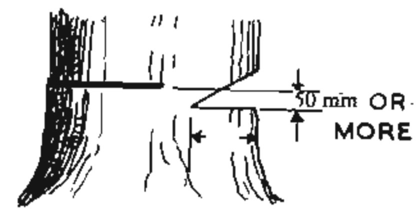
FELLING BY CHAIN SAW.

FIG. P.S. 42



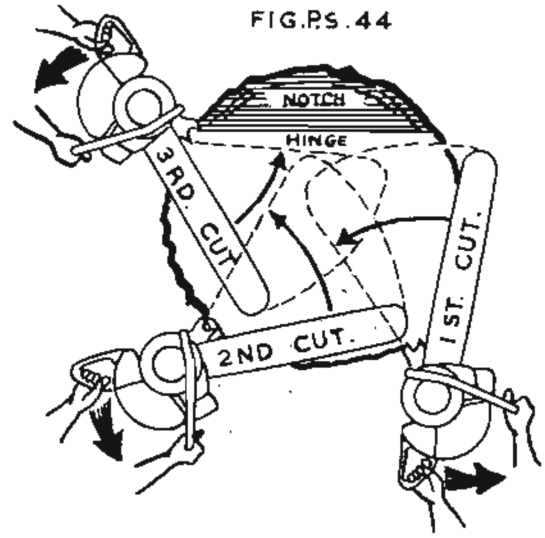
SIDE VIEW.

FIG. P.S. 43.



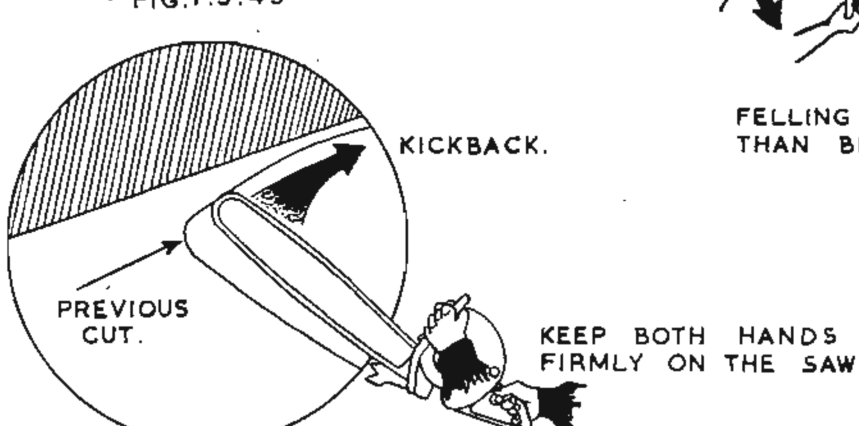
SIZE OF NOTCH SHOULD BE ABOUT 1/3 OF THE TRUNK DIAMETER.

FIG. P.S. 44



FELLING TREE LARGER THAN BLADE LENGTH.

FIG. P.S. 45



AVOID LETTING TOP OR TIP OF BLADE HIT BOTTOM OR SIDES OF PREVIOUS KERF WHEN INSERTING.

FIG.P.S46

CARRYING THE SAW.

FIG.P.S.48

DROPPING THE TREE.

FIG.P.S.47

STARTING THE ENGINE, GATHERING THE TOOL, NEARING THE TREE AND SAWING.

FIG. P.S49

FELLING BY POWER-DRIVEN CHAIN SAW.

in the cut, release the throttle, pull the saw free and re-engage in the cut. Stop pivoting before the blade hits the ground (cross-cutting) or when you can no longer pivot and cut wood (Fig. P.S. 37). Keep the chain running in the cut, but pull out the spikes from the wood. Push down on the engine end to reach a new pivot point, re-engage the spikes and continue to cut, using the same pivot action (Fig. P.S. 38).

B. FELLING

(a) GENERAL

Dangerous trees or snags within reach of working areas, roads or rigging should be felled before regular operations begin. Fellers should be so positioned that they will not endanger themselves or others from falling or rolling trees or logs. Fellers should not work in strong winds. In felling, adjacent brush should be cleared away to provide room to use the saw and axe, and permit a quick getaway. Before the tree is felled an escape route should be selected (Fig. P.S. 41). The point of escape should be at least 8m back and to one side. Fellers should give timely warning to other persons in the vicinity of a tree which is being felled.

(b) SELECTION OF A SAW

Small or medium size timber can be felled with a one-man power chain saw, but large timber of 1,5m or more in diameter can best be felled with a two-man saw. The size of the timber and the steepness of the slope are usually the deciding factors. On fairly smooth ground one man fells the trees and then cross-cuts them as he fells them. This is a good method as it avoids covering with limbs and brush the trees already felled but not yet cross-cut. The size of timber to be cut will determine the length of the cutter bar to be used.

(c) WHERE TO BEGIN

Select a "lead" (the direction most trees will lay when felled), considering such things as saving timber from breakages, yarding logs to the road or spar tree, cross-cutting, and other trees to be felled.

(d) FELLING THE TREE

If brushy around the tree, first clear a working space for safety, then determine the direction of fall of the tree. Select a lay where there will be little or no damage due to breakage when the tree strikes the ground.

Proceed with felling in the same way as if you were using the ordinary hand-saw. If the cut is obstructed by earth, remove the earth and saw off any protruding roots if necessary.

Notch the tree on the side towards which you want it to fall. In order to get a low stump make the notch as low as possible. Several types of undercuts are used, as illustrated in Fig. P.S. 39. Choose the one best suited to your needs as explained under the diagrams. The most popularly used notch is that shown in A, B and C of the diagrams, having a wedge-shaped form. Fig. P.S. 40 shows the Humboldt undercut, which is the same as B in the diagram. The notch should be about 1/4 to 1/3 through the tree (Fig. P.S. 43). Remove the wedge-shaped segment when the cut is complete.

Begin the back cut, or felling cut, at the correct height in relation to the undercut as shown by the dotted lines in Fig. P.S. 39. Keep the felling cut horizontal, otherwise the tree may not fall in the desired direction.

If the tree is small, felling can be completed from the same side where you began, but with a large tree, however, you should saw from each side. The latter method is generally used. Do not cut right through to the notch, but leave a section of wood parallel to the notch to act as a hinge for the tree to tip over (Fig. P.S. 42). The width of the hinge depends on the diameter of the tree. As you make the felling cut, keep glancing at the top of the tree for signs of movement. Stop before the tree is ready to fall and give warning. Be sure that no one is in the danger area before completing the back cut. When the tree begins to fall, pull the saw from the cut and retreat to a safe position. The safest place for you is behind another tree to the rear and to one side. Fig. P.S. 46, 47 and 48 show the sequence of operations for felling a tree by power saw, while Fig. P.S. 49 shows a typical felling operation, with the assistant saw operator looking on.

(e) DIFFICULT SITUATIONS

(1) Felling trees larger than the bar length

First notch the tree in the usual way for directional felling. After notching the felling is accomplished by making a series of pivot cuts as illustrated in Fig. P.S. 44. Make sure that the first cut is made in the right position in relation to the notch. The last cut must be made cutting towards the notch to be sure that the tree falls in the right direction. Use a wedge to keep the felling cut open when there is a danger of pinching. If the centre of the tree cannot be reached, side notching must be resorted to. Avoid letting the nosebar of the blade hit the bottom or sides of the kerf when inserting the saw into previous cuts, or the saw may kick back, as shown in Fig. P.S. 45.

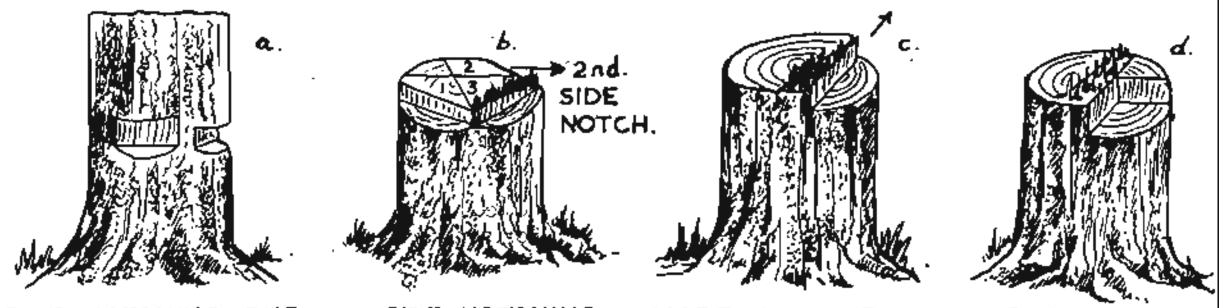
(2) Heavy forward lean

When cutting inclined trees, there is a danger that the log will get broken and splintered as the crown of the tree holds the trunk in tension. In order to avoid splintering the log, make the notch smaller and make two small cuts or side notches (Fig. P.S. 50a, b) at right angles to the notch, on both sides of the trunk if necessary. Then make the usual felling cut towards the notch. Diagonal cutting of the felling cut, as illustrated, helps to relieve tension, and some of the centre can be quickly cut as the tree begins to fall.

(3) Heavy side lean

There are two methods commonly used in overcoming side lean when felling a tree: holding more

FIG. P.S.50. CONTROLLING THE FALL.



SIDE NOTCHING ONE SIDE. | SIDE NOTCHING BOTH SIDES. | MORE WOOD HELD ON ONE SIDE TO CONTROL LEAN. | DUTCHMAN USED TO CONTROL LEAN.

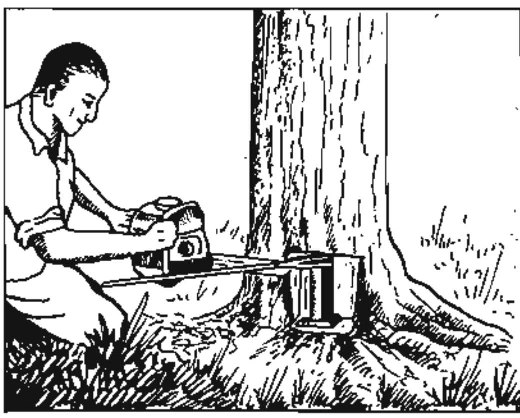


FIG. P.S.51.

DIRECTING THE FALL OF A TREE WITH ADVERSE LEAN BY MEANS OF A LIFTING JACK.

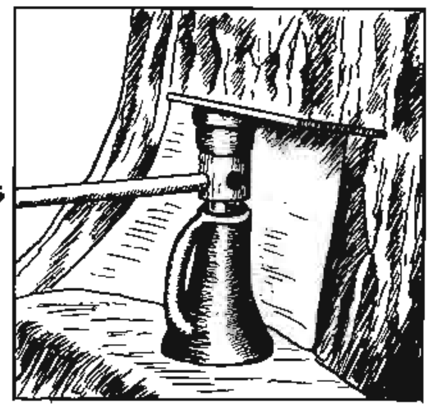
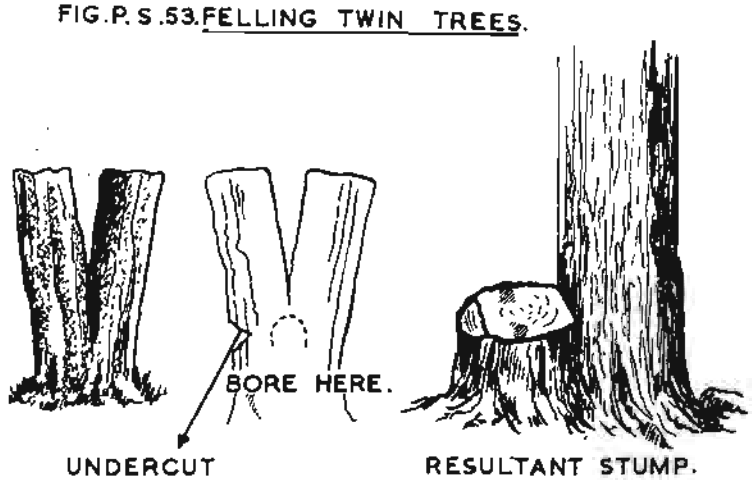


FIG. P.S.52.

SNAG FELLING.

A GOOD UNDERCUT FOR A SNAG. TIP OF ARROW SHOWS APPROXIMATE CENTRE OF BALANCE.

FIG. P. S. 53. FELLING TWIN TREES.



RESULTANT STUMP. THE OTHER TREE MAY BE FELLED IN THE USUAL MANNER.

FIG. P.S.54

CROSSCUTTING BY POWER CHAIN SAWS.

FIG. P.S.55

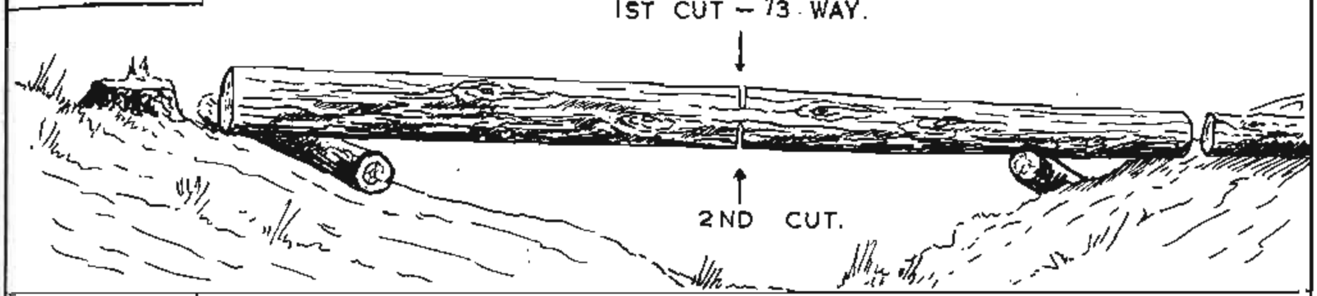
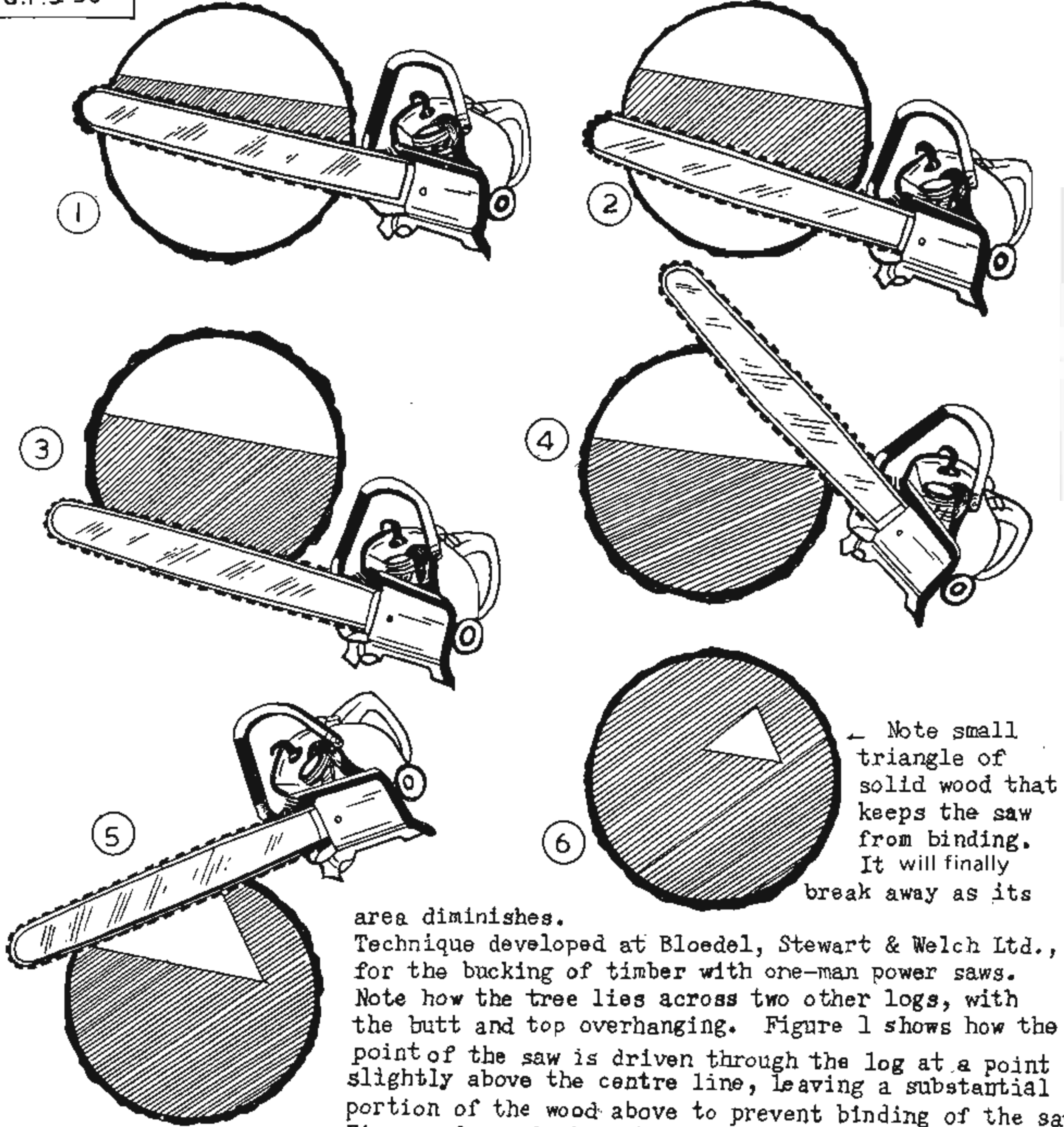


FIG. P.S. 56



← Note small triangle of solid wood that keeps the saw from binding. It will finally break away as its area diminishes.

Technique developed at Bloedel, Stewart & Welch Ltd., for the bucking of timber with one-man power saws. Note how the tree lies across two other logs, with the butt and top overhanging. Figure 1 shows how the point of the saw is driven through the log at a point slightly above the centre line, leaving a substantial portion of the wood above to prevent binding of the saw. Figures 2 and 3 show the progress of the saw toward the lower side. Figures 4 and 5 show how the upper portion is then attacked. Figure 6 shows small triangle of wood that lets go and breaks cleanly.

CROSS-CUTTING TECHNIQUE WITH ONE-MAN POWER CHAIN SAW wood on the side away from the lean (Fig. P.S. 50c) or by using a "Dutchman" (Fig. P.S. 50d). The latter is simply a section of the undercut block placed back for use as a fulcrum in lifting the tree over to where you want it. The heavier the lean the larger the block of wood which must be inserted to offset it.

(4) Backward lean

When you have sawn far enough into the back to insert wedges, do so before the tree has a chance to settle back and tighten up on your bar and chain. Wedge at this early stage just enough to hold the tree as it is and then saw up to where it can be wedged over without having to break too great an amount of wood. If considerable lifting is required, it is well to have wedge plates inserted into the kerf and then place the wedges between them. Wedge plates give greater lifting power to the wedge and greater height to the lift.

Drive the wedges deeper into the felling cut as the tree is about to go over.

For larger trees a lifting jack can be used instead of wedges, as shown in Fig. P.S. 51.

(5) Snag felling

A snag is a tree which has been dead for some time and has dry branches and loose bark. Overhead bark is one of the worst potential dangers in snag felling. If the bark does not extend far up the snag, pry it loose, if possible, with a long pole.

When wedging is to be done and one is working with a partner, one should keep a sharp lookout overhead while the other is hammering in the wedges.

Felling proceeds in the usual fashion, except that an undercut of larger size than normal is required to fell the tree (Fig. P.S. 52).

(6) Twin trees

If two trees have grown together and lean in opposite directions (Fig. P.S. 53), they must be felled separately. With a one-man saw you can make the undercut in the usual manner and then bore in between them to get the back cut started. When one tree is felled and out of the way, no difficulty will be experienced with the remaining one.

C. CROSS-CUTTING

(a) GENERAL

Cross-cutting operations should be arranged to keep the cutters uphill from previously cut logs, and cutters should always stand on the uphill side of logs they are busy cutting. Cross-cutters should give timely warning to other persons in the vicinity of any log which may have a tendency to roll after having been cut.

Unlike felling, cross-cutting operations vary considerably. In cross-cutting the lay of the tree can be either on the ground, or over previously felled trees, stumps, rocks etc. Sometimes it may be necessary to take off the top logs first, sometimes the butt logs. Sometimes the cuts must be made from underneath, sometimes from the top, sides and then bottom. Footing conditions also vary considerably.

On steep slopes every tree will present a problem. Carefully consider the situation so that you will not make a mistake and get the cutter bar and chain caught fast in the kerf.

(b) CROSS-CUTTING A TREE

On level ground cross-cutting is a simple matter (Fig. P.S. 54). Bring the machine into the cross-cutting position, with the bottom spike of the bumper placed against the wood, and the guide bar pointing upwards so that the chain cannot cut into the wood. Make sure that the spike is set firmly against the wood before starting the cut. Open the throttle and start cutting, and pivot the saw on its spikes by pulling on the pistol grip and exerting pressure on the handle bar. Continue with pivoting and re-engage as previously described (Fig. P.S. 36, 37 38) until the cut is finished. When the cut is almost completed, hold the saw firmly with both hands to avoid cutting into the ground and damaging the chain.

When the cut is likely to close up, insert a soft wedge made of wood, metal with a small mass or plastic into the cut, or raise the trunk. In small timber where wedging is impractical, it is best to use a V-shaped incision.

When it is necessary to cut with the top or tip of the blade, brace the engine against your hip or thigh, because the saw may kick backwards if the chain binds. Logs flat on the ground should be cut from the top; but when a log is supported only at the ends, it should be cut only one third through at the top, then the cut is finished from the bottom, (Fig. P.S. 55). Experience will teach that cutting a suspended log all the way through from one side may result in either pinching or splitting. Whenever you are unsure whether the cut will open or close on the blade, use soft wedges to keep the cut open.

(c) DIFFICULT SITUATIONS

(1) Tree supported only at the ends

A tree may be lying across a depression or on other logs with only the butt and top touching. Such a tree when being cross-cut quickly binds at the top and opens wide at the kerf below and splits underneath if given the opportunity. It must therefore be cut as illustrated in Fig. P.S. 55.

With large logs side cuts angled from the vertical should first be made in each side, overlapping at the top, so as to relieve pressure gradually, and then the final cut can be made from below. This will drop the log without splitting or damage.

Large logs can also be cut by first boring, then cutting through to the bottom, and finally angle-cutting the top, as illustrated in Fig. P.S. 56.

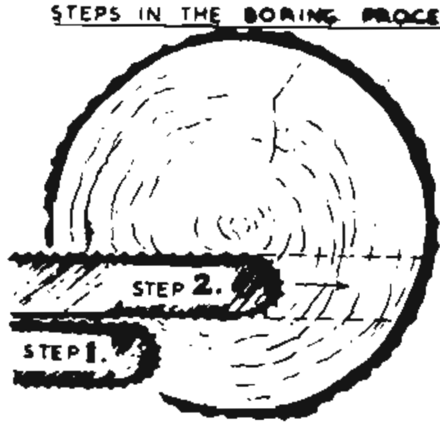
FIG. PS. 57.

HOW TO DROP OFF A LARGE LOG.

IN BUCKING OFF A LARGE LOG THAT EXTENDS OUT INTO THE AIR AND NEEDS UNDERCUTTING, GET ON TOP OF IT WITH YOUR CHAIN SAW AND MAKE THE SIDE CUTS, A. AND B. THESE KERFS OVERLAP UNDERNEATH TO PREVENT SPLITTING OR CHECKING WHEN PORTION C. IS CUT FROM A POSITION ON THE GROUND. THE V-SHAPED. CENTRE WILL BREAK CLEANLY WITHOUT ANY DAMAGE TO EITHER LOG.

FIG. PS. 58.

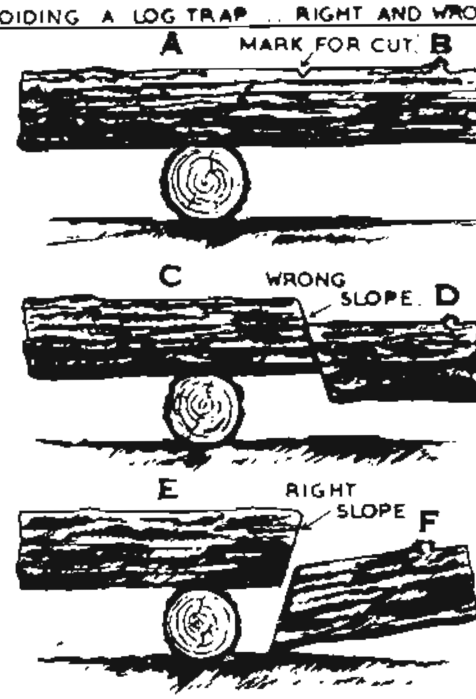
STEPS IN THE BORING PROCESS



BORING IS NECESSARY WHEN THE CROSS CUTTING MUST BE DONE OVER A ROCK, STUMP, OR OTHER OBSTRUCTION, WHEN ONE WOULD NOT BE ABLE TO GET THE BAR UNDER THE LOG TO MAKE A BEGINNING, AND WHEN A CUT FROM ABOVE CANNOT BE MADE WITHOUT DAMAGE TO THE LOG OR CHAIN.

FIG. PS. 59.

AVOIDING A LOG TRAP ... RIGHT AND WRONG WAY



E. 551.

FIG. P.S.60

DEBRANCHING A LARGE TREE BY POWER CHAIN SAW. SEQUENCE OF OPERATION.

FIG. P.S.61

FELLING ON A STEEP SLOPE.

(2) Underbind - log extended in the air (Fig. P.S. 57)

A tree touching only at the mid section, perhaps lying over a ridge or over another fallen tree, presents another problem, the reverse of the one described above. The log to be cross-cut may have its full length extended in the air with nothing to hold it up. The sides and much of the underpart are sawn first as shown in the diagram (Fig. P.S 57), with overlapping kerfs underneath. The top part is left to the last.

(3) Side bind

A tree lying horizontally across a steep slope, held there by a stump, standing tree or stone, will bind on the lower side and the log will roll when it is cut loose. The lower side should be partially cut through first, then the top cut made by the cutter standing above the tree.

(4) Log traps

A cutter too often makes himself a trap (as shown in Fig. P.S. 59) by making a cut at the wrong angle. This is especially true where one log will drop and the other will not move when the cut is made. If at the wrong angle as shown by logs (c) and (d) the bar and chain will get caught.

When cut at the angle shown by logs (e) and (f), (f) drops away from the end of (e) and the bar and chain are left free.

Lateral movements of a log can likewise catch a bar and chain. Before commencing a cut, size up the situation and determine what movements the log will make when cut. Use the mass of the log to your advantage.

Another precaution when cross-cutting a log at a point marked between (a) and (b) in the diagram (P.S. 59) is: do not saw straight through from the top until log (b) drops. If you do it will drop before the cut is completed, resulting in a slab splitting from the log (a) and the tension being all the tighter on the bar and chain.

(5) Jammed bar and chain

If the bar and chain are jammed in a cut, they must be freed by chopping with an axe, or cutting free with another saw if one is available. Sometimes when caught you can free the bar but not the chain. Then if you have another chain to fit the bar you can rig up again and cut yourself free. In small timber the logs may be wedged apart to free the bar and chain.

(6) Boring or plunge cutting

Sometimes boring into a log is necessary and at other times it is the easiest way of doing the preliminary cross-cutting in order to prevent splitting, as in Fig. P.S. 55. When you bore into a log you can either saw up or down, whichever is necessary. Plunge cutting may also be employed to fell forked or twin trees (Fig. P.S. 53). Inexperienced cutters have difficulty in getting started as the end of the bar will not stay put where they want it. It will want to climb or kick away from the beginning point. A good way to overcome this is by starting well under the lower quarter of the log (Fig. P.S. 58) with the tip of the blade, then sawing a short distance upwards before commencing boring. At this point the saw may be brought into position by applying gentle pressure and the cut can be finished. When making a plunge cut, work with full throttle to avoid chattering of the saw chain.

D. DEBRANCHING

The power chain saw can be used for debranching very large trees, as shown in Fig. P.S. 60. Both hands must be kept firmly on the saw at all times. If the tree is small enough the cutter should stand on the opposite side of the tree to the branches he is removing. Debranching small or medium-sized trees with the power saw is dangerous. On such trees debranching can be carried out faster and more efficiently by axe.

3. PRODUCTION AND COSTS

A. FELLING AND CROSS-CUTTING NORMS

The expected output achievement of power chain saws was determined and norms based on the cut diameter were tabulated for felling and cross-cutting, based on a daily working time of 540 minutes.

TABLE P.S. 1 - Allowed times for debranching

	Time in minutes per labourer per tree							
Stump diam. cm	P.tae / P.pat	P.ell	P. rad	P. pal	P.pin	P. pseud	P. rox	P. can
13,5	3,0	2,6	-	-	-	-	-	-
15	3,7	2,9	-	-	1,0	-	-	-
17	4,5	3,3	-	-	1,4	-	-	-
19	5,4	3,6	-	-	2,0	-	4,4	1,7
21	6,2	3,9	-	2,0	2,7	-	5,8	2,5
23	7,0	4,2	3,5	2,5	3,4	-	7,4	3,3
25	7,8	4,6	5,5	3,0	4,2	-	8,6	4,0
27	8,6	4,9	7,3	3,5	5,1	-	9,6	4,8
29	9,2	5,2	8,5	4,0	6,0	-	10,4	5,6
31	10,0	5,5	9,8	4,4	6,8	8,5	11,3	6,3
33	10,6	5,9	10,8	4,8	7,4	9,4	12,2	7,0
35	11,2	6,2	11,8	5,2	8,0	10,2	13,0	7,8
37	11,8	6,5	12,5	5,6	8,7	10,8	13,8	8,6
39	12,4	6,8	13,4	5,9	9,2	11,4	-	-
41	13,0	7,1	14,0	6,2	10,0	12,0	-	-
43	13,4	7,5	14,6	6,4	11,5	12,6	-	-
45	13,8	7,9	15,2	6,7	12,3	13,1	-	-
47	14,2	8,2	16,0	7,0	13,1	13,6	-	-
49	14,5	8,5	16,9	7,2	13,8	14,1	-	-
51	14,8	8,8	18,0	7,4	14,5	14,6	-	-
53	15,1	9,1	19,2	-	15,0	15,0	-	-
55	15,4	9,4	21,0	-	15,4	15,4	-	-
57	15,6	9,7	23,5	-	16,0	15,8	-	-
59	15,8	10,1	25,5	-	16,4	-	-	-
61	16,0	10,4	28,0	-	16,8	-	-	-
63	16,2	10,7	31,0	-	-	-	-	-
65	16,3	11,1	-	-	-	-	-	-
67	16,4	11,4	-	-	-	-	-	-

TABLE P.S. 2 - Felling and debranching - times for 5,2 kW mechanical saws for a team of 4-5 men

Stump diam. cm	Allowed time per tree in minutes: P. patula / P. pseudo-strobus	P. elliottii / P. palus-tris	P. taeda / P. pinaster	P. radiata / P. rox-burghii / P. cana-riensis
13,5	0,6	0,6	0,7	0,7
15	0,7	0,6	0,7	0,8
17	0,7	0,7	0,8	0,8
19	0,8	0,7	0,8	0,9
21	0,8	0,7	0,9	0,9
23	0,9	0,8	0,9	1,0
25	1,0	0,8	1,0	1,1
27	1,0	0,9	1,1	1,2
29	1,1	1,0	1,1	1,2
31	1,2	1,0	1,2	1,3
33	1,3	1,1	1,3	1,4
35	1,3	1,2	1,4	1,5
37	1,4	1,3	1,5	1,6
39	1,5	1,4	1,6	1,7
41	1,6	1,4	1,7	1,8
43	1,7	1,6	1,8	2,0
45	1,8	1,7	1,9	2,1
47	2,0	1,8	2,0	2,2
49	2,1	1,9	2,1	2,4
51	2,2	2,0	2,3	2,5
53	2,3	2,1	2,4	2,7
55	2,5	2,2	2,6	2,8
57	2,6	2,3	2,7	3,0
59	2,8	2,5	2,9	3,2
61	2,9	2,6	3,0	3,3
63	3,1	2,8	3,2	3,5
65	3,3	2,9	3,3	3,7
67	3,4	3,1	3,5	3,9
69	3,6	3,2	3,7	4,1
71	3,8	3,4	3,9	4,3
73	3,9	3,6	4,0	4,5
75	4,1	3,7	4,2	4,7

Allowances for slope:

0 - 15°	-	labourers start on	0 min.
16 - 20°	-	" " "	27 "
21 - 30°	-	" " "	54 "
31 - 40°	-	" " "	81 "
41° and over		" " "	108 "

TABLE P.S. 3 - Cross-cutting allowed times for 5,2 kW mechanical saw

Thin end diameter of log cm	Allowed time per cut in minutes: P. patula / P. pseudostrobus	P. elliottii / P. palustris	P. taeda	P. radiata / P. canariensis	P. pinaster / P. roxburghii
13,5	0,4	0,3	0,4	0,4	0,4
15	0,4	0,3	0,4	0,4	0,5
17	0,4	0,4	0,4	0,5	0,5
19	0,4	0,4	0,5	0,5	0,6
21	0,5	0,5	0,5	0,6	0,6
23	0,5	0,5	0,6	0,6	0,7
25	0,6	0,6	0,6	0,7	0,7
27	0,6	0,6	0,7	0,8	0,8
29	0,7	0,7	0,7	0,9	0,9
31	0,8	0,7	0,8	0,9	1,0
33	0,8	0,8	0,9	1,1	1,1
35	0,9	0,9	0,9	1,2	1,1
37	0,9	0,9	1,0	1,3	1,2
39	1,0	1,0	1,1	1,4	1,3
41	1,1	1,1	1,2	1,5	1,4
43	1,2	1,2	1,3	1,6	1,6
45	1,3	1,3	1,4	1,7	1,7
47	1,4	1,4	1,5	1,9	1,8
49	1,5	1,5	1,6	2,0	1,9
51	1,6	1,6	1,7	2,2	2,0
53	1,8	1,7	1,8	2,3	2,2
55	1,9	1,9	1,9	2,5	2,3
57	2,0	2,0	2,0	2,7	2,4
59	2,2	2,1	2,2	2,8	2,6
61	2,3	2,2	2,4	3,0	2,8

Allowance for slope:

0 - 15°	-	labourers begin on	0 min.
16 - 20°	-	" " "	27 "
21 - 30°	-	" " "	54 "
31 - 40°	-	" " "	81 "
41° and over		" " "	108 "

B. TEAMS AND THEIR DUTIES

The norms listed in the tables are based on third thinnings and clearfellings under the following conditions:

1. One mechanical saw and 4 labourers, trees being felled and cross-cut by the same team

Team No.	No. of labourers	Duties
1	1	Removal of obstacles around tree base (± 1/4 of days work). Assists team 3 with debranching
2	2	Responsible for saw, felling and cross-cutting. The 2 men take turns with the saw, the man not sawing to assist the sawyer if necessary
3	1	Debranching. The labourer under team 1 to assist. Note: The above 4 labourers must earn 540 allowed minutes per day as set out in the table

2. One mechanical saw and 5 or 6 labourers, where trees are felled and debranched, but not cross-cut, by the same team

Team No.	No. of labourers		Duties
1		1	Removal of obstacles around tree base (± 1/3 of day's work). After this he must assist team No. 3 with debranching.
2		2	Responsible for saw and felling the number of trees which will give an allowed time of 540 minutes per day.
3	P. ell.	3	Responsible for debranching trees felled by team No. 1. When all the felled trees are debranched their daily task is completed.
	P. pin.	3	
	P. tae.	4	
	P. pat.	4	
	P. rad.	3	
	P. pal.	2	
	P. pseud.	4	
	P. rox.	5	
	P. can.	2	

3. One mechanical saw and three labourers - cross-cutting

Team No.	No. of labourers	Duties
1	3	Responsible for cross-cutting trees into logs. They must earn 540 allowed minutes per day according to tables. One labourer provided with axe to remove branches below the logs. All cross-cut logs must be rolled over to check for knots.

C. APPLICATION OF THE SCHEME

(a) FELLING AND DEBRANCHING TREES

The allowed times in the tables are based on the large end diameter of the first log (stump log), which must be cut cleanly. Diameters are measured by talliers for the daily production sheet.

Allowed times are based on the trees felled, and debranchers are allotted accordingly, thus all trees felled daily must be debranched by the debranching teams. If the debranchers cannot complete their task, individual tasks must be given to each labourer.

(b) CROSS-CUTTING

Allowed times are based on the large end diameter of logs.

(c) MARKING OF FELLED TREES AND CROSS-CUT LOGS

Fellers and cross-cutters are given individual numbers which they write on the butt end of trees or the large end of logs immediately after felling or cross-cutting is completed. Talliers cross these numbers out when they note the logs on the daily production sheets.

(d) ALTERNATIVE WORK FOR LABOURERS IF SAWS BECOME DEFECTIVE

If the power saws become defective during the day and cannot be repaired within 20 minutes, and no spare is available, the labourers must complete their task using bow saws. The procedure is as follows:

(1) The sawyers receive one bow saw and commence work immediately.

(2) The foreman determines the time already earned and adds 20 minutes for idle time.

(3) The logs or trees sawn by bow saws are recorded on a separate production sheet and allowed times are determined as for felling by bow saws, using the bow saw norms. Allowed times for mechanical and bow saws added together should total 540 minutes before the task is completed.

(4) If the saw is repaired or replaced, it must again be taken into use until the task is completed.

(e) DUTIES OF THE FOREMAN

The foreman must train sawyers and supervise the teams. He must determine the allowed times daily and see that the teams complete their tasks, and he must also complete the idle time sheets if necessary. He must ensure that petrol and oil are received from the store in time.

The foreman is responsible for power saw maintenance, and his duties in this respect are those set out in I. Description and maintenance, but may be summed up as follows:

Daily production sheet: Cross-cutting

Date ____________ Compt. No. ____________ Species ____________ Slope ____________

Thin end diameter of logs (cm)	Team No. ____________ Labourers: 1. ________ 2. ________ 3. ________
	Allowances made for slope
13,5	
15	
17	
-	
-	
-	
-	
73	
75	
Total	

Teller ____________ Foreman ____________

Daily production sheet - felling and debranching

Date ____________ Compt. No. ____________ Species ____________ Slope ____________

Thick end diameter of 1st log (cm)	Team No. ____________ Labourers: 1. ________ 2. ________ 3. ________ 4. ________ 5. ________ 6. ________ 7. ________
cm	Allowances made for slope
13,5	
15	
17	
-	
-	
-	
-	
73	
75	
Total	

Teller ____________ Foreman ____________

(1) Fuel and oil

(i) The fuel tank and its mount must be kept free of dirt.
(ii) Funnels must be kept clean.
(iii) Fuel must be well shaken before fueling.
(iv) Spilling and overflow must be avoided.
(v) The fuel must be kept watertight.
(vi) The oil level must be kept exactly on the mark.

(2) The chain

He must check to see that the chain is correctly tensioned. When running the tension is often too high. Before adjusting tension he must check to see that the oil ducts are not blocked.

Chains that chatter are faulty and the foreman must be able to ascertain the cause of the trouble. He must check sharpening and repair operations to ensure that the work is being properly done. The foreman must be acquainted with the causes of chattering, crooked cutting, chains "jumping" the bars, etc., so that he can correct faults and maintain the saw in good condition. Short sawdust of 5mm long or less indicates a blunt saw, while sawdust of 25mm long indicates a sharp saw.

A saw which does not cut into the ground will only require sharpening twice per day.

Note: The average life of a chain is from 1 000 m^3 to 1 500 m^3 of softwood sawlogs in felling and cross-cutting combined

(3) Filters

Fuel filters must be replaced immediately they become dirty. Air filters must be washed regularly as indicated in the handbook.

(4) Nuts and bolts

The foreman should examine the machine for loose nuts and bolts at least twice a day.

(f) PERMISSIBLE IDLE TIME

Idle time is granted when work is stopped by rain, the actual clock time being recorded. When moving from compartment to compartment 12 minutes are allowed per kilometre. Justification for idle time must, however, be confirmed by the forester.

D. TABLES OF ALLOWED TIMES AND THEIR USES

Tables have been compiled for the following species:

P. canariensis, *P. elliottii*, *P. patula*, *P. pinaster*, *P. palustris*, *P. pseudostrobus*, *P. radiata*, *P. roxburghii*, *P. taeda*.

(a) ALLOWANCES MADE

(1) All times were normalised.

(2) 10% allowance was made for refueling.

(3) 20% rest allowance was made for debranching.

(4) 10% allowance was made for cuts not yielding logs, in cross-cutting only.

(5) No rest allowances were made for sawyers, as they work in turns.

(b) USE OF TABLES

The production sheet data must be filled in and the number of trees felled or cross-cut must be indicated for each diameter class. The applicable table is then used to determine the allowed times, and the number of trees or logs is multiplied by the allowed time. The allowed times for the various diameter classes are added together, and the daily task is completed when the number of minutes in the day have been earned.

(c) DAILY PRODUCTION SHEETS (see examples)

Daily production sheets are completed by tellers and foremen. The forester shall determine the slope. Where definite divisions of slope occur, they should be treated separately and each of the separate divisions listed on the production sheet.

The field foreman must determine the time earned so that the labourers earn the time allowed in the day. The completed production sheets should be checked by the forester, who books the labourers for the day if he is satisfied. The foreman's calculations must be correct to 5%.

E. TEAM STRENGTH FOR THE PREPARATION OF SAWLOGS

Table P.S. 4 gives the team strength for the preparation of sawlogs (mechanical saws).

TABLE P.S. 4 - Team strength for the preparation of sawlogs - mechanical saws

Team No.	Work done by the team	Number of labourers required per day for annual timber volume production in m^3				
		43 000	35 000	28 000	21 000	14 000 7 000
	No. of saws	3	3	3	2	0
1	Fell and debranch	7	7	7	4	Use bow saws
2	Cross-cut	3	3	3	-	
3	Markers for (2)	2	2	2	2	
4	Log tellers	1	1	1	1	
5	Tree tellers	1	1	1		
6	Transport equipment to and from store	1	1	1	1	
Total		15	15	15	8	

NOTES (to Table P.S. 4)

(i) The table is based on P. patula and P. taeda, 3rd and 4th thinnings, slope: 0 - 15°.

(ii) The number of labourers is the average per day for the year.

(iii) In team 1 for 43 000 m^3 the fellers will assist the cross-cutters every fifth day.

(iv) For columns of 35 000 and 28 000 m^3, the labourers should be able to prepare more than the required volumes.

(v) The saws indicated are only those necessary for the operation. It is desirable to have spare saws in stock.

F. POWER CHAIN SAWS: OUTPUT AND COSTS

Four power saws were placed under strict observation while working in Berlin plantation and the following data were obtained:

(a) 2 McCULLOCH 1-70 DIRECT-DRIVE POWER SAWS

(D.B. 111/92 and D.B. 111/93)
Full operation period: 4.5.62 - 28.2.63
Saws withdrawn from service on 28.2.63

	R
Hiring cost: 115 days @ 167c/day	192,05
Fuel	63,44
Labour: Foreman : 115 days @ R3,62	417,45
Labourers: 460 days @ R0,67	308,20
Total cost for the two saws	981,14

Volume sawn: 7 906m^3
Cost per m^3 12,41cents
i.e. 49,4 m^3 daily per saw 13,7m^3 per labour unit.
Total power saw; (Average): 3953 m^3

(b) 2 HOMELITE 707 G: GEAR DRIVEN

(D.B. 111/80 and D.B. 111/81)
Period of operation: 21.5.62 - 30.6.63 (Saws still in operation)

	R
Hire costs: 180 days @ 167c/day	300,60
Fuel	166,75
Labour: Foreman : 180 days @ R3,62 ..	651,60
Labourers: 720 days @ 0,67c .	482,40
Total for the two saws	1 601,35

Volume sawn: 12 597m^3
Cost per m^3 12,67cents/m^3
i.e. 46,1 m^3 daily per saw 14m^3 per unit.
Volume per saw: 6 299 m^3 (average).

NOTE:

(1) The above costs cover felling, debranching, and the preparation of sawlogs.

(2) Labour costs are those of the foreman and the team operating the saws and preparing sawlogs.

(3) Average for each of the four saws: 5 126 m^3.

(4) The saws were used in third and fourth thinnings and clearfelling operations. Clearfellings included felling in P. roxburghii compartments.

Saws	
D.B. 111/92 Thinnings	3 332 m^3
D.B. 111/93 Clearfellings	4 574 m^3
Total	7 906 m^3
D.B. 111/80 Thinnings	2 980 m^3
D.B. 111/81 Clearfellings	9 617 m^3
Total	12 597 m^3

4. POWER-SAW SAFETY MANUAL

A. TRAINING

(a) NEED FOR TRAINING POWER-SAW OPERATORS

(1) To provide healthier, more stable and more contented workers.

(2) To achieve more production per unit.

(3) To lower production costs.

(4) To facilitate the introduction of new methods.

(5) To facilitate the introduction of operators to new and varied topographies.

(6) To prevent careless habits.

(b) HOW TRAINING SHOULD BE DONE

The worker's interest in the job must first be aroused and then he must be shown the correct way of doing his job. The trainee should be frequently tested while in training, to see if he fully understands what he is being taught, and when trained be must be checked and rechecked at intervals to ensure that he is using his machine correctly.

(c) VARIOUS TYPES OF TRAINING

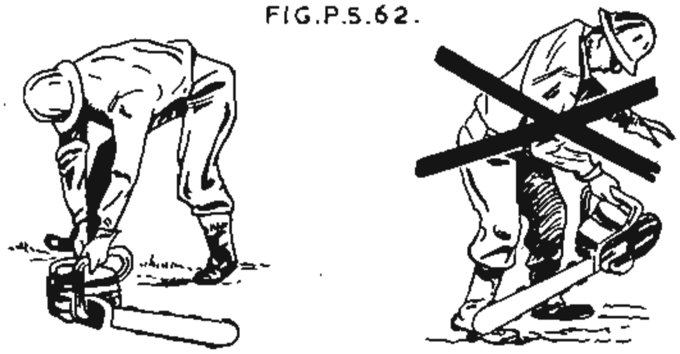
(1) Apprentice: new worker trained by a master worker for a set period until qualified.

(2) Group or class teaching, using the lecture and practice method.

(3) Discussion: Trained men answer questions and demonstrate various operating techniques.

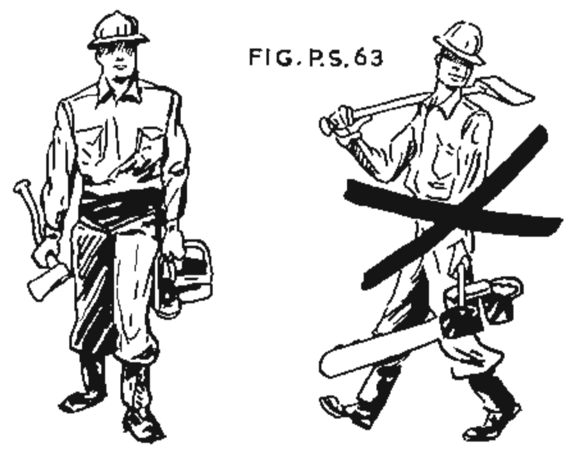
(4) "On the job" training: The learner works with an experienced man, learning each stage of the job until proficient.

FIG.P.S.62.



SAFE AND UNSAFE METHODS OF STARTING A CHAIN SAW.

FIG. P.S. 63



THE CHAIN SAW MUST BE CARRIED WITH THE BLADE TO THE REAR AND MUST NOT BE CARRIED WITH THE MOTOR RUNNING.

FIG. P.S. 64.

WHEN UNDERCUTTING A LOG HOLD THE SAW FIRMLY AND KEEP THE LEGS AWAY FROM THE SAW.

CHAIN SAW SAFETY

(d) WHO SHOULD DO THE TRAINING

Training should be done by a qualified field official, preferably the foreman, who will be able to check on the work from time to time after training, and who is responsible or partially responsible for obtaining results.

(e) DEPARTMENTAL TRAINING OF OPERATORS

A training team consists of 3 labourers, their training commencing with cross-cutting. They should handle the saw in turn, progressing to felling when the foreman is satisfied with their progress. The teams should be in training for no less than three weeks, during which period the foreman should instruct them in every aspect of the use and maintenance of the saw, as previously set out in Chapter I. After three weeks the foreman may commence training a further three men, provided that he is satisfied with his original training team.

(f) TRAINING AIDS

The most popular training aids are written materials such as instruction manuals, etc., and visual aids in the form of slides, motion pictures or safety posters.

B. SAFETY

(a) IMPORTANCE OF SAFETY

The importance of safety should be driven home to each trainee. The untrained man must be made to realise that his worst enemy is himself, besides which he is a constant source of danger to others.

(b) WOODCUTTING SAFETY PROGRAMME

(1) The forester or foreman must be responsible for safety.

(2) Workers must be made safety conscious, both during training and during the actual operation.

(3) Workers must wear safety clothing, such as safety hats, shoes, etc.

(4) Workers should be given basic training in first aid, particularly foremen and operators, and a first aid kit should always be at hand.

(5) Training sessions and refresher courses should be conducted periodically.

(6) Unsafe working conditions must be removed and avoided.

(c) SAFETY RULES IN THE OPERATION OF THE POWER CHAIN SAW

(1) Wear safety clothing.

(2) Stop the saw when moving any distance, carrying it by the handle with the guide bar to the rear (Fig. P.S. 63).

(3) When fueling follow the fire precaution rules.

(4) Place the saw firmly on the ground to start it (Fig. P.S. 62).

(5) Before starting make sure that the saw blade or chain is not touching anything (Fig. P.S. 62).

(6) No one else should be near when starting the saw. Never ask anyone to hold the saw while starting it.

(7) Before starting the cut make sure that you have a path of safe retreat to use when the tree begins to fall.

(8) Keep both hands on the saw when working.

(9) When starting the cut, place the spikes against the wood before engaging the saw.

(10) Be sure that the proper notch or undercut is made.

(11) Warn other people in the vicinity well before the tree falls.

(12) When removing the saw from a cut, shut off the motor, before the chain leaves the tree.

(13) Step aside, not back from a falling tree and beware of falling branches.

(14) Carry the saw with the blade to the rear, and never carry a saw with the motor running (Fig. P.S. 63).

(15) Use a power saw with caution when cutting heavy branches. Limb from the side of the tree away from the branches if possible.

(16) When cross-cutting always stand on the high side of the log, keeping the saw carefully under control.

(17) When undercutting a log in cross-cutting, hold the saw firmly and keep the legs away from the saw (Fig. P.S. 64).

(18) Keep the body clear of the exhaust system at all times.

(19) Use only wedges of wood, metal with a small mass or plastics - never steel.

(20) Never touch or try to stop a moving chain.

(21) Never attempt to sharpen the chain or check the tension while the motor is running.

(22) Keep the chain bar away from stones, dirt, etc.

C. FIRE

(a) FIRE PRECAUTIONS

(1) Allow the hot saw to cool before refueling.

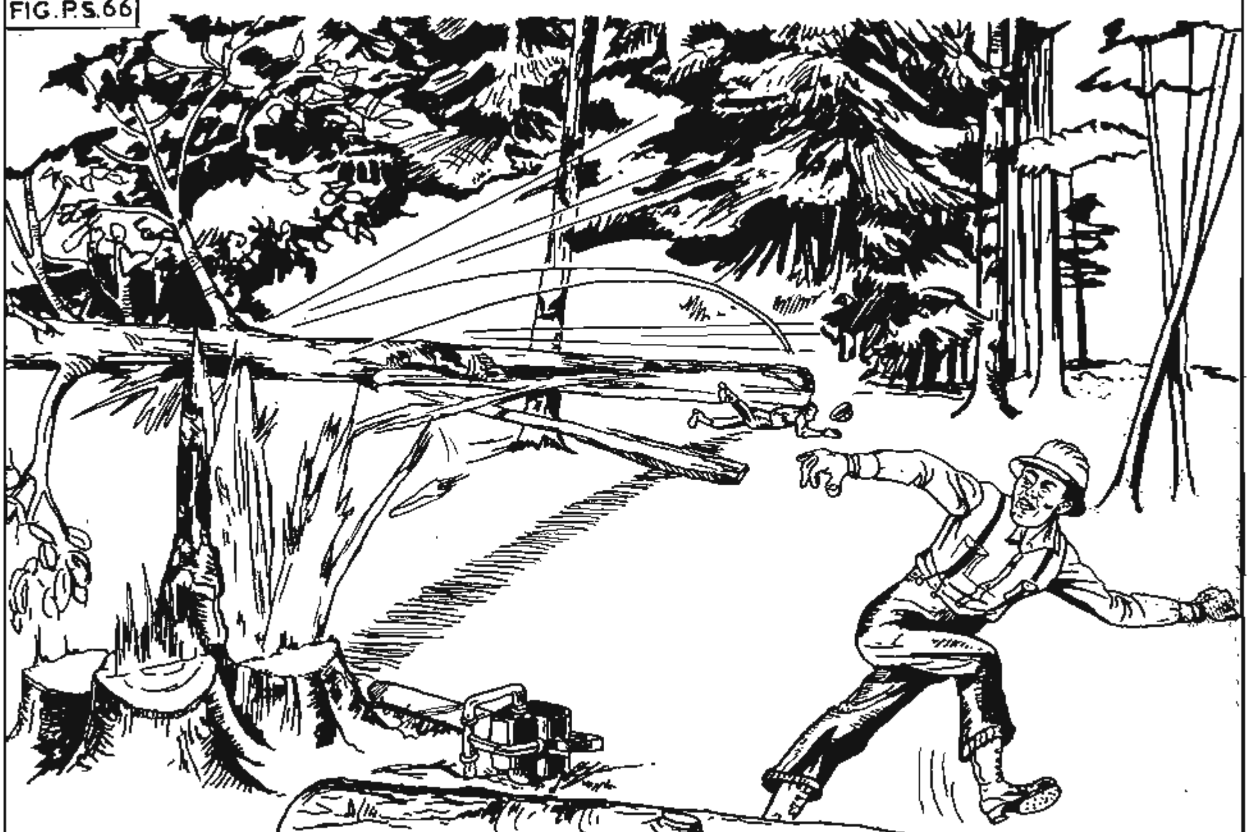
(2) Place the saw on bare ground before adding the fuel.

(3) Avoid spilling. Do not fill the tank to the top.

FIG. P.S.65.

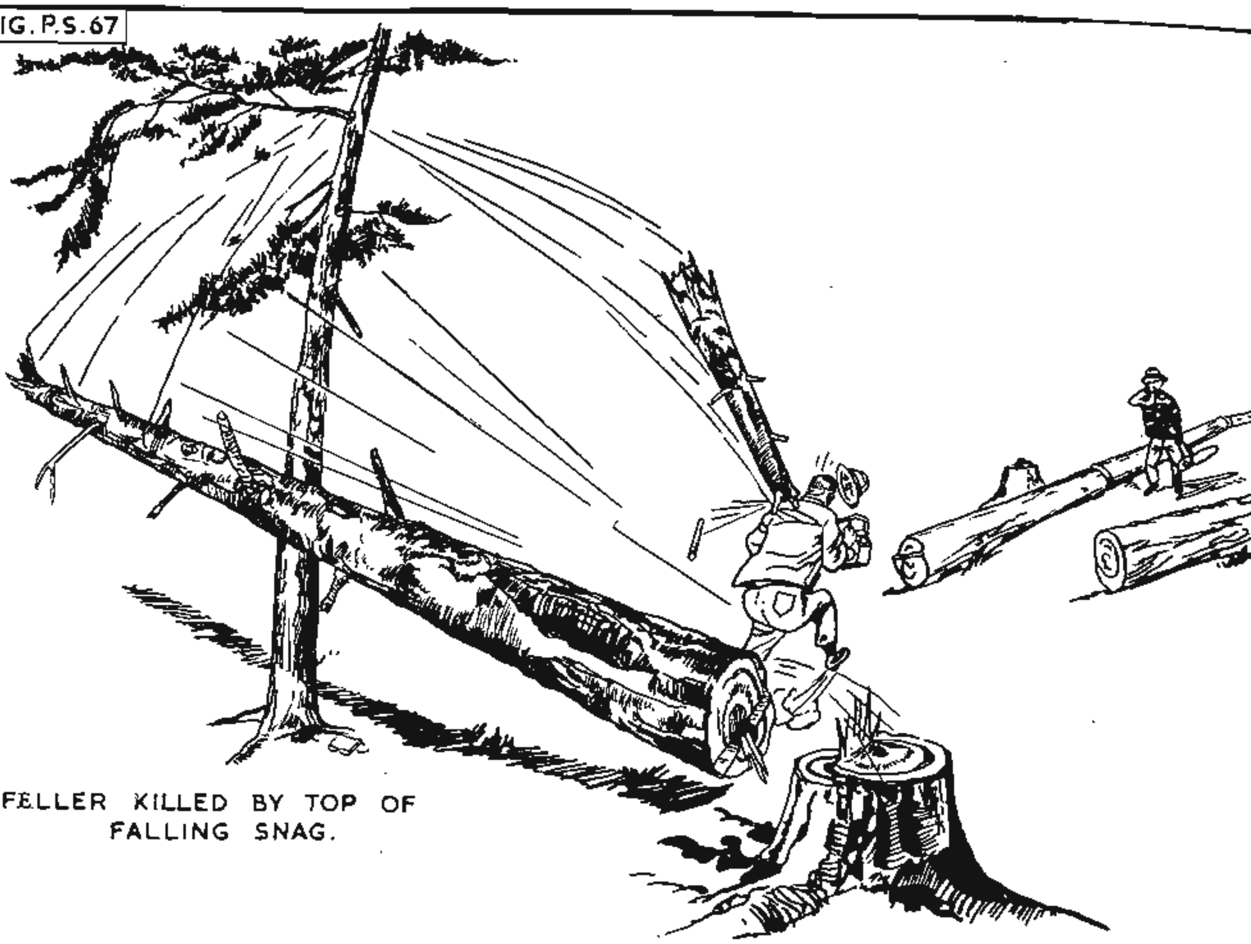
TIMBER FELLER KILLED BY FALLING LIMB FROM A STANDING TREE.

FIG. P.S.66



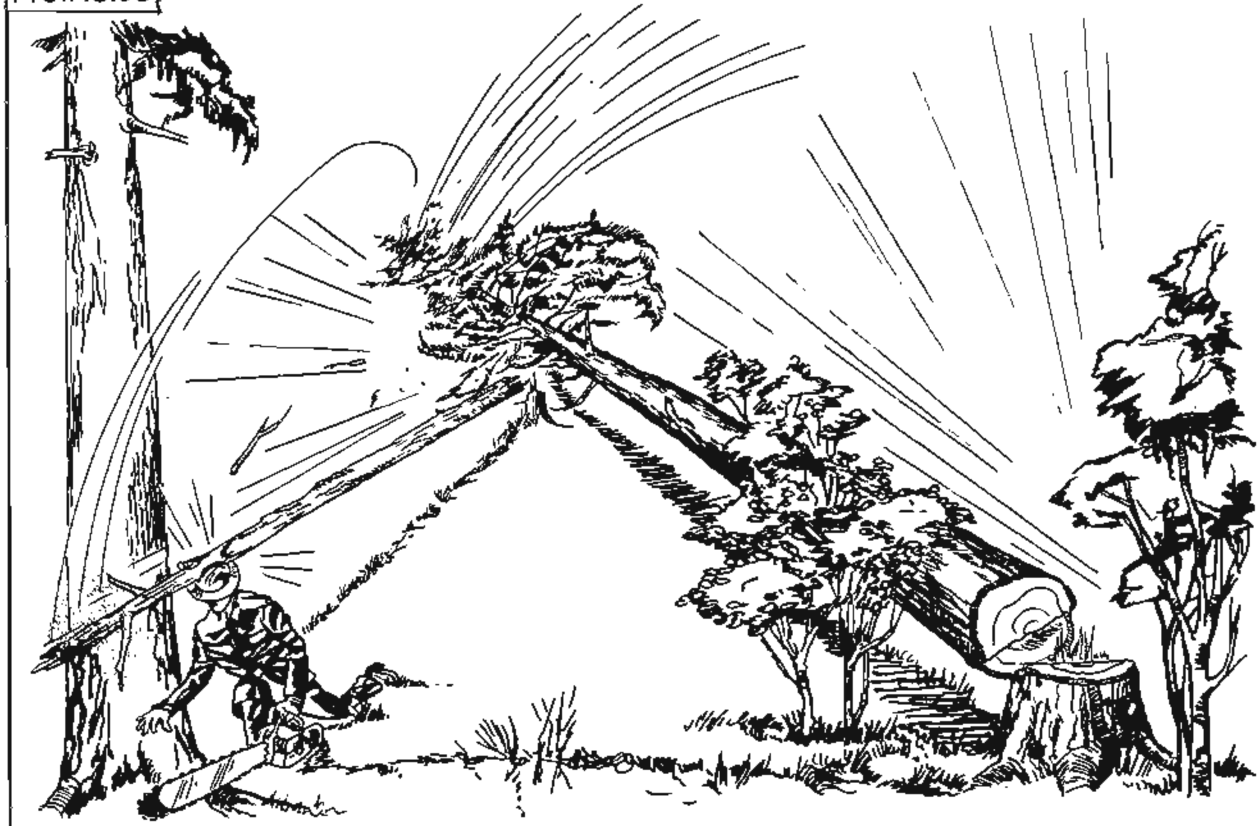
FELLER CRUSHED BENEATH BUTT OF SPLIT TREE THAT KICKED BACK.

FIG. P.S. 67



FELLER KILLED BY TOP OF FALLING SNAG.

FIG. P.S. 68



FELLER KILLED BY FALLING SNAG WHICH WAS STRUCK BY FELLED TREE.

FIG. P.S. 69.

THE TIMBER FELLER WAS INSTANTLY KILLED WHEN CRUSHED BENEATH THE BUTT OF A 45 cm DIAMETER TREE AS HE WAS TRYING TO SAVE THE SAW AFTER CUTTING THROUGH THE HOLDING WOOD, LETTING THE TREE FALL SIDEWAYS, PINCHING THE CUTTER BAR.

(4) Remove all traces of fuel and oil from the outside of the saw before starting.

(5) Start engine at least 3m from the place of fueling.

(6) Use the proper mixture and grade of oil and fuel to minimise carbon formation.

(7) Do not wait for the engine to run out of fuel before refueling.

(8) Check fuel lines periodically for leaks.

(9) Remove carbon from muffler at least once a week.

(10) Check insulation of the spark-plug wire regularly.

(11) Do not use a saw that back-fires or misses - have it repaired.

(12) Do not leave a hot saw on dry litter or slash.

(13) When moving from a cut, check sawdust and litter for sparks.

(14) Keep an approved fire extinguisher handy, but not on the saw.

(15) Do not leave the saw standing idling unattended.

(16) Do not leave the cutting area earlier than 15 minutes after stopping the saw.

(17) Do not leave empty fuel cans in the bush.

(18) Remember the ember.

(b) FIRE FIGHTING TOOLS

(1) Keep an approved fire extinguisher close at hand.

(2) Keep a shovel and packpump nearby.

(3) A piece of canvas kept handy is usefull to cover the saw as it will smother a small flame.

D. ACCIDENTS IN THE USE OF POWER CHAIN SAWS

The illustrations included in this section are published by courtesy of the Oregon State Accident Commission of the U.S.A.; and illustrate actual accidents which occurred during logging operations.

(a) TIMBER FELLER KILLED BY FALLING LIMB (Fig. P.S. 65)

A timber feller was instantly killed when struck on the head by a limb (1m long and 13 cm in diameter) that was broken off and thrown back as the falling tree brushed against another tree.

Preventive measures:

(1) Fell trees away from standing trees.

(2) Fell trees first that may interfere with the felling of other trees.

(3) Move a safe distance from the stump as the tree starts to fall, keeping a watchful eye overhead for falling branches.

(b) FELLER CRUSHED BY FALLING TREE (Fig. P.S. 66)

The feller was instantly killed when crushed beneath the butt of a tree that split up, kicked back and then fell on him.

Preventive measures

(1) Look each tree over carefully to determine the direction of fall, then make an adequate undercut. If the tree leans, relieve pressure gradually by angled cuts.

(2) Plan your way of escape in advance - to the back and to one side of the tree.

(c) FELLER KILLED BY TOP OF FALLING SNAG (Fig. P.S. 67)

The feller was instantly killed when the top of a snag brushed a standing tree, broke and snapped back, striking him on the head and shoulders as he attempted to leave the area with his power saw.

Preventive measures

(1) Fell all snags into the open.

(2) When the tree starts to fall, get clear as quickly as possible, and leave the saw if there is immediate danger.

(d) FELLER KILLED BY FALLING SNAG (Fig. P.S. 68)

The timber feller was instantly killed when struck on the head by a falling snag. He had tried to fell the snag but when it settled back, he felled another tree to knock it over. This caused the snag to twist off the stump and fall back towards him.

Preventive measures

(1) Never leave a cut snag standing. Wedge it over if necessary.

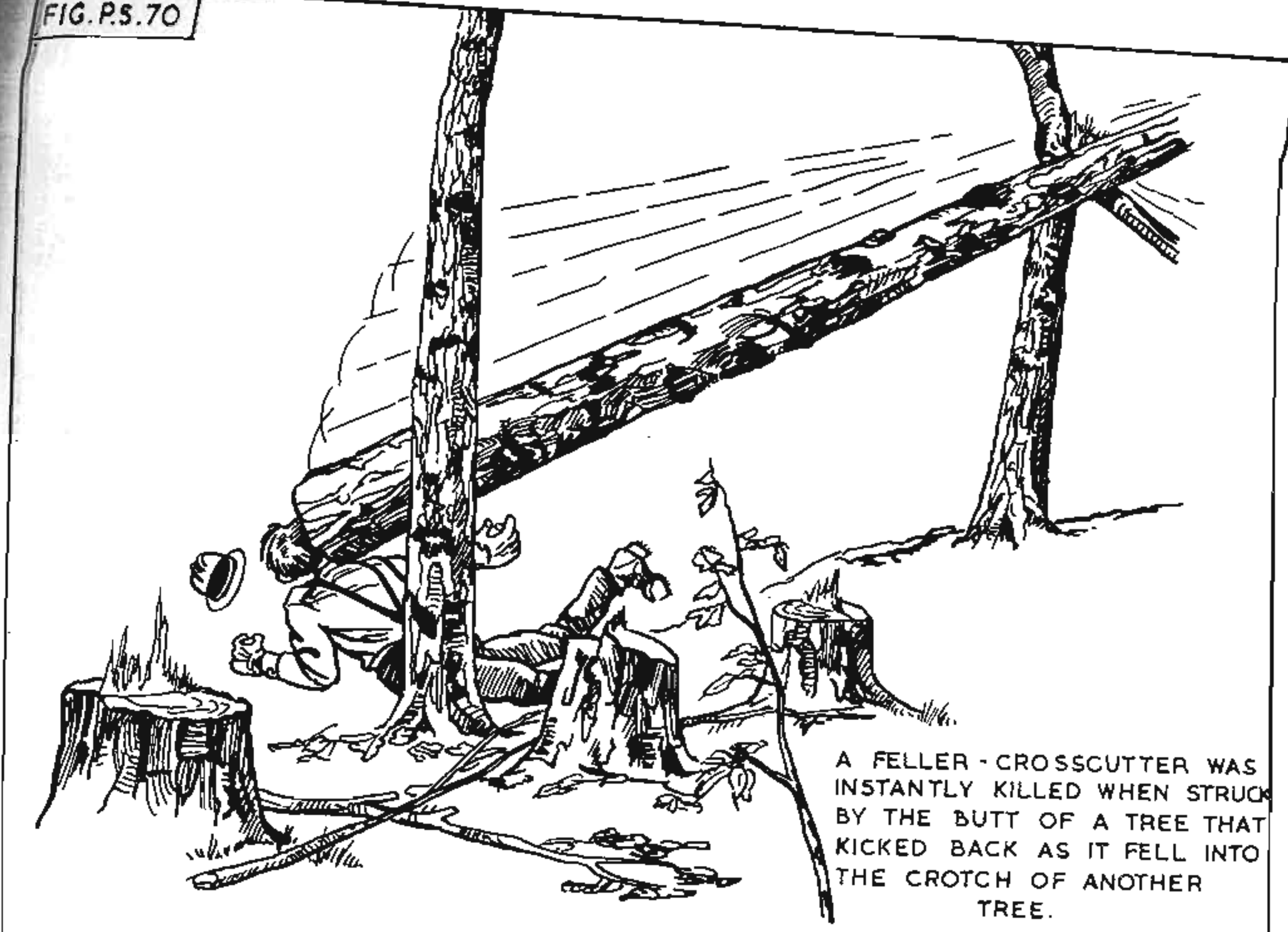
(2) Move to a safe place, behind another tree if possible, when the felled tree starts to move.

(3) Plan and clear a predetermined route of escape to a safe place.

(e) FELLER KILLED BY SIDEWAYS FALLING TREE (Fig. P.S. 69)

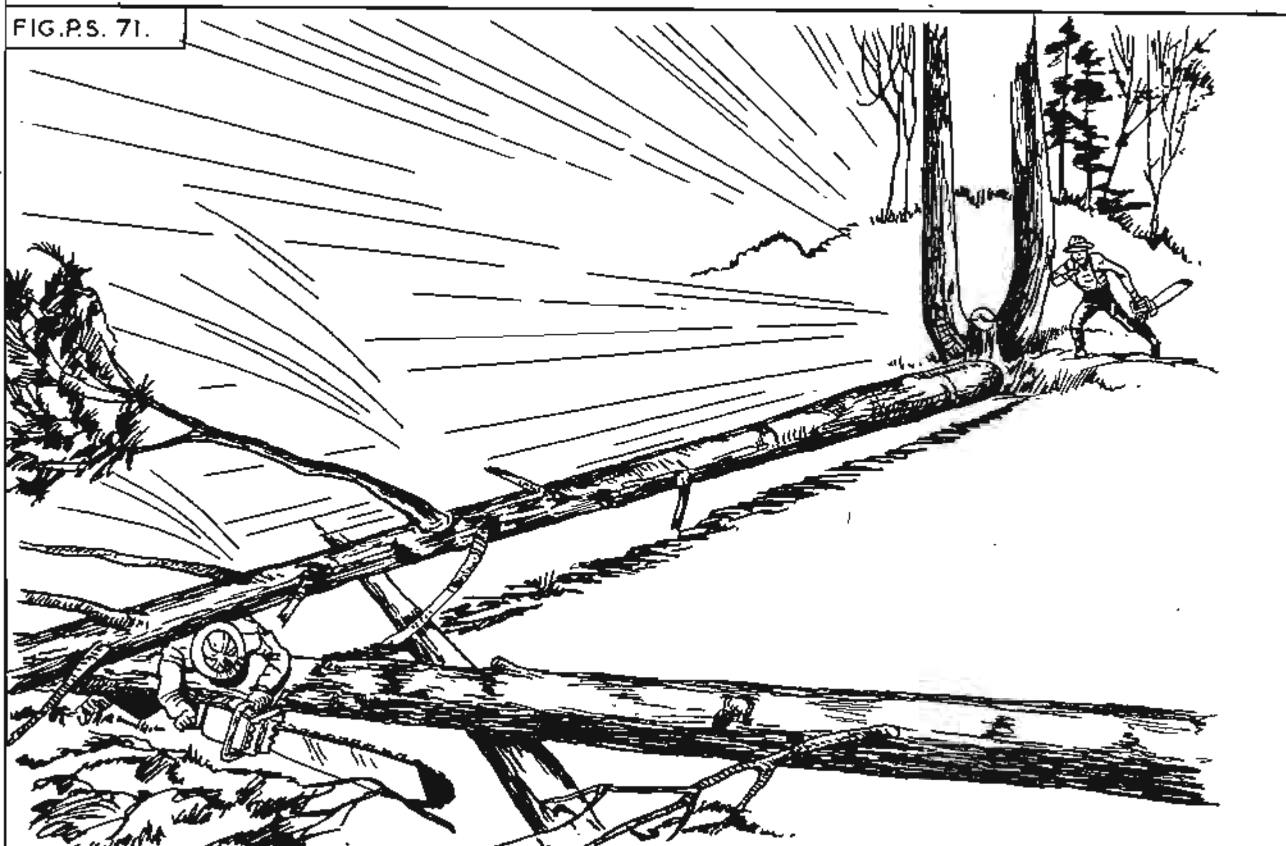
The timber feller was instantly killed when crushed beneath the butt of a 45 cm tree as he was trying to save the saw after cutting through the holding wood, letting the tree fall sideways, pinching the cutting bar.

FIG. P.S. 70



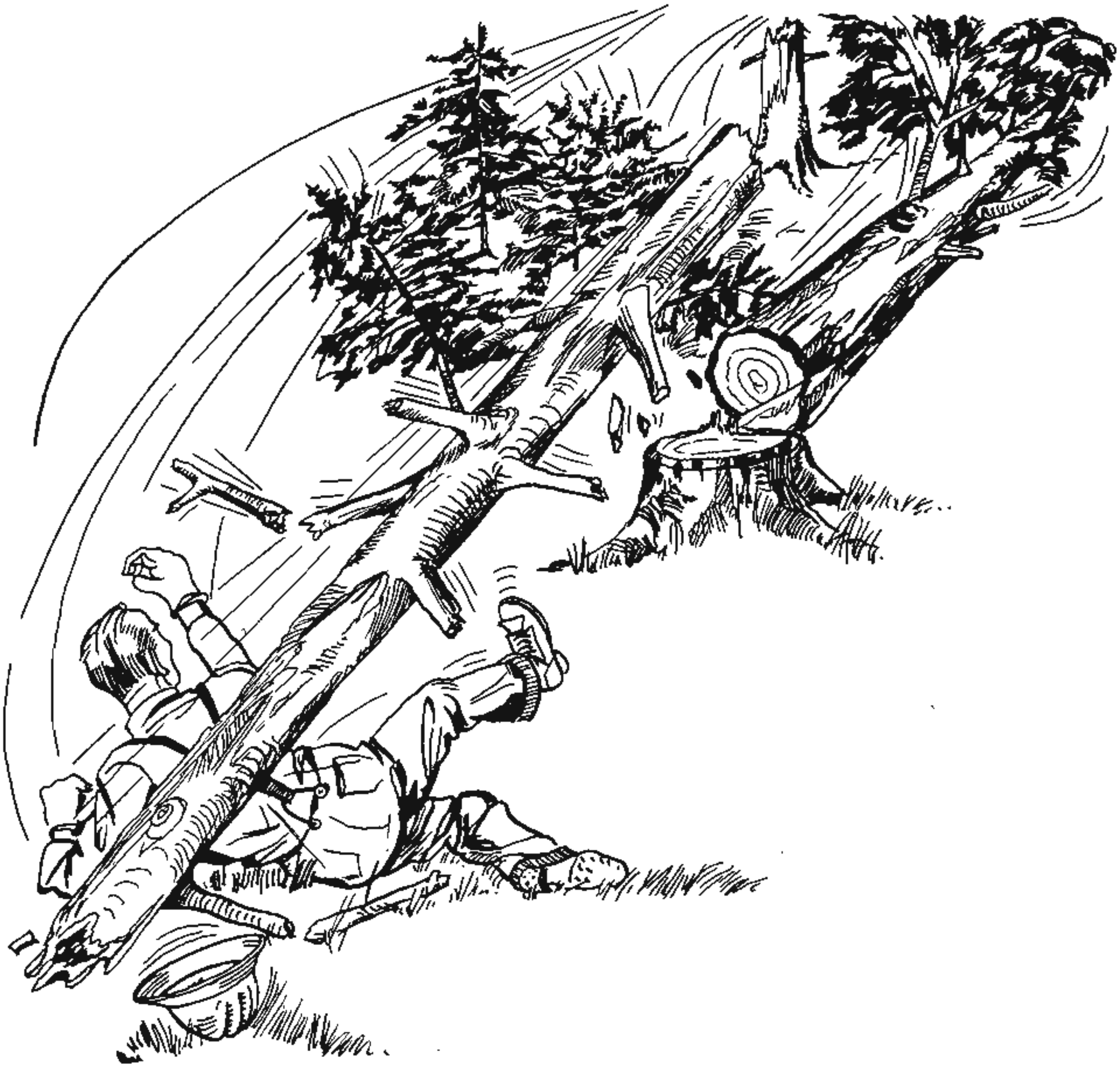
A FELLER - CROSSCUTTER WAS INSTANTLY KILLED WHEN STRUCK BY THE BUTT OF A TREE THAT KICKED BACK AS IT FELL INTO THE CROTCH OF ANOTHER TREE.

FIG. P.S. 71.



FELLER - CROSSCUTTER KILLED WHEN STRUCK BY A TREE FELLED BY A FELLOW WORKMAN WHO HAD CUT THE HOLDING WOOD ON ONE SIDE OF THE TREE, LETTING IT FALL AT AN ANGLE TO THE UNDERCUT.

FIG. P.S.72.



A FELLER-CROSSCUTTER WAS INSTANTLY KILLED WHEN STRUCK BY A SNAG THAT BROKE 5 METRES ABOVE THE GROUND AND FELL BACKWARDS AS A TREE WAS FELLED INTO IT TO KNOCK IT DOWN.

FIG. P.S. 73

CROSSCUTTER INSTANTLY KILLED BY A FALLING LIMB.

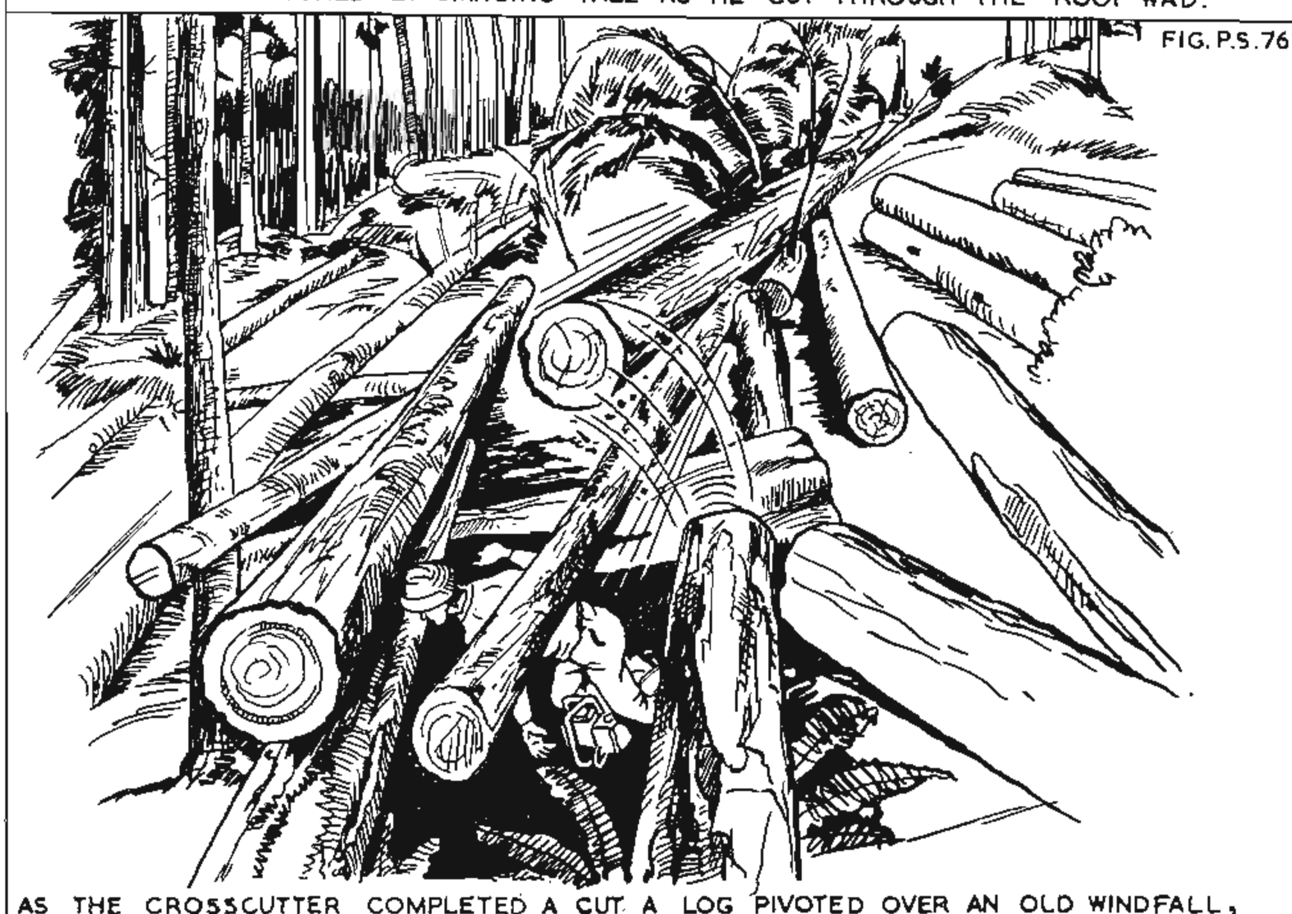
FIG. P.S. 74

CROSSCUTTER KILLED BY SLIDING TREE THAT WHIPPED DOWN THE STEEP SLOPE.

FIG. P.S. 75.

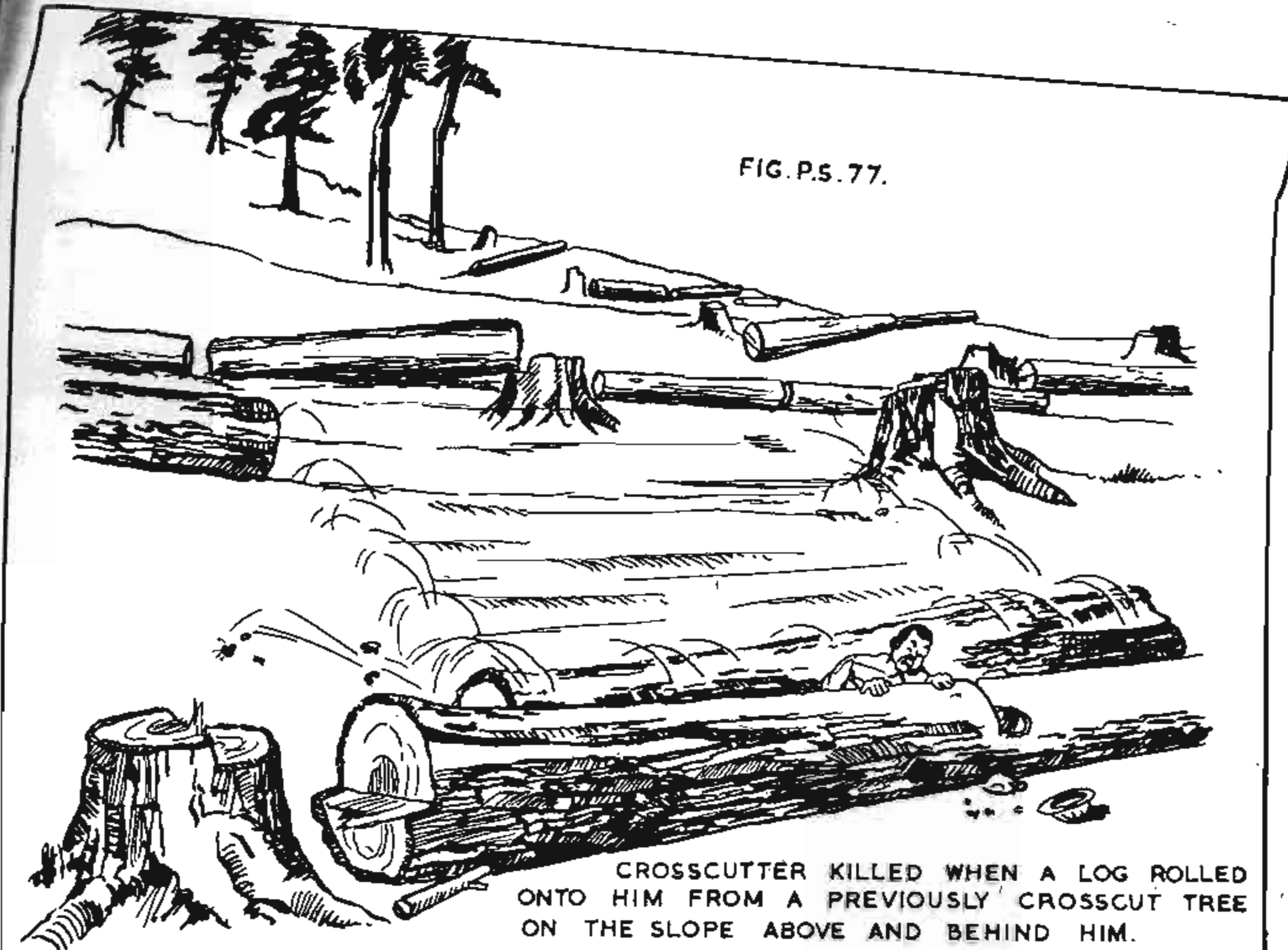
CROSSCUTTER CRUSHED BY SWINGING TREE AS HE CUT THROUGH THE ROOT WAD.

FIG. P.S. 76



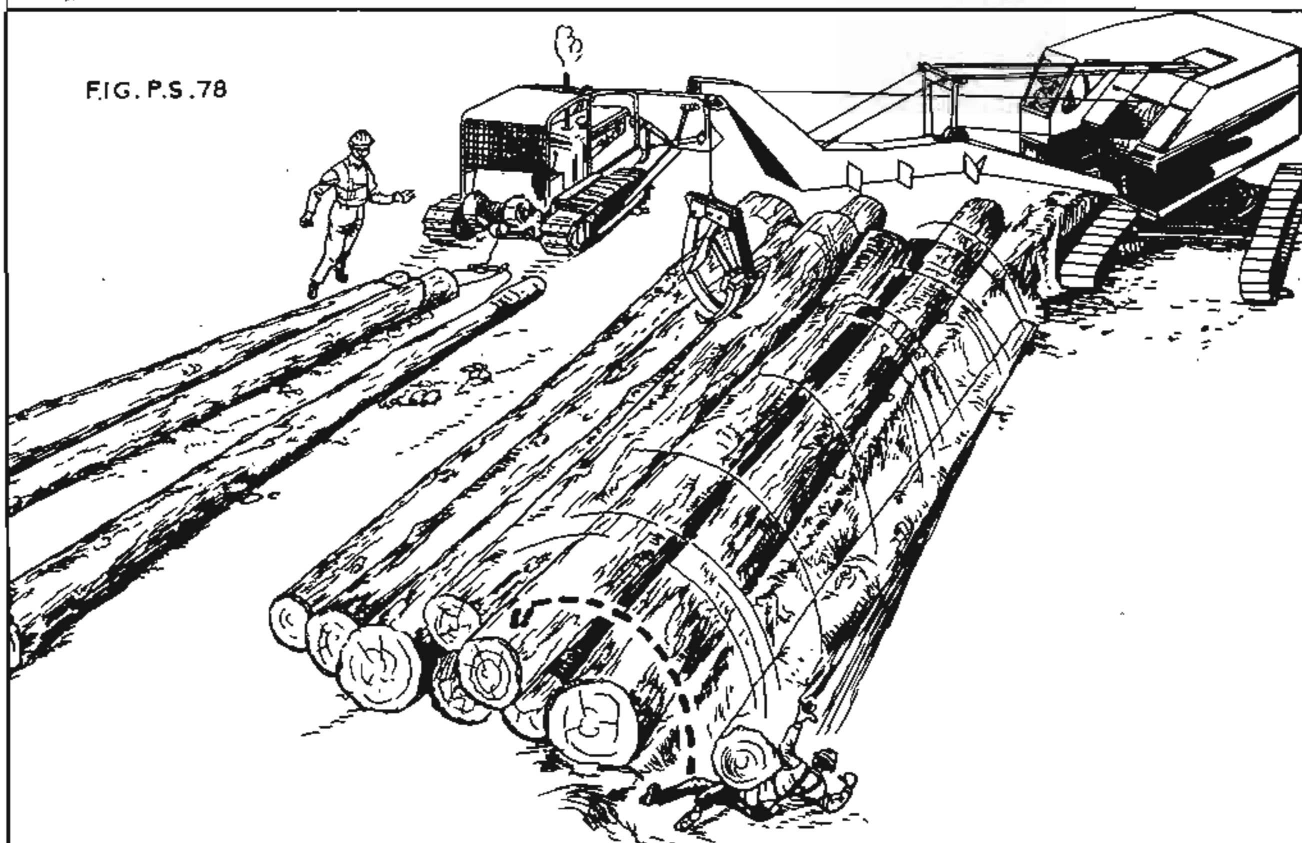
AS THE CROSSCUTTER COMPLETED A CUT A LOG PIVOTED OVER AN OLD WINDFALL, DISLODGING A LOG FROM ABOVE, WHICH ROLLED ONTO HIM, CRUSHING HIM.

FIG. P.S. 77.



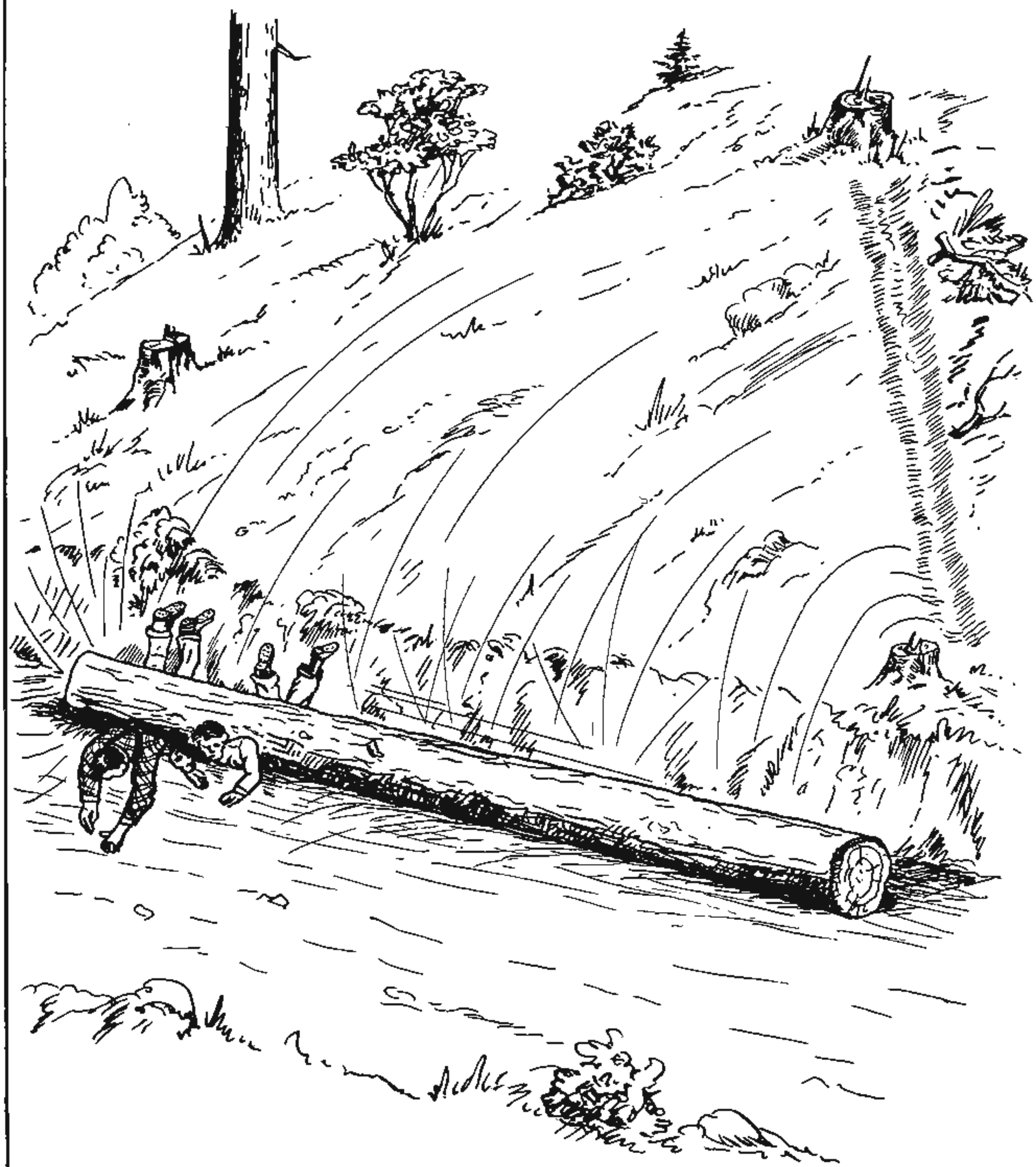
CROSSCUTTER KILLED WHEN A LOG ROLLED ONTO HIM FROM A PREVIOUSLY CROSSCUT TREE ON THE SLOPE ABOVE AND BEHIND HIM.

FIG. P.S. 78



A CROSSCUTTER AT THE LANDING DECK WAS KILLED WHEN THE LOG ON WHICH HE WAS STANDING ROLLED, THROWING HIM OFF BALANCE AND INTO THE PATH OF THE SAME LOG, WHICH STRUCK HIM.

FIG. P.S. 79.



TWO FELLERS WERE INSTANTLY KILLED BY A SECTION OF TREE THAT ROLLED DOWN THE HILLSIDE CRUSHING THEM BENEATH IT AS IT CAME TO REST AT THE ROADSIDE. THEY WERE WALKING BELOW THE SECTION OF THE TREE AS THEY WERE LEAVING THE AREA.

Preventive measures

(1) Make an adequate undercut and retain sufficient holding wood to control and guide the tree in the intended direction of fall.

(2) In all cases, clear the undercut and do not leave any excess wood that may cause the holding wood to break prematurely.

(f) FELLER KILLED WHEN STRUCK BY BUTT OF TREE (Fig. P.S. 70)

The feller was instantly killed when he was struck and crushed by the butt of a tree that kicked back as it fell into the crotch of another tree.

Preventive measures

(1) Trees that are likely to be brushed by a falling tree must be felled first.

(2) Fell trees into the open whenever possible.

(3) Plan and prepare a way of escape before felling trees.

(g) FELLER-CROSSCUTTER STRUCK BY TREE FELLED BY FELLOW WORKMAN (Fig. P.S. 71)

The feller-crosscutter was dead on arrival at the hospital as the result of injuries received when he was struck by the top of a tree felled by a fellow workman, who had cut the holding wood through on one side of a small tree, letting it fall at an angle to the undercut.

Preventive measures

(1) Retain adequate holding wood to guide the tree in the desired direction of fall.

(2) Fellers should warn all other workmen in the vicinity well in advance of the fall of the tree.

(3) Plan ahead and locate fellers so that they will not endanger other workmen.

(h) FELLER-CROSSCUTTER KILLED BY FALLING SNAG (Fig. P.S. 72)

The feller was instantly killed when he was struck by a snag that broke 5m above the ground and fell backwards as a tree was felled onto it to knock it down.

Preventive measures

(1) Fell trees into the open whenever possible.

(2) Dangerous trees and snags which are likely to be brushed by a falling tree shall be the first to be felled.

(3) Plan a safe route of escape, preferably behind another tree to the rear and side of the tree being felled.

(i) CROSS-CUTTER KILLED BY FALLING BRANCH (Fig. P.S. 73)

The cross-cutter was killed when struck on the head by a limb that fell from a standing tree while he was cross-cutting a top directly beneath it. The limb was one of several that were broken and left hanging after being brushed by a large tree that a feller had let fall sideways, when it settled back on the stump.

Preventive measures

(1) Retain enough holding wood to control the fall of trees and fell them into the open.

(2) Use wedges, when necessary, to tip a tree in the desired direction of fall.

(3) Avoid working under hanging limbs, but if necessary, ask a fellow workman to keep a watch overhead while sawing.

(j) CROSS-CUTTER KILLED BY SLIDING TREE (Fig. P.S. 74)

The cross-cutter died en route to hospital from injuries received when he was struck by the top of a tree that suddenly whipped downhill, striking him in the back as he was preparing to cross-cut a tree that lay below the last felled tree.

Preventive measures

(1) Cross-cut each tree after felling when working on hillsides and stay above the tree being cross-cut, and above previously cross-cut boles.

(2) Look the tree over carefully to determine the safe way to cross-cut it, then proceed accordingly.

(k) CROSS-CUTTER CRUSHED BY SWINGING TREE (Fig. P.S. 75)

The cross-cutter died five days later as the result of injuries received when the tree from which he cut the root-wad pivoted around a small snag, struck him in the chest and crushed him against another wind-blown tree.

Preventive measures

(1) Carefully examine windfall trees to determine the safest way to cut them, then proceed accordingly by the safest method. Preferably stand on the clear side of a tree if the slope permits.

(l) CROSS-CUTTER KILLED BY DISLODGED LOG (Fig. P.S. 76)

As the cross-cutter completed a cut, a log from the bole pivoted over an old windfall, dislodging a log from above, which rolled on him, crushing him.

Preventive measures

(1) Look the tree over to find the safest way to cross-cut it.

(2) Take the greatest care when standing below loose or unstable logs.

(m) CROSS-CUTTER KILLED BY ROLLING LOG (Fig. P.S. 77)

The cross-cutter was cross-cutting four trees, just below one that was cross-cut the previous day, when a log 10m long and 90cm in diameter rolled from the tree above him, crushing and killing him instantly.

POWER – DRIVEN CIRCULAR SAW.

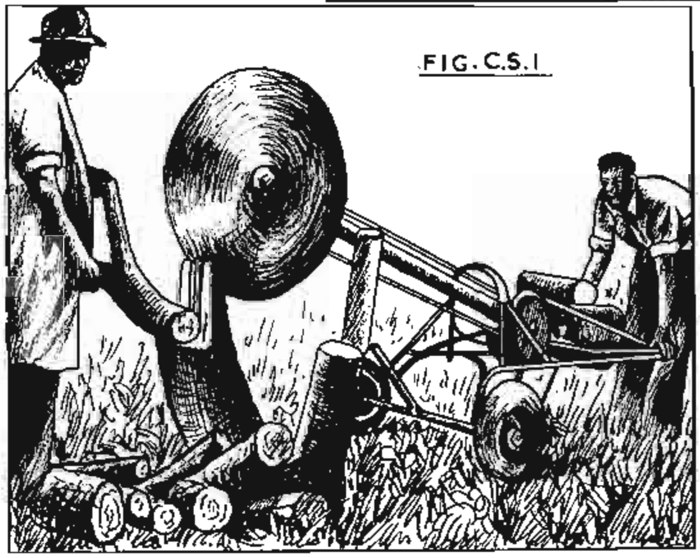


FIG. C.S.1

FIG. C.S.2.

CROSSCUTTING FIREWOOD.

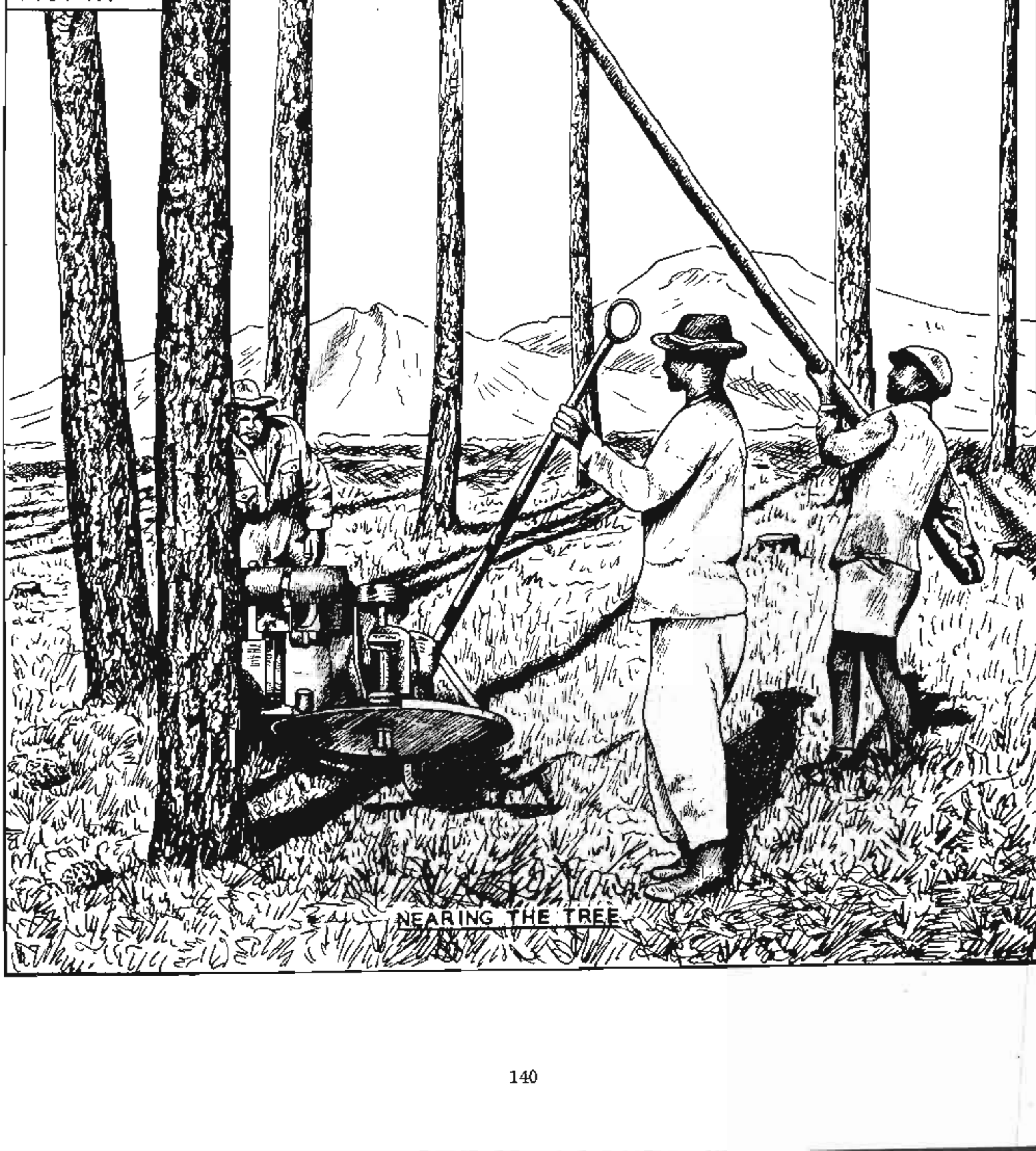
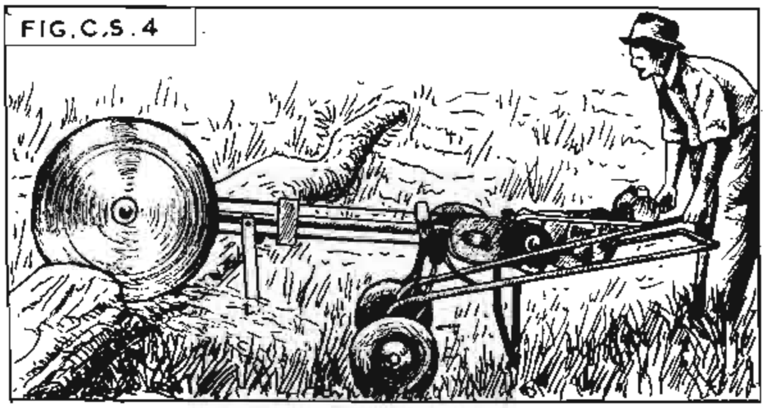


FIG. C.S.3

POWER-DRIVEN CIRCULAR SAW.

FIG.C.S.4

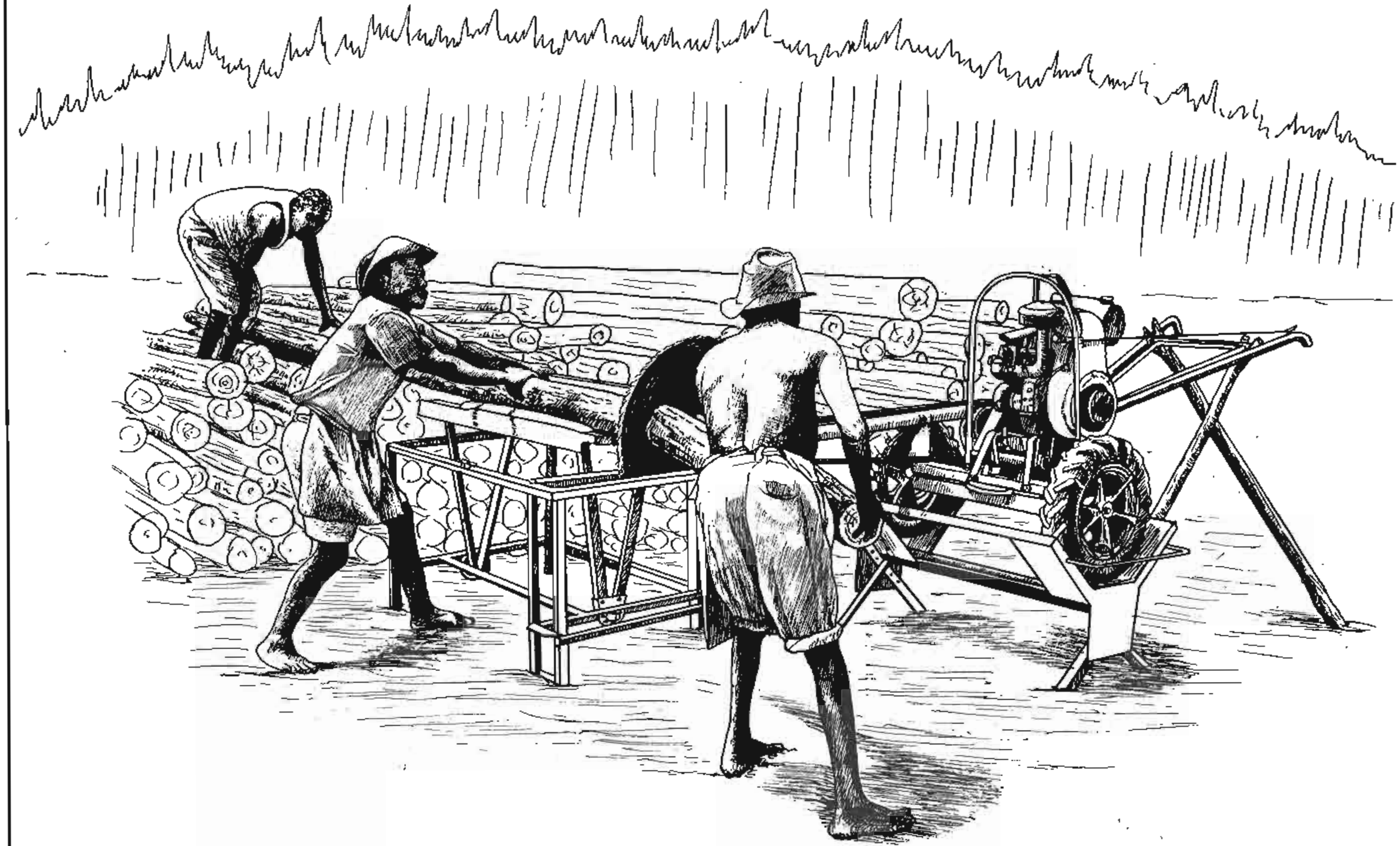


CROSSCUTTING

FIG.C.S.5.

FELLING

FIG.C.S.6.



CROSSCUTTING OF SHORT LOGS BY PORTABLE CIRCULAR CROSSCUT SAW, SHOWING MOUNTING AND HINGED TABLE.

Preventive measures

(1) Arrange the work so that workmen will not be working below previously cross-cut logs.

(2) Make dangerous logs secure by blocking or snubbing if working below them is unavoidable.

(n) CROSS-CUTTER KILLED BY LOG ROLLING ON HIM FROM STACK (Fig. P.S. 78)

The cross-cutter was killed when a log in the landing deck that he was standing on suddenly rolled, throwing him off balance and into the path of the same log, which struck him.

Preventive measures

(1) Workmen should be required to stay in the clear of operations where they are not assigned to work.

(2) Stay in the clear of logs that show a tendency to roll or slide.

(o) TWO FELLERS INSTANTLY KILLED BY ROLLING SECTION OF TREE (Fig.P.S. 79)

Two timber fellers were instantly killed when they were crushed by a 20m section of a tree that rolled down the hillside, crushing them beneath it as it came to rest in a roadside ditch. They were walking below the section of the tree as they were leaving the area after felling the last tree.

Preventive measures

No rigid preventive measures can be prescribed. When leaving the area just felled, however, the feller should walk on the opposite side of the road from the uphill slope and be alert for rolling logs or stones.

5. PORTABLE POWER CIRCULAR SAW

The power circular saw is usually chassis mounted, belt driven and equipped with two rubber-tyred wheels. It is powered by a petrol engine of about 5,2 kW. The unit may be self propelled, with one wheel being driven, or it may require to be pushed by the operator when moving from place to place. For logging purposes a 10 gauge blade with a diameter of 105cm is suitable for felling trees of small or medium diameter.

The saw may be used for felling, cross-cutting, or cutting firewood, as the blade may be positioned horizontally or vertically.

A. OPERATION

When felling trees the blade is positioned horizontally, as shown in Fig. C.S. 3 and 5. When nearing the tree (Fig. C.S. 3) the saw must be positioned with the middle of the blade diameter towards the girth mid-point of the tree, i.e. the centre of both the saw and the tree are in a line at right angles to the saw arm. The saw must be engaged at full throttle, and the operator pushes the saw through the tree by acting side-ways on the handles (*Fig. C.S. 5*). Trees with large diameters are usually felled with two cuts from opposite sides by the standard method, but small trees (up to 40cm) may be felled with one cut, with the lean (if any), provided that a man with a push stick assists in directing the fall of the tree.

For cross-cutting (Fig. C.S. 4) the blade is positioned vertically, with its diameter mid-point over the mid-point of the log diameter. By lifting the handles the operator engages the saw in the log at full throttle. If necessary, assistance must be provided to prevent the saw from pinching, as wedging is obviously impossible. In this case the log must be propped up by push sticks on both sides of the saw.

The limitations of the saw become evident when it has to move from cut to cut, as the saw is mounted on wheels and cannot be carried. Under ideal conditions its speed of movement is that of a walking man. In felling, generally speaking, if the ground is flat and no surface obstacles are encountered, movement is easy and efficient, and self propelled units can move under their own power. If surface conditions are unfavourable, however (slope, littered with slash, branches, etc.), the operator's assistance will be required to move the saw. If pushing is not sufficient, the assistant operator should assist movement by acting on the rim of the wheel which is not mechanically driven. Under such conditions movement is considerably limited. Non-self-propelled units would obviously require more manpower for their movement. In cross-cutting in the compartment fallen trees provide added obstruction to hinder the movement of the saw, while at cross-cutting decks logs of previously cross-cut boles are usually a hindrance to movement, unless they are swiftly removed.

B. USE OF THE SAW

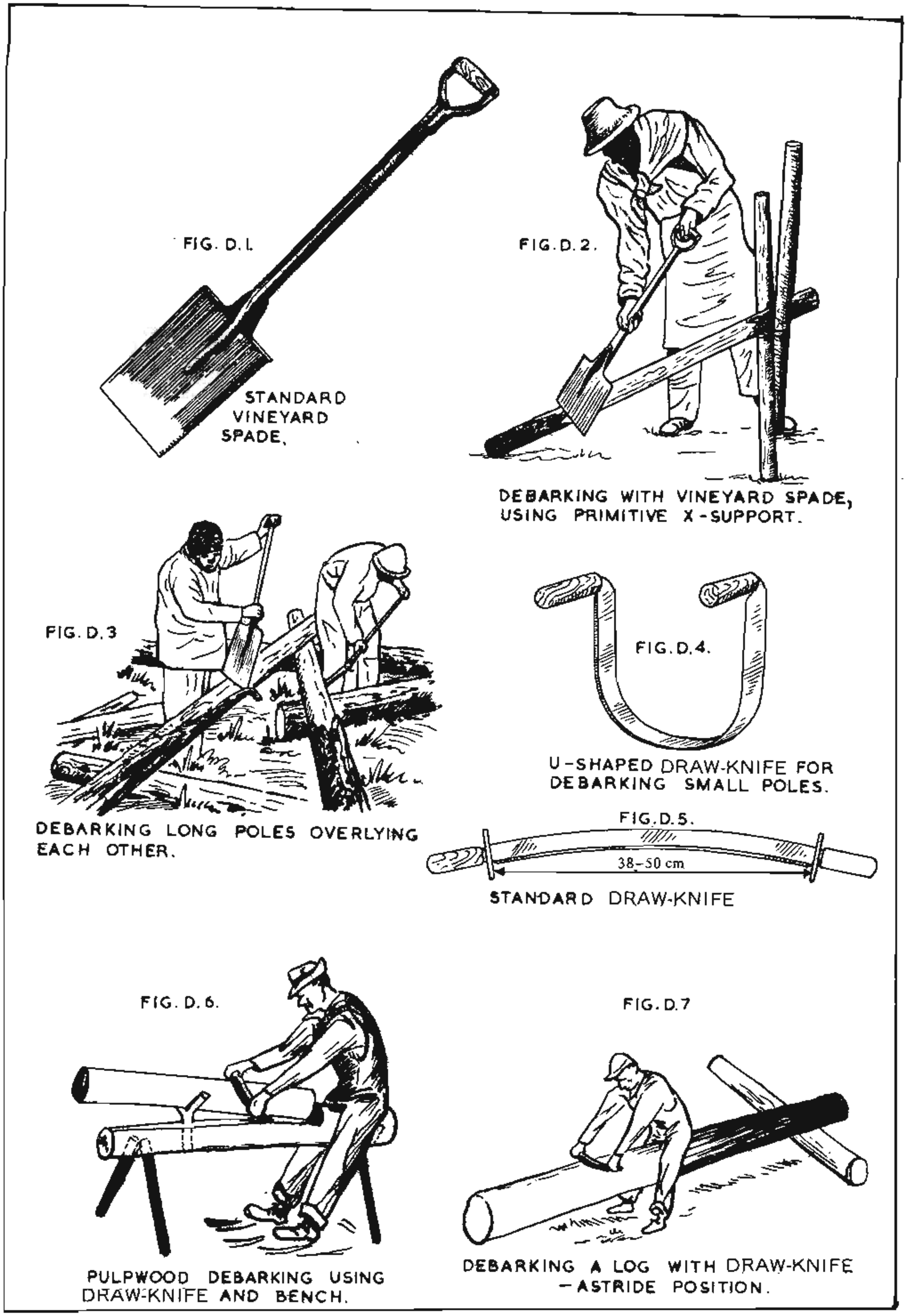
Ideal conditions for using the saw in felling occur in flat country with little or no surface obstacles, where small or medium trees of up to 40cm diameter are to be felled. For cross-cutting, flat, spacious log decks are the ideal. In conditions other than these the saw is an encumbrance rather than an asset owing to difficulties experienced in moving the saw from cut to cut.

The saw may also be used for cutting poles to length or for cutting firewood. No attempt should be made to cut poles, light logs or firewood on the ground, as the saw will violently throw the cut section aside. Fig. C.S. 1 and 2 illustrate a method of cutting firewood, using a simple stump "bench" with a pre-cut fork. Fig. C.S. 6 shows the saw mounted in a rigid position on a portable base with the saw positioned in a hinged log bench. The logs are pushed against the saw by means of the hinged part of the bench, as illustrated.

C. CREW REQUIRED

(a) FELLING

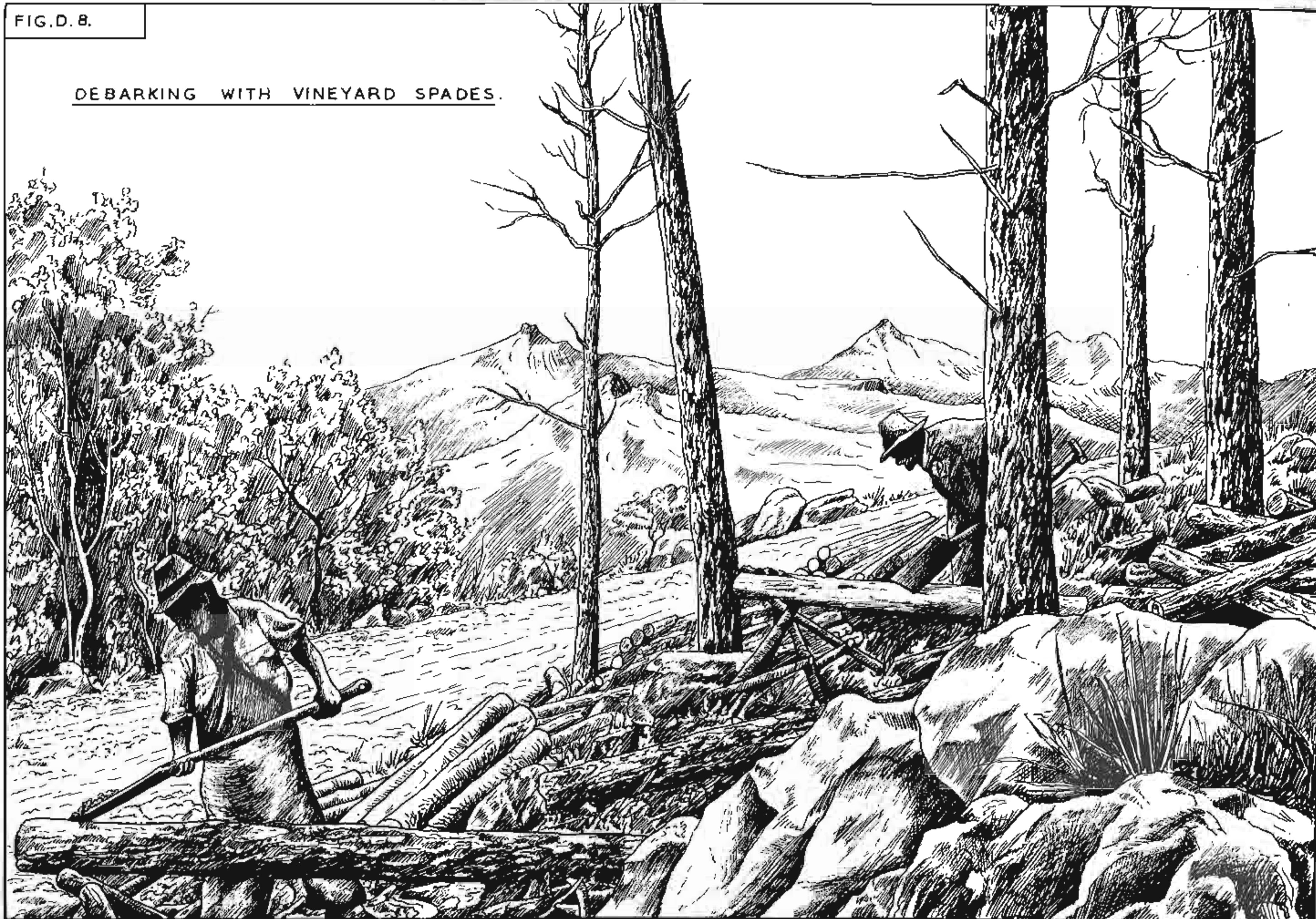
One operator, 1 assistant operator, 1 man with a push stick to direct the fall of the tree, and 1 man to clear a route of access for the machine to the trees to be felled. If the operator is skilful and access to trees presents no problems, two men would probably suffice.



HAND TOOLS AND THEIR APPLICATION

FIG.D.8.

DEBARKING WITH VINEYARD SPADES.



(b) CROSS-CUTTING

For cross-cutting, which should preferably be done at the log deck: 1 operator, 1 assistant operator, and 3 or 4 men with push sticks to prop or stabilise the log while it is being cut.

D. POWER CIRCULAR SAW UNIT TESTED DEPARTMENTALLY

The self-propelled unit tested Departmentally proved to be attractively fast as far as the actual cutting was concerned, but this asset was offset to a large extent by the difficulties experienced in moving the saw. The number of labourers required to move the saw, or to steady logs for cross-cutting, was out of proportion from an economic point of view.

The main disadvantage of the unit for tree felling was that the minimum cutting height above the ground was 30cm, while for easy access of logging equipment a stump height of from 10 - 15cm, is required.

E. DETAILS OF CROSS-CUTTING TEST

The saw was tested in cross-cutting trees at a fairly flat, firm highlead landing, where tree lengths were skidded, cross-cut by the power circular saw, and the cross-cut logs removed to the stacking deck by two teams of animals.

The test was observed for 2 hours 2 minutes, during which time the saw was in operation for 1 hour 12 minutes, being idle for 50 minutes while logs were removed from the cross-cutting to the stacking decks by the animal teams.

Average tree volume : $0,36m^3$ - 2,8 logs
Average log : $0,13m^3$ - 20cm x 3,3m
Maximum diameter cut: 28cm

F. OUTPUT

30 trees - 85 logs - 86 cuts - $10,9m^3$ in 1 hour 12 minutes, i.e. $9,1m^3$ per working hour, or $5,4m^3$ per working hour if the delay for log removal is included.

G. COSTS

Costs are based on 6 men employed with the saw and the hourly cost of the unit, which cost R1 000 to purchase.

Cost per hour: 57 cents
Cost per m^3 : 6,3c or 10,2c if the delay is included

DEBARKING

A. GENERAL INTRODUCTION

Debarking is the process of removing bark from logs, this applies mainly to poles, but the debarking of logs and pulpwood will also be dealt with in this section on timber preparation.

In Departmental plantations debarking is done either manually or mechanically. The mechanisation of debarking has recently taken on added importance due to the increasing shortage of manpower, coupled with the rapid development of industry in the country. During the past decade the Department has witnessed the development of the debarking process and the evolution of debarking machinery. The greatest advance has been made in developing debarking machines for round timber.

Recent evidence indicates that debarking timber in the plantations (at the roadside) in close proximity to the timber felling area is a considerable advantage. Bark need not be transported, and the problem of disposing of bark concentrated at the sawmill is eliminated, which reduces costs proportionately. Consequently the Department has shown an increased interest in machines which are capable of working in the compartments and are as mobile as possible, so that concentrations of poles and loose bark can be avoided to a large extent. Such mobile debarking machines must be compact enough to be able to move along the narrow, twisting roads in the compartments.

There is no such thing at present as a universal timber debarker which will suit all cases, so the machine most suited to local conditions must be chosen.

It is not within the scope of this manual to deal with all the types of debarking machines available on the market, and the information given will apply only to methods and machines employed Departmentally, together with their costs. Some information will also be given with regard to the possible future employment of more advanced methods and machines.

A number of mechanical debarkers have been tested, but the machines available at the time did not prove satisfactory for plantation conditions, consequently manual debarking still plays a big part in operations, and only a few machines have been employed.

B. MANUAL DEBARKING

(a) DEBARKING BY VINEYARD SPADE (Fig. D.1, 2, 3, 8)

The vineyard spade (Fig. D. 1) has been almost universally adopted for hand debarking in Departmental plantations. The front side of the blade is concave, so when the spade is turned with the concave side to the log or pole it removes a greater area of bark than any other hand tool with a straight blade. As the vineyard spade has a long handle, the worker need not work in a low bending position, which considerably eases the strain of work. Working with both hands he can exert considerable pressure, and in the standing position he can add the mass of his body to the stroke. In addition, when standing he can achieve a longer stroke by using the swing of his body as well as the push of his arms. For further convenience a portable bench in the form of a simple tripod with its flared ends protruding at the top, may be used to elevate one end of the pole for debarking, while the other end rests on the ground (Fig. D. 8). When one half of the pole has been *debarked its position is reversed on the tripod* and the second half is done. This process may only be applied to logs or poles which can easily be lifted or handled. Large-size timber is debarked when lying on the ground (Fig. D. 3). When one side of the pole has been debarked from end to end the pole is turned over by means of peavy hooks or hand spars. Cross-sticks under large poles make turning over much easier. Large poles may be turned 4 times during the debarking process.

Debarking by vineyard spade does not give a perfect result as a lot of cambium remains attached to the wood, but it shows when it peels off during seasoning. At times it is difficult to differentiate between fresh cambium and wood surface, which is often the reason for imperfect debarking. Patches of cambium that are not removed may interfere with the timber treating process.

Note: As the vineyard spade is square in shape and has sharp corners, it is handy for removing bark around knots or other irregularities in the timber shape.

Output and costs

The following data give some idea of the output and cost of a debarking operation using the vineyard spade. The timber was freshly sawn. The tables below show figures of output for one day.

Long poles
Measurement
Length 3,65m - 7,3m
Thin diameter 7,6cm - 13,9cm
No. of poles 501
Volume - 65m^3
Predominant: - 7,3 x 13cm

Average pole: 0,13m^3
Labour: 1 foreman and 36 labourers
Costs: - R41,40
Cost per m^3 - 63,7c
Output per labourer: 1,8m^3 - 14 poles - 100m

Short poles
Measurements - 2m x 8 cm - 12,7 cm
No. of poles: - 630
Volume: - 11,72m^3

Average pole: - 0,02m^3 (Approx.)
Time: - 6 hr 15 min
Labour: - 1 foreman and 21 labourers
Costs: - R17,09
Cost per m^3: - R1,55
Output per labourer: - 0,54 m^3 - 30 poles - 60m

(b) DEBARKING BY DRAW-KNIFE (Fig. D. 4, 5, 6, 7)

The draw-knife may have a straight blade, or the blade may be slightly curved in the direction of pull to steady the tool (Fig. D. 5). For a draw-knife debarking operation to be successful the pole to be debarked must be placed on a bench, which is only possible for light logs (Fig. D. 6). A heavy bench is required, and there should be a concentration of logs in the vicinity.

Some contractors use a draw-knife curved along the plane of the blade in the form of a bow (Fig. D.4). with the handles elevated. This reduces the bending required by the workmen when peeling small poles lying flat on the ground. If small poles lying on the ground are to be debarked the "bow" draw-knife is particularly handy. Small poles do not move under the bow draw-knife.

Large poles are debarked on the ground. In this case the labourer crouches over the pole or sits astride it so as to increase his stroke length and ease his position of work (Fig. D. 7). Medium-sized logs or poles can be rolled over logs lying nearby so as to elevate them and reduce bending while working.

The finished product when debarking by draw-knife is more or less the same as when the vineyard spade is used. When the bark is thick the draw-knife is very slow and the operation uneconomic. The draw-knife is seldom used in Departmental plantations.

A hatchet is usually used in conjunction with the draw-knife for removing bark left around knots and other irregularities in the pole.

(c) DEBARKING BY AXE

Debarking poles by means of an axe of approximately 1,5kg in mass gives a better result than that of either of the tools mentioned previously, but the operation is much slower. Virtually all the bark and cambium is removed, and the operation is nearly perfect.

When one end of the pole is raised onto a bench the operation is more convenient and faster, as the axe head can make contact with the bark with the full area of the head, thus a larger area of bark is affected by the axe blow. The butt (blunt end) of the axe is used to pound the bark, which loosens and comes free. The corners of the axe blade may be used to remove any bark from around knots or irregularities on the pole surface. Repeated blows may be necessary to loosen the bark completely. When the bark has been removed from the pole from end to end it is turned over and the process is repeated. Several side turnings may be necessary to finalise the process.

The axe is seldom used for debarking as it is a slow and costly process.

(d) DATA FOR POLE PREPARATION AND DEBARKING - MANUAL LABOUR

Pole preparation was investigated primarily to determine a task-work system, to be applied to the following operation:

(i) Pole preparation as a by-product of sawlog preparation.

(ii) Timber felled for the sole purpose of pole preparation.

(iii) Debarking of poles by labourers on plantations.

The following factors will affect debarking:

(i) Task work can be given according to the tables which follow.

(ii) Trees must be debarked on the same day as they are felled.

(iii) Where the sole operation is pole preparation, the task for each labourer must be the full preparation of poles, even debarking; cross-cutting being done by different labourers.

(iv) Poles debark more easily in winter or autumn than in other seasons. Tasks were determined for operations during summer and autumn in the Cape Midlands Region.

(1) REMARKS RELEVANT TO TABLES

Table D. 1. - This table is used when labourers are only employed on debarking, which is usually the case where poles are prepared in conjunction with sawlogs. The poles are slipped to the roadside with the logs.

TABLE D. 1 - Debarking of pine poles by vineyard spade

P. pinaster	: 90 running m per unit
P. canariensis	: 96 running m per unit
P. radiata	: 1. Poles without thick bark; 135 running m per unit
	2. Poles with thick bark; 90 running m per unit

The latter will only occur with long poles

Table D. 2. - This table is used for cases where the sole purpose of the operation is pole preparation. Single logs will be counted as poles, although they are not debarked. Poles are debarked in the compartment. The labourer must stack his poles in stacks of 10 or more to simplify slipping, which must be a separate operation.

Allowed times provide for the following:

(i) Felling the tree.
(ii) Debranching.
(iii) Cross-cutting.
(iv) Debarking.
(v) Stacking the poles.

Table D. 3. - Allowed times per pole include felling, debranching, cross-cutting and stacking the smaller poles.

Table D. 4. - This table may be used when the forester wants to determine the task work for pole preparation. A normal task is determined as follows:

(i) Find a representative strip in the compartment.

(ii) Fell 40 to 50 trees and cut out the available poles.

(iii) Record the stump diameters of the trees and the thin end diameters of the poles on a production sheet and convert into allowed times.

(iv) Total allowed time ÷ number of poles = time per pole.

(v) Time per pole divided into total day time gives the number of poles for a normal day task. Labourers work in pairs.

TABLE D. 2 - Allowed times: preparation and debarking of pine poles

Length of pole	Allowed times in minutes for 2 labourers per pole		
	P. rad.	P. pin.	P. can.
m	min	min	min
1,5	5,1	7,2	6,5
1,8	5,9	8,4	7,5
2,1	6,7	9,5	8,5
2,4	7,5	10,7	9,5
2,7	8,4	11,8	10,5
3,0	9,4	13,0	11,6
3,6	11,3	15,3	13,6
4,2	13,4	17,6	15,6
4,8	15,6	20,0	17,6
5,4	18,2	22,2	19,6
6,0	21,1	24,5	21,6
6,6	24,2	26,8	23,6
7,2	27,9	29,1	25,6
7,8	-	-	27,8
8,4	-	-	30,3
9,0	-	-	32,7
10,5	-	-	37,9
12,0	-	-	43,1
13,5	-	-	48,4

TABLE D. 3 - Allowed times : preparation of pine poles, only felling and cross-cutting*

Pole length	Allowed times per pole in minutes - 2 labourers		
	P. rad.	P. pin.	P. can.
m	min	min	min
1,5	2,2	2,5	2,0
1,8	2,4	2,7	2,1
2,1	2,6	3,0	2,3
2,4	2,8	3,2	2,4
2,7	3,0	3,5	2,6
3,0	3,2	3,7	2,8
3,6	3,6	4,2	3,1
4,2	4,0	4,7	3,4
4,8	4,4	5,2	3,7
5,4	4,8	5,7	4,0
6,6	5,2	6,2	4,3
6,8	5,6	6,7	4,6
7,2	6,0	7,2	4,9
7,8	-	-	5,4
8,4	-	-	6,2
9,0	-	-	6,9
10,5	-	-	7,6
12,0	-	-	8,6
13,5	-	-	9,6

* Poles prepared from compartments solely devoted to pole preparation. Logs are counted as poles.

TABLE D. 4 - Allowed times : preparation of pine poles

Felling and debranching		Cross-cutting	
Stump diam.	Allowed times 2 labourers	Pole diam.	Allowed time in minutes 2 labourers <u>P. pin.</u> <u>P. can.</u> <u>P. rad.</u>
cm	min	cm	
8	1,1	5 - 8	2,0
10	1,9	9 - 12	2,5
12	2,7	13 - 15	3,0
14	3,5	16 - 18	3,6
16	4,3	19 - 20	4,1
18	5,0	21 - 24	4,6
20	5,7	-	-
22	6,6	-	-
24	7,4	-	-

Allowances made: Felling and debranching
1. 10 per cent incidental allowance on sawing time
2. 20 per cent resting allowance based on time per cut
3. 12 per cent resting allowance for walking

Allowances made : Crosscutting
1. 30 per cent for additional cuts
2. 20 per cent resting time based on time per cut.
3. $12\frac{1}{2}$ per cent resting time for walking

(2) CONTROL OF THE SCHEME

The production of the labourers must be recorded on the production sheet and allowed times filled in on the sheet.

In all cases the day time will be 540 minutes.

For work as in Table D. 1, the total length of the poles will be recorded on the production sheet instead of the total time. In this case the task will consist of the number of running metres.

Note: No provision is made for thin-end diameters below 13cm, as this is dealt with under the preparation of droppers.

Production sheet - pole preparation

Plantation ______________ Foreman ______________ Date ______________

Compartment ______________ Slope ______________ Species ______________

Indicate with a cross: 1. Preparation; or 2. debarking; or 3. preparation and debarking

Pole length	Table time/ pole	Team No.		Team No.		Team No.	
		No. of poles	Time for poles	No. of poles	Time for poles	No. of poles	Time for poles
Total							
Add time for slope							
Total							

Percentage allowance for slope:

0 - 15°	....	no allowance
16 - 20°	....	plus 5%
21 - 30°	....	plus 10%
31 - 40°	....	plus 15%
over 40°	....	plus 20%

FIG. D.9.

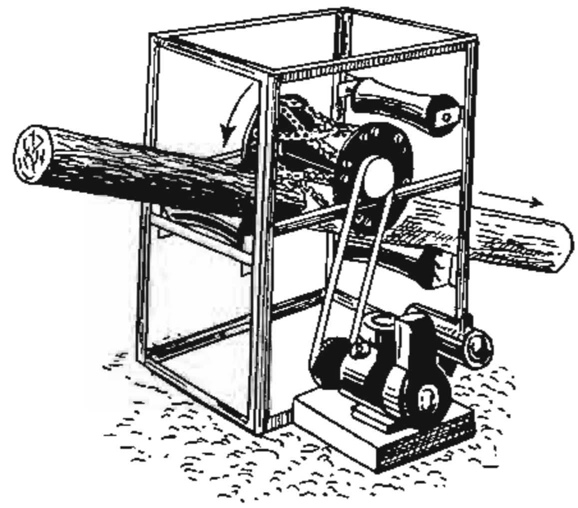
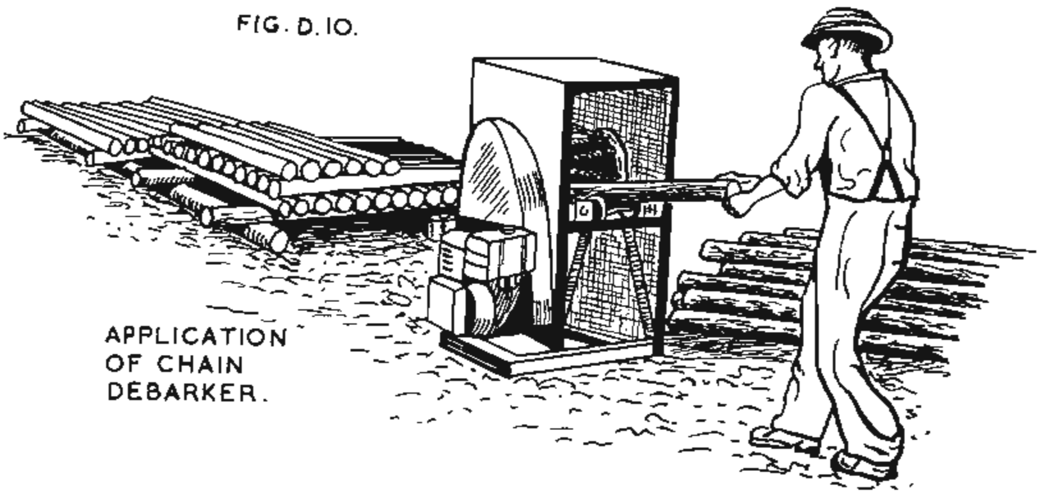


DIAGRAM OF CHAIN DEBARKER.

FIG. D.10.



APPLICATION OF CHAIN DEBARKER.

FIG. D.11.

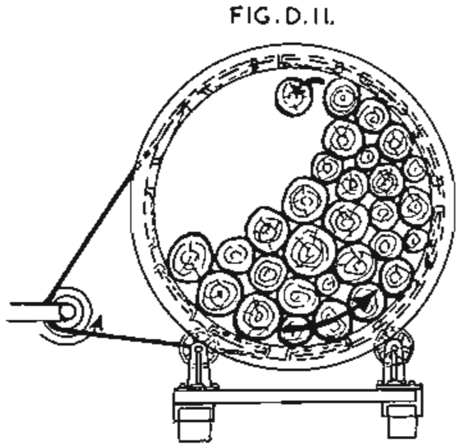


DIAGRAM SHOWING WORKING OF TRANSPORTABLE DRUM DEBARKER.

FIG. D.12

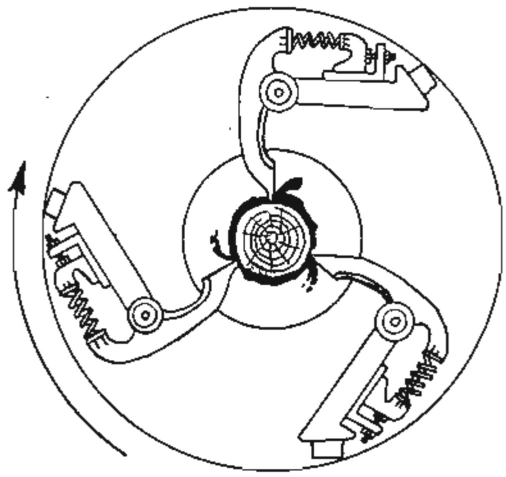


DIAGRAM SHOWING WORKING PRINCIPLE OF SÖDERHAMN B.12M RING DEBARKER.

MECHANICAL DEBARKING

C. METHOD OF DEBARKING : MECHANICAL DEBARKING

Two main methods of debarking may be distinguished:

(1) The separation of the bark from the wood takes place at the area of contact, where the cambium is located. Machines follow this area of contact.

(2) By rigid machines equipped with debarking "knives" which cut uniformly through the bark and wood, giving a uniform shape to the log or pole. At times the bark may not be completely removed, and on occasions the wood may be cut.

The Department has adopted the former method, i.e. removing the bark at the point of contact between the bark and the wood, leaving the wood intact.

D. CHOICE OF METHOD AND EQUIPMENT

For the majority of plantations mobile debarking units appear to be the most suitable. When considering the selection of a machine, however, the following factors must be considered:

(i) Mobility.
(ii) Purchase cost.
(iii) Power required.
(iv) Feed rate and output.
(v) Diameter and length of timber to be debarked.
(vi) Crookedness of material machine can peel.
(vii) Wood loss.
(viii) Feeding equipment in relation to the concentration of wood available.
(ix) Labour required, and labour qualifications.
(x) Logging equipment best suited to the debarking process.

Regardless of the choice of even the best machine, the output can be affected by:

(i) Irregular feed, i.e. interval between logs too great.
(ii) Irregular form of logs (knots, crookedness, etc.).
(iii) Dry wood.
(iv) Conditions of bark (hardness and thickness), which affects seasoning, felling and debarking.

The machines tested Departmentally were all of the cambium type, i.e. the bark was separated from the wood at the point of contact. The methods tested fell into the following categories:

(i) Breaking cambium tension, using hand tools. - The tension method pulls the cells of the cambium layer apart. The cambium has moderate resistance to tension, so hand-operated tools may be used as less power is required. This method is most successful if applied during the season of rapid growth and immediately after trees have been felled.

(ii) Direct crushing types-chain operated machine (Fig. D. 9). - The direct crushing type of machine removes by eroding some of the bark, and then peels the bark.

(iii) Indirect crushing types-drum peeler (Fig. D. 11). - The indirect crushing-type of machine removes by eroding some of the bark before the cambium is crushed.

(iv) Shear machine for rupturing the cambium - scraper-type (Fig. D. 12). - Shearing machine: The bark is scraped off with the cambium by means of shearing tools.

Timber debarked: Poles (both short and long), posts, logs and pulpwood.

Note: The word poles may apply to all of the above wood products. Debarking and peeling may be considered as having the same meaning.

E. MECHANICAL DEBARKING

In view of the slowly but steadily growing demand for debarked poles, posts and pulpwood, the Department decided to introduce mechanical debarking methods, particularly in those plantations and preservation plants handling substantial quantities of this timber.

Initially small, cheap machines of low production were tested, but as the demand for peeled timber increased, more advanced types of mechanical units were either constructed Departmentally or purchased. The following types of machines were tested and employed in plantations or preservation plants:

(i) Chain debarker - friction between timber and rotating chain.

(ii) Drum post peeler - friction between timber loaded in the drum.

(iii) Cambium tangential shearer - machines operated with sharp shearing tools.

(a) CHAIN DEBARKER (Fig. D. 9, 10)

(1) Semi-mobile process

This machine was originally developed by the Tenessee Valley Authority, U.S.A.

The machine is portable and consists of a steel frame constructed from angle iron reinforced with cross-members on three sides in the middle of the frame. The cross-members serve for mounting the drum and roller from the feeder side. The remaining two rollers on the outlet side are mounted one above the other in such a way that the poles can be fed in below or above the revolving drum, while receiving the roller support from beneath.

A 9mm mild steel chain of twisted link construction is spanned cross-wise between the drum flanges and secured with "U"-bolts of 3% nickel-chrome steel. Tight chains under an elastic tension proved more satisfactory than either slack or rigidly fixed chains. Coil springs or rubber block fittings provide elasticity to the chain.

A V-belt conveys the power from the engine to the drum. The engine used was a Briggs and Stratton Model 23, air-cooled, petrol-driven, single cylinder, 4-stroke, developing 6 kW at 3 200 r.p.m. The engine governor was set to operate at an altitude of 1 500m at 2 200 r.p.m., giving the chain a speed of 850 r.p.m. Under different altitudes it would be necessary to alter the governor setting. The object was to maintain a chain head speed of 800 r.p.m. under load at half throttle.

The machine was used for debarking fence posts and vine trellis material, and not for any larger material. All knots in the timber must be cut off flush with the wood (not with the bark).

(2) Operation (Fig. D. 10)

The machine is designed to separate the bark from the wood by destroying the cambium, which is the thin layer of cells between the bark and the wood. The tightened chains beat and rub off the bark without any appreciable damage to the wood. All of the bark, both inner and outer, is removed.

A post of 11-13cm diameter is debarked by feeding it back and forth across the top of the chain head. Its mass holds it against the revolving head with sufficient force to permit satisfactory peeling. Lighter posts are fed against the lower side of the revolving head and from the opposite side of the machine. The lower roller serves as a fulcrum when the post is held against the chain. Fatigue relief should be provided by alternating operators from debarking to handling.

The cost of the chain debarking machine, complete with engine, was R281,00 in 1952.

In Appendix D. 1 are data obtained during preliminary tests with three machine units. The following are the average results of the test:

(i) Three labourers were employed with each machine.
(ii) Average debarking costs per m^3: 261,0c (including overheads).
(iii) Average debarking costs per m^3:183,6c (excluding overheads).
(iv) Volume of poles debarked per labour unit: $0{,}73m^3$.
(v) Number of poles debarked per labour unit: 88.
(vi) Total average cost of machine and labour per hour: 61,0c (excluding overheads).
(vii) Total average cost of petrol per hour: (@ 4c per l): 6,1c.
(viii) Total average cost of oil per hour: (@ 15c per l): 0,48c.

(3) Conclusion

The chain type of debarking machine proved to be too small, with a low output, and required considerable manual handling of the poles. The unit should, none the less, be useful on a small forest where cheap labour is available.

Note: For details see Appendix D. 1 and D. 2.

(b) DRUM POST PEELER (Fig. D 11)

The drum post peeler was constructed Departmentally to a pattern of unknown origin. It was mounted on a 5 ton truck, and was thus fully mobile. The machine consists of a small diameter revolving drum with blunt steel ribs welded inside. Peeling is accomplished by friction between the poles themselves and between the poles and the ribbed sides of the drum. At the correct revolving speed the poles remain parallel to each other. The bark is removed by gravity through the apertures in the shell of the apparatus. The Departmental drum had an inner diameter of 1,04m and was 3m in length. Power was supplied from the truck engine through the power take-off.

Drum cost:	Labour	R581,60
	Material	R181,30
		R762,90
Truck (carrier) 2nd hand		R630,00
Total costs		R1 392,90

Hiring charges: 2 265c per month of 168 working hours.
Fuel consumption: 2,3 l per hour.

(1) Test with the drum post peeler

(i) Timber tested - Poles of 2,4m x 8 - 10cm top diameter derived from the tops of thinned *P. canariensis* (31 years old), were used for the test with the drum debarker. The average pole had a volume of $0{,}02m^3$. Bark on the poles was 12mm thick, dry and firmly set. Approximately 60% of the poles was straight, and the balance was almost straight. All of the poles were knotty, some of the knot bases being cut flush with the wood, and others cut flush with the bark.

A load of 25 poles of the above dimensions occupied approximately 36% of the drum cross-section area.

(ii) Labour: One European driver - R3,00 per day. 4 Bantu labourers - 50c each per day.

(2) Operation

(i) A parallel test was arranged simultaneously with the drum test: one Bantu debarked 25 poles by hand, using the vineyard spade and a bench.

(ii) Some poles required a final cleaning of bark after having passed through the peeler, so one Bantu with a vineyard spade was engaged to remove this bark by hand.

(iii) Two labourers loaded and unloaded the peeler drum, and also sorted and stacked the peeled poles.

Note: None of the men employed in the test had any previous debarking experience

(3) Site

The site for the drum peeling operation was flat and large enough to accommodate the operation. Poles were stacked, loaded and unloaded from the drum and again stacked with ease and with the minimum loss of time.

After the preliminary test it was found that a time of 25 minutes in the peeling drum was sufficient, and that no better results could be obtained by keeping the load revolving in the drum for a longer period. The result of the test was as follows:

59% of the poles debarked was free of bark
41% of the poles debarked was almost free of bark.

It has been estimated that the drum post peeler can only work a maximum of 6 hours per day, actually revolving for only $4\frac{1}{2}$ hours (approx.). The balance of the working time is taken up by loading, unloading and adjustment to the machine. The optimum drum speed was 35 r.p.m., i.e. 64m per minute. At this speed part of the load is lifted almost to the top of the revolving drum, then dropped down onto the bottom logs, a condition which appeared to give the best possible debarking results. The "dropping" action of the poles added to the friction as they rubbed against each other and the drum shell.

(4) Final remarks

The suspension of the truck chassis is best left unaltered so as to absorb movement of the drum structure. If the drum is mounted rigidly breakages may easily occur under the vibration.

A manual control should be installed on the accelerator to maintain an even flow of petrol. The installation of an idling screw directly onto the accelerator did not prove satisfactory.

(5) Work capacity of the drum peeler

During 6 hours per day, actual working time, and a time of 4 hours 35 minutes actually revolving with a load, 264 poles with a volume of $5{,}2m^3$ were debarked, i.e. 1,13m per working hour.

264 poles ÷ 3 labourers = 88 poles per labour unit (excluding driver). $5{,}2m^3$ ÷ 3 labourers = $1{,}7m^3$ per labour unit (excluding driver) or 264 poles ÷ 4 labourers = 66 poles per unit (including driver). $5{,}2m^3$ ÷ 4 labourers = $1{,}3\ m^3$ per unit (including driver).

(6) Costs

Hire of drum peeler per month (21 days) = 2 265c
2 265c ÷ 21 days = 108c per day

Hire of drum peeler/day		108c
Wages:	One European driver	300c
	3 Bantu @ 50c	150c
	Total per day	R5,58
Overheads (administration) 30%		R1,67
	Grand total cost per day	R7,25

Cost per m^3 558c ÷ 5,2 m^3 = R1,07c
(excluding overheads)
or 725c ÷ 5,2 m^3 = R1,39c
(including overheads)

By hand. - Operation conducted simultaneously with drum peeler.

1 labourer with vineyard spade debarked 25 poles @ 0,0198 m^3 = 0,49 m^3

1 Bantu @ 50c ÷ 0,49 m^3	=	102c per m^3
Overhead charges - 30%	=	30,6c per m^3
		132,6c per m^3

Note: The labourers' wages quoted were as in 1958

The drum peeler operation was charged with the wages of a European driver, who only supervised the work, and consequently the production costs are slightly higher for the drum peeler than for the hand labour alone, where no supervision was charged.

(7) Removal of residual bark

The costs of removing residual bark are included in the costs given above, but some additional data relating to this operation are given in Appendix D. 3.

A similar, but larger drum post peeler has been permanently installed in Longmore preservation plant, where the average daily output was as follows:

Bark soft - crew $2\frac{1}{2}$ Bantu (average)

Debarked poles:	8 - 10 cm x 2,4 m long	664
	Running m	1 620
	Volume in m^3 (u.b.)	13,1
	Volume in m^3 (o.b.)	20,5
	Bark in m^2	575
Per labour unit:	Number of poles	266
	Running m	648
	m^3 (u.b.)	5,2
Total time per pole 2,44 m long		44 sec

Note: 1. European supervision has not been included as the foreman supervised operations in the whole pole yard, and did not confine his supervision to the debarking at any one time

2. For details see Appendix D. 3 and 4

(c) MECHANICAL SEMI-PORTABLE DEBARKER

(1) WORK ORGANISATION

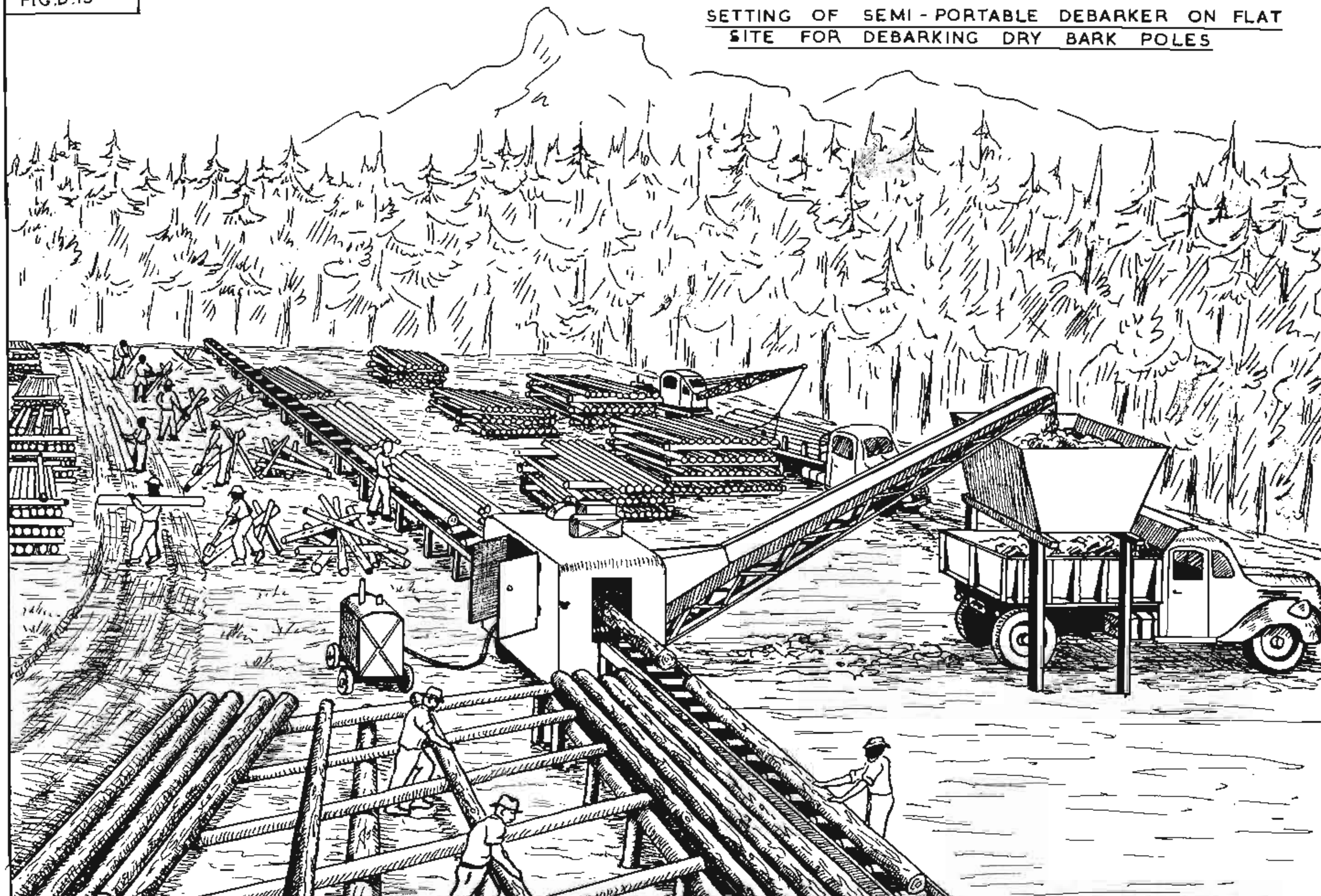
To obtain full advantage of the capacity of a fast mechanical debarker a continuous supply of an adequate volume of wood is essential. The feeding and discharging of wood should be arranged in such a way that bottlenecks will not occur.

A general layout suitable for all conditions cannot be prescribed, as organisation and planning depend on the site, terrain, size of timber, transport and storage.

When debarking short wood of standard lengths short feed conveyors should be used, in which case the labourer who feeds the poles into the machine will also be positioned close enough to the machine to be able to operate the controls. This will avoid collision of the logs or double feeding.

Note: The conveyor should not be shorter than the logs being fed. The timber to be debarked is unloaded near the debarker conveyor upon arrival, as close as possible to the conveyor so as to reduce handling distances between the stacks and the conveyor. It is necessary to have a reserve quantity of wood stacked nearby, however, to keep the machine going should the supply of timber become irregular.

FIG.D.13



SETTING OF SEMI - PORTABLE DEBARKER ON FLAT SITE FOR DEBARKING DRY BARK POLES

FIG. D.14

SETTING OF SEMI-PORTABLE DEBARKER AND CONVEYOR DOWNHILL ON A MILD SLOPE BETWEEN TWO ROADS.

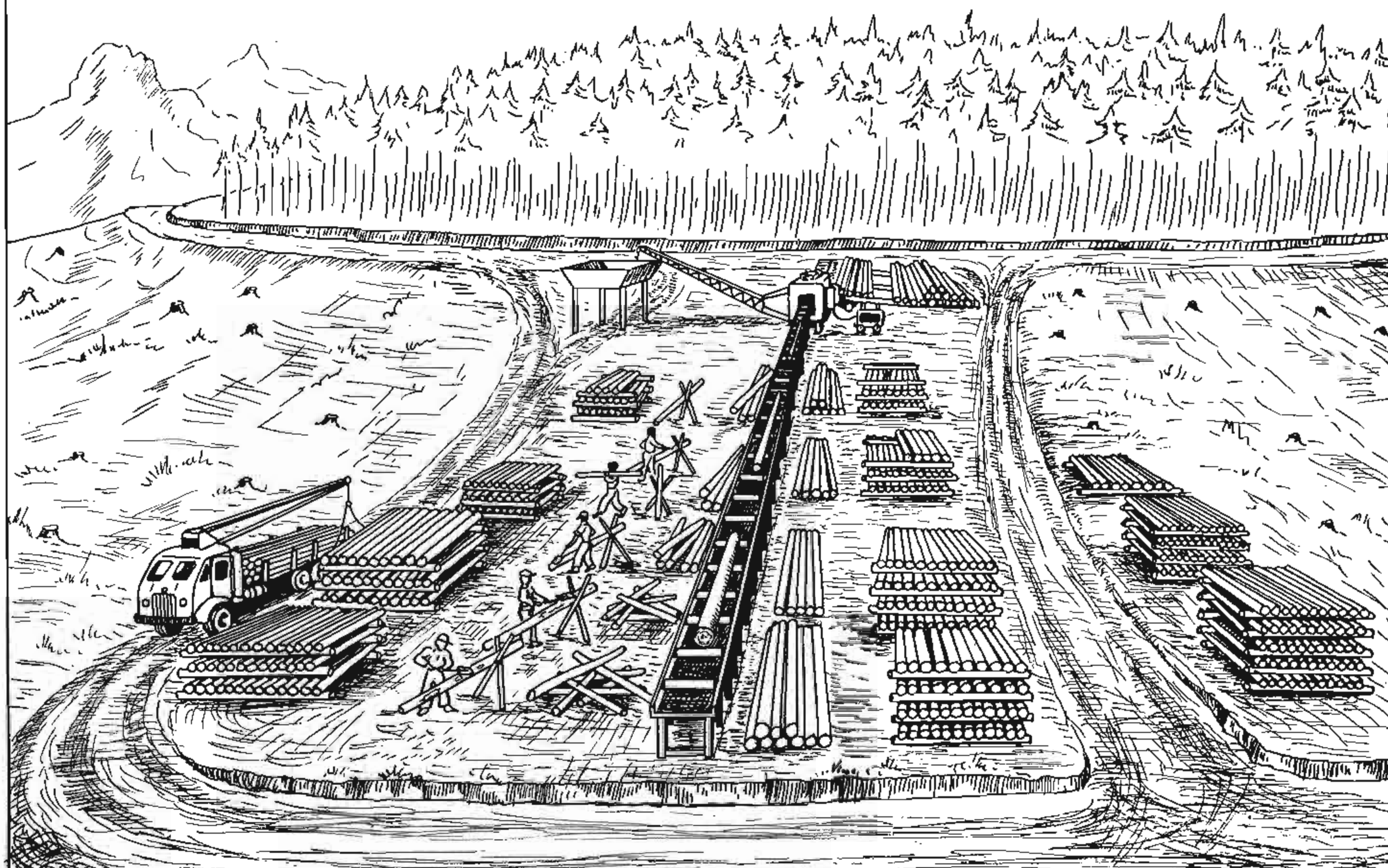
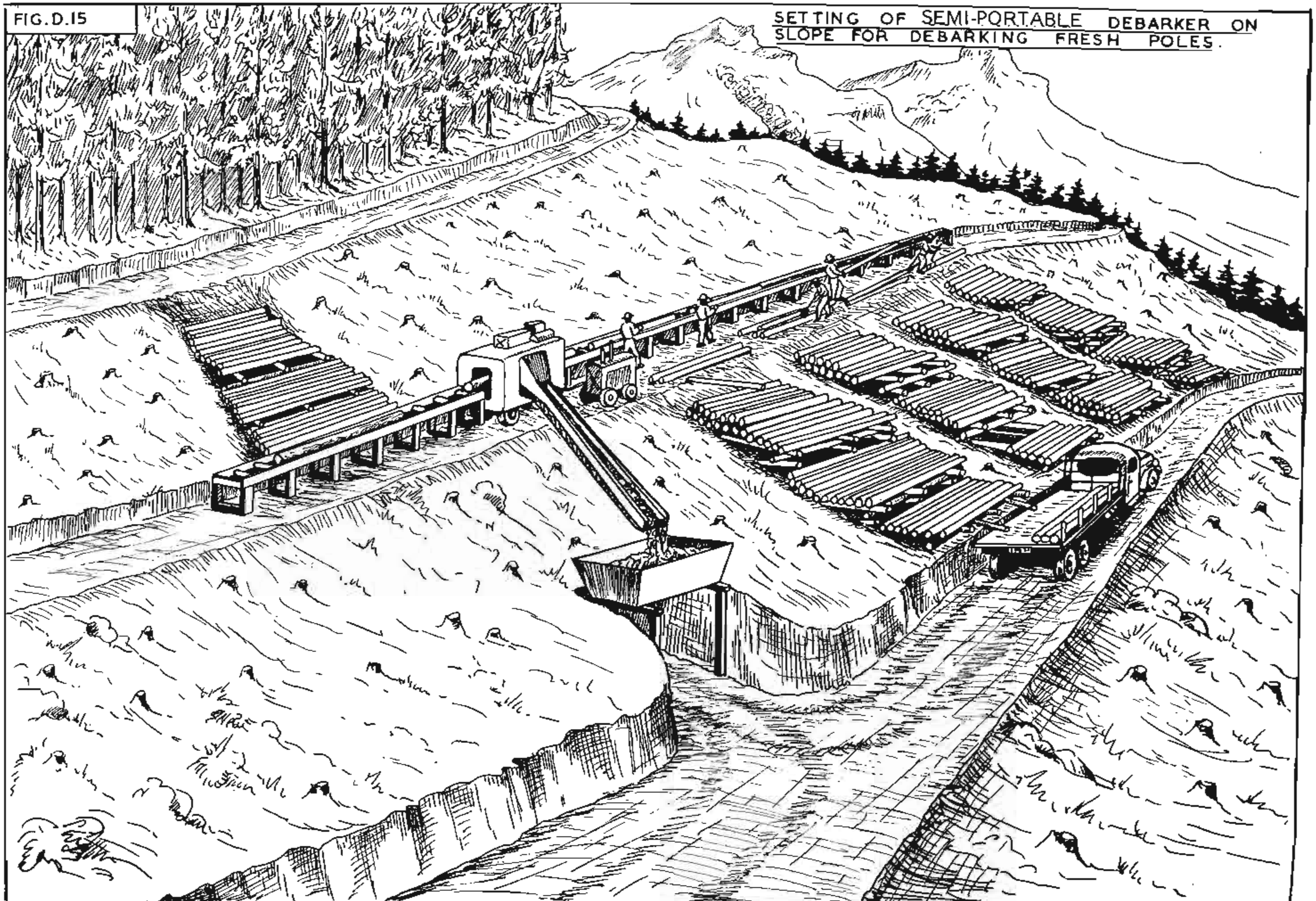


FIG. D.15

SETTING OF SEMI-PORTABLE DEBARKER ON SLOPE FOR DEBARKING FRESH POLES.



For semi-portable debarkers the concentration of timber need not be great, but stacking of timber for debarking may present a problem owing to the steepness of the terrain at the site, or possibly to roughness of the ground surface. If a site cannot be selected to the best advantage debarking costs may increase as the handling costs increase. Fig. D. 13, 14, 15 show various locations of the portable debarking units and pole stacks for different terrains.

(2) SITING OF DEBARKING ASSEMBLY IN VARIOUS TERRAIN CONDITIONS

Refer to Fig. D. 13 and 14.

At times in the past mechanical debarkers were used for debarking poles with dry, fire-hardened bark. This operation was not fully successful as a certain percentage of the bark remained, and had to be removed manually. The illustrations mentioned above show poles completely free of bark stacked to one side of the conveyor (to the right in the sketch), while poles not cleanly debarked are stacked on the opposite side of the conveyor. The latter poles had to be cleaned of residual bark by labourers using tripod benches and vineyard spades.

Refer to Fig. D. 14 and 15.

While Fig. D. 13 shows the debarker setting on a flat site, Fig. D. 14 and 15 show settings for two degrees of slope. In Fig. D. 14 the terrain has a mild gradient of not more than 5^{0} slope, so pole movement along the conveyors is easier, conveyors may be longer, and the stacking and loading of debarked poles are more convenient.

Fig. D. 15 shows the debarker on a steep slope, where an additional road had to be excavated between two existing roads to provide a convenient location for the debarker. Such a setting requires considerable handling of the debarked poles from the conveyor to the roadside where they are to be loaded onto lorries.

In the case of semi-portable or stationary debarkers, storage and handling problems may occur if timber is delivered to the site by rail. Several trucks may arrive at once, involving large quantities of timber to be handled in a short time. In this case stacking close to the debarker for direct handling will be virtually impossible, so "cold-decking" in large stacks will have to be resorted to.

Timber stacked in the plant yard may be delivered to the debarking machine by means of wagons, trollies, fork-lifts, or hoists, dependent on the conditions.

The State pole preservation plant at Bellville, Cape Province, serves as a good example of plant lay-out for a permanent debarking site. A number of parallel narrow gauge railway branchlines is constructed, between which wooden ramps are erected at a convenient height for trolley loading. Poles from the railway trucks are unloaded and stacked on the off-loading ramps. The debarker is moved and positioned against the off-loading ramp and the poles are simply rolled onto the conveyor and fed through the debarker. When the debarking on one stack has been completed the debarker is moved to the following pole stack on the same ramp and the process is repeated.

When poles have been debarked they are rolled onto another ramp on the opposite side of the debarker, from where they are taken by trolley for seasoning. When the poles have reached the required degree of dryness they are again loaded onto trolleys and taken to the impregnation cylinder.

(3) INSTALLATION OF THE DEBARKER

A low installation of the debarker simplifies delivery of the poles without additional cross-conveyors, but the falling bark has to be continuously removed from beneath the debarker. Bark is discharged from the debarker through an outlet either in the side or bottom of the machine, which frequently necessitates the installation of a bark conveyor below ground level, and usually at right angles to the machine. In this case a drain must also be made for rain water.

A high installation of the debarker is only recommended for permanent plants. In this case the handling of bark is easier and the machine can be kept clean of dirt and bark, but an additional elevator is necessary to deliver the poles to the feeding conveyor.

(d) CAMBIUM TANGENTIAL SHEAR DEBARKER

These debarking machines operate with sharp shearing tools, which cut the bark from the wood.

(1) MAIN PARTS OF THE ASSEMBLY

(a) Debarking unit, consisting of:

(i) Two electric motors, 7,5 and 3,7 kW for driving the rotor and in and outfeed rollers.

(ii) Rotor, consisting of 3 debarking tools arranged on a rotating disc (Fig. D. 12).

(iii) Six-speed gearbox mounted on outside cover of unit for easy access.

(iv) In and outfeed rollers.

(v) Sprockets and chains for driving rotor and rollers.

(b) Waste conveyors, consisting of:

(i) Electric motor, 0,75 kW for driving waste conveyor unit.

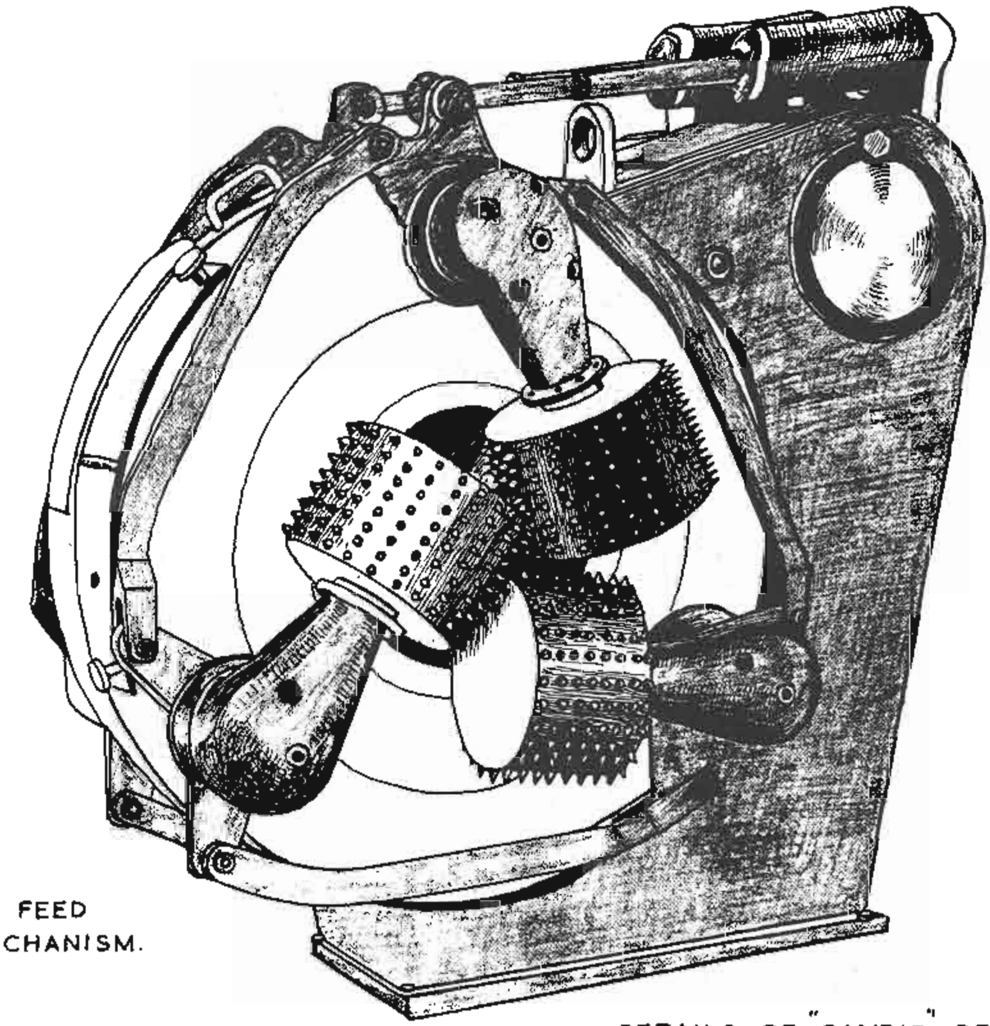
(ii) Chain for conveying bark from rotor, along elevator, to discharge point.

(c) Infeed conveyor, comprised of four lengths of roller tracks, 3,2m long, and provided with 3 driven rollers each. The machines are electrically powered, and require a generator to provide power, or may receive current from electric power lines. The permanent installation at Bellville has six sockets installed 24,4m apart along the pole receiving ramp, for electric power supplied by the Electricity Supply Commission.

(2) PURCHASE COSTS: - SÖDERHAMN-TYPE (See Appendix D. 5)

1. Basic price - complete	R6 248,25
2. Freight charges	471,51
3. Landing charges	112,30
4. Commission	653,59
	R7 485,65

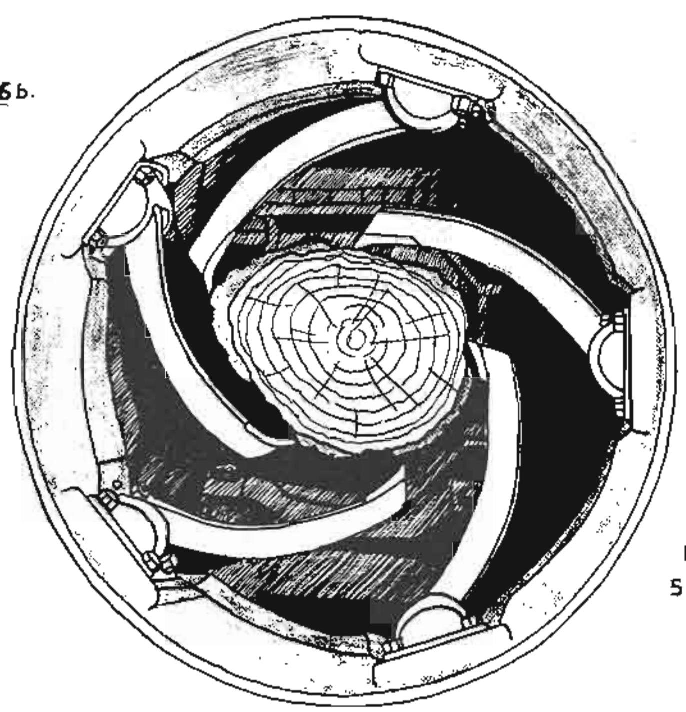
FIG. D. 16a.



FEED MECHANISM.

DETAILS OF "CAMBIO" DEBARKER.

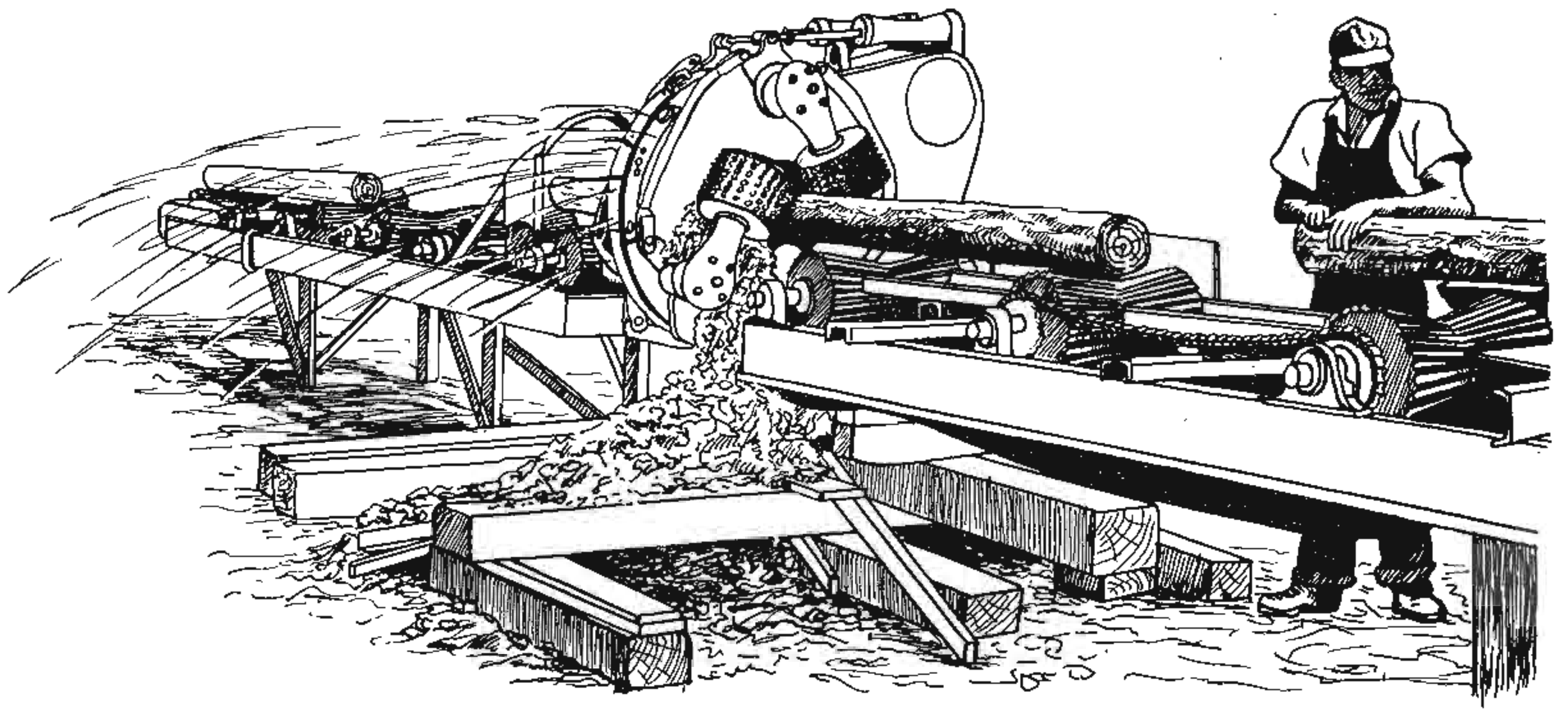
FIG. D. 16b.



DEBARKING MECHANISM. 5-BLADE TYPE.

FIG.D.18.

GENERAL VIEW OF "CAMBIO" DEBARKER.



(3) *ASSEMBLING TIME*

At the permanent installation where power plugs are fitted for the unit, the machine only moves 24,4m at a time. The time between stopping at one site and starting at the next is 12 minutes. The cost of such a movement is approximately R1,19.

(4) WORKING PERFORMANCE

The output of the unit largely depends on dimensions, species and the time elapsed between felling and debarking.

Dimensions: Best results are obtained with poles 4 - 8m long and 8 - 13 cm top diameter.

Species: *P. canariensis*, *P. radiata*, *P. pinaster* and *P. halepensis*, in order of preference.

For the best results poles must be debarked as soon as possible after felling, but they should not be left longer than the times specified below:

Summer months: *P. canariensis*: at least within 3 weeks after felling. Other species (*Pinus*): within 7 days.

Winter months: *P. canariensis*: up to 8 weeks after felling. Other *Pinus* species: 4 to 5 weeks after felling.

The best machine results were obtained after it had been running for one hour, with *P. canariensis* poles 4 - 8m long and 8 - 13cm top diameter. The machine operated at 30m/min. with an output of 1 625 running m per hour, equalling 22,4m^3. There was, however, a delay of 7 minutes due to trolleys having to be replaced. These poles were very straight and were completely free of bark after the operation, requiring no further trimming in the yard.

Upon completion of the above test the machine was kept in operation for a further 4 hours 40 minutes at 16,8 m/min. and a mixed batch of *P. canariensis*, *P. radiata* and *P. pinaster* was put through. Dimensions of the poles varied between 2m x 5-7cm to 6m x 12-14cm. A total of 2 604 running m or 42,6m^3 was debarked during this time. Sixty one per cent of all poles less than 3m in length and under 8 to 10cm had to be further trimmed in the yard.

Conclusive tests have proved that this machine is not suitable for debarking poles under 8cm in diameter and less than 2m long successfully. In addition short, thin poles cause considerable loss of time as they ride over each other on the infeed conveyor, causing jamming of the machine, which necessitates frequent reversals of the feed.

(5) SINGLE DEBARKER PERFORMANCE AND OBSERVATIONS

Refer to Appendix D. 5 for details of the performance of the Söderhamn debarker, Type B. 12 M, including basic costs, repairs, hiring charges, etc.

Average debarking costs amounted to 102,4c per m^3.

The machine cost an average of R41,20 per day and R6,60 per hour.

Output: 39,8 m^3 per day; 4,93 m^3 per hour.

A similar machine was employed in the field, moving from plantation to plantation, but no accurate records of outputs and costs are available.

Since the last Departmental purchase of a semi-portable Söderhamn debarker, and following observations made Departmentally and on trials by private firms in South Africa and overseas, sometimes involving considerable investment, the latest trend is towards fully mobile types of debarkers suitable for work in compartments.

Difficulties would probably be encountered in mounting the debarker on a carrier, complete with infeed and discharge conveyors long enough to handle long poles, but there is reason to believe that these difficulties could be overcome.

(e) ABBREVIATED DESCRIPTION OF THE OPERATING PRINCIPLE OF THE CAMBIO MOBILE DEBARKER

Refer to Fig. D. 16, 17, 18.

The main feature of the Cambio debarker consists of a blunt-edged shearing tool pressed elastically against the log, penetrating the bark and then sliding along the circumference, in contact with the wood surface. Tangential pressure against the bark produces shear stresses between the bark and the wood sufficient to overcome the strength of the cambium layer.

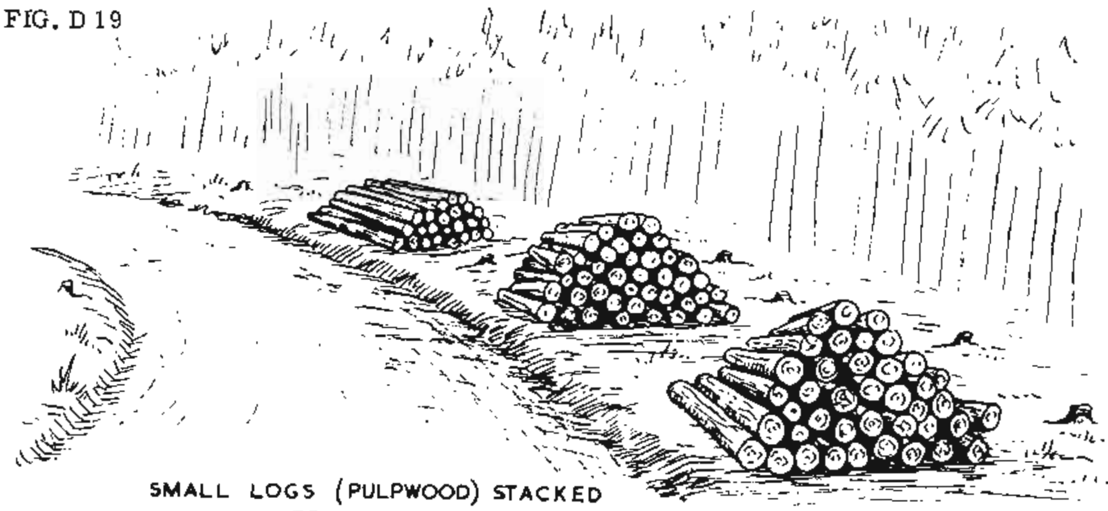
The Cambio debarker is a "hollow head" machine, where the debarking tools are carried by a rotating ring (Fig. D. 16b and 17). Tool pressure is mechanically applied and is almost uniform throughout the range of the working diameter. Feed is supplied by driven spiked rollers disposed in a triangle in the front and back of the head (Fig. D. 16a and 17). The rollers ride freely over the end of the log and maintain contact throughout the engagement.

The rotor head carries five spring loaded debarking tools (Fig. D. 16b and 17). The pulley, which is screwed to the rear of the head, receives the driving power for the head from the motor by means of V-belts.

The processed logs and bark are ejected from the machine, the bark through alternate openings in the base or side of the rotor casing. Five fan blades, secured to the front of the head, propel the bark to the opening at the side or bottom of the housing structure (Fig. D. 18).

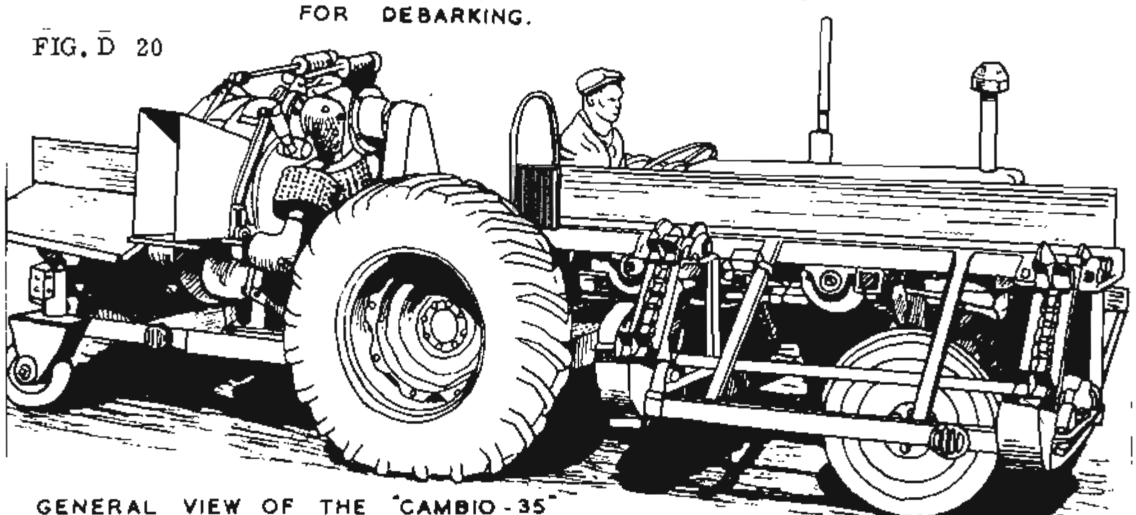
The following is an outline of the working principle of the fully mobile, tractor-mounted Cambio debarker, moving from compartment to compartment along the narrow forestry roads located on steep slopes. The conditions are such as those generally encountered where poles are stacked for debarking.

FIG. D 19



SMALL LOGS (PULPWOOD) STACKED FOR DEBARKING.

FIG. D 20



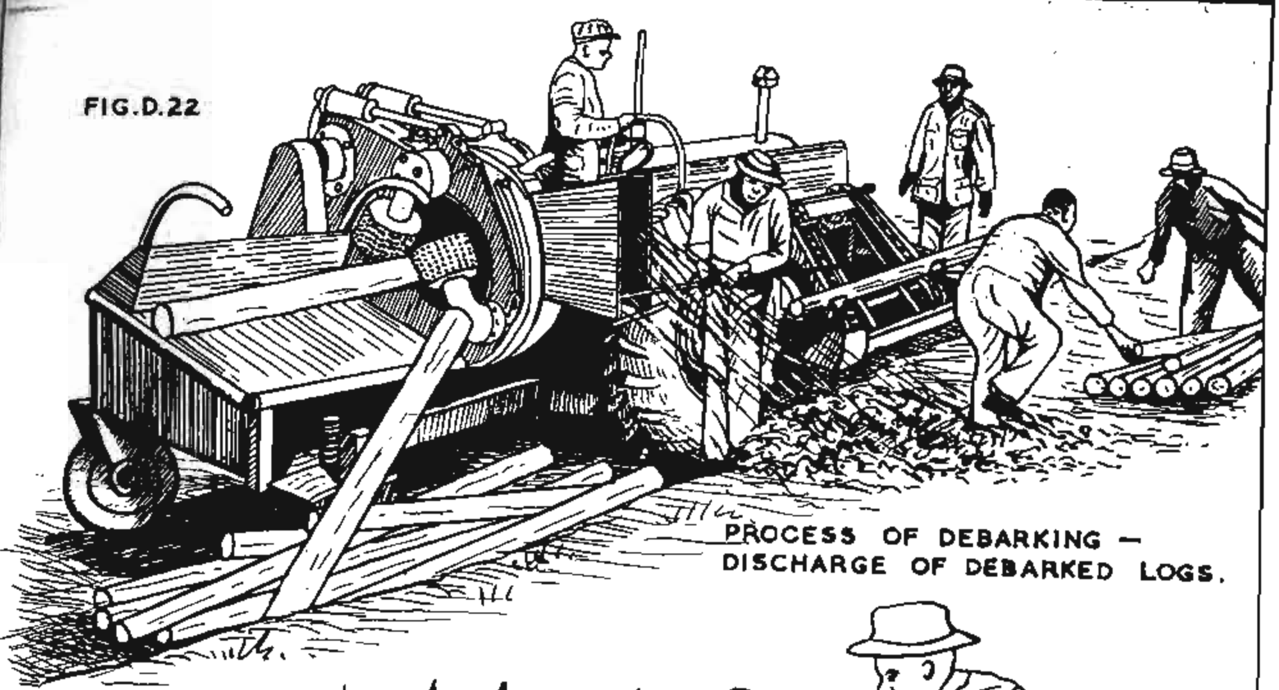
GENERAL VIEW OF THE "CAMBIO-35" DEBARKING UNIT, WHEEL TRACTOR MOUNTED.

FIG. D. 21

E.499

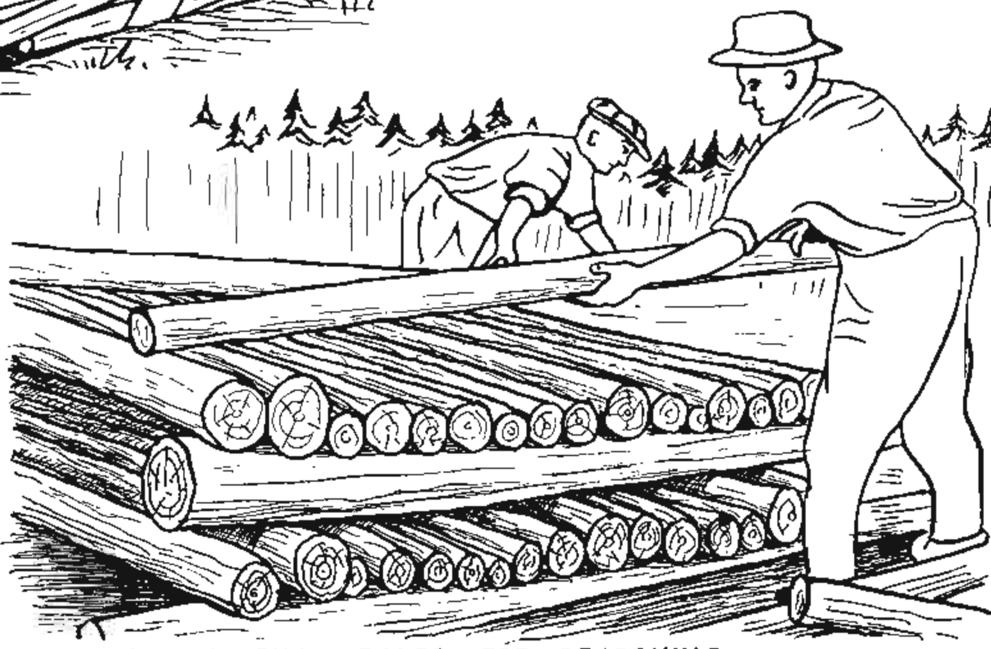
PROCESS OF DEBARKING - FEEDING LOGS INTO DEBARKER

FIG.D.22



PROCESS OF DEBARKING — DISCHARGE OF DEBARKED LOGS.

FIG.D 23



STACKING DEBARKED POLES FOR SEASONING.

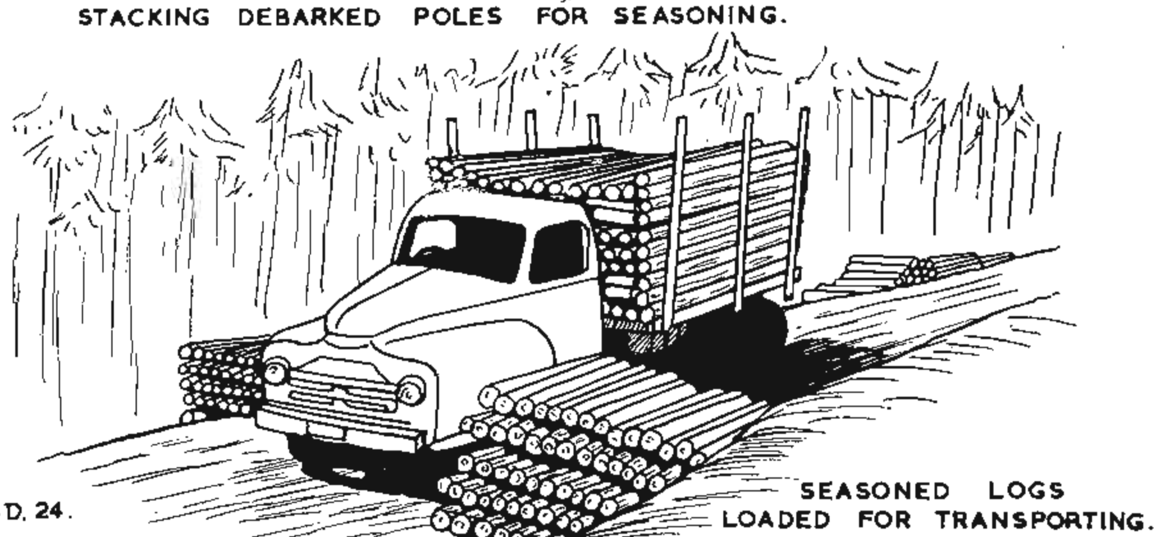
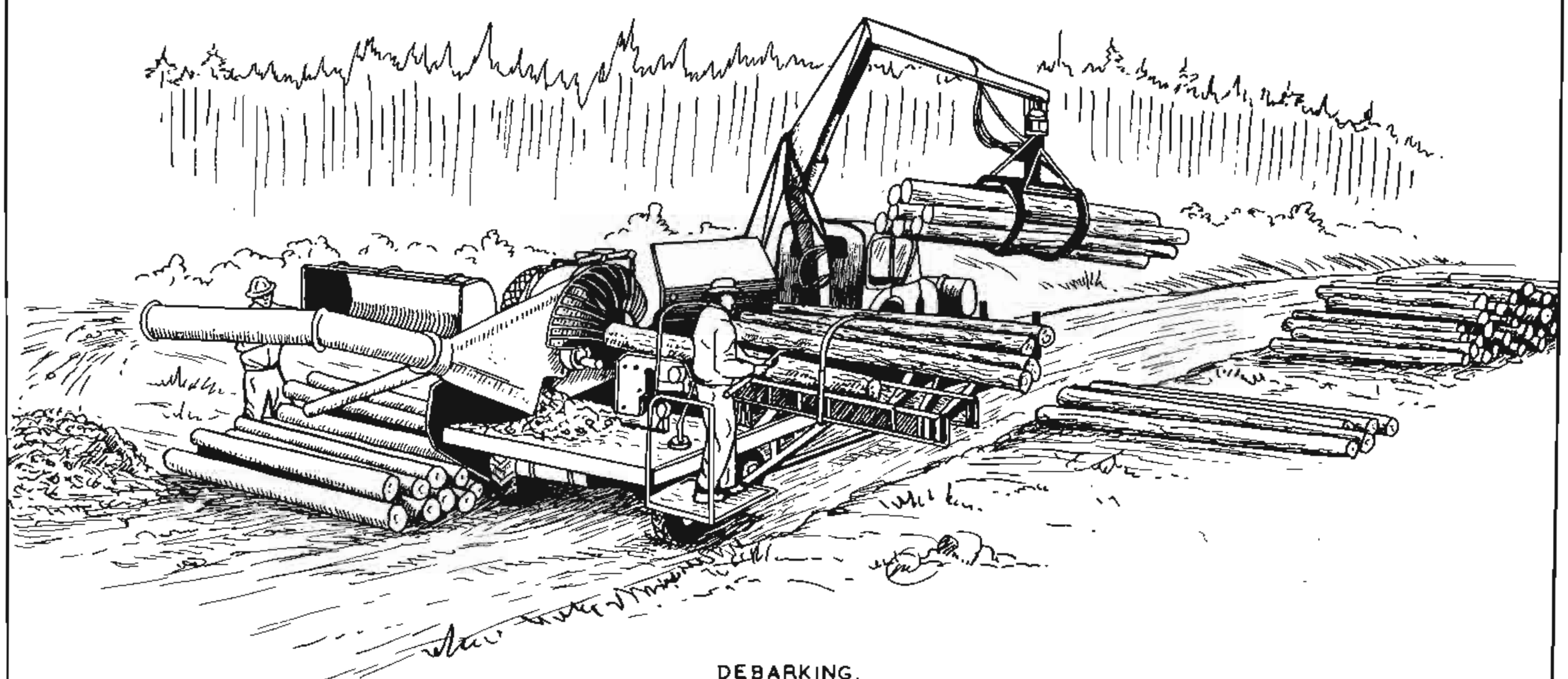


FIG.D. 24.

SEASONED LOGS LOADED FOR TRANSPORTING.

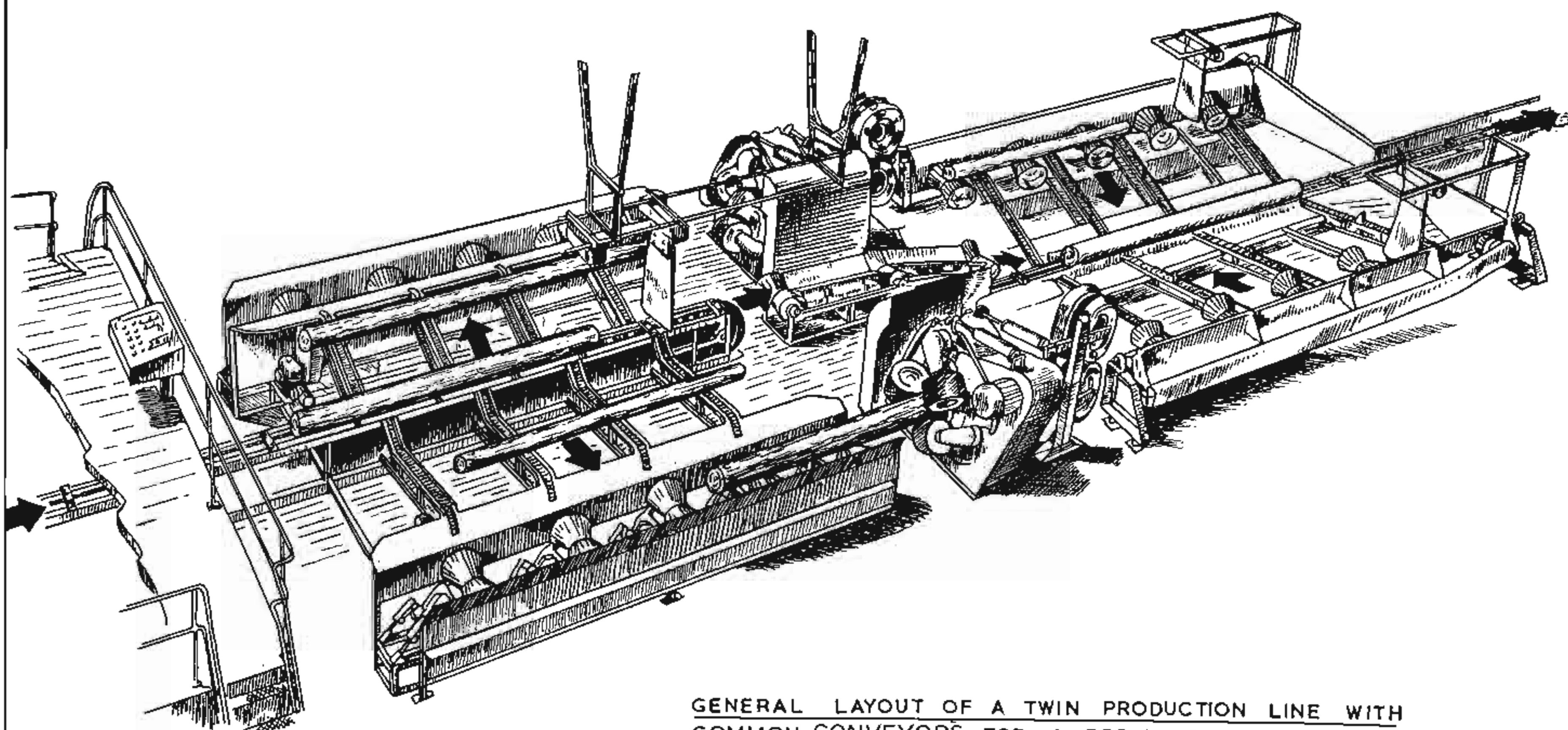
FIG. D. 25.



DEBARKING.

LORRY–MOUNTED PORTABLE DEBARKER WITH
CRANE. TRANSVERSE FEEDING.

FIG.D.26.



GENERAL LAYOUT OF A TWIN PRODUCTION LINE WITH COMMON CONVEYORS FOR A PERMANENT DEBARKING PLANT.

FIG. D.27

DEBARKING WITH MOBILE CAMBIO DEBARKER, TRACTOR MOUNTED

POLES FED FROM THE FRONT TO THE REAR OF THE TRACTOR.

OPERATION ALONG A ROAD LOCATED ON A MILD SLOPE.

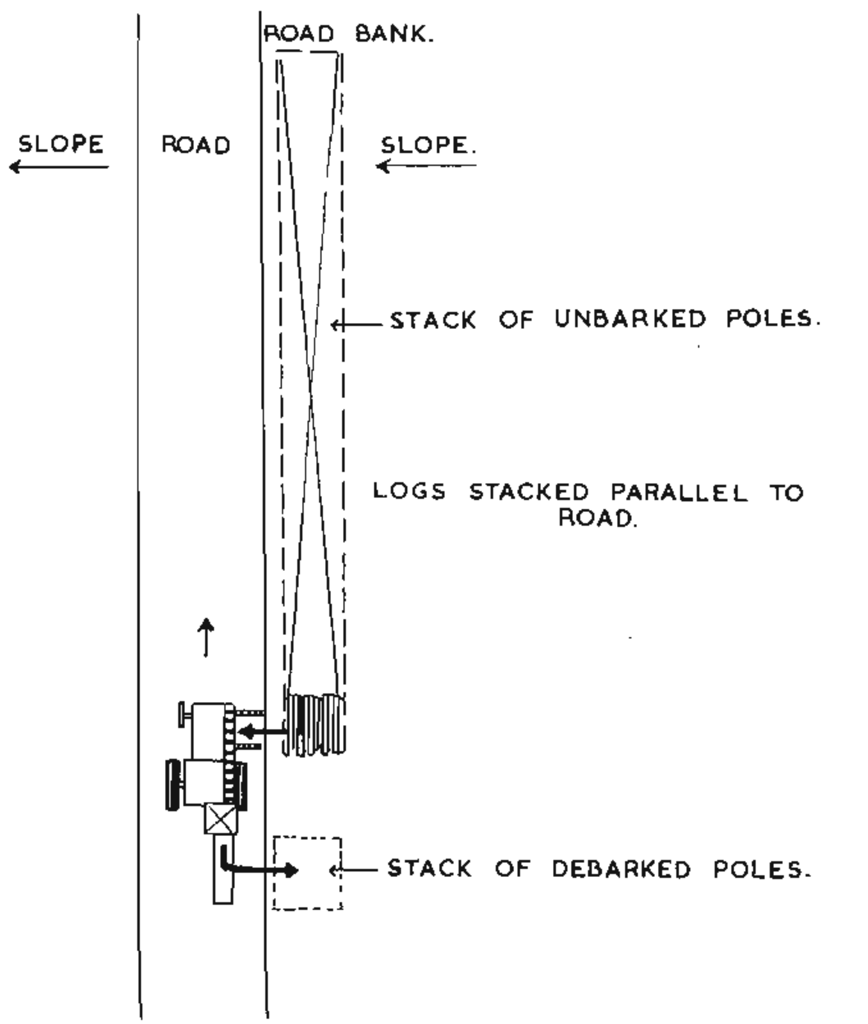
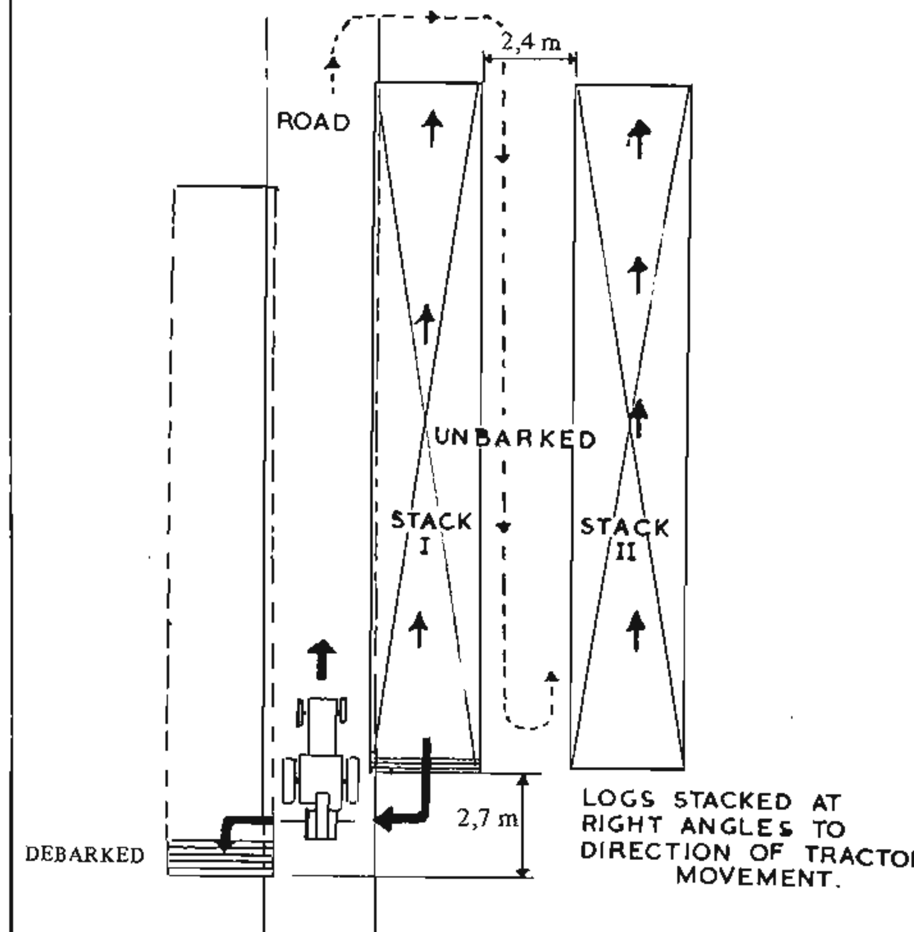


FIG. D.28

DEBARKING WITH MOBILE TRANSVERSE MOUNTED CAMBIO DEBARKER - TRACTOR MOUNTED.



OPERATION ON FLAT AREA SHOWING TRANSVERSE FEEDING

To fully mobilise the machine it is mounted on a wheel-tractor of approximately 37kW. The debarking machine is powered by the tractor engine, through the power take-off. The whole debarking assembly is located in an offset position to the side of the centre line of the tractor (refer to Fig. D. 20).

On one side of the tractor, opposite the tractor engine, a hinged, chain type cross-conveyor is fitted at right angles to the engine. The top of this conveyor reaches the next conveyor which runs alongside and close to the tractor engine. The engine is protected by a metal sheet to safeguard it against accidental knocks by passing logs. The second conveyor mentioned above is in line with the spiked feed rolls of the debarker.

The debarking machine assembly is mounted between, and protruding to the rear of the tractor rear wheels, with the machine frame fitted to the tractor frame. The machine frame extends rigidly to the rear, and the discharge deck is fitted to it. The end of the discharge deck frame is supported by a single self-aligning wheel.

The total overall length of such a mobile debarking assembly is approximately 6m.

Only short logs or poles of 2-2,5m in length can be debarked. The diameter of timber for debarking depends on the machine capacity.

Modus operandi

Stacks of logs or poles should be located close to and parallel to the road bank (Fig. D. 19). See Fig. D. 27 for stack layout. It is advisable to find the correct stack size and depth (away from the road), as this will influence the frequency of machine movement. The feeding crew's movements from the stack to the machine must also be considered, as an uninterrupted flow of logs from the stack to the machine is desirable. In the case of large stacks, particularly those stacks extending far from the road, additional manpower may be required to ensure a constant feed. The correct balance of operations should be determined and maintained.

Logs from stacks of timber for debarking are carried by two men, (one if the logs are small) and placed on the chain cross-conveyor (Fig. D. 21). As the logs reach the top of this conveyor they fall onto the second conveyor, running parallel to the tractor engine, and are pushed manually to the debarker feed rollers, which feed them into the machine. As the head of the log emerges from the other side of the machine it is engaged by the outfeed spiked rollers and landed on the discharge deck (Fig. D. 22). Logs are stacked manually by one or two men (Fig. D. 23).

Lorry-loading methods must also be considered when the debarked poles are stacked (Fig. D. 24). Freshly debarked poles are usually left along the road for seasoning, which requires a special manner of cross-stacking. Sometimes cross sticks or spacer sticks are used to provide better air circulation.

No reliable cost figures of the operation are available at present, but an output of 2,3m^3 per labour unit has been achieved.

The economic and efficiency aspects mentioned above may be upset by the terrain - if road banks are inconvenient, a concentration of logs in larger stacks at suitably accessible sites on the roadbank is inevitable.

Note: The Swedish firm manufacturing debarking machines has produced a debarker so positioned on the tractor or carrier that logs are fed transversely into the machine, i.e. at right angles to the tractor longitudinal line. This arrangement is suitable for flat country, as logs are usually stacked on the opposite side of the road. See Fig. D. 28 for stack lay-out.

Progressive advances in debarking machines are:

(i) Trailer-mounted Cambio, designed to overcome the limitation in pole length, which is present with tractor-mounted machines.

(ii) Lorry-mounted Cambio (Fig. D. 25).

Both the above methods employ a crane as an auxiliary to the operation. The crane is mounted on the same trailer or lorry as the debarker.

Fig. D. 26 shows the general lay-out of a twin production line with common conveyors for a permanent debarking plant.

APPENDIX D. 1

Chain debarker - data for 3 machine units obtained during preliminary tests

	1	2	3
1. Machines	1	2	3
2. Total test hours	19	157	19
3. Hiring costs of machines. Total for test	356c	2 120c	1 215c
4. Total labour wages during test	1 144c	6 235c	4 617c
5. Total overhead charges (30%)	454c	2 507c	1 750c
6. Total operating cost for test	1 954c	10 862c	7 582c
7. Total volume debarked - m^3	9,6	41,6	26,4
8. Debarking cost per m^3	203,5c	165,9c	286,0c
9. Total number of labour units used	9	60	37
10. Volume debarked per labour unit m^3	1,08	0,69	0,71
11. Volume in m^3 debarked per hour	0,48	0,25	0,27
12. Average volume per log - m^3	0,006	0,008	0,008
13. Poles debarked (Total 9 200)	1 744	4 927	2 529
14. Total petrol used (@ 4c per litre)	40,5 l	193,5 l	144 l
15. Total oil used (@ 15c per litre)	0,57 l	0,57 l	4,56 l
16. Petrol cost per hour	8,5c	5c	8,5c
17. Oil cost per hour	0,5c	0,3c	0,65c
18. Wages - cost per hour	55c	40c	46,6c
19. Machine hire per hour (2 265c) 168 hr per month	-	-	-

Note: Some differences may be noted in the data shown in the above summary table, which may be accounted for by the method of booking working hours. Overhead charges included in the costs greatly increase the cost of debarking

APPENDIX D. 2

RANDOM OBSERVATION WITH CHAIN DEBARKER

The units were tried with poles from burnt areas, but it was found that the poles were damaged and the output low, as bark stuck to the poles. The machines were unable to remove all the bark and extra labour was necessary to remove the remaining bark, using hatchets.

The following figures refer to freshly sawn *P. radiata* poles

Date	Measurements	No. of poles		Volume m^3	Time hr	Labour units
23.7.58	1,5m x 5 - 8 cm	88)		0,5		
		)	198		6	3
	2 m x 8 - 10 cm	110)		1,56		
24.7.58	1,5m x 5 - 8 cm	194)		1,1		
		)	300		6½	3
	2 m x 8 - 10 cm	106)		1,5		
25.7.58	1,5m x 5 - 8 cm	209)		1,18		
		)				
	1,5m x 8 - 10 cm	13)	475	0,13	6½	3
		)				
	1,37m x 5 - 6 cm	8)		0,03		
		)				
	2 m x 8 - 10 cm	245)		3,47		
			973	9,47 m^3	19	9

Average pole : 1,67 x 9cm = 0,01 m^3
Output per labourer : 1,05 m^3 - 108 poles - 187,4 m
Labour cost : R10,36
Fuel : 1,06
Machine hire : 2,66
R14,08 ÷ 9,47 m^3 = 148c m^3
overheads = 45c
Total cost per m^3 .... 193c

APPENDIX D. 3

DRUM POST PEELER

REMOVAL OF RESIDUAL BARK

Poles handled: 22 poles, 2,4m x 8 - 10cm

Time taken:

Loading onto bench: 6 sec x 22 logs	132 sec
Off-loading from bench: 4 sec x 22 logs	88 sec
Removing bark with vineyard spade	55min. 25 sec
Time taken	59min. 15 sec
Time not alloted	15min. 35 sec

Total time for operation - 1 hour 15 minutes

Total number of strokes with vineyard spade: 2 254.
2 254 strokes ÷ 22 logs = 102 strokes per pole (av.).

Note: A minimum of 3 strokes per pole
A maximum of 195 strokes per pole

	Per pole
Average time per pole: Loading onto bench	6 sec
Removing poles from bench	4 sec
Debarking time	2min. 29 sec
Total time for removal of residual bark	2min. 39 sec

Costs:

1 Bantu per day (6 hours) 50c
Actually working $1^1/_4$ hours

$$\frac{50c \times 1{,}25\ hr}{6\ hr} = 10{,}4c$$

10,4c ÷ 22 logs = 0,47c per log
0,47c ÷ 0,019 m^3 = 24,7 c per m^3

APPENDIX D. 4

RANDOM OBSERVATION WITH POLE PEELER: LORRY MOUNTED

The information below applies to a single day's observation.

Short poles: Average 2m x 9cm - 0,014 m^3 volume.
Bark dry and over average thickness.
Number of drum loads per day - 11 loads, 0,62m^3 each load as an average.
Average drum revolutions per minute: 34.

Operation

			Average per load
Time filling drum with poles	64 min 11 sec	19%	6 min
Revolving	219 min 39 sec	66%	20 min
Unloading	53 min 11 sec	15%	5 min

Volume debarked 7,08m^3

Poles debarked free of bark	167 - 37%	
Poles almost free of bark	282 - 63%	
Total number of poles debarked	449 - 100%	41 poles per load

Labour units: European 1
Bantu 5
Total output - 886 running m
Output per Bantu labour unit - 1,42m^3 - 90 poles - 177 running m.

Costs:

Hire of machine: 6 hr @ 11c	R0,66
Labour: European	R3,00
Bantu: 5 @ 50c	R2,50
Total daily cost	R6,16

R6,16 ÷ 7m^3 =	88c per m^3
Overhead charges (30%)	25c per m^3
Total cost	113c per m^3

OPERATING DATA FOR SEMI-PORTABLE DEBARKER AT BELLVILLE PRESERVATION PLANT

1. MACHINE

Machine: Söderhamn (Sweden) Type B. 12M; Serial No. 57187.

Main parts: As described previously for the Cambium Tangential shear debarker.

Alterations made locally to the machine

(a) Infeed conveyors

(i) To facilitate adjustment of 8 chains of infeed conveyor, i.e. to keep them tight, a slot was made on the outside plate on both sides of the roller and take-up bolts were fitted to the plate.

(ii) 2 channel-iron stays or trestles were made for each roller track to facilitate the assembly of the machine after it has been moved.

(b) Infeed roller arms

To increase the rigidity of the infeed mechanism a retaining bar of 25mm mild steel was used to connect the roller holding arms. One retaining bar was used for each set of arms. This reduced wear on the friction bearing of the infeed roller to an appreciable extent.

(c) Rotor bearing

To renew the ball bearing retaining wires in the rotor bearing. This consists of 4 large outer and 4 small inner wires, made from 4mm stainless steel piano wire, rolled to the correct size. They can be made locally at an approximate cost of R2 if a replacement is necessary.

2. TOTAL PURCHASE COST

The following is a detailed statement of the costs incurred in connection with the import of this machine:

(i) Basic price

		R
Portable pole-debarking machine	5 447,55	
Waste conveyor, type 501 B	349,65	
Infeed conveyor	451,05	6 248,25

(ii) Freight charges

1 case machinery - $19{,}6m^3$	292,78	
1 case machinery - $13{,}2m^3$	178,73	471,51

(iii) Landing charges

		R
Wharfage	77,02	
Lighterage 29 tons @ 25c	7,25	
Landing 29 tons @ 92c	26,58	
Fines (?) 29 tons @ 5c	1,45	112,30

(iv) Commission

Difference between basic and tendered price paid to S.A. agents	653,59
Total cost	7 485,65

Assembling. - The machine was assembled and ready for work the day after its arrival at the debarking plant.

3. DEBARKER PERFORMANCE FOR PERIOD 21.4.54 - 27.7.59

(i) Days worked: approximately 591.
(ii) Figures based on the average for 12 months
(iii) Total hours worked: 4 772 hours
(iv) Total output of debarked poles: 23 534 m^3
(v) (a) Lubricant - 168 litre R27,75
(b) Electrical units 7 499 @ 0,47c R29,62
(c) Labour: European R531,90
Bantu R7 387,50
(d) Transport. Removal of bark 4 967 km @ 6,2c 308,70
R8 285,47

(vi) Repair costs

(a) Purchase price of the following: (In Swedish kroner)

	Sw. kr.
3 only debarking tools complete	306,50
3 balance arms	290,00
3 stretchers	97,00
4 draw springs	40,00
3 compression springs	14,00
3 rubber buffers	2,60
3 meters roller chain, 19mm	79,20
5 only, straight coupling links, 19mm	2,05
5 only bent coupling links, 19mm	2,85
2 meters roller chain 25mm	74,00
5 only straight coupling links 25mm	2,65
5 only bent coupling links 25mm	3,50
	894,25
Less 14%	125,19
	769,06

Rate of exchange at the time:

	R
14,30 Sw. kr. = R2. 769,055 Sw. kr. =	107,56
1 only thermal overload starter	22,00
8 only retaining wires for ball bearing	58,40
Various items from store, eg. bolts, nuts, V-belts, phosphor bronze, etc.	83,17
(b) Delivery cost of parts	34,00
(c) Labour (workshop) European	
Bantu	1 671,25
Total	1 976,38

(i) *Hiring costs of debarker estimated for the whole period. Debarking unit only. Generator not used at* Bellville R6 561,50

(ii) Estimated cost per m^3 debarked:

Operating costs	R8 285,47
Hiring costs	R6 561,50
Total	R14,846,97

i.e. 102c per m^3

Cost per day	R25,12
Cost per hour	R 3,11
Hours per day	8 hours
m^3 per day	39,8
m^3 per hour	4,93

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Volume 1, Part 2

Log skidding by animals and tractors

I. GENERAL INTRODUCTION

In forest exploitation, skidding (or slipping) is defined as the moving of timber from the stump to the roadside or other point where it will be loaded. This part of the logging operation is the most arduous and costly of the exploitation activities.

The term "slipping" is usually applied when animals are used, while the term "skidding" applies to a mechanical towing means of extracting timber.

Timber is skidded under various topographical and soil surface conditions, with or against gradients of varying steepness, in thinnings or clearfellings, in mature or immature plantations. Operations may be on a small or large scale, and may be planned in advance, or undertaken as emergency measures.

Timber may be skidded in the form of tree length (tree bole debranched and topped, but not crosscut) or in large, long logs, or small, short logs.

It is therefore evident that a wide range of equipment would be required to cope with all possible skidding situations. No universal skidding equipment exists which will suit all cases, so some knowledge of existing skidding methods and logging units and their performance is needed in order that the proper equipment for each individual situation may be selected, to ensure an operation that is both efficient and economical.

Log skidding has developed steadily in the maturing departmental plantations, to keep pace with the increase in log size. Manual handling and carrying of timber and the use of oxen and mules, either singly or in teams, were the accepted practices with the advent of timber skidding operations. As timber increased in size and mass tractors were introduced, and where difficult skidding cases demanded special yarding means, highleads and skylines were brought into use.

Fig. S.K. 1 shows terrain generally suited to log skidding by conventional towing means. The mild slopes in the foreground are ideal for skidding by tractors or slipping by animals, while the steeper slopes in the background are well suited to conventional highlead operations.

While a knowledge of the major power units is essential, correct choice of auxiliary skidding equipment, or minor equipment, in the form of chains, slings, cables and their components is of great importance if the operation is to be successful. The chapters which follow, deal with the skidding problem in detail, as far as is practically possible, covering the use of animals and power-skidding units, as well as the appropriate auxiliary equipment.

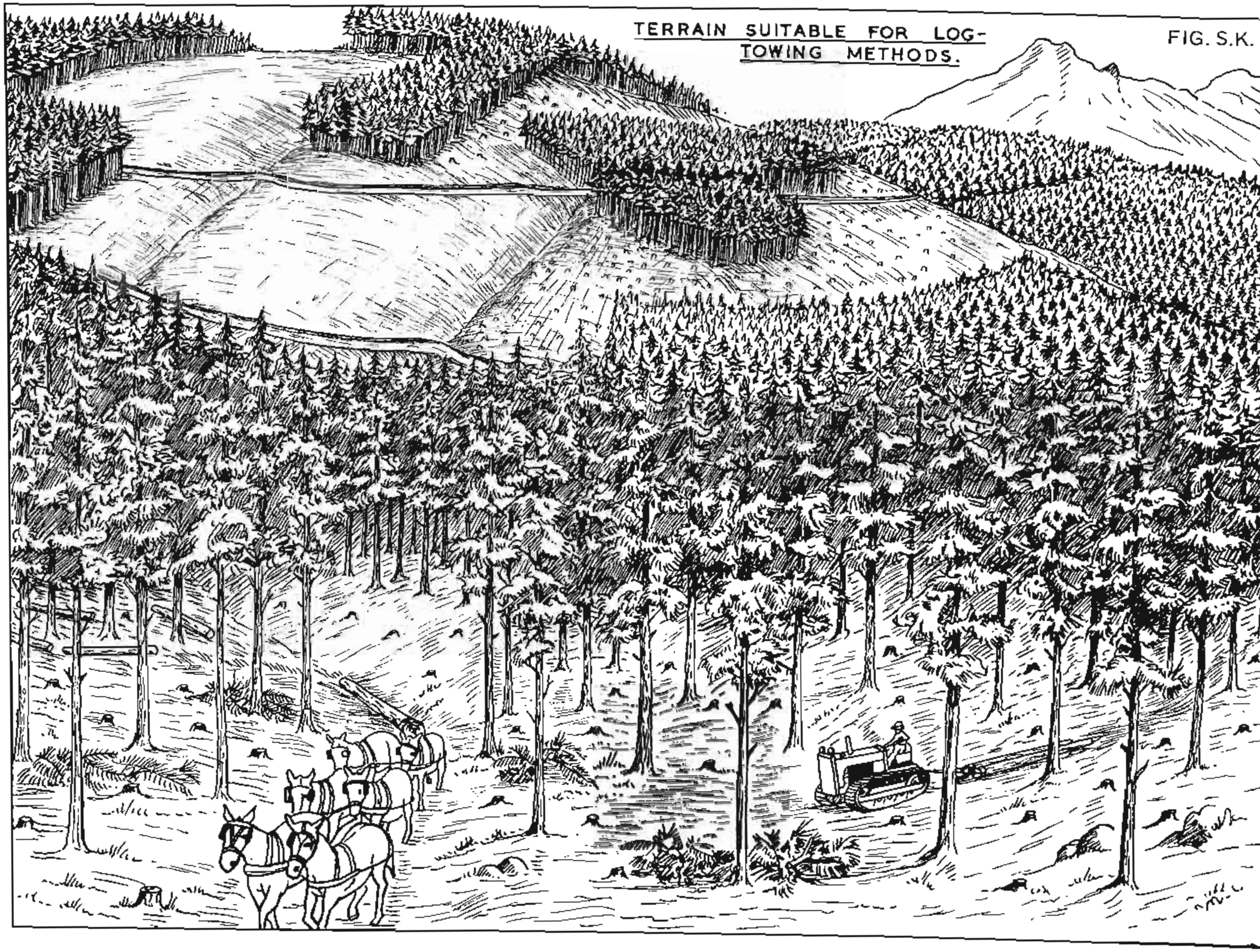
It is interesting to note that, during the past 15 years, mechanisation has played an increasingly important role in departmental logging operations. Ten years ago 1 700 oxen were employed in plantations, as compared with 800 at present, although the number of mules has increased from 700 to 800. Mechanical units, on the other hand, have increased tremendously in number: for example, 3 tractors were employed 20 years ago, as compared with 85 being used at present. Mechanisation will continue to play a major role in departmental logging, and will eventually completely replace extraction methods using animals.

MANUAL HANDLING OF TIMBER

Prior to mechanisation and the use of animals in logging, timber was manhandled from the stump to the roadside by the workers themselves. This particularly applies to the early days of exotic forests in South Africa when timber derived from early thinnings was generally small. Light poles or logs were usually carried by one or two men, generally supporting the timber on their shoulders. Larger logs were carried by a gang of men, either holding the log themselves or carrying it by means of hand spars, as in Fig. H. 1, in which case the log was rolled onto the spars and then picked up by the men. The next advance in the handling of timber was the introduction of timber carriers (Fig. H 2, H. 3 and 4). The one-man carrier (Fig. H. 2) may be used for dragging small timber, while two-man carriers are used by four or more men, working in pairs, for carrying heavy timber (Fig. H. 5).

Timber handling as described above is seldom applied in practice under present-day conditions, except where logs are pre-assembeld into loads for tractor or animal skidding, or where the logs close to the roadside are moved by hand to commence log stacks while other skidding means are being employed for logs further away in the compartment. This only applies to logs very close to the roadside, but handling distances may be increased if the slope is favourable, and the ground surface is without obstacles.

Rolling timber by hand (Fig. H. 6) is still applied in the Department, although only in isolated instances. This is only done in thinnings on steep, rocky slopes when logs are small, and the terrain does not lend itself to the construction of slip-paths for animal skidding. Logs are usually rolled end over end. Rolling commences from the bottom of the slope, and logs are first rolled to a central pile. As the top logs of the pile are rolled, they tend to slide over the lower logs, which increases the distance of each movement.



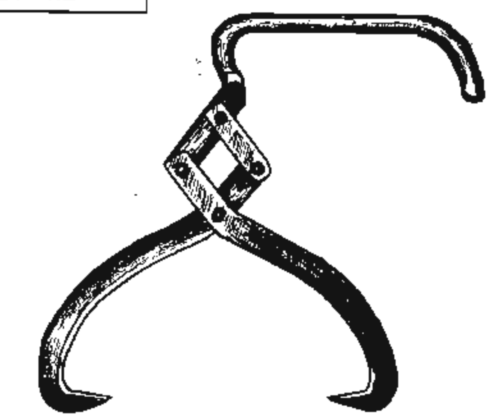
TERRAIN SUITABLE FOR LOG-TOWING METHODS.

FIG. S.K. 1

FIG. H.1

CARRYING LOGS BY HAND SPARS

FIG. H.2



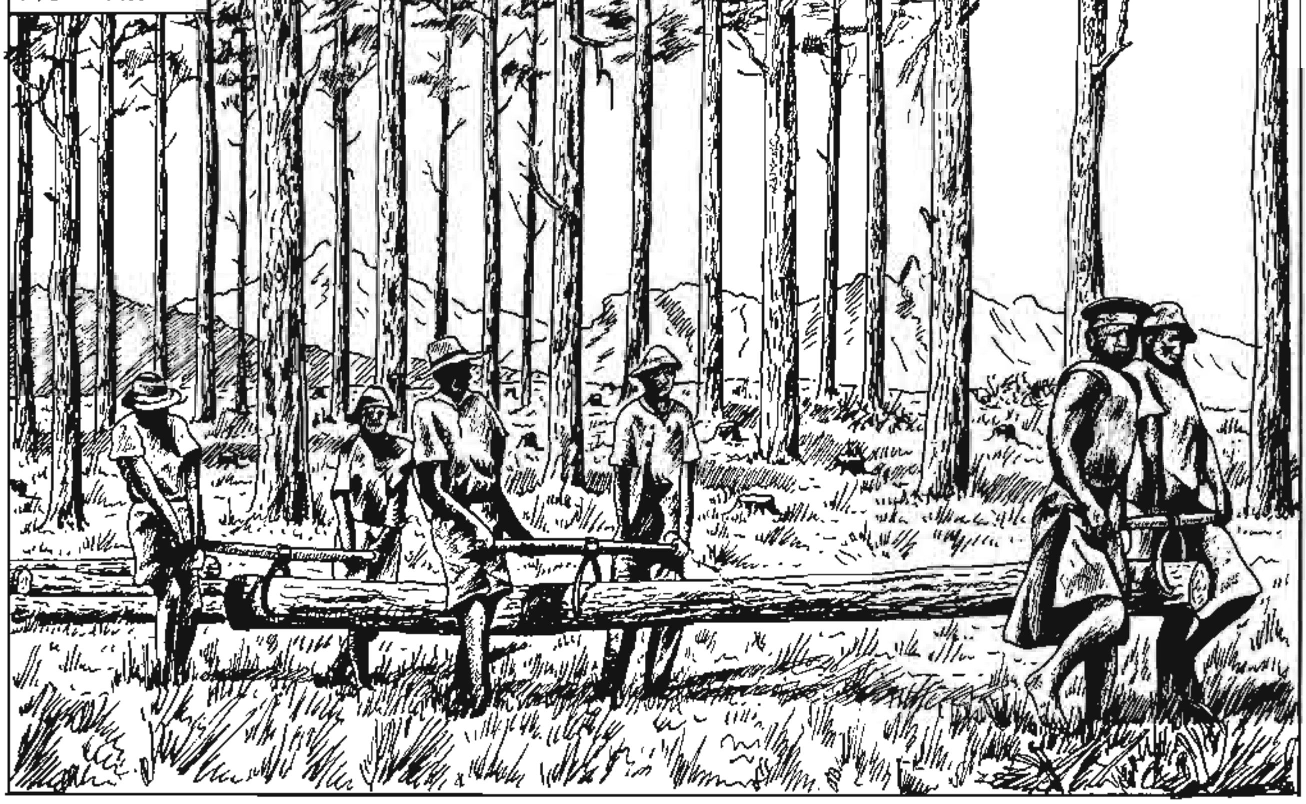
ONE-MAN TIMBER CARRIER.

FIG. H.3

TWO-MAN TIMBER CARRIER.

FIG. H.4

FIG. H.5



SMOOTHING KNOTS OFF DROPPERS.

FIG. H. 6

SKIDDING SMALL LOGS STEEPLY DOWNHILL BY HAND IN THINNINGS.

For general interest some data relating to timber handling and rolling are given below:

Random test - log carrying by single men

As an experiment logs were carried out to the road by 24 labourers under supervision of a foreman. The distance varied from 50 to 70 metres, over easy terrain with almost no slope. As a result the following was observed:

Time: 8 hours 52 minutes (one working day)
Wages and C.O.L.A. for foreman and 24 labourers: R27,60
Number of logs carried out: 848
Volume: 55,4 m^3 - approximately 69 000 kg
Per labourer: 35 logs - 2,3 m^3 - 2 870 kg
Average log 0,065 m^3
Cost per m^3 : 2 760 ÷ 55,4 = 49,8c

Note: No figures are available for gang carrying of timber, as illustrated in Fig. H. 1, as this method was abandoned some years ago.

Rolling logs - random test

A short log-rolling test was arranged to determine the output and cost of pulpwood extraction on rocky and inaccessible areas with no roads.

Two Bantu labourers were engaged in felling, debranching, cross-cutting and rolling logs over a 400 metres distance down a slope of 22° - 30°, through standing trees.

Two trees were felled and cross-cut into 8 logs, 2 metres long with 13 to 20 cm top diameters, and a total volume of 0,39 m^3. Logs were rolled down the slope and stacked at the roadside.

The rolling job lasted 63 minutes, which included resting time, indicating that two men could deliver 3,3 m^3 per day. Reducing this to 3,0 m^3 one arrives at a delivery of 1,5 m^3 per unit. As Bantu labourers were paid 80c per day, the cost of delivery was 53c per m^3.

Note: The logs arrived completely debarked, as they rolled over a very rocky slope. No damage to the wood was evident. The labourers employed for the test were old and inexperienced.

One drawback of the log-rolling method is that standing trees are liable to be damaged by logs rolling down the steep slopes in thinnings.

LOGGING with OXEN

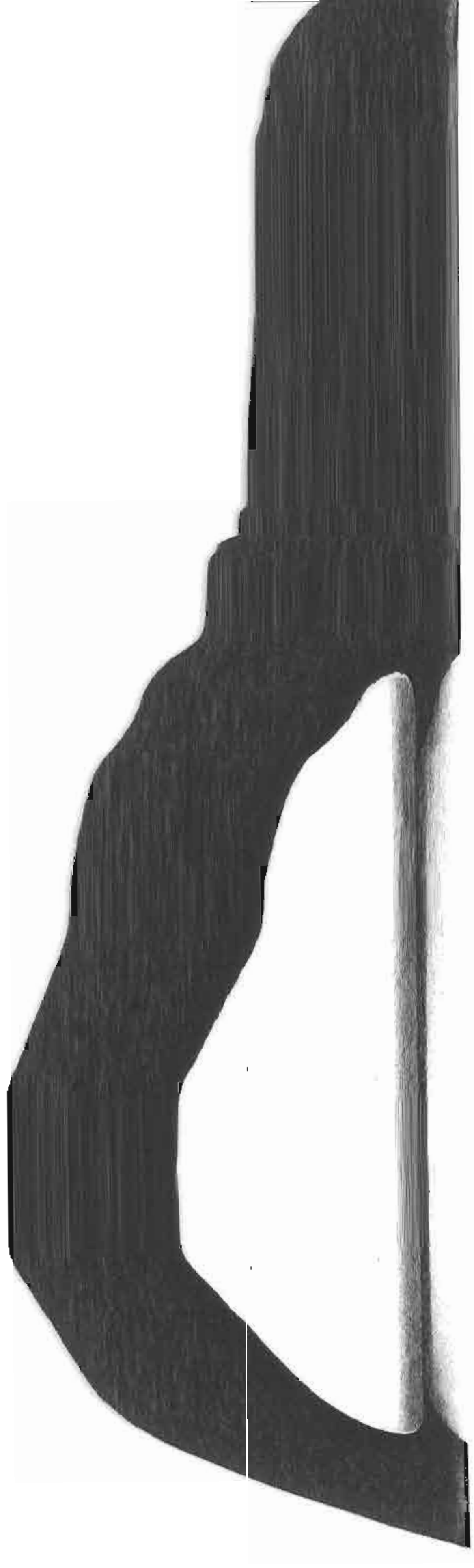
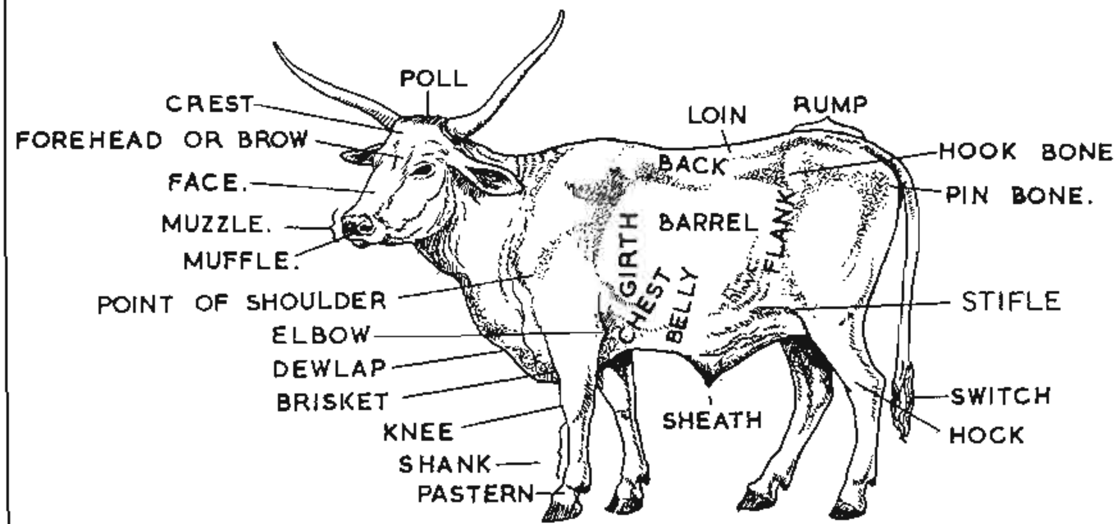
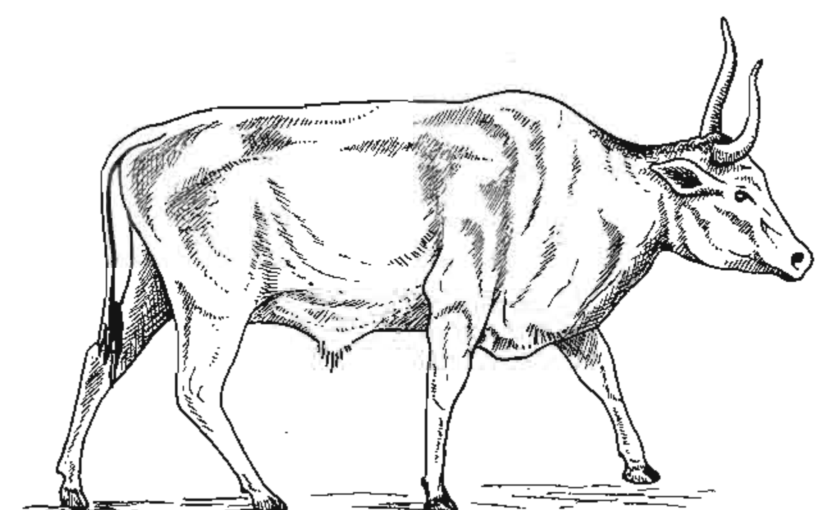


FIG. O.1



POINTS OF AN OX



TYPICAL OX IN GOOD TRAINING FOR LOG SLIPPING.

FIG. O. 2

TREK GEAR FOR OXEN

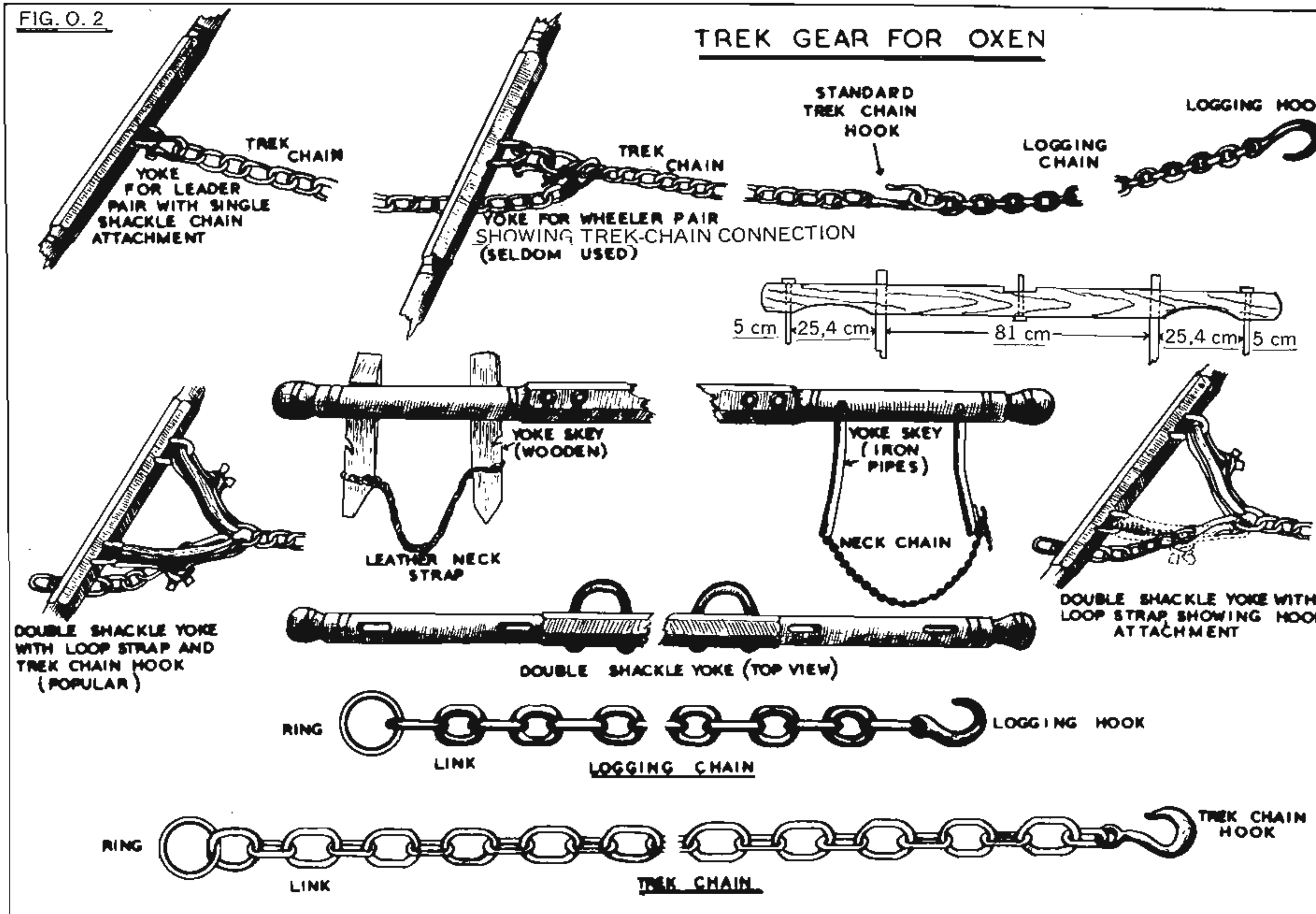
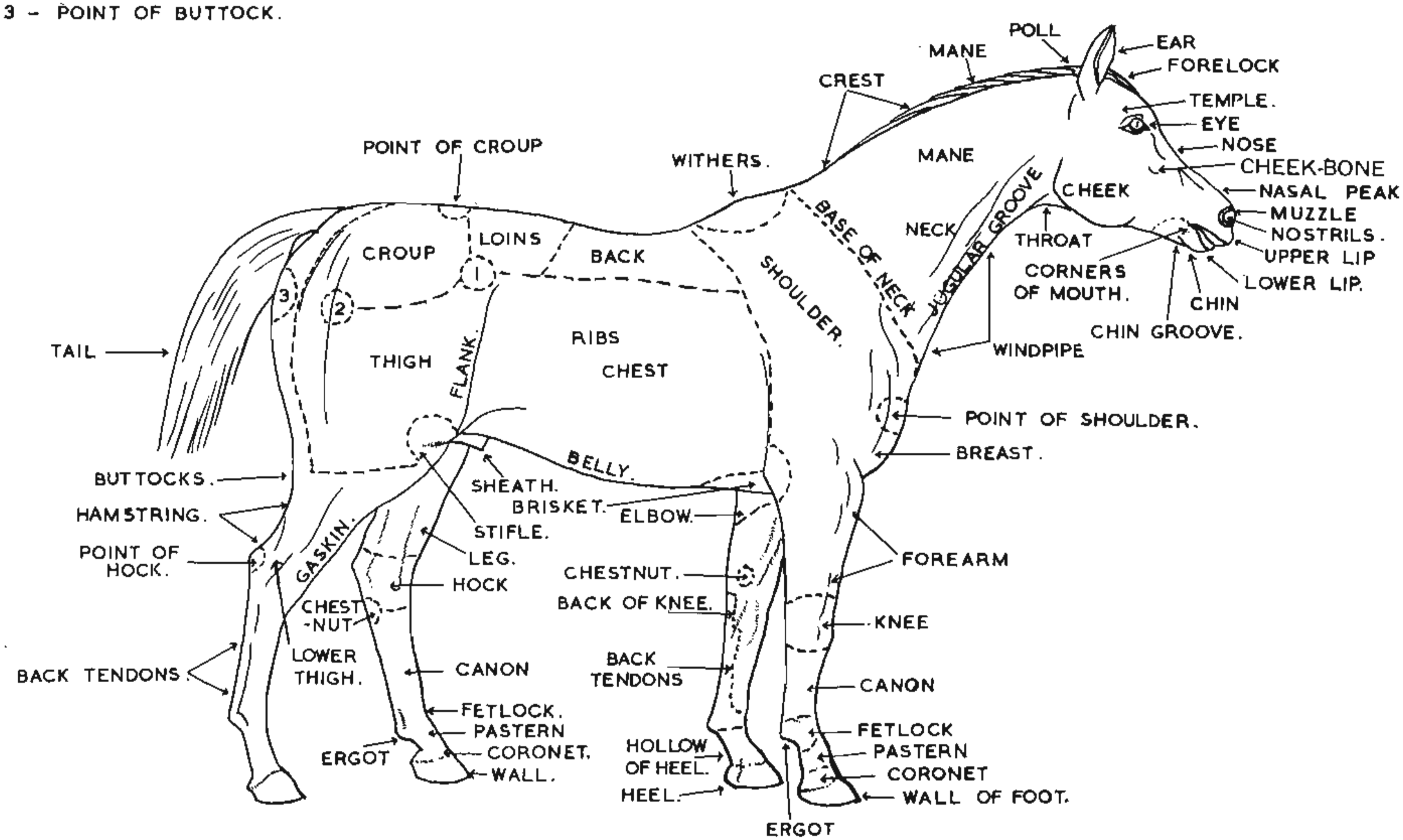


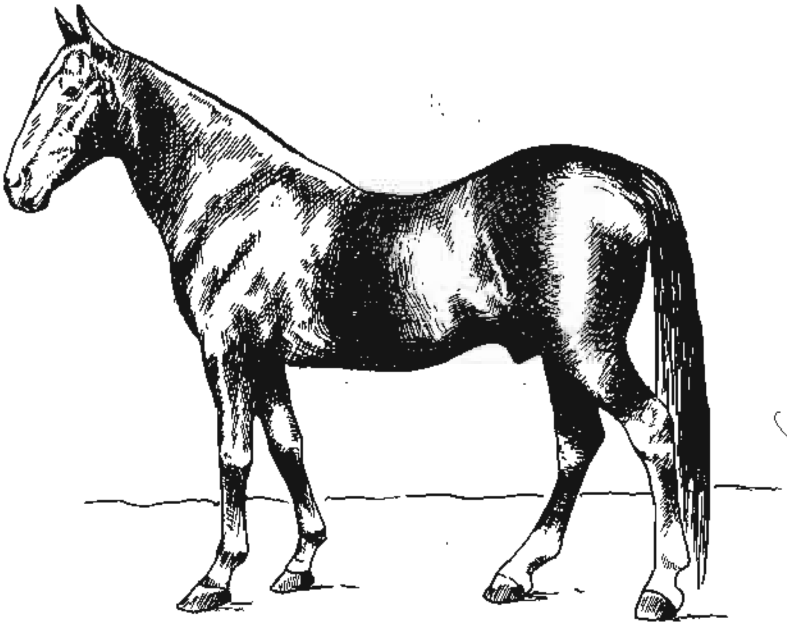
FIG. M. 4

1 – POINT OF HIP.
2 – HIP JOINT
3 – POINT OF BUTTOCK.



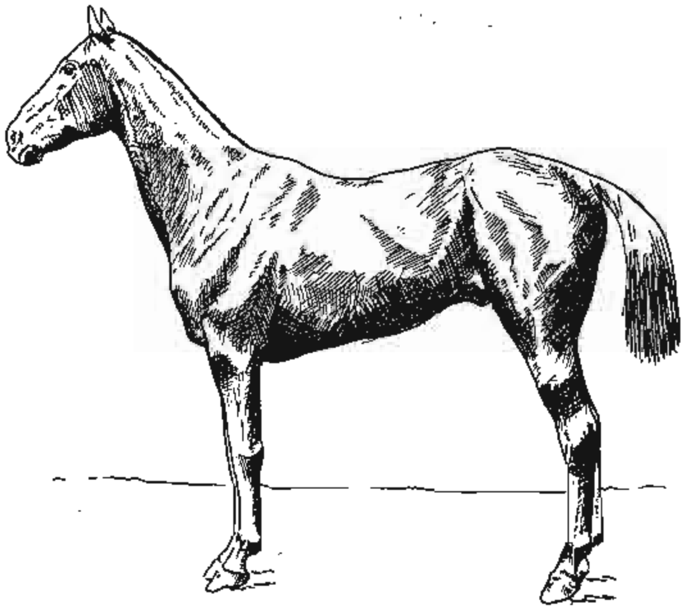
POINTS OF THE HORSE

FIG. M. 5.



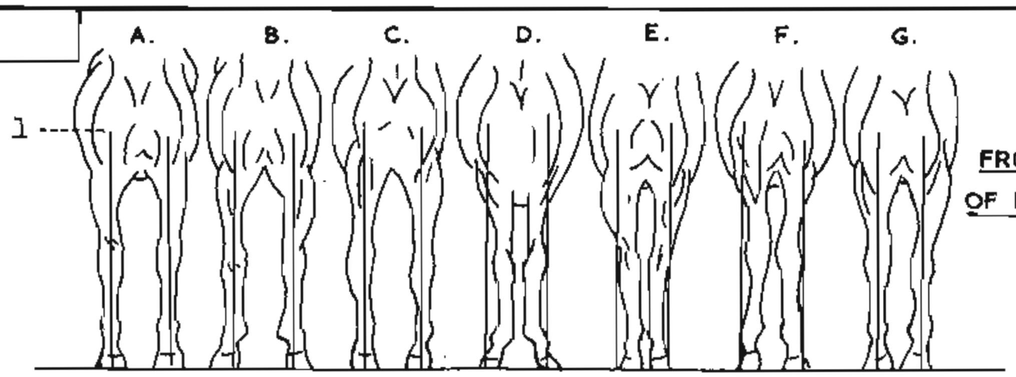
"HOLLOW-BACKED" HORSE — FAULTY.

FIG. M. 6.



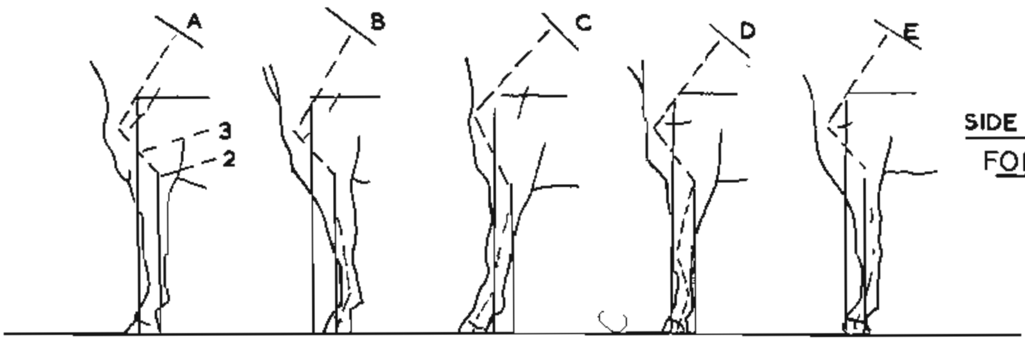
IDEAL HORSE.

FIG. M. 7



FRONT VIEW OF FORE LIMBS

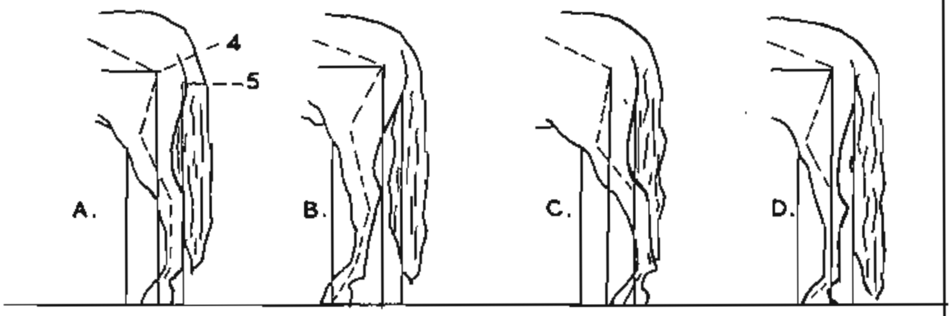
A. NORMAL. B. TOES TURNED OUT. C. LEGS TOO FAR APART. D. CALF-KNEES AND TOES TURNED OUT. E. LEGS TOO CLOSE TOGETHER. F. CALF-KNEES. G. TURNED IN TOES.



SIDE VIEW OF FORE LIMBS

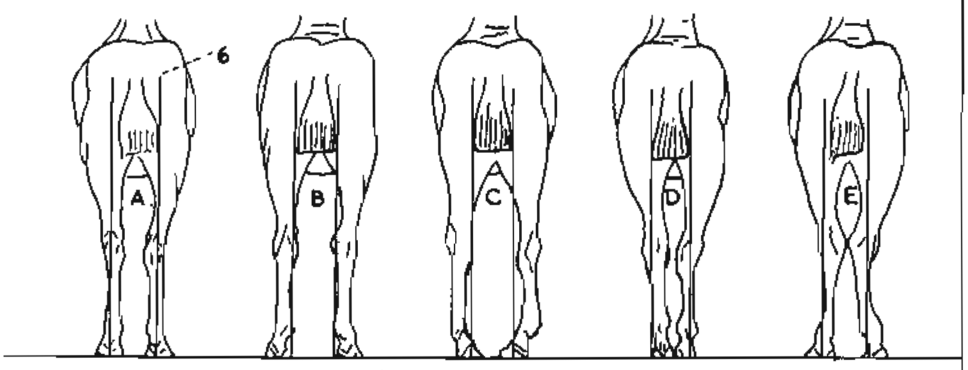
A. NORMAL. B. "STANDING UNDER" C. "STANDING OVER". D. "OVER" AT KNEES. E. CALF-KNEES.

A. NORMAL
B. INCLINED A LITTLE BACKWARDS.
C. TOO FAR BACK.
D. INCLINED A LITTLE FORWARD.



SIDE VIEW OF HIND LIMBS.

A. NORMAL STRAIGHT LEGS.
B. TOO WIDE APART.
C. TURNED-IN TOES.
D. LEGS TOO CLOSE.
E. COW HOCKED.



BACK VIEW OF HIND LIMBS.

FIG.M. 8

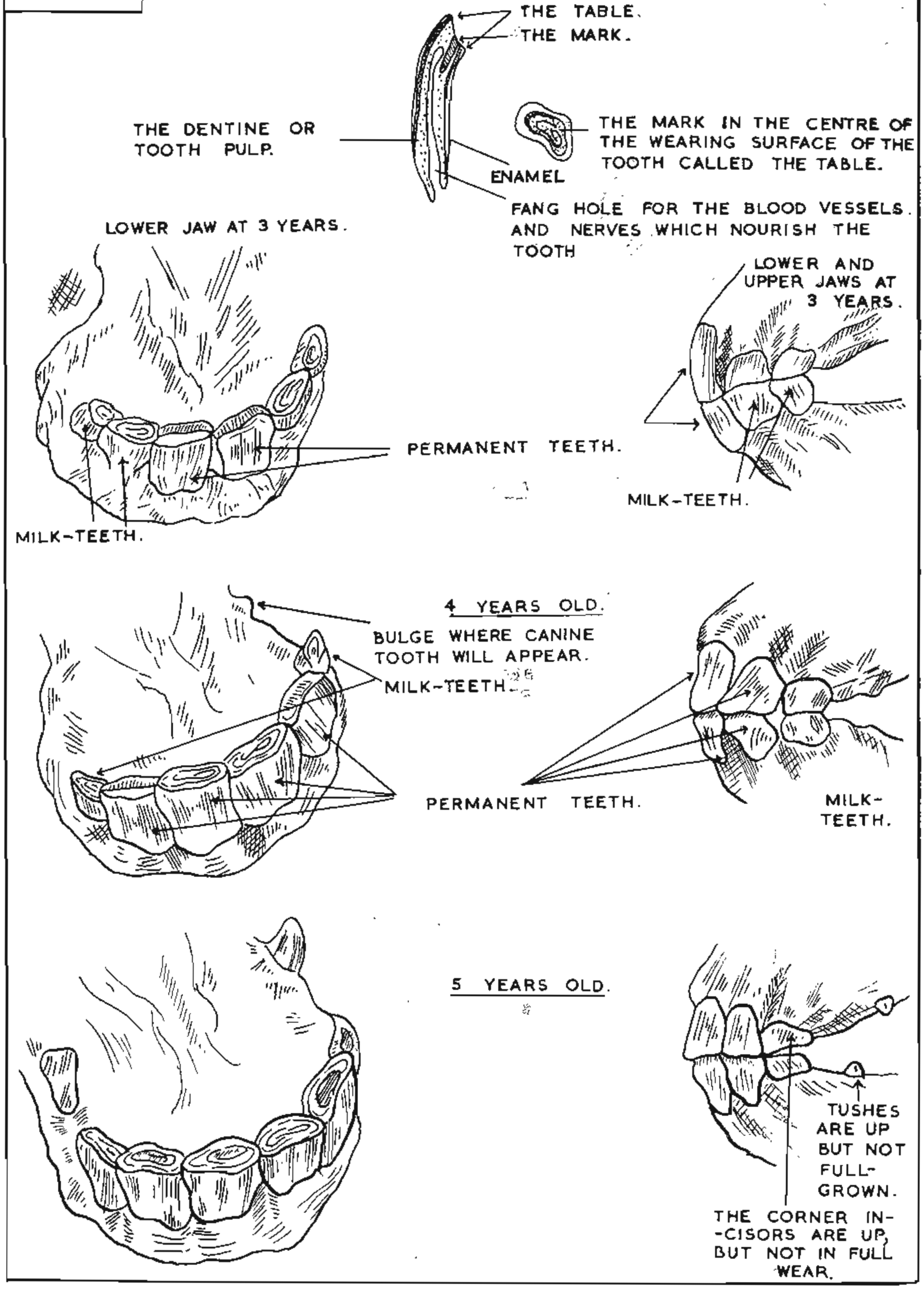

THE TABLE.
THE MARK.
THE DENTINE OR TOOTH PULP.
THE MARK IN THE CENTRE OF THE WEARING SURFACE OF THE TOOTH CALLED THE TABLE.
ENAMEL
FANG HOLE FOR THE BLOOD VESSELS AND NERVES WHICH NOURISH THE TOOTH
LOWER JAW AT 3 YEARS.
LOWER AND UPPER JAWS AT 3 YEARS.
PERMANENT TEETH.
MILK-TEETH.
MILK-TEETH.
4 YEARS OLD.
BULGE WHERE CANINE TOOTH WILL APPEAR.
MILK-TEETH.
PERMANENT TEETH.
MILK-TEETH.
5 YEARS OLD.
TUSHES ARE UP BUT NOT FULL-GROWN.
THE CORNER IN--CISORS ARE UP, BUT NOT IN FULL WEAR.

FIG.M.9

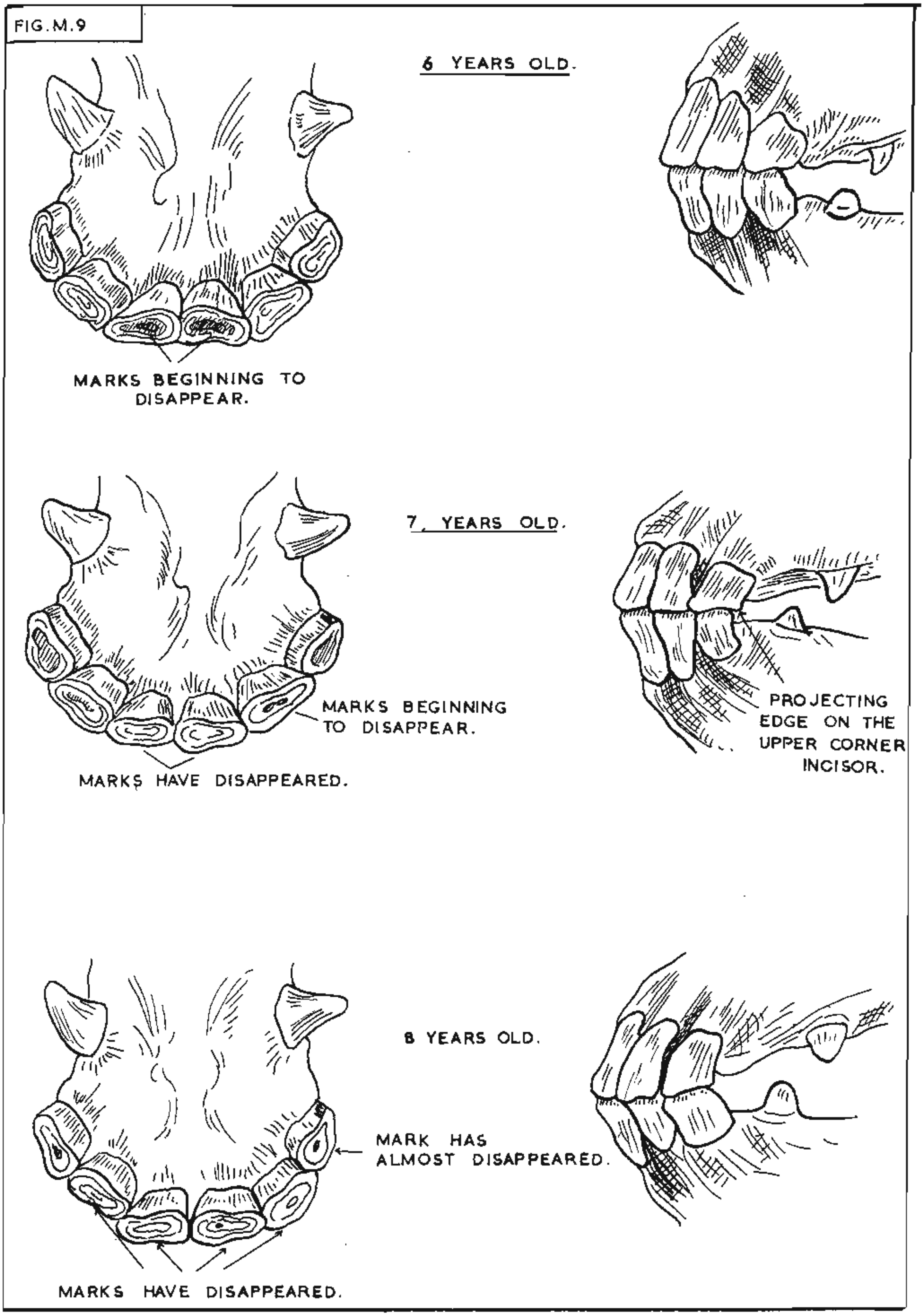
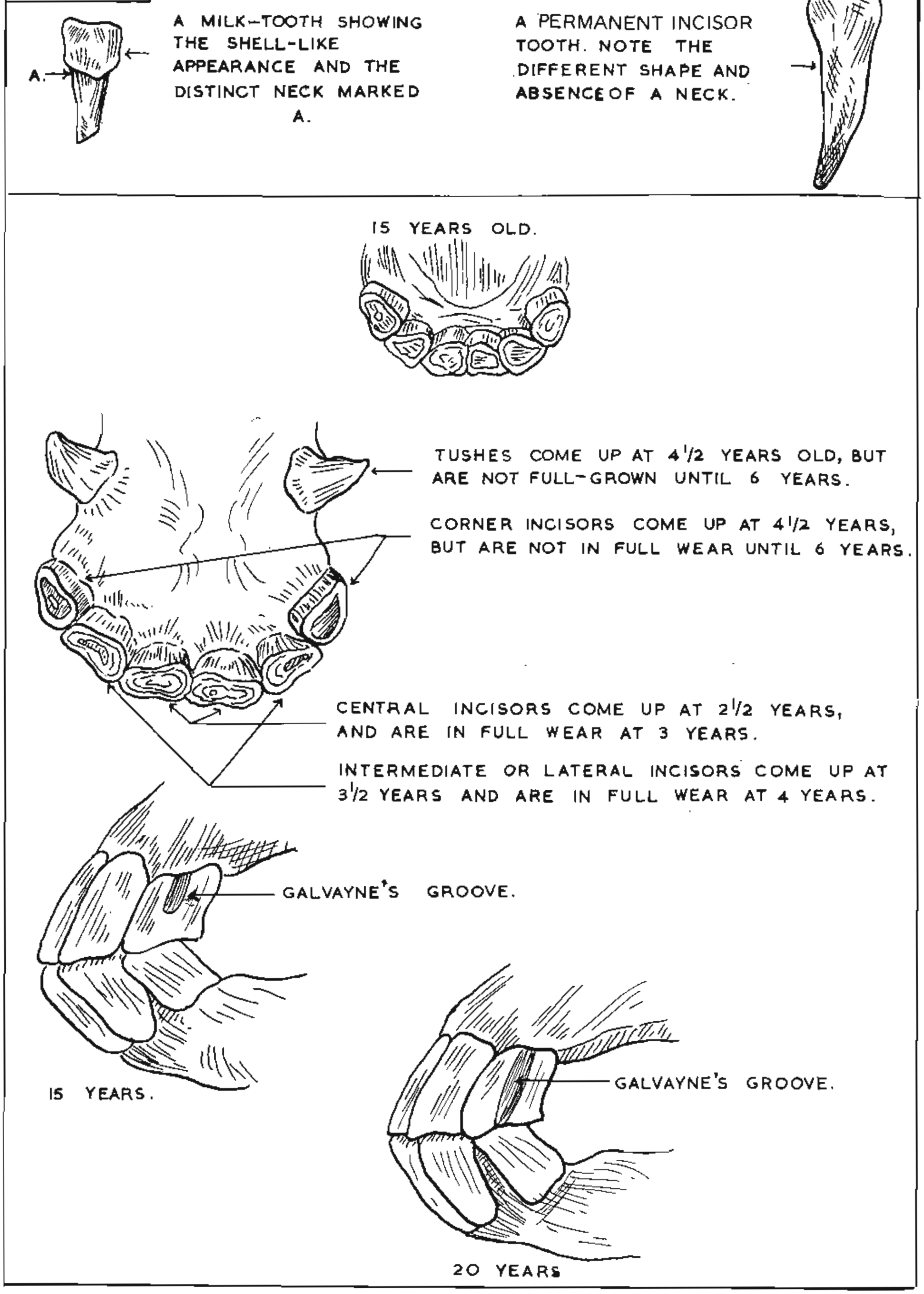

6 YEARS OLD.
MARKS BEGINNING TO DISAPPEAR.
7. YEARS OLD.
MARKS BEGINNING TO DISAPPEAR.
MARKS HAVE DISAPPEARED.
PROJECTING EDGE ON THE UPPER CORNER INCISOR.
8 YEARS OLD.
MARK HAS ALMOST DISAPPEARED.
MARKS HAVE DISAPPEARED.

FIG. M. 10


A MILK-TOOTH SHOWING THE SHELL-LIKE APPEARANCE AND THE DISTINCT NECK MARKED A.
A.
A PERMANENT INCISOR TOOTH. NOTE THE DIFFERENT SHAPE AND ABSENCE OF A NECK.
15 YEARS OLD.
TUSHES COME UP AT 4 1/2 YEARS OLD, BUT ARE NOT FULL-GROWN UNTIL 6 YEARS.
CORNER INCISORS COME UP AT 4 1/2 YEARS, BUT ARE NOT IN FULL WEAR UNTIL 6 YEARS.
CENTRAL INCISORS COME UP AT 2 1/2 YEARS, AND ARE IN FULL WEAR AT 3 YEARS.
INTERMEDIATE OR LATERAL INCISORS COME UP AT 3 1/2 YEARS AND ARE IN FULL WEAR AT 4 YEARS.
GALVAYNE'S GROOVE.
15 YEARS.
GALVAYNE'S GROOVE.
20 YEARS

Lesion	Material required	Use
(a) Puncture wounds anywhere on the body and any wound below knee and hock.	Anti-tetanus serum. 5 ml syringe. 20 B. W.G.hypodermic needle.	Inject 3 000 units subcutaneously, as soon as practicable after the injury,
(b) Any wound on the body, except the eye.	Acriflavine in glycerine 1/500, have 2 x 454 cm bottles.	Apply to any open wounds for 5 days, twice daily.
(c) As above.	Gentian violet in water. 1%	Apply as above. Alternate (a) and (b) until healed.
(d) Puncture wounds in feet.	Kaolin plaster (anti-flogistine is a proprietary brand example).	See directions on tin.
(e) Sore eyes.	Sulphanilamide, 1 part. Cod-liver oil - 8 parts.	Apply 5 drops 3 times daily.
(f) General foot hygiene.	Hoof pick.	Remove dirt from feet.
	Stockholm tar in fish oil. 1: 10.	Paint on with brush on soles and walls at least twice weekly.
(g) Colic or other pain.	Chloral hydrate crystals.	Put a table spoon in 0,56 litre of warm milk and give by mouth.
(h) Constipation	Magnesium sulphate.	25g in drinking water daily till faeces soft.
(i) Ticks in ears.	Tick grease.	Apply to inside of ears twice monthly if necessary.

Six elastoplast bandages and 1 kg of cotton wool should be kept on hand.

Periodically a veterinary surgeon should visit the mules, say once in every four or six months.

D. FEET AND SHOEING

The hoof (see Fig. M 11) is comprised of the wall or outer shell, divided into the "toe", "quarters" and heel. The heels turn sharply inwards and run forward between the horny "frog" and sole to form the bars. The part of the wall that touches the ground is called the bearing surface, to which the shoe is fixed.

The hindfeet, which act as a point from which the body is propelled, are narrower and more pointed than the forefeet, which bear the main mass of the body (Fig. M 12, 13 and 14). The position of the limbs influences the shape of the feet. A normal limb, if the feet are properly cared for, will have a proportionate foot, as in Fig. M 18, while an abnormal position of the limb will develop an abnormal foot to suit the shape of the limb. Fig. M 12, 15, 19 and 20 illustrate regular and irregular hoof positions and proportionate feet.

In parts of the country the ground is hard and often rocky and shoeing is necessary to protect the foot, or the hoof may become bared and the sensitive tissue beneath the horn become exposed. Shoeing has been described as a "necessary evil", but proper shoeing does not harm the foot, and in many cases, particularly with young animals, deformities may be corrected.

Shoeing of mules is not necessary in areas covered with soft soil and where the surface is covered with a thick mat of needles. The hoofs must, however, be trimmed regularly. Level trimmed hoofs are necessary so that the animal does not develop incorrect leg postures, and so that the "frog" may make proper contact with the ground to perform its shock-absorbing function correctly.

It will soon become evident whether mules need to be shod or not as the wear of the foot is greater than the growth when mules work on hard soil. Mules will develop "boxy" foot if not shod and the sensitive tissues beneath the horn become exposed.

The position of the limbs and feet modify the action of the animal, and it is necessary to observe the position of the limbs as well as the animal in action before shoeing. In normal action the feet and limbs move in a straight line (Fig. M 16) with the heel coming to the ground first. The bearing surface, on both sides of the quarters, comes to the ground together. Any abnormalities will be fairly evident if the basic movements and hoof-marks are observed (Fig. M 17) and shoes can be selected accordingly in order to correct irregularities and produce well-proportioned feet.

It is advisable that an experienced farrier examine the hoofs of mules at least twice a year. A set of shoes should last from one to two months, depending on the type of work and the ground surface, and a mule should not go for longer than a month without its feet being attended to as the horn may have grown a considerable amount during that period.

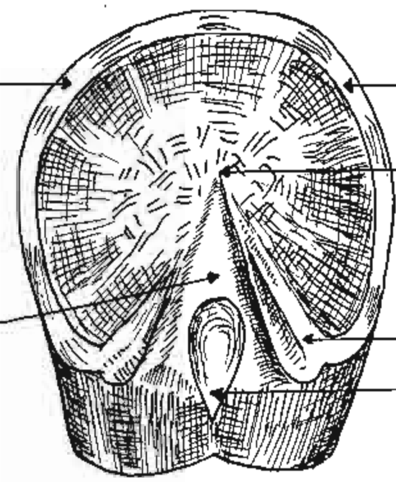
Experienced farriers are few and hard to find in the present-day world of mechanisation, and it is advisable to train up younger labourers in the arts of shoeing so that they can replace the older trained men when they are no longer capable of work.

(a) THE SHOE (Fig. M 21)

The web is the whole substance of the shoe. The surface in contact with the ground is the ground surface and the part in contact with the foot is the bearing surface. A good shoe should conform to the outer line of the bearing surface to which

A FOREFOOT

FIG. M. 11.



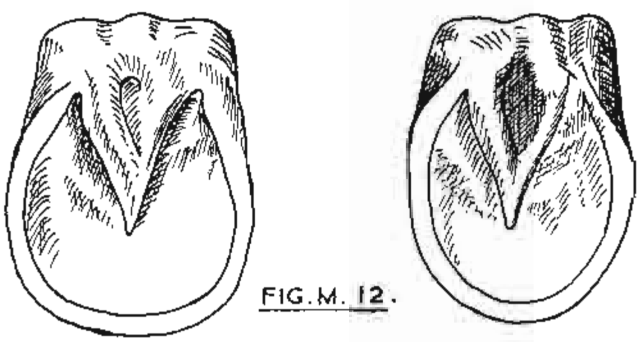


FIG. M. 12.

FOREHOOFS – GROUND WIDE POSITION.

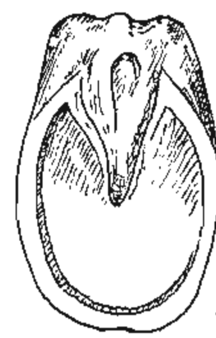


FIG. M. 13.

NARROW HOOF.

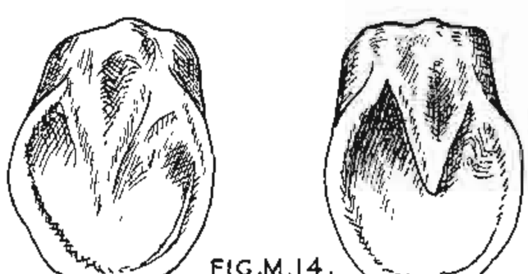


FIG. M. 14.

NORMAL NEAR FOREFOOT

NORMAL NEAR HINDFOOT

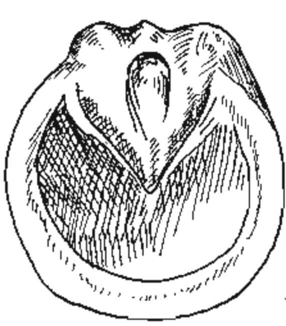


FIG. M. 15.

WIDE HOOF.

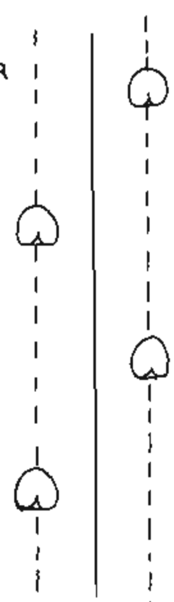


FIG. M. 16.

NORMAL ACTION.

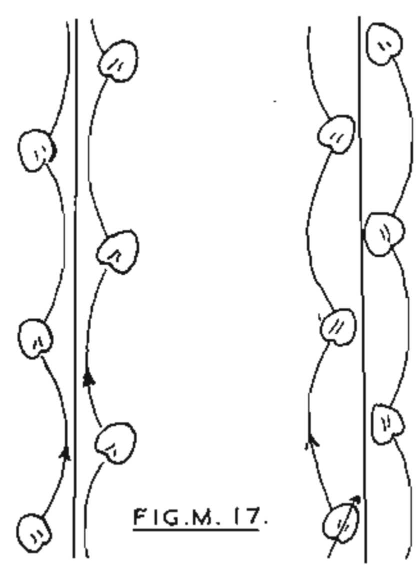
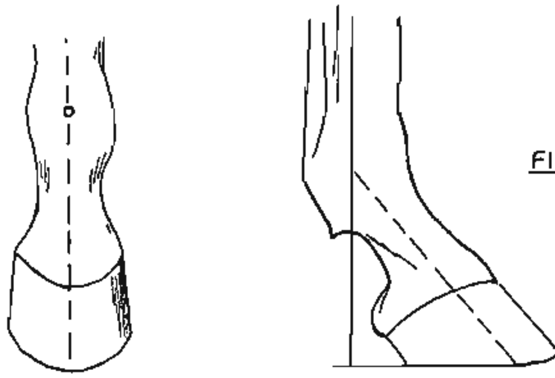


FIG. M. 17.

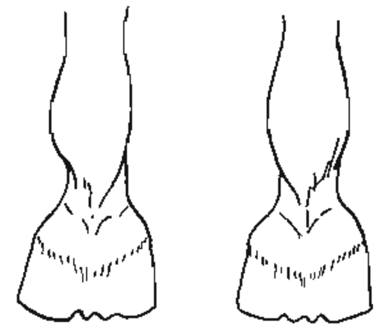
ACTION IN LADY-TOED POSITION.

ACTION IN PIGEON-TOED POSITION.

FIG. M. 18.



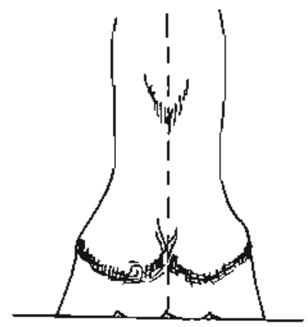
NORMAL TOE-AXIS WHEN VIEWED FROM THE FRONT AND SIDE.



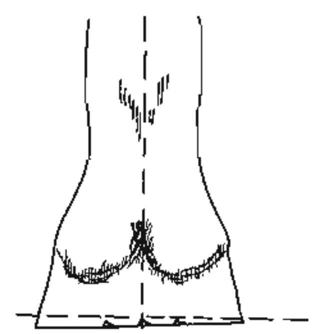
NORMAL TOE-AXIS WHEN VIEWED FROM BEHIND.

FIG. M. 19.

BEAR-FOOTED POSITION.

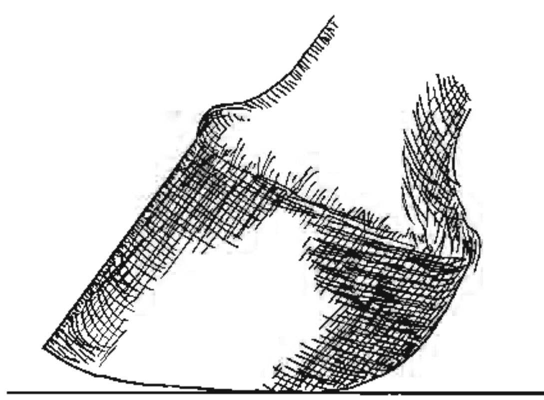


LEVEL FOOT.

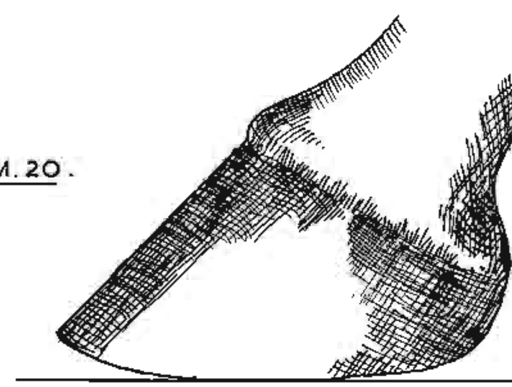


ONE SIDE TOO HIGH.

FIG. M. 20.



HEELS HIGH.



HEELS LOW — TOE LONG.

FIG.M. 21.

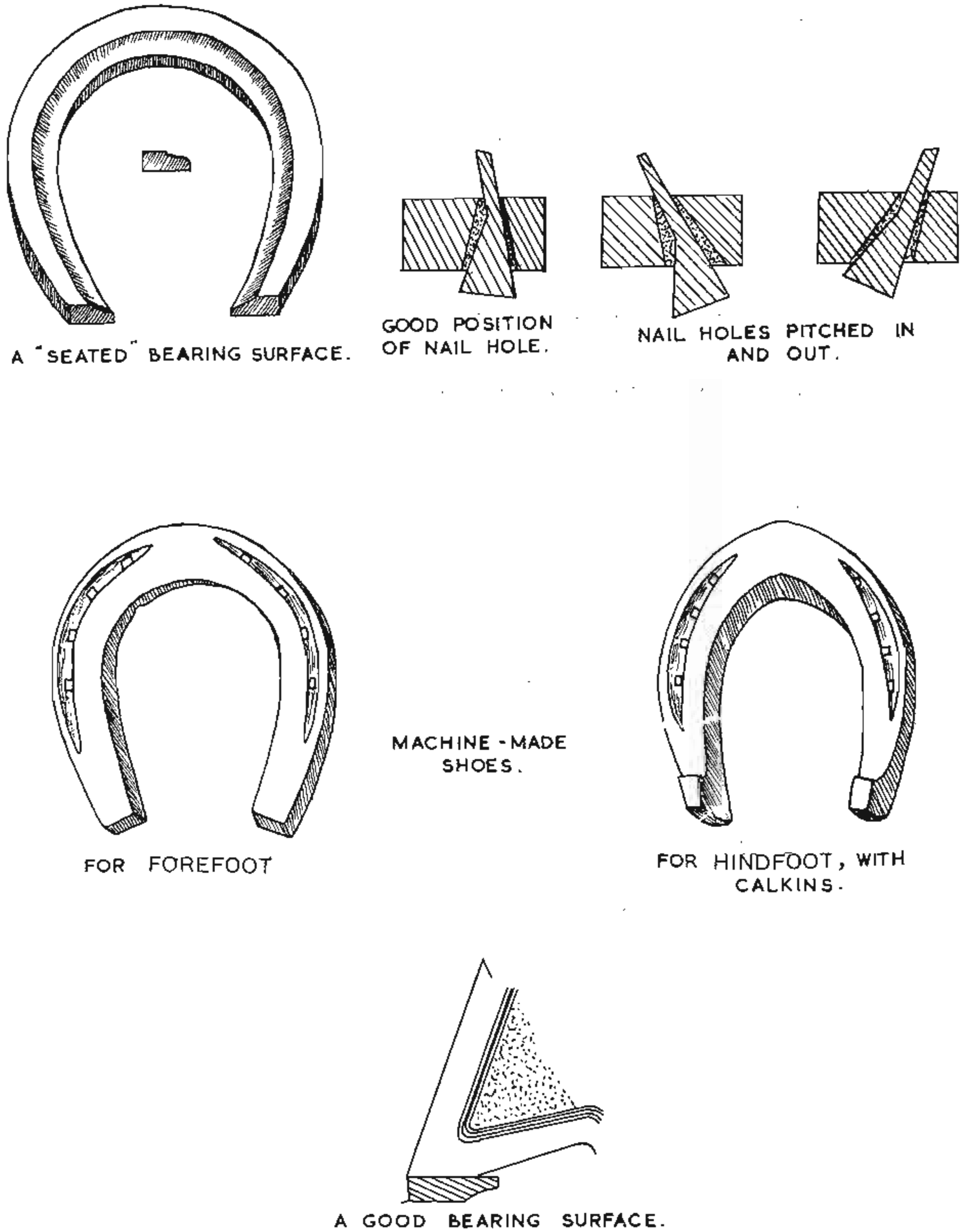
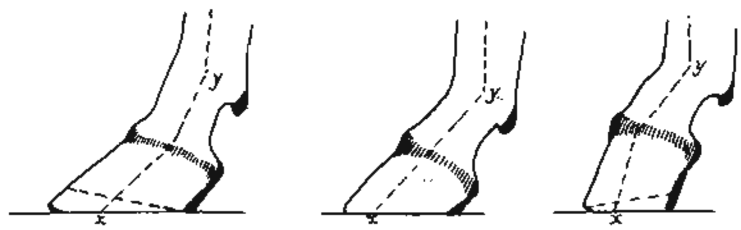

A "SEATED" BEARING SURFACE.
GOOD POSITION OF NAIL HOLE.
NAIL HOLES PITCHED IN AND OUT.
MACHINE-MADE SHOES.
FOR FOREFOOT
FOR HINDFOOT, WITH CALKINS.
A GOOD BEARING SURFACE.

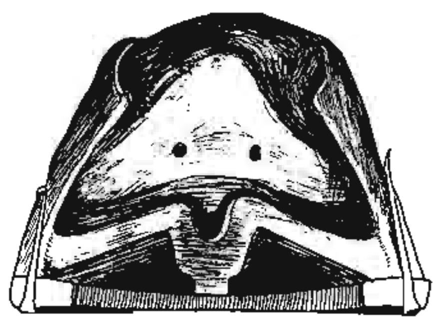
FIG.M.22.



EXCESS HORN ON TOE. NORMAL FOOT. EXCESS HORN ON HEEL.

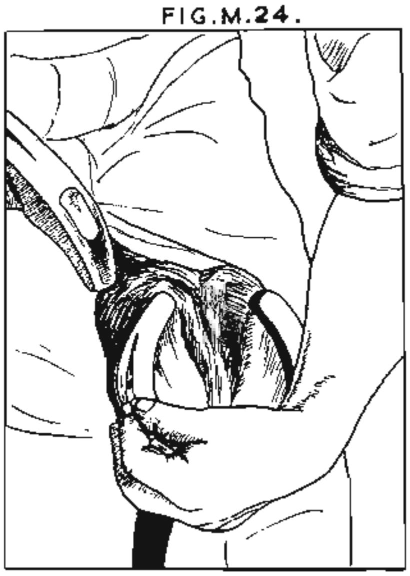
HORIZONTAL DOTTED LINE SHOWS HOW HOOF MUST BE TRIMMED TO RESTORE NORMAL POSTURE.

FIG.M.23.



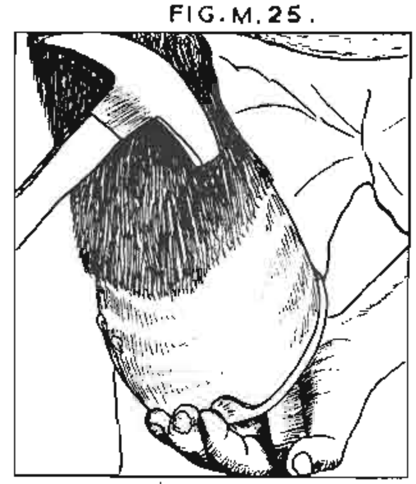
CROSS-SECTION OF HOOF SHOWING NAIL THROUGH WALL (RIGHT) AND CLINCHED NAIL (LEFT)

FIG.M.24.



CORRECT WAY OF HOLDING THE SHOE FOR NAILING.

FIG.M.25.



CLINCHING THE NAILS.

it is fitted and provide adequate coverage to protect the foot. Nail holes in the shoe should be large enough to accommodate the nail heads with the minimum of play between the nail and shoe.

(b) SHOEING

(i) Excess horn should be trimmed off the hoof to restore normal posture (Fig. M 22).

(ii) The hoof should not be rasped or pared to fit the shoe, but the shoe should be made to fit the hoof.

(iii) The "frog" may be trimmed of scraggy pieces.

(iv) The shoe must have a level bearing surface.

(v) If the hoof is unduly dry it should be oiled with hoof oil.

(vi) When the shoe fits, it is cooled and then prepared for nailing on by smoothing it and rounding the edges slightly with a file.

(vii) The nail holes should be so positioned that the nail enters at the "white line", between the inner surface of the wall and the horny sole, as shown in Fig. M 23. Nails must not be driven too high, but sufficiently high to give a good hold and keep the shoe tight to the bearing surface. Fig. M 24 shows the correct way of holding the shoe for nailing. Where the point of the nail comes through the outside of the wall it must be "clinched", or bent over, as in Fig. M 23 (left) and Fig. M 25.

E. FEEDING MULES

(1) AMOUNT OF FODDER TO BE GIVEN

(i) Resting mules

When mules are resting they can be kept in a healthy condition on good grazing alone, but, if grazing is poor, it can be supplemented by a high quality hay. Mules which have been idle for a long spell can be ready for work within two weeks if fed on a medium ration of concentrates and hay, provided that they have not lost too much mass during the idle spell.

Hardworking mules which have been idle for a day or two must receive the same ration as the working mules (more bulky feeds such as wheat bran can be fed). Sudden changes in rations must be avoided. The concentrate ration must be decreased gradually as the amount of work decreases until only hay is fed (if the grazing is good hay need not be given).

(ii) Working mules

Working mules should receive the following quantities of feed per day:

- For light work: 200 g grain (concentrates) and 500 g to 600 g of hay (roughage) per 50 kg of body mass.

- For medium work: 300 g of grain (concentrate) and 400 to 500 g of hay (roughage) per 50 kg of body mass.

- For hard work: 400 g of concentrate and 400 g of hay per 50 kg of body mass.

The above recommendations indicate that the concentrates plus roughages should total 800 g per 50 kg of body mass.

Note: The average departmental mule may be considered as having a mass of between 400-500 kg, thus requiring between 6 and 8 kg of foodstuff per day for hard-working animals

(2) FEEDING TIMES AND WATERING

Mules should be fed a little at a time, but at fairly frequent intervals, as they have small stomachs in proportion to their size. Working mules should be fed at least thrice daily as follows: 1/4 of the roughage in the morning, 1/4 in the afternoon and ½ in the evening. The concentrate should be given at a rate of 1/3 in the morning, 1/3 in the afternoon and 1/3 in the evening. Whenever possible mules should be put out to graze overnight and over week-ends.

Animals must always be watered moderately before feeding and moderately after feeding just before working. A mule should not be permitted to drink its fill just before work or when it is hot just after work. When animals work in hot weather they should receive more water, but the salt ration must also be raised to 3% of the daily concentrates instead of 1%. After hard work the animal should be led until it has cooled down before being permitted to drink.

Note: (i) All foods should be consumed daily. If left in the manger there is a tendency for the warm, moist breath of the mules to cause fermentation of the food which leads to digestive disturbances

(ii) Water should be provided at the spot where work is performed. The method of leading mules for long distances to water is undesirable

(3) BALANCED RATIONS FOR HORSES AND MULES

The following rations for horses and mules were selected and recommended by the "Bureau of Animal Industry" of the U.S.A:

(i)	Mealies	3,6 kg
	Wheat bran	0,9 kg
	Lucerne hay	3,6 kg
	Timothy hay	1,8 kg
(ii)	Mealies	5,0 kg
	Kaffir corn or legume hay	2,7 kg
	Mealie stalks	2,7 kg
(iii)	Mealies	4,5 kg
	Soya or kaffir beans	0,4 kg
	Lucerne	2,7 kg
	Mealie stalks	2,7 kg

Note: Timothy hay can be replaced by any of the South African grass hays, e.g. teff hay

The daily ration above applies to a mule of 450 kg doing medium work. This ration must be reduced by 1 kg of concentrate and 1 kg of roughage per 100 kg of body mass for mules of smaller body mass.

The following balanced ration is recommended by the Veterinary Research Institute, Onderstepoort, as being suitable for horses and mules:

Crushed maize or whole oats (or undergrade barley)	68%	3,2 kg	Ration per mule per day 450 kg live mass
Wheat bran	19%	900 g	
Groundnut or sunflower oil cake meal	7%	350 g	
Bone meal or dicalcium phosphate	4,5%	210 g	
Salt	1,5%	70 g	
	100%	4,73 kg	

The hay (roughage) to supplement the concentrate balanced ration should consist of a mixture of equal parts of lucerne hay and teff hay, or lucerne hay and oat hay. The latter mixture can be fed at the Cape Province centres and the former at the Transvaal and Natal centres.

A ration consisting mainly of lucerne (roughage) and mealies (concentrates) has no balance or ratio between the proteins, easily digestible carbohydrates and minerals. Too much mealies in the ration of heavy draught mules causes the animals to get unduly hot, due to the energy value of mealies, and makes them soft and short winded.

One of South Africa's animal feed distributors has prescribed the following balanced rations for mules:

40% crushed or rolled oats (or undergrade barley)
30% yellow mealie meal
10% lucerne meal
10% wheat bran
6% groundnut cake meal
3% dicalcium phosphate
1% salt

The animal nutrition expert from the Department of Agriculture has advocated the following balanced ration for mules:

50% crushed or rolled oats
30% crushed yellow mealies
12% wheat bran
5% groundnut or sunflower cake meal
2% dicalcium phosphate
1% salt

If balanced rations are to be fed to mules, the following difficulties and complications must be considered.

- Balanced rations consist of certain percentages of various components and the feeds must be mixed and prepared in certain fixed proportions.

- More storage space is required for the components of a balanced ration.

- If a component of a balanced ration is not available due to ordering or transport difficulties, the whole balance of the ration is disturbed.

These practical complications arising from introducing balanced rations are not so serious that they cannot be overcome, but should be taken into account. A compressed or "cube" form of these rations would minimise the above complications.

Compressed feeds have the following advantages:

(i) In order to obtain a homogeneous mixture and because concentrates are more edible and digestible in crushed forms, it is frequently necessary for them to be milled. Fine meal is not a suitable feed, however, as it tends to form indigestible lumps. Compressed rations eliminate this disadvantage.

(ii) Animals can chew the food naturally.

(iii) It is more palatable.

(iv) Wastages of concentrates are minimised - it cannot be blown away by the wind or the animals' breath.

(v) Cubed concentrates require less storage space.

(vi) Cubed concentrates are as or more digestible than grain in its original form.

(vii) Cubed concentrates will simplify the control of feeding.

(viii) The movement of heavy substances such as calcium and urea to the bottom of the hay is prevented.

(ix) The food mixtures can be accurately balanced in order to supply the mule with the necessary energy, proteins, fats, minerals and trace elements.

(x) It will obviate the need for preparing and mixing a balanced ration on the plantations; work which is usually done by unskilled labour.

(xi) A standard ration could be applied for all mules.

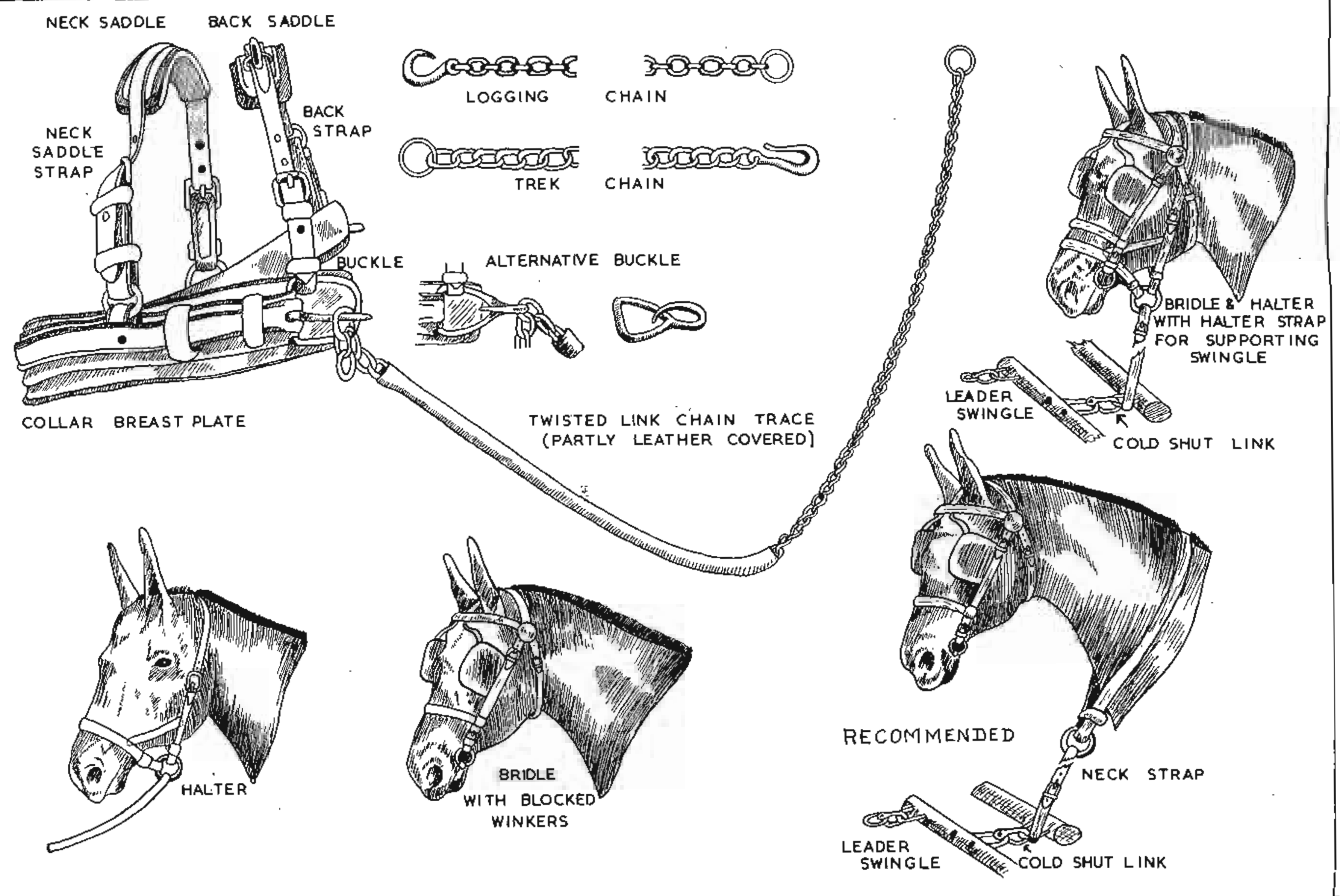
Large firms, with branches in most of the major cities and towns, could be approached to supply a ration of specific composition, thus ensuring a constant supply of food of the required composition. The cost of feeding balanced rations would range from 22 to 25 cents per mule per day, based on the cost of the feed at R3,22 per 68 kg bag, and feeding 4,5 kg per animal per day.

See tables in Appendix M 1 and 2 for quantities of feed to be given to animals per day, for various conditions.

Grazing camps

To keep horses and mules healthy and vigorous they must be put to grazing whenever possible, especially over week-ends when they are not working. Apart from that, mules prefer running loose in paddocks to being stabled, besides which green grass is very good for the mules' hoofs.

FIG. M. 26 MULE HARNESS



In areas where the grazing is poor, grazing camps may be improved by planting grass, or lucerne or other legumes or cereals. The best known hay planted over the whole country, except perhaps in the winter rainfall areas, is teff. Some of the lesser known perennial grass types for grazing and hay are the following:

Nile grass (nylvleigras) (Acroceras). This grass is established by planting root cuttings and is suitable for summer rainfall areas which get 750 to 1 250 mm of rain per annum.

Napier fodder (olifantsgras) (Pennisetum) can be used in areas with an average rainfall of 550 mm, and is also established by planting root cuttings. Setaria and Rhodes grass (Chloris) can also be used and are cultivated by sowing seed.

Buffalo grass (buffelsgras) (Panicum) and finger grass (vingergras) (Digitaria) are recommended for areas with a rainfall of less than 560 mm per annum.

In the Eastern Province grazing must be planted due to the presence of the poisonous plant, Senecio retrorsus, in the natural veld. Grazing of Rhodes and Kikuyu grass (Pennisetum) is generally used.

For the best advice regarding the type of grazing to be planted and its treatment the nearest Agricultural Research Institute may be approached.

F. REST PERIODS FOR MULES

If mules are well cared for and regularly fed and groomed, injuries, hoofs and chafing attended to, they can work every day of the week during the whole year. Mules must, however, not pull too-heavy loads or work too long hours or they will not be able to maintain the pace day in and day out without losing considerable mass. Mules should not work more than 7 hours a day and should be given an hour break during lunch time.

It is advisable to have 20% more mules on the plantations than actually required to cope with the work. These reserve mules can be substituted for sick, injured or chafed mules and can be incorporated into the working teams if regular rests of 1 day per week per mule are to be instituted.

G. STABLING

Well-drained and ventilated stables should be provided for mules, with firm, built-in mangers. Openings under the mangers are undesirable as the animals are inclined to hurt themselves by jarring their feet or legs against the sharp edges. Mules should be well and regularly groomed.

It is advisable to provide crushes near the stables to facilitate treatment of mules for injuries or against diseases.

On large plantations where work is sometimes done appreciable distances from the stables, temporary stables or shelters can be provided at different points to save the mules from having to walk long distances each morning and evening.

2. THE MULE HARNESS AND LOG-SLIPPING ATTACHMENTS

A. THE MULE HARNESS (Fig. M 26)

The collar breastplate harness has been universally adopted for use in departmental plantations. Care should be taken to ensure that the breastplate is neither too large nor too small for the size of mules used. Ill-fitting harnesses are a cause of chafing, and when ordering harnesses it is important to specify whether the mules are big (15 hands and over) or very small (below 14 hands). The harnesses supplied are usually for average mules of between 14 and 15 hands.

When ordering harnesses for very small mules it must be specified that the standard harness will not be suitable and the breastplate of the required harness should be 100 - 106 cm long from the base of the one main buckle to the base of the other. For very big mules the same priniciple applies and larger breastplates than the standard must be asked for, being at least 115 - 120 cm long. The use of breastplates wider than 7 cm is inadvisable as they cause chafing.

Heavily padded harnesses, as well as the plain collar type of harness, are not very suitable in hot or wet weather as they get wet and do not dry easily.

The collar type of harness without the breastplate is considered unsuitable for use with mules in South Africa. The use of this type of harness requires experienced mule-drivers, especially with the fitting of the harness on each mule and its maintenance. After wet weather the padded harness dries very slowly, during which time it cannot be used as it will cause chafing.

Bridles with blocked winkers are used for draught mules. Reins are not used for log slipping operations as the animals can either be led by a leather bridle strap, or taught to obey spoken commands.

Leather-covered chain traces are fixed from the breastplate buckle to the swingle where they are attached by means of steel shackles. Notches in the swingles may replace the steel shackles for trace attachment, the chains being looped around the notches, but this method is inclined to weaken the swingles. Notched swingles are not shown in the drawings.

A grab hook, with or without a swivel, is attached to the log side of the swingle for hooking the logging chain. As this hook firmly grips the chain over the link it facilitates shortening or lengthening at will. This is important from the point of view of traction, manoeuvrability and safety over various configurations of terrain during the slipping trip with logs. The importance of using a grab hook is fully dealt with under "log slipping".

Note : Detailed specifications of the mule harness and specifications and drawings of auxiliary equipment can be found in the attached appendix

FIG. M. 27

MULES IN HARNESS

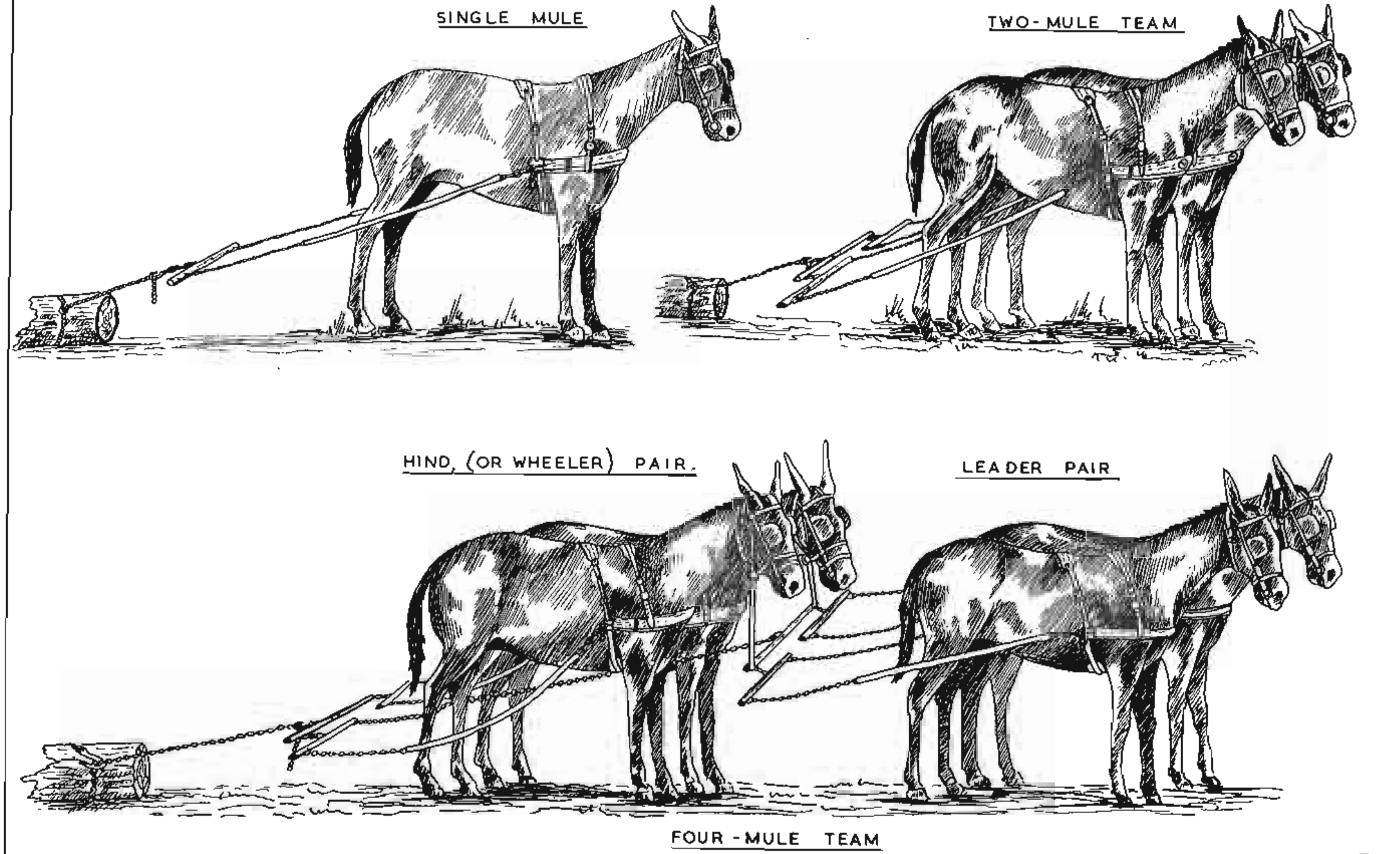
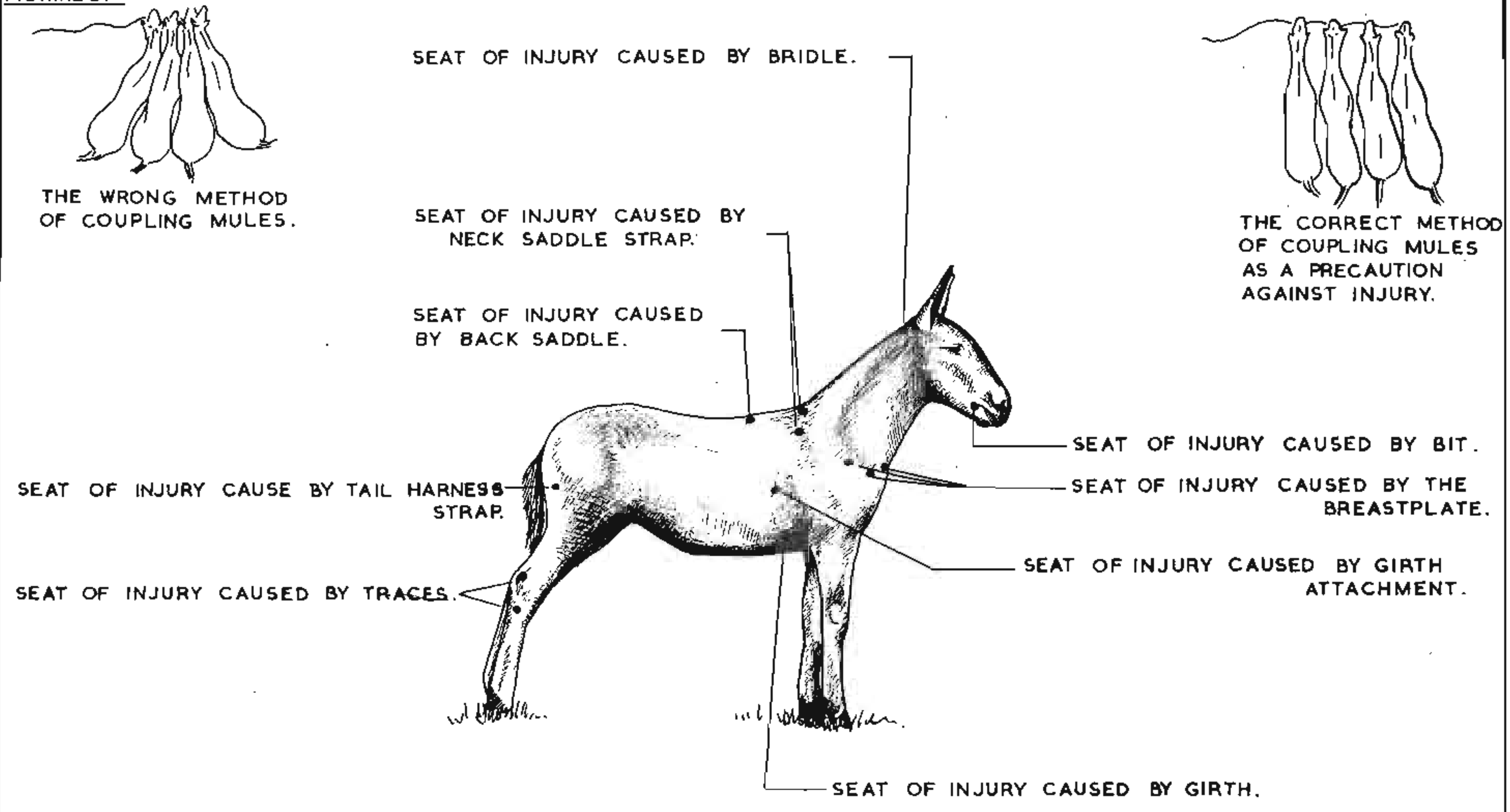


FIG.M.28.



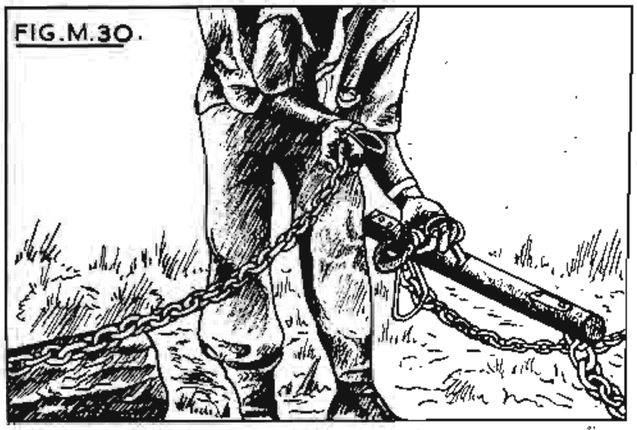
MULES.

DIAGRAM SHOWING THE SEATS OF INJURIES CAUSED BY THE HARNESS.

FIG. M. 29

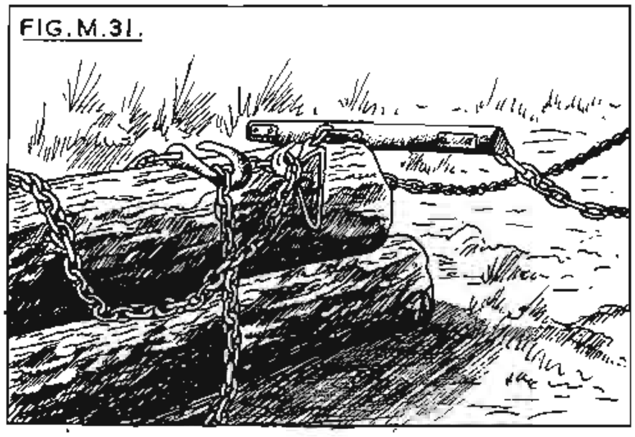
PRESTACKING LOGS FOR SKIDDING.

FIG.M.30.



HOOKING THE CHAIN TO THE SWINGLE GRAB HOOK.

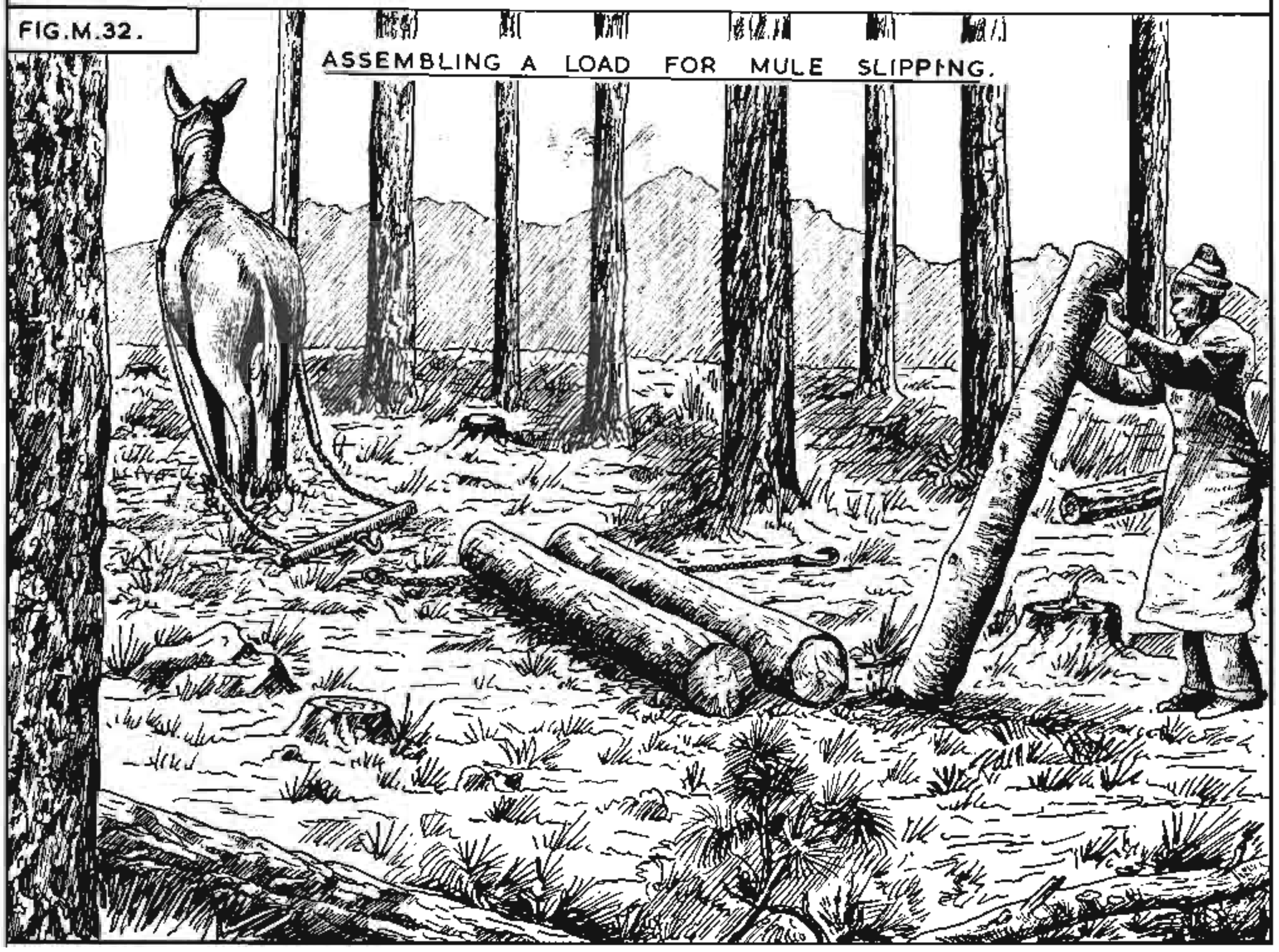
FIG.M.31.



A CHAINED BUNCH OF LOGS HOOKED TO THE SWINGLE GRAB HOOK.

FIG.M.32.

ASSEMBLING A LOAD FOR MULE SLIPPING.



WHEN TURNING SHARPLY WITH THE MULE TEAM, THE SWINGLE MUST BE LIFTED TO PREVENT OVERSTEPPING OF THE TRACES.

FIG. M.33.

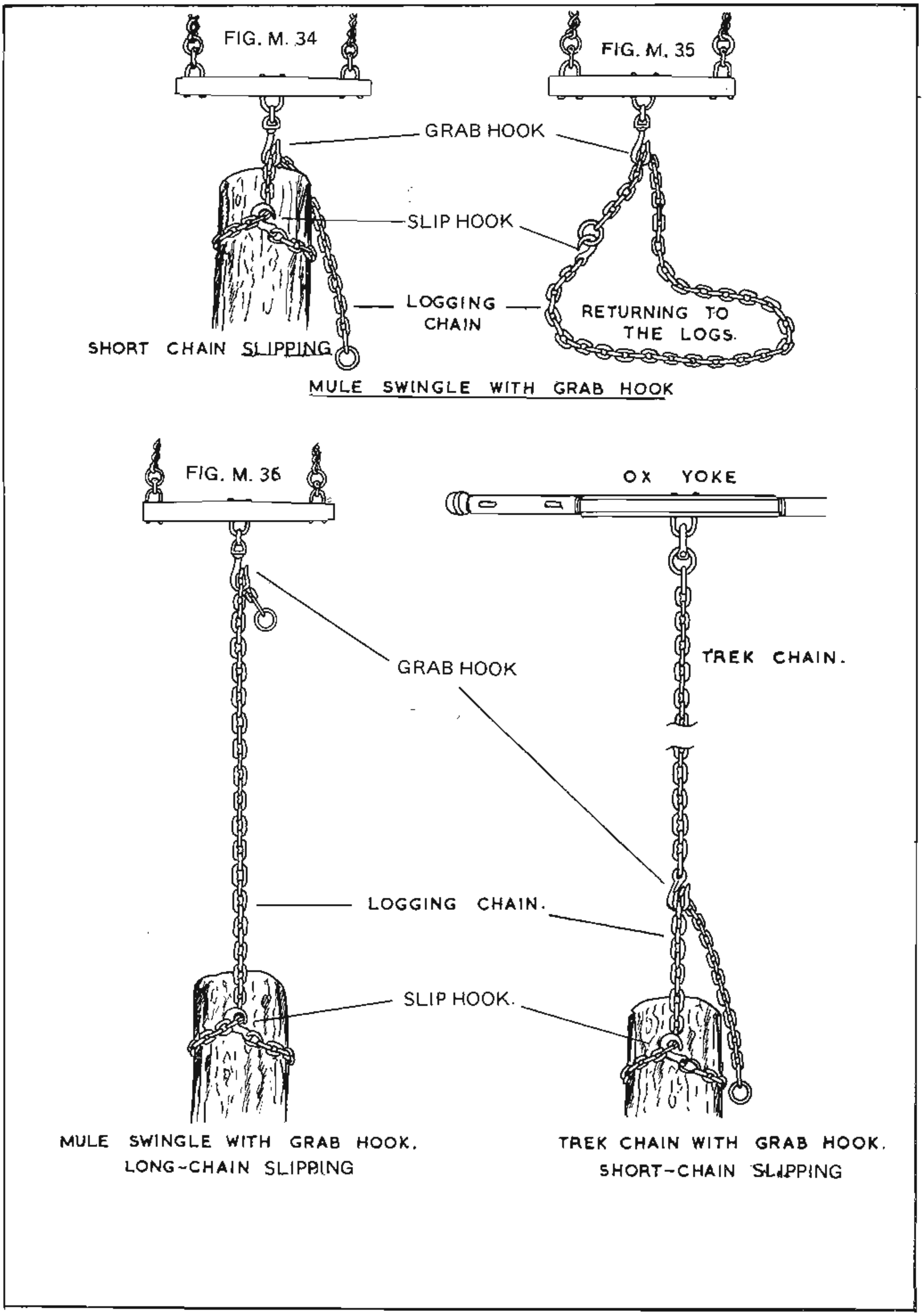


FIG. M. 34
FIG. M. 35
GRAB HOOK
SLIP HOOK
LOGGING CHAIN
RETURNING TO THE LOGS.
SHORT CHAIN SLIPPING
MULE SWINGLE WITH GRAB HOOK
FIG. M. 36
OX YOKE
GRAB HOOK
TREK CHAIN.
LOGGING CHAIN.
SLIP HOOK.
MULE SWINGLE WITH GRAB HOOK.
LONG-CHAIN SLIPPING
TREK CHAIN WITH GRAB HOOK.
SHORT-CHAIN SLIPPING

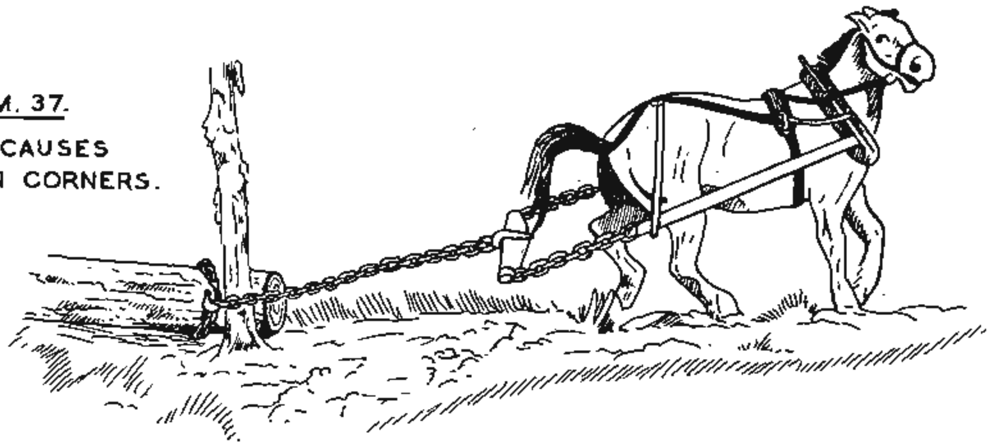


FIG.M. 37.
LONG CHAIN CAUSES HANG-UPS ON CORNERS.

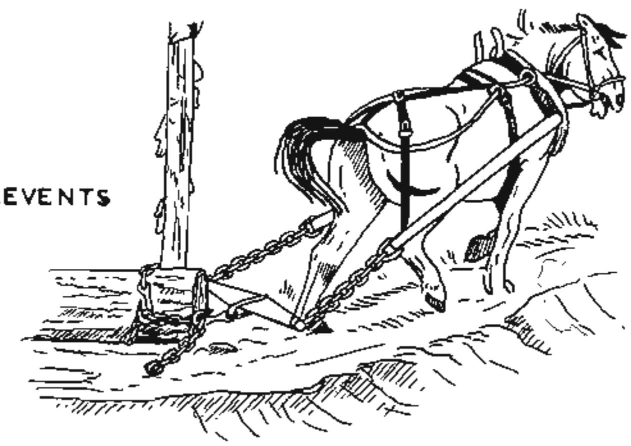


FIG.M. 38
SHORT CHAIN PREVENTS HANG-UPS

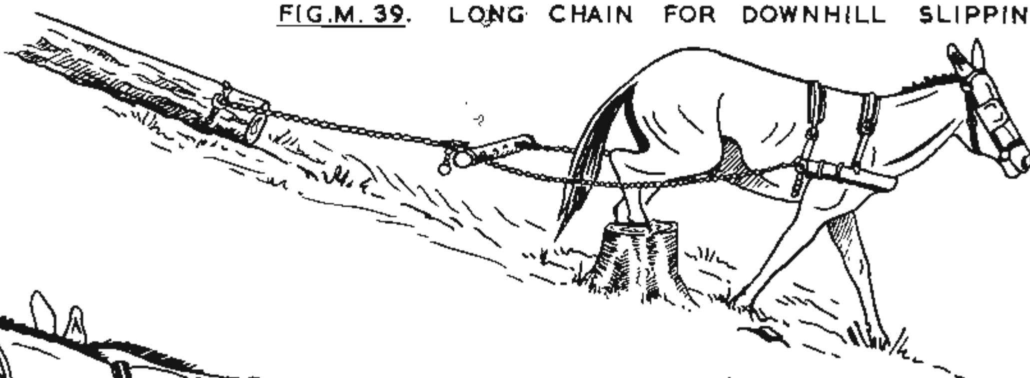


FIG.M. 39. LONG CHAIN FOR DOWNHILL SLIPPING.

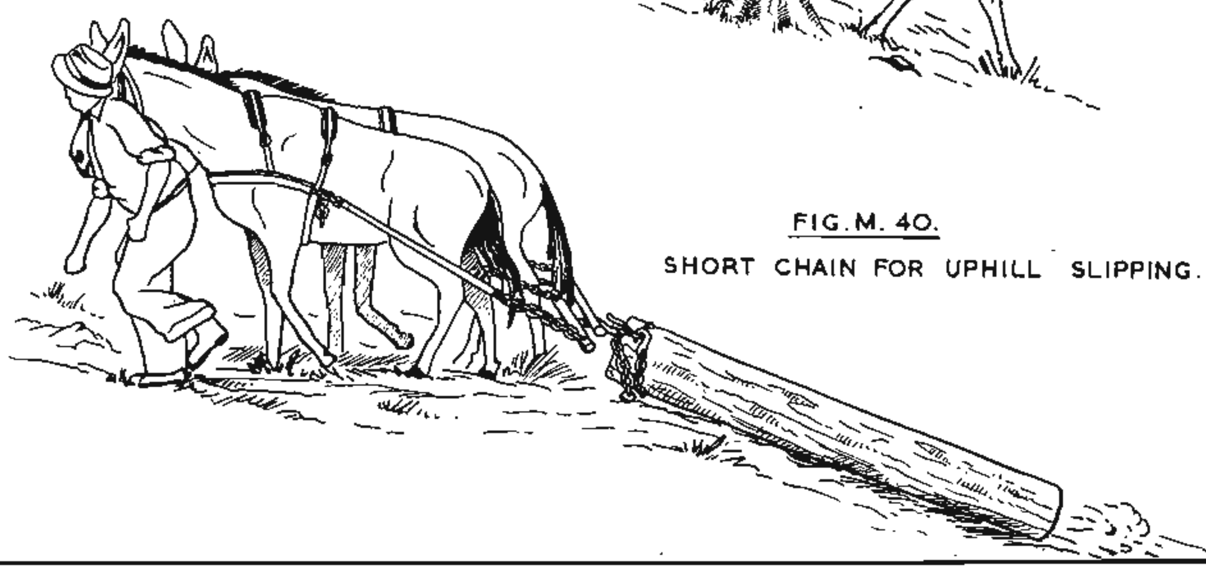


FIG.M. 40.
SHORT CHAIN FOR UPHILL SLIPPING.

The following are some hints concerning the application of log-slipping attachments used with animals for log slipping operations:

(i) The traces can be attached to the mule swingle shackles by welded links, by shackles, or by cold-shut links. The latter are recommended as they are easy to fit using only a hammer, and when locked they present a smooth surface which cannot harm the legs of the animals. Use 11 mm coldshuts for 9 mm chain.

(ii) Cold-shut links can also be used for attaching the grab hook to the swingle and for repairing the broken chain.

(iii) A split link can also be used for repairing the chain as a temporary measure in an emergency.

B. THE MULE IN HARNESS

(1) The breastplate used in plantations is the same as that used by farmers for their mules employed to pull wagons etc. The point of attachment to the wagon thill is located higher than the point of attachment of the swingle to the log, hence the back saddle strap proves too short for large mules employed in log slipping, and must be lengthened beyond normal or it will cause rubbing of the mule's crest. Fig. M 28 illustrates how various parts of the harness may cause injury to the mule.

(2) Two mules pulling in tandem (single file) were tested in the Department and the following discovered:

(i) The arrangement of the harness requires both mules to pull in one line, which is difficult to achieve because the traces of the front and rear mules pull at an angle. Under these circumstances both mules experienced continuous jerking when pulling, which disturbed them, and more nervous animals tended to slacken the traces, with the result that only one mule was actually pulling.

(ii) The traces of the "leader" were suspended on straps hanging from the breastplate buckle of the "wheeler" and constant additional jerking occurred on the breastplate, which annoyed the animals.

(iii) As the traces of the leader passed close to the ground they were inclined to interfere with turning, i.e. the wheeler often overstepped the traces of the leader.

(3) When a four-mule team or larger is used in tandem (pairs), the swingle of the leader pair is suspended from straps attached to the halters of the wheeler pair. This unfortunately produces strain on the necks of the mules carrying the swingle. Apart from this, when the terrain undulates sharply, the heads of the hind pair of mules are pulled down to the ground as the leader pair negotiates sharp drops. Fig. M.27

There is, however, no satisfactory solution to the problem, apart from using a neck strap for the attachment of the leader swingle, but in this case the swingle could rub against the breast of the hind pair, causing injury, or slide to the side of the mule's head (see Fig. M 26).

Overlapping the traces of the leader pair and connecting them to the swingle of the wheeler pair was also tried, but without success. In this case the traces were too low and interfered with the mules' movements, especially on turnings.

(4) Mules should not be worked excessively during wet weather as a wet harness causes chafing and aggravates it when it dries, as it becomes hard.

(5) While the mules are shedding their winter coats they are more susceptible to being chafed, and must be given regular rests or work shorter hours.

C. LOG SLIPPING WITH MULES

Before slipping, small logs should be prestacked in the compartment, as illustrated in Fig. M 29, to accelerate the slipping process and to simplify the operation. Assembling a load generally accounts for a large percentage of the actual slipping time. Fig. M 32 shows the assembling of a load for a single mule in the compartment, where no prestacking was done.

When turning a mule team to gain access to the logs, overstepping of the traces is a frequent occurrence, usually causing loss of time as the team is "straightened out" and sometimes even injury to the animals' legs. It is a good practice for the mule driver to lift the swingle, as in Fig. M 33, to prevent overstepping while turning the team sharply.

Note : Two chains are hooked to the swingle in the illustration

The logs are secured for slipping by means of the logging chain, which is 2 m long, fitted with a ring at one end and a logging slip hook at the other (Fig. M 64). The chain is passed round the log, then through the slip hook as in Fig. M 31, and finally hooked to the mule swingle. If the swingle is fitted with an ordinary hook, the ring of the logging chain is slipped over the hook as in Fig. M 30.

A grab hook fitted to the swingle, as in Fig. M 31, 34, 35 and 36, has the following advantages:

(i) When slipping over level ground or uphill, the chain can be shortened, as in Fig. M 34, in order to give an easier pull, as the head of the log can be "lifted" slightly. Fig. M 40 shows a two-mule team slipping a log uphill with the logging chain "short hooked" to the swingle grab hook.

(ii) By shortening the chain on turnings the log head closely follows the mule and hang-ups can be avoided. Fig. M 37 shows a hang-up caused on a turning when a long chain was used, without a swingle grab hook. Fig. M 38 shows how this hang-up could have been avoided by using a swingle grab hook to shorten the chain.

FIG.M. 41.

MULES STRAINING WITH AN OVERLOAD OF LOGS.

FIG. M. 42.

HIGH STUMP CAUSES HANG-UP.

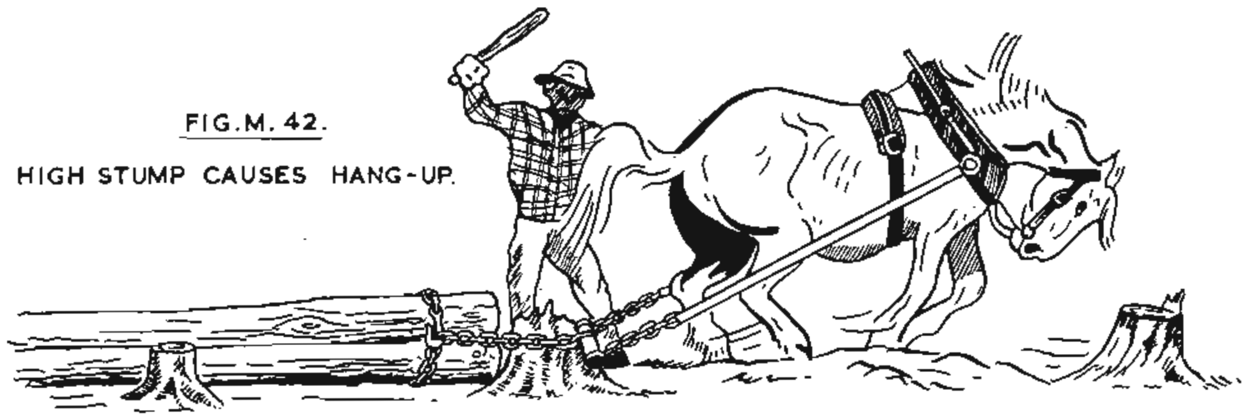


FIG. M. 43.

CLEARING THE SLIP PATH

FIG. M. 44.

SMOOTH: SLIPPING -OBSTRUCTIONS REMOVED.

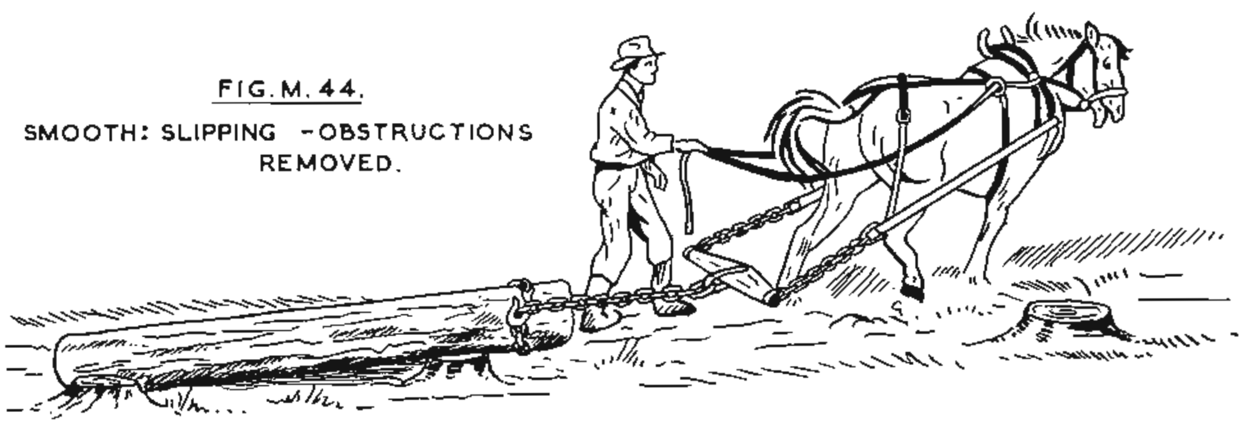
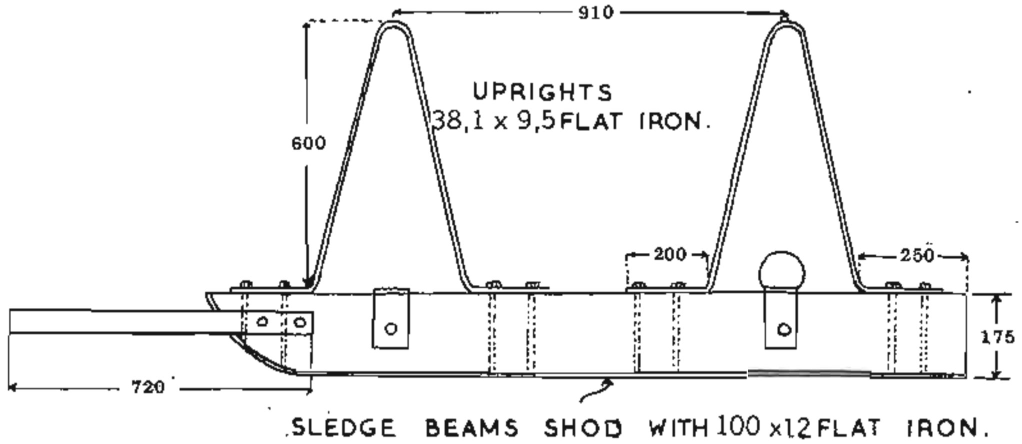


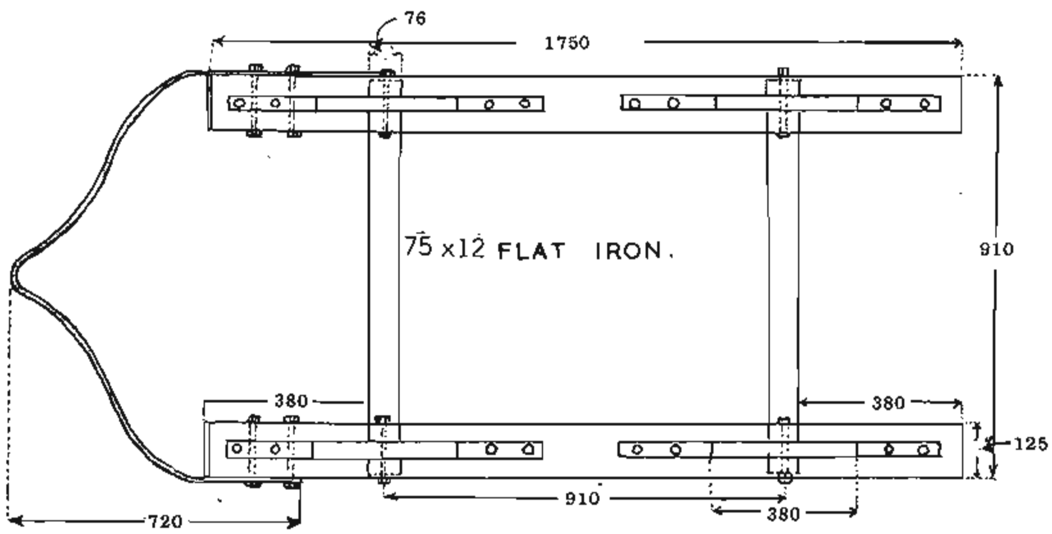
FIG. M. 45

BERLIN TIMBER SLEDGE (ANIMAL DRAWN) FOR TIMBER TRANSPORT.

ALL DIMENSIONS IN mm



A POLE IS TIED OVER THE BACK CROSS-MEMBER TO GIVE THE SLEDGE A FOREWARD CANT WHEN LONG POLES ARE LOADED.



SCALE: 1 : 10.

FIG. M.46. CARRYING PULPWOOD TO SLIPPATH STACKS FOR SLIPPING BY SLEDGE.

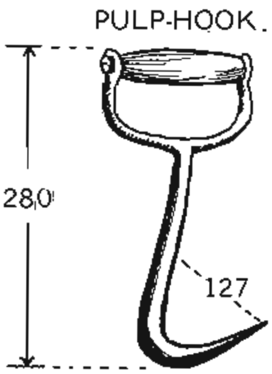
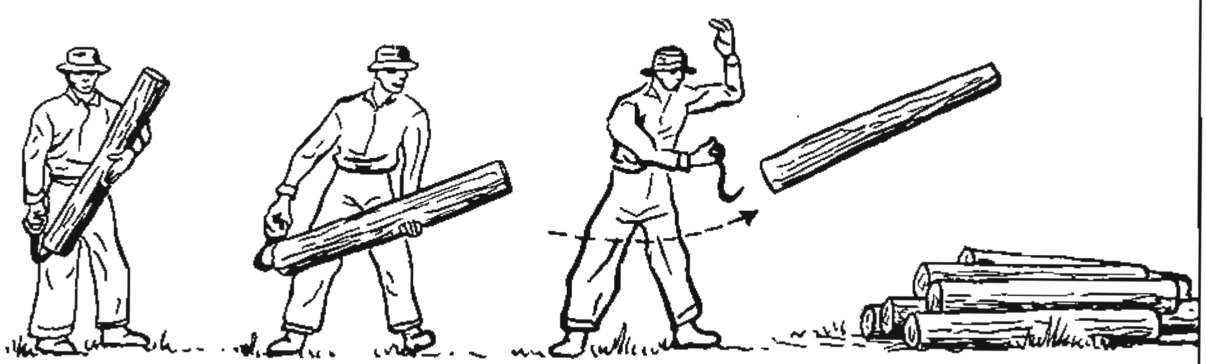


FIG. M.47.

USE OF THE PULP-HOOK FOR CARRYING AND STACKING PULPWOOD.

ALL DIMENSIONS IN mm

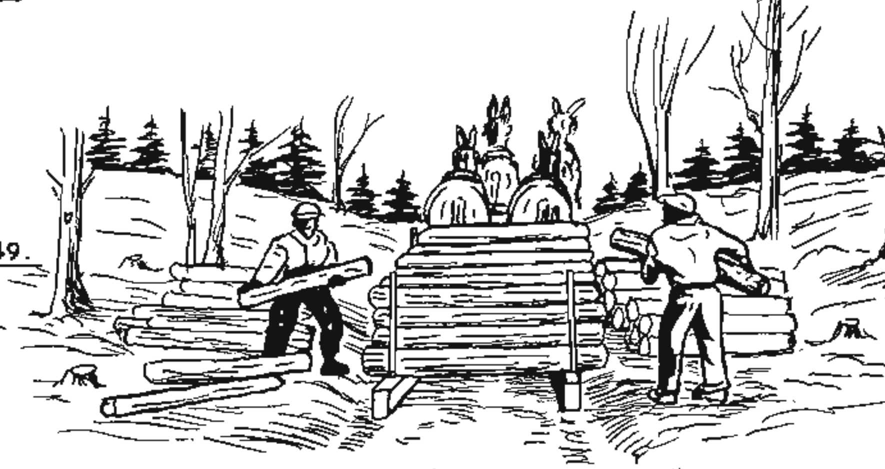


FOUR-MULE TEAM WITH SLEDGE

FIG. M. 48.

"IN" TO THE LOGS WITH EMPTY SLEDGE.

FIG. M. 49.



LOADING PULPWOOD ONTO SLEDGE.

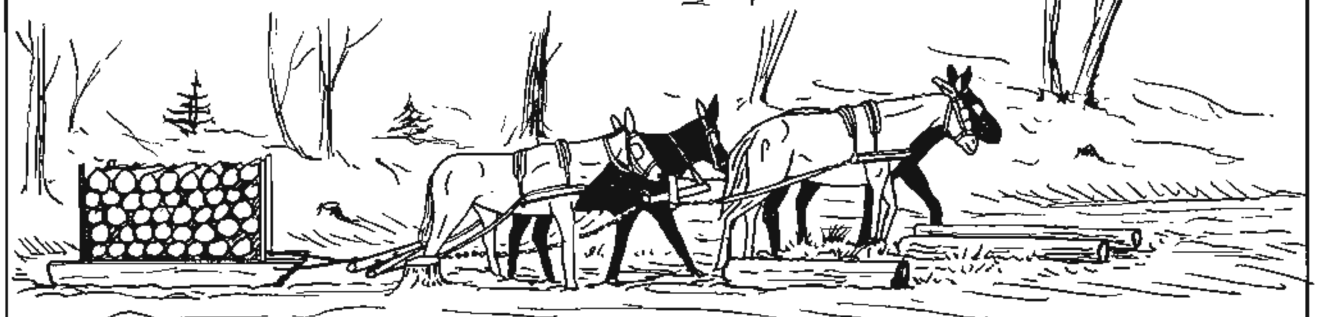
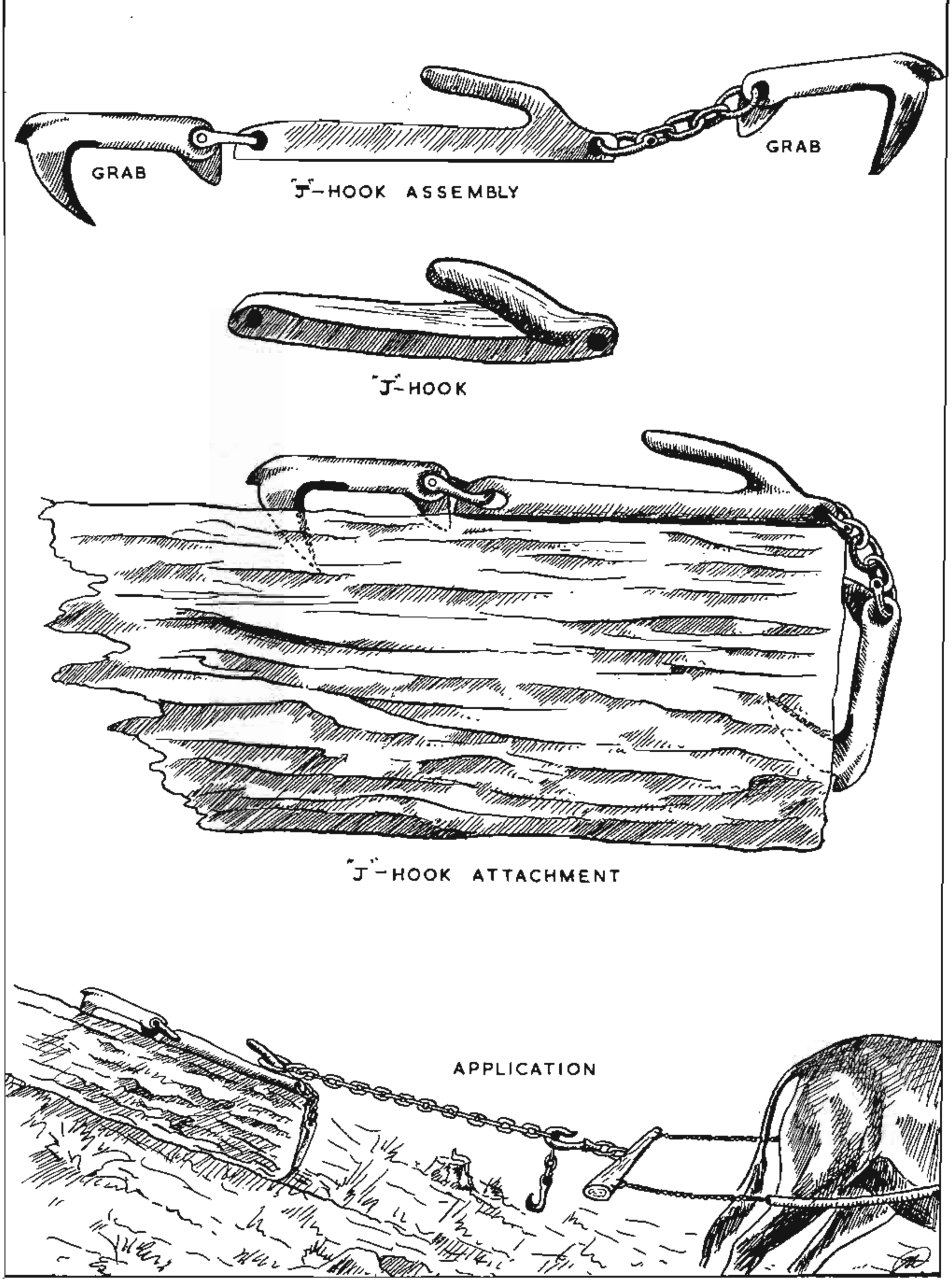


FIG. M. 50. HAULING LOADED SLEDGE TO ROADSIDE.

FIG. M. 51. OFF-LOADING AND STACKING AT ROADSIDE.

FIG. M.52 "J"-HOOK USED ON THE FRONT LOG OF A TURN IN MOUNTAIN SKIDDING



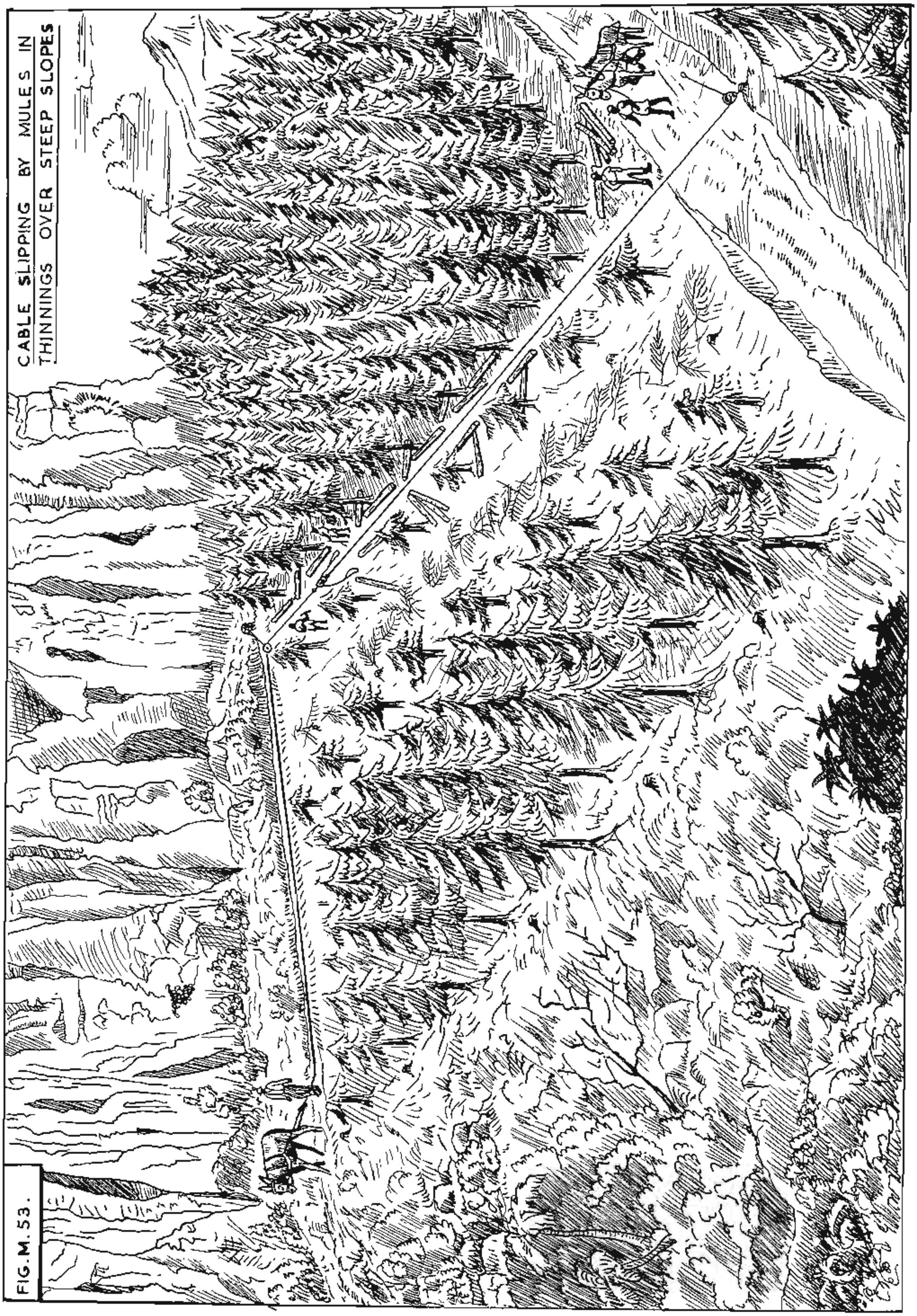


FIG. M.53.

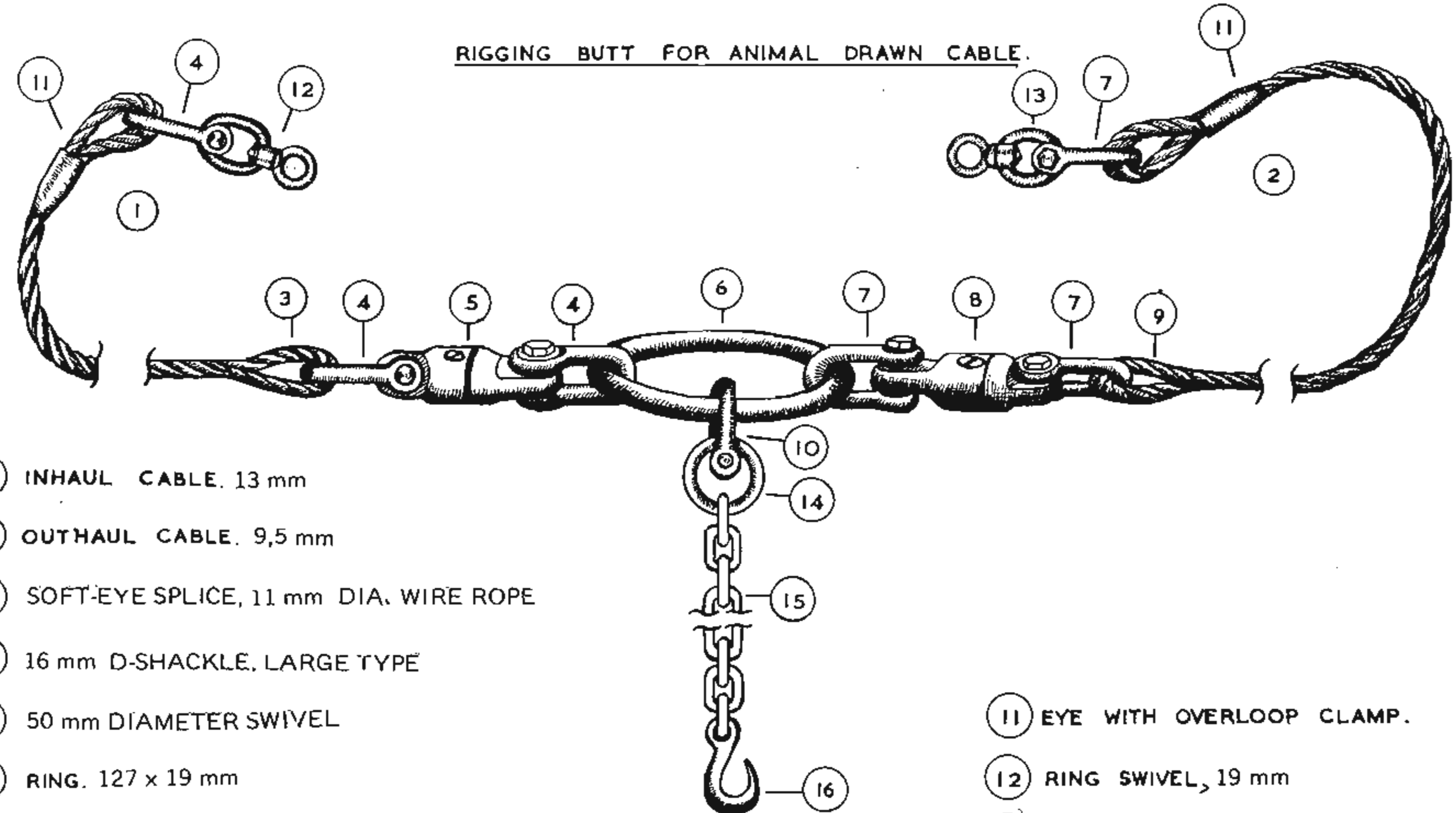
CABLE SLIPPING BY MULES IN THINNINGS OVER STEEP SLOPES

FIG. M.54.

LOG SLIPPING BY MULES IN THINNINGS, USING A CABLE ON VERY STEEP SLOPES.

FIG. M. 55

RIGGING BUTT FOR ANIMAL DRAWN CABLE.



1. INHAUL CABLE. 13 mm
2. OUTHAUL CABLE. 9,5 mm
3. SOFT-EYE SPLICE, 11 mm DIA. WIRE ROPE
4. 16 mm D-SHACKLE, LARGE TYPE
5. 50 mm DIAMETER SWIVEL
6. RING. 127 x 19 mm
7. 13 mm D-SHACKLE, LARGE TYPE
8. 38 mm DIAMETER SWIVEL
9. SOFT EYE SPLICE, 9,5 mm
10. 16 mm D-SHACKLE
11. EYE WITH OVERLOOP CLAMP.
12. RING SWIVEL, 19 mm
13. RING SWIVEL, 13 mm
14. 13 mm MATERIAL DIAMETER RING
15. 9,5 mm CHAIN
16. 9,5 mm SLIP HOOK

(iii) When slipping downhill, the chain can be lengthened as in Fig. M 36 in order to protect the mule's legs should the log slide down unexpectedly (Fig. M 39).

(iv) When returning to the woods for a fresh load, the logging chain can be hooked as illustrated, in Fig. M 35, to prevent the slip hook from snagging stumps, roots, stones, etc.

Note : A 15 to 20 degree angle of pull on the chain is most advantageous, and this is controlled by chain length, which can in turn be adjusted by the grab hook

When the load has been hooked it is slipped to the roadside stacks as in Fig. M 41. This illustration shows the mules straining with an overload of logs, which should be avoided where possible. Overloads are common when a load, which the mules could normally pull with ease, is hooked to the swingle for downhill slipping. Approach to the roadside stacks is often along level ground, however, consequently the easy load for downhill slipping then exceeds their normal pulling capacity over level ground.

To ensure a smooth slipping operation it is essential that slip paths be kept clean and free of obstructions. Fig. M 43 illustrates: (a) cutting through a windfall trunk lying across the slip path; (b) removing branches and slash from the slip path; (c) cutting down high stumps with a bow saw; and (d) cutting down high stumps with an axe. Any protruding rocks or stones which may hamper slipping operations, should be removed if possible, or else the slip path should bypass them. Slipping efficiency is increased when slip paths are free of obstackles, as in Fig. M 44.

Note : It is difficult to predict the route of a temporary slip path in advance of the operation, but obstacles should be removed immediately they are encountered

D. USE OF A SLEDGE FOR LOG SLIPPING BY MULES

Several types of animal-drawn sledges have been used from time to time in the plantations, but the most common type is that shown in Fig. M 45. This type of sledge is easy to construct, is light and short and has a capacity of from 0,5 to 0,8 m^3 of short, small logs.

The chain from the animal team swingle is attached to the drawbar hitch and no thill, shaft or disselboom is used. To brake the sledge on steep slopes, one or two logs can be chained behind the sledge, or chains can be wrapped tightly round the runners.

Fig. M 46 illustrates how small logs or pulpwood are carried by hand in the compartment and stacked beside the slip path, preparatory to being loaded onto the sledge and slipped to the roadside. Fig. M 47 shows how the pulpwood hook can be an aid to carrying and stacking small logs.

Fig. M 48, 49, 50 and 51 illustrate a four-mule team slipping small logs or pulpwood by sledge. Loading and unloading of the sledge are done by the labourers with the team. Loads are assembled in the compartment as previously shown.

E. SPECIAL CASES FOR LOG SLIPPING BY MULE

(a) USE OF THE "J"-HOOK IN LOG SLIPPING WITH MULES

Fig. M 52 illustrates the use of a J-hook for slipping logs over dangerously steep slopes. The J-hook is attached to the log by means of grabs, the points of which are driven into the side and front of the logs respectively as shown. The ring of the logging chain is then placed over the J-hook itself, while the other end of the chain, with the slip hook, is secured to the swingle grab hook.

The J-hook is used when there is a danger of the slipped log sliding down and over-running or running into the mule. Should the log start to slide, the mule is swung aside from its course and the log slides harmlessly by. If the log continues to slide the chain ring easily slips off, thus preventing any injury to the animal.

(b) CABLE SLIPPING (Fig. M 53, 54, 55)

Isolated cases occur where insignificant volumes of small logs derived from thinnings are to be slipped down steep slopes in small plantations. The use of cable slipping with mules has proved a practical solution.

Conditions. Slopes with a gradient of 25° and over; soil smooth and soft; rows of trees planted at right angles to the road; bridle path in the compartment above the road; distances between 70 and 100 metres; log slipping downhill.

A 9 mm diameter wire rope cable of suitable length is used with the rig for log chaining as shown in Fig. M 55. Two snatch blocks are attached to stumps by wire rope slings at the corners of the road and bridle path.

The illustrations of the operation are self explanatory, the empty rope being pulled up to the logs by a single mule walking along the bridle path (Fig. M 53) and the chained logs pulled down to the road by a two-mule team walking along the road (Fig. M 54).

To prevent the logs from rolling against the standing trees it is sometimes necessary to provide slip paths.

The log slipping output is low and costly and the method cannot be recommended for use other than in emergencies. The single advantage of the operation is, however, that the remaining trees are undamaged, which would not be the case if the logs were rolled down by hand.

FIG. M. 56.

GENERAL VIEW OF MULE SULKY.

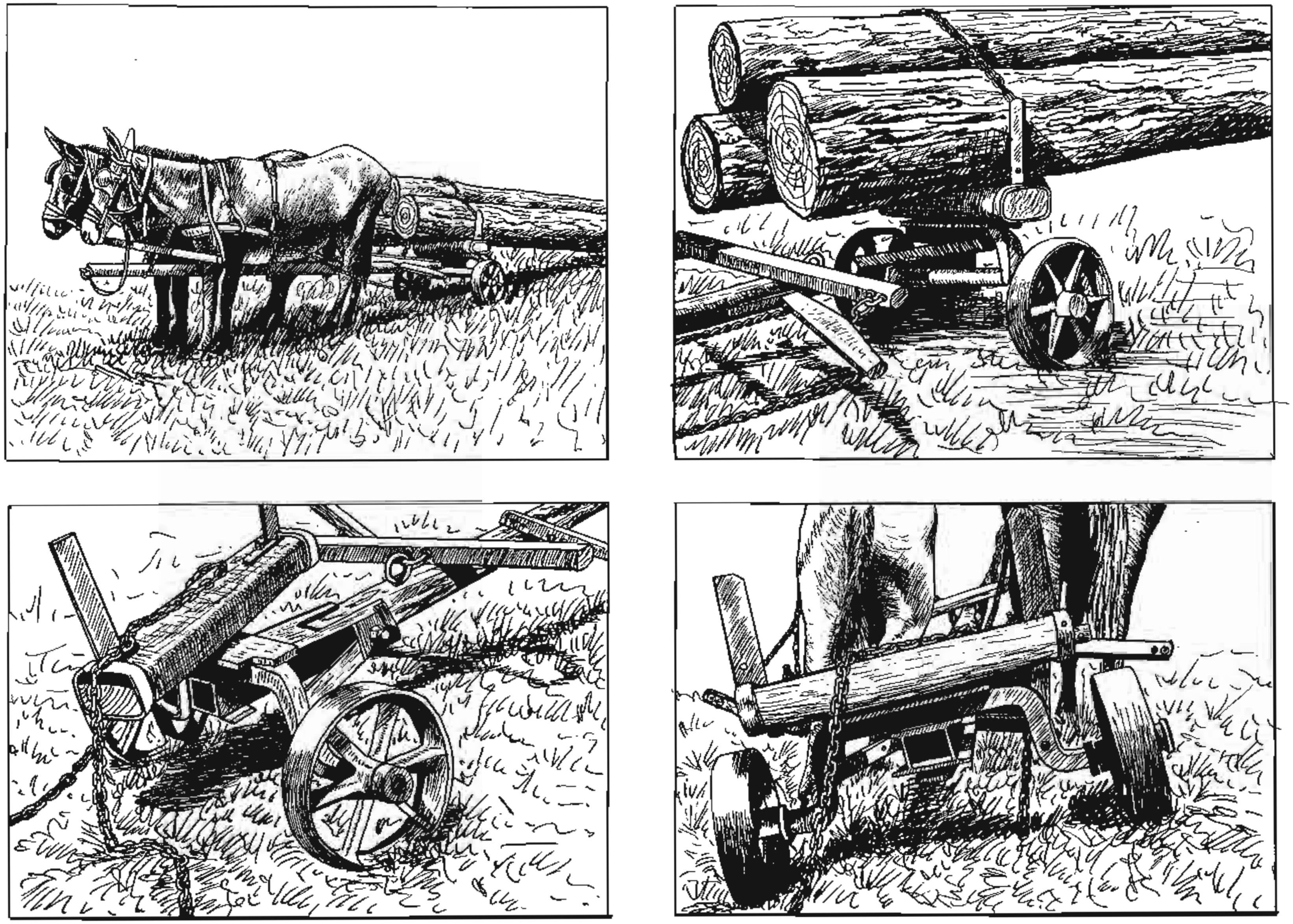
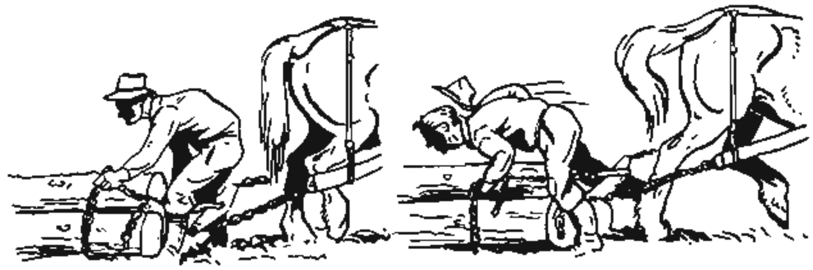
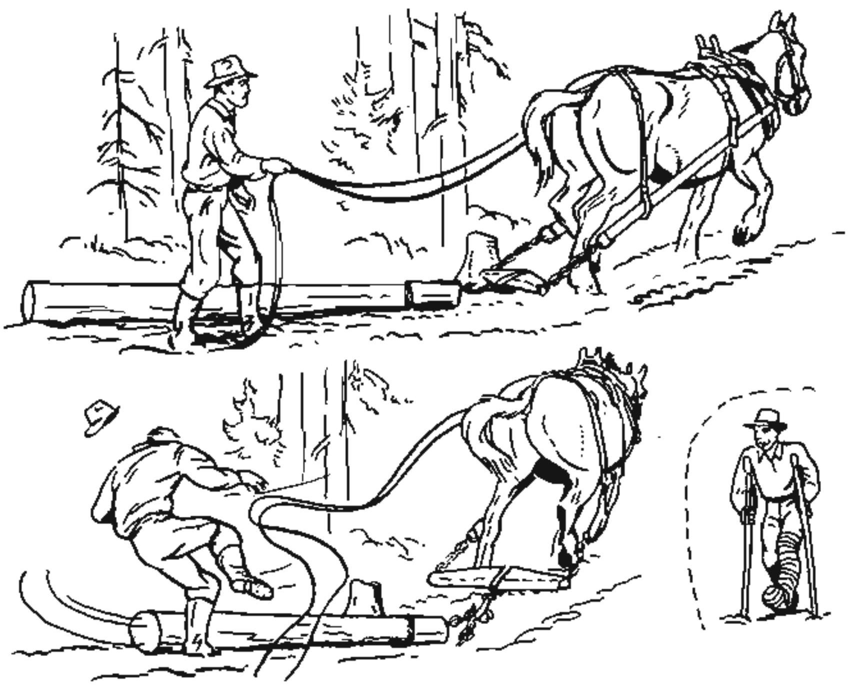


FIG.M.57



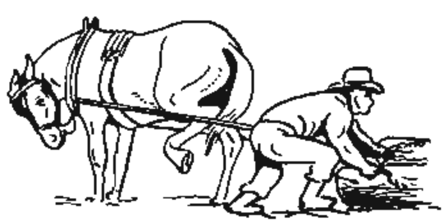
REMEMBER THE HORSE MIGHT START SUDDENLY.
TAKE NO CHANCES.

FIG.M.58



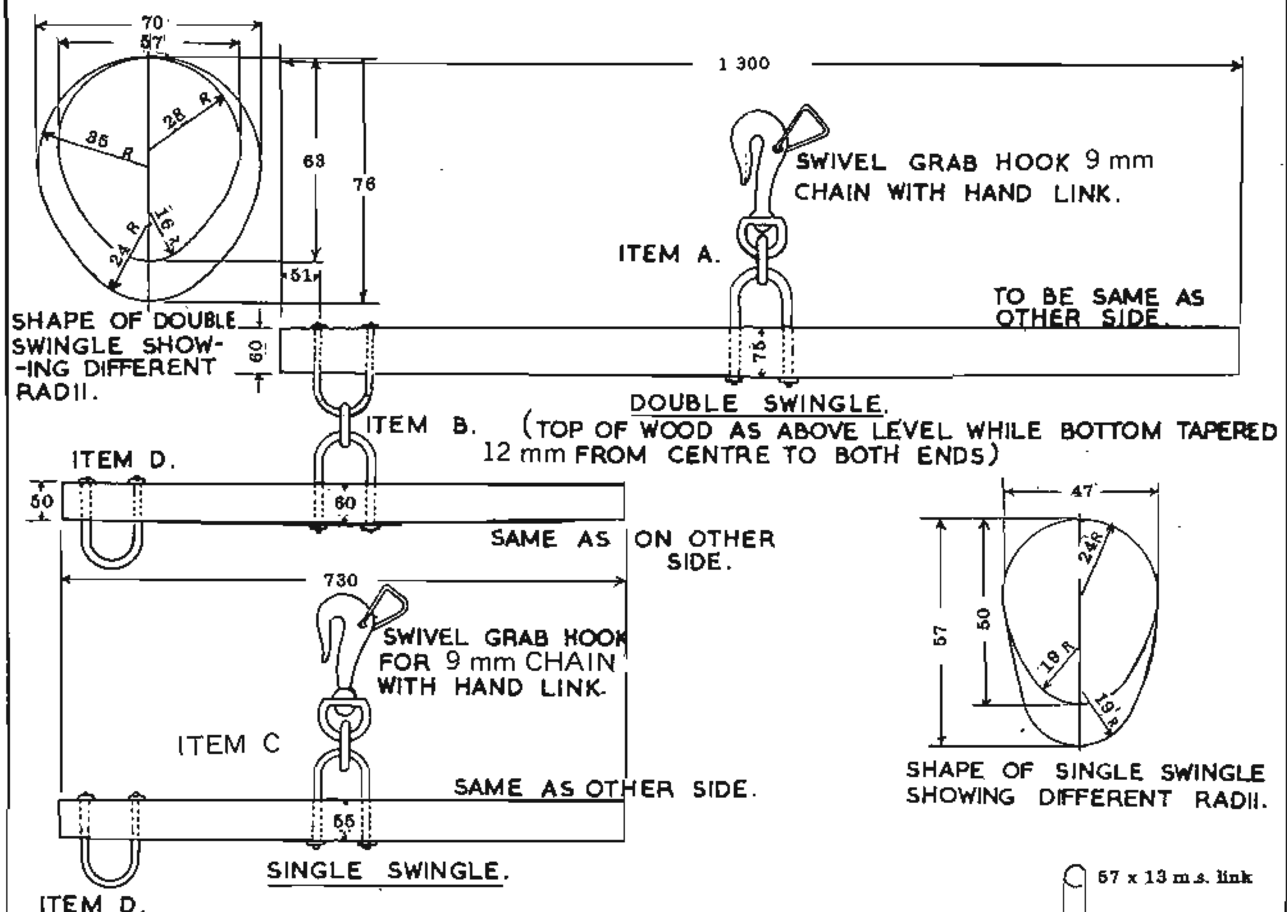
THIS IS A COMMON CAUSE OF ACCIDENT IN SLIPPING
WALK JUST BEHIND THE LOAD IF POSSIBLE.

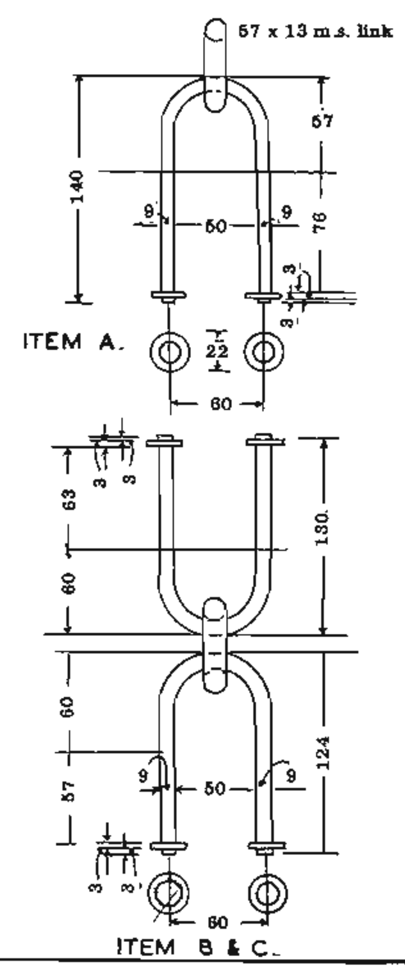
FIG.M.59



TAKE NO CHANCES LIKE THIS.
WORK FROM THE SIDE OF THE LOGS.

FIG. M.60 *ALL DIMENSIONS IN mm*





QUANTITY LIST.

DOUBLE SWINGLE.

SWINGLE:	1300 mm	1	OFF.
ITEM A. MILD STEEL U LINK	9 x 140 mm	1	OFF.
ITEM B. MILD STEEL U LINK	9 x 130 mm	4	OFF.
CONNECTING LINKS	57 x 13 mm	2	OFF.
ITEM D. MILD STEEL U LINK	9 x 108 mm	4	OFF.
SWINGLE:	730mm	2	OFF.
3 mm WASHERS	9 I.D. 22 O.D.	6	OFF.

SINGLE SWINGLE.

SWINGLE	730mm	1	OFF.
ITEM C. MILD STEEL U LINK	9 x 124mm	1	OFF.
ITEM D. MILD STEEL U LINK	9 x 108 mm	2	OFF.
3 mm WASHERS	9 mm I.D 22 mm O.D.	6	OFF

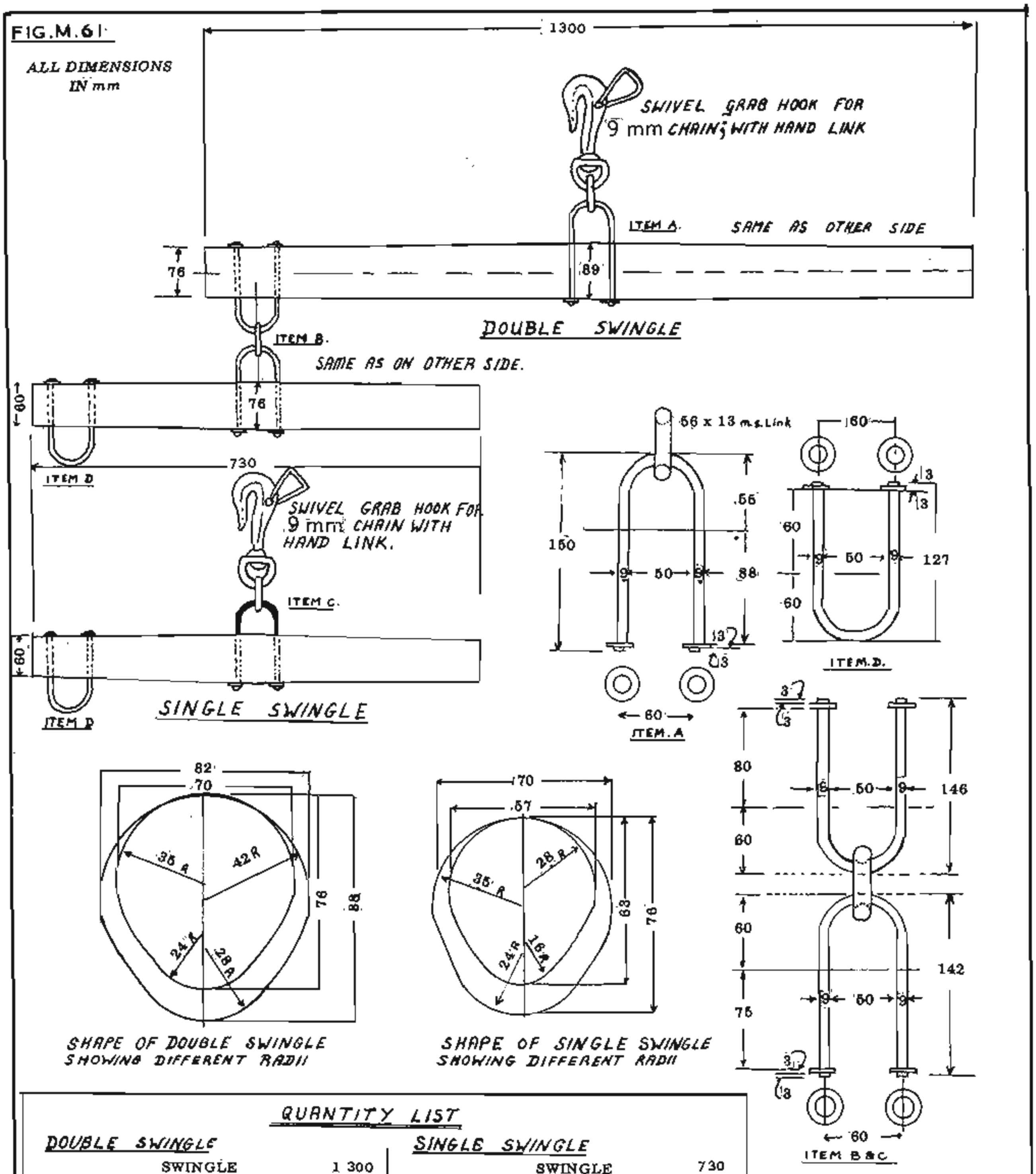
N.B.

LOG CHAIN FOR DOUBLE SWINGLE IS 9 mm McKINNON NO.15.

LOG CHAIN FOR SINGLE SWINGLE IS 8 mm McKINNON NO.14.

NOT TO SCALE

FIG. M. 61



QUANTITY LIST

DOUBLE SWINGLE

SWINGLE	1 300	1 OFF.
ITEM "A" MILD STEEL 'U' LINK	9 x 150	1 OFF.
ITEM "B" " " "	9 x 146	4 OFF
CONNECTING LINKS	57 x 13	2 OFF
ITEM "D" MILD STEEL U LINK	9 x 133	4 OFF
SWINGLE	730	2 OFF
3mm WASHERS 9mm I.D., 22mm O.D.		18 OFF

N.B. LOGGING CHAIN FOR DOUBLE SWINGLE 8mm Mc KINNON No. 15

SINGLE SWINGLE

SWINGLE	730	1 OFF
ITEM "C" MILD STEEL 'U' LINK	9 x 142	1 OFF
ITEM "D" " " "	9 x 127	1 OFF
3mm WASHERS 9mm I.D. 22mm O.D.		6 OFF

NB LOGCHAIN FOR SINGLE SWINGLE IS 8mm Mc KINNON No 14

NOT TO SCALE

(c) MULE SULKY

A home-made mule sulky, illustrated in Fig. M 56, was tested for log slipping with a two-mule team, but it proved cumbersome to manoeuvre among the debris and forest litter with its dissel-boom and rigidly harnessed mules. To position the sulky near the first log presented no problem, but great difficulty was experienced in approaching a second log once the first was on the sulky. Logs were rolled to the sulky by hand or had to be slipped to the sulky by another team of mules, which was a time and labour consuming operation.

In view of the above it was decided to abandon the use of this device, particularly considering the general unevenness of the forest floor and the close proximity of roads in the plantations.

An improved type of sulky may be useful where longer slipping distances are involved over a level and smooth forest floor and where access to a sufficiently large number of logs will present no problems.

3. WORK PERFORMANCE OF MULES

A. TRACTIVE POWER

It is very difficult to accurately judge the working capacity of a mule as only speed and tractive power, of all the relevant factors involved, can really be measured.

Tractive power is the power exerted upon a load.

Maximum tractive power is the power used to bring a stationary load into motion and for practical purposes this power may be considered to be equal to half of the animal's body mass, i.e. 225 kg for an animal mass of 450 kg.

Normal tractive power is the power that is required to keep a load in motion once it has started to move and for practical purposes this may be considered as being equal to $1/10$ to $1/8$ of the animal's body mass. For forestry purposes where the animal pulls for shorter distances with more frequent intervals of rest, the normal tractive power may be increased slightly when working on level ground or gentle slopes.

The maximum practical capacity of a mule will thus be 56 kg at a speed of 5 km per hr. These figures represent the mule's pulling capacity on level ground.

B. FACTORS INFLUENCING TRACTIVE POWER

(a) GRADIENT

Considerably greater power is required for uphill gradient. It has been accepted that the necessary tractive power for 1 000 kg on wheels increases by 18 to 22 kg for every 1% of climb. The tractive power of the mule also decreases as the gradient increases, as it must pull its own mass as well as that of the load, and the gradient can become so steep that the animal can later only carry its own mass.

(b) BODY MASS

This is an important influence on the tractive power, particularly when maximum tractive power is required over short distances.

(c) AGE

Age has very little effect on the towing capacity of mules between the ages of 7 and 15 years, except when the animals are in poor condition.

(d) HARNESS

The correct harness that fits well is important, as sore shoulders, more than fatigue or loss of mass, limit tractive power.

(e) DRIVER

A good driver achieves more than a poor driver. The use of a whip is inclined to make the animals irritable, nervous and stubborn.

(f) REMARKS

The above information is only of a general nature, as all research on the subject of tractive power was carried out overseas, and referred to horses, which usually have a greater mass than departmental mules. The information has thus little practical application for South African conditions.

C. WORK PERFORMANCE NORMS

Tables M 1 and M 2 of volumes to be slipped daily by mules have been determined for plantation use.

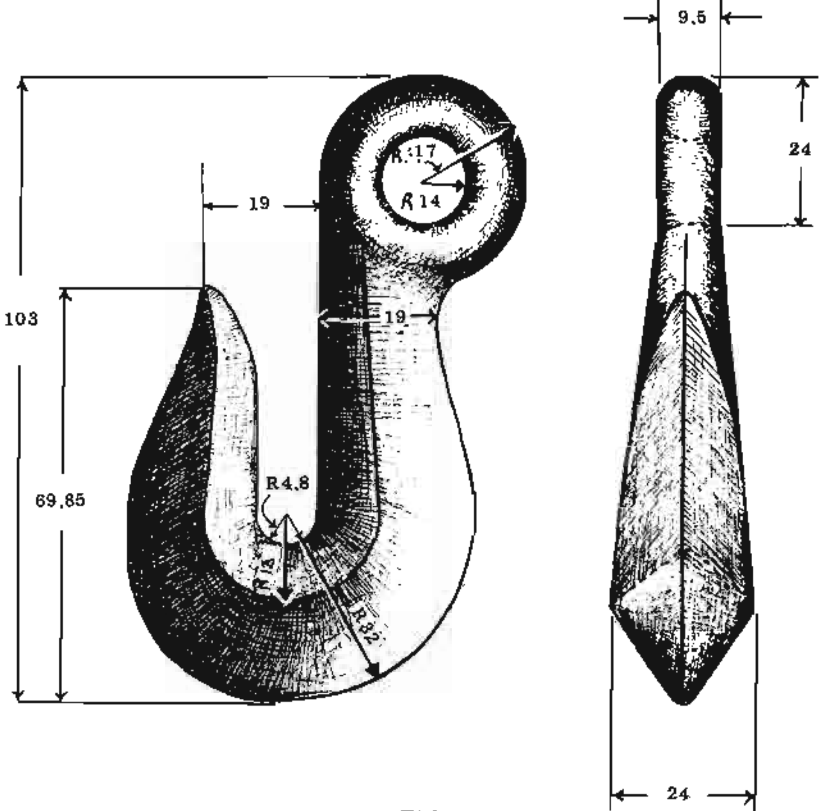


FIG. M. 62

ALLOY-STEEL GRAB HOOK.

HEAT-TREATED DROP-FORGED STEEL.

ALL DIMENSIONS IN mm

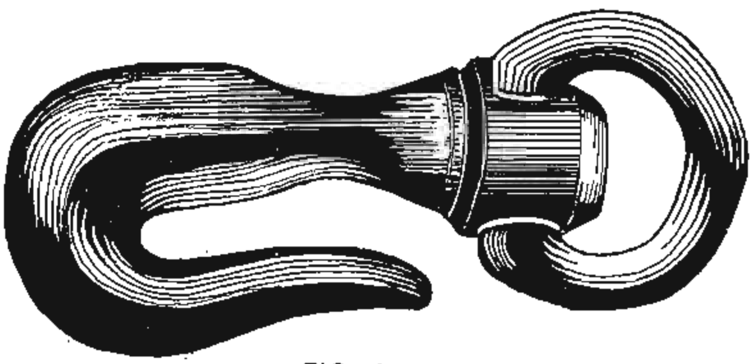


FIG. M. 63

SWIVEL GRAB HOOK.

DROP-FORGED STEEL.

FIG. M 64

ALL DIMENSIONS IN mm

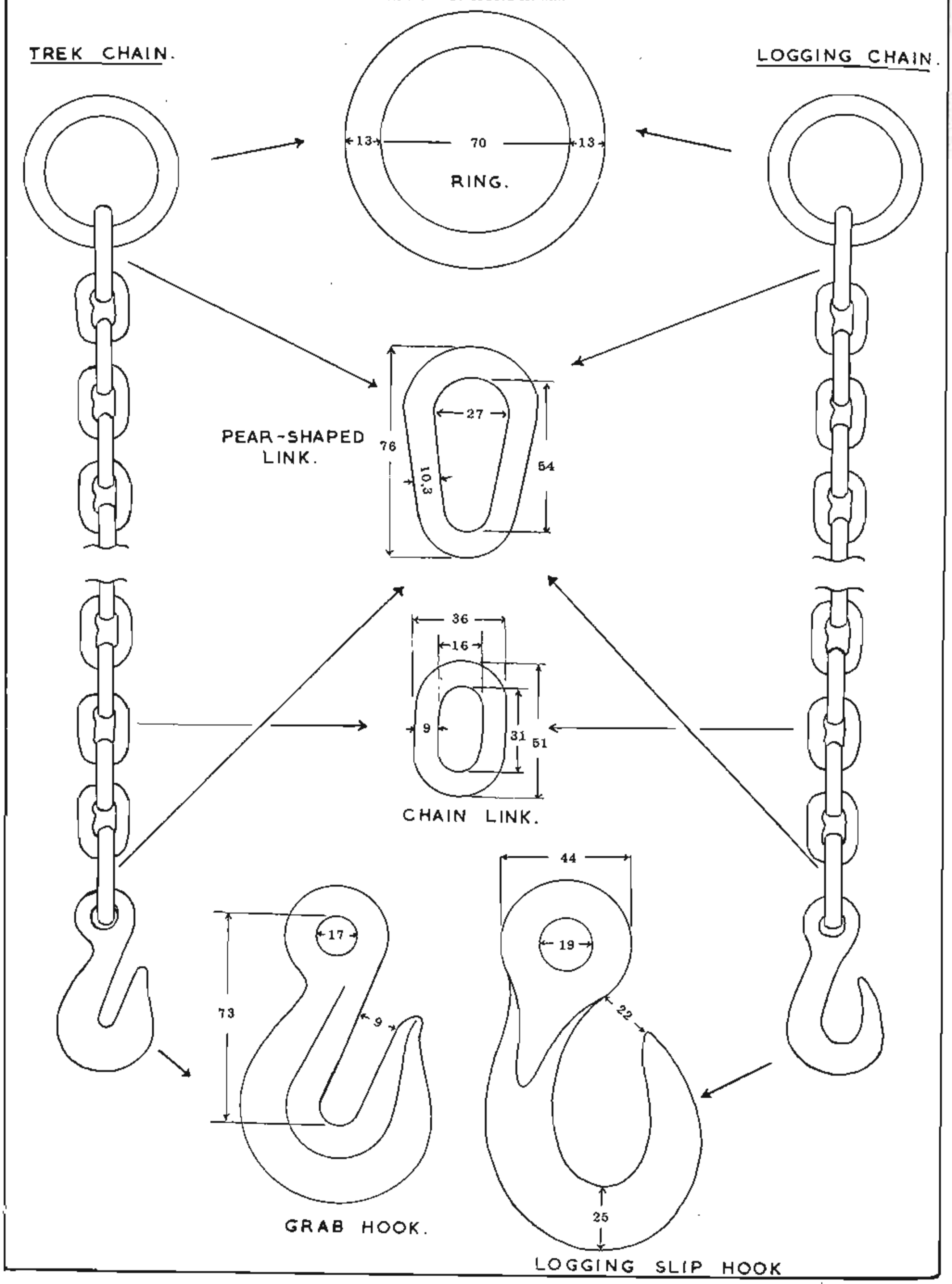


TABLE M 1 - Estimated volume to be slipped daily by each mule

Average distance	Time per load	Expected volume to be slipped per mule per day in m^3			
		6-18° down $0,17\ m^3$ per load	1-5° down $0,113\ m^3$ per load	0-5° up $0,085\ m^3$ per load	6-10° up $0,057\ m^3$ per load
m	min	m3	m3	m3	m3
0 - 20	3,5	26,18	17,40	13,09	8,78
21 - 30	4,6	19,89	13,22	9,94	6,67
31 - 40	5,7	16,15	10,74	8,08	5,42
41 - 50	6,8	13,43	8,93	6,72	4,50
51 - 60	7,9	11,56	7,68	5,78	3,88
61 - 70	8,9	10,37	6,89	5,18	3,48
71 - 80	10,0	9,18	6,10	4,59	3,08
81 - 90	11,1	8,33	5,54	4,16	2,79
91 - 100	12,2	7,48	4,97	3,74	2,51
101 - 110	13,3	6,97	4,63	3,48	2,34
111 - 120	14,3	6,46	4,29	3,23	2,17
121 - 130	15,5	5,95	3,96	2,98	2,00
131 - 140	16,5	5,61	3,73	2,80	1,88
141 - 150	17,6	5,27	3,50	2,64	1,77

Particulars for calculations:

(a) Walking time 3,28 sec per m

(b) Hooking and unhooking time per load 80 sec

(c) Distance used for calculations - the largest number in each range i.e. 21-30 m range the time is calculated for 30 m

(d) The maximum per mule per day is 15,28 m^3

The distance used is the average between the furthest and the closest distance from the roadside stack.

TABLE M 2 - Load sizes for a single mule

Degree of slope	Up or down slipping	Average volume per load
6 - 18°	down	$0,17\ m^3$
1 - 5°	down	$0,11\ m^3$
0 - 5°	up	$0,08\ m^3$
6 - 10°	up	$0,06\ m^3$

Note: If the volume of a log exceeds the permissible maximum then two or more mules must be used

(a) The above norms were achieved under the conditions indicated in Table M. 2.

(b) Number of labourers for 6 mules - 13 (see duty sheet). One labourer is permitted per mule and 1 labourer per 17 m^3 for log stacking at the roadside.

(c) A duty sheet for a team of labourers with 6 mules is given in Table M. 3.

(d) Slopes given are the maximum possible.

(e) Speed allowed: Speeds at which mules can slip:

Slope 3 - 18° down	2,7 sec/m
Slope level to 10° up	3,3 sec/m

TABLE M. 3 - The duty sheet

Team No.	Number of labourers	Duties of the team
1	6	These labourers are responsible for the mules, the hooking of logs and slipping to the roadside, including unhooking. Three of these men shall take the mules to and from the stable or camp in the morning and evening. When the mules are absent, the remaining 3 labourers will assist team 2.
2	2	These men are responsible for opening slip paths.
3	5	These men are responsible for stacking slipped logs. Logs rolled to the stack before the arrival of the mules will be included in the calculations for the number of logs per day. The exploitation foreman must check the daily production sheets and see that the mules are well cared for.

Mules walking to and from work or from compartment to compartment are allowed 12 min/km

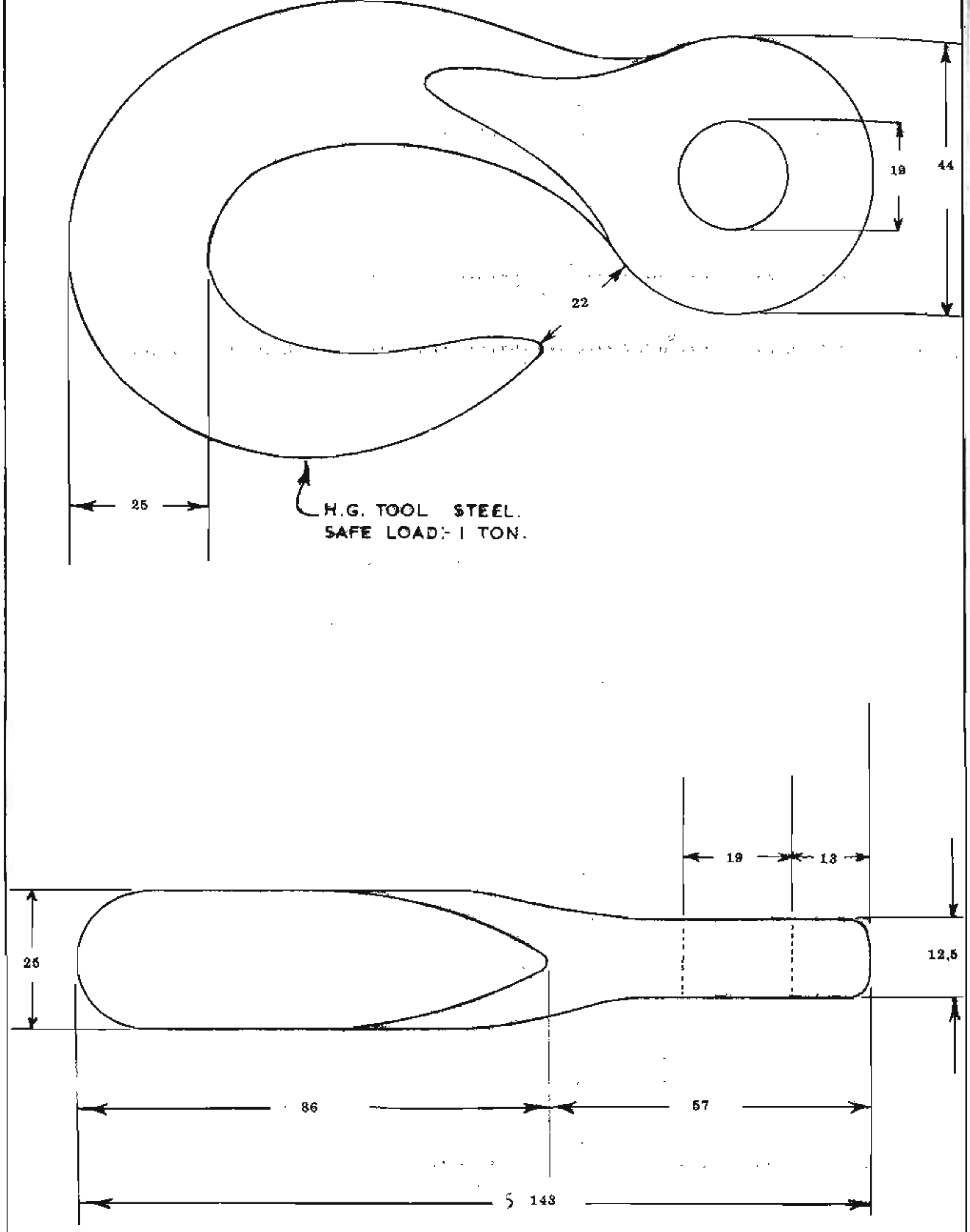
(f) Distribution of time. The percentage time per day that a mule actually pulls a load is indicated in Table M 4 for an average slipping distance of 50 m.

(g) Method of stacking logs. The logs are hooked in long and short log lengths and slipped to different stacks according to the length group. Logs 2-3 m long are regarded as short logs and logs over 3 m as long logs.

FIG. M 65

LOGGING SLIP-HOOK.

ALL DIMENSIONS IN mm



SCALE:- FULL SIZE.

TABLE M 4 - Operation time analysis : average slipping distance of 50 m

Load in m^3	Number of loads/day	Hooking and unhooking time/day	Walking time with load	Walking time without load	Percentage of day under load
m^3		sec	sec	sec	%
0,17	90	11 070	11 250	11 250	33
0,11	90	7 200	13 500	13 500	39

TABLE M 5 - Actual production: two-mule teams

Case No.	Mules in team	Labourers with 2 mules		Per mule team		Time increased per trip	Volume slipped	Decrease in log slipping output	
		Leader	Driver	Assembling load	Stacking load				
						min sec	m^3	m^3	%
1	2	1	-	½ Special unit ½		Basis	11,3	-	-
2	2	1	-	Leader	Special unit	1 - 16	8,5	2,8	26
3	2	1	1	Leader & driver		0 - 38	9,4	1,9	17
4	2	1	1	Leader and driver		1 - 40	7,6	3,7	32

Note: Under the above conditions, assuming the cost per m^3 delivered at the roadside to be 35c and the wages of the daily labourers to be 65c, it would pay to employ additional labour for each team to assemble logs and stack at the roadside.

D. CONTROL OF OPERATIONS

(1) When commencing work in a new compartment the forester must determine the number of logs to be contained in a load.

(2) The number of logs slipped daily multiplied by the volume of the average log will give the volume slipped per day. This figure, when divided by the number of mules, gives the volume slipped per mule per day. This volume can be compared with the estimated volume to be slipped as given in the table.

Note : The average log volume can be determined from the felling and cross-cutting production sheet or by a test arranged for log slipping during the first day.

(3) If 45 m^3 of logs are slipped daily a head labourer shall be appointed to count the logs.

(4) The forester or his representative shall check the distances slipped every alternate day.

(a) ALLOWANCES MADE

(1) All times were normalised.
(2) 12½% was allowed for rest and incidentals.

(b) TIMES ACCEPTED

(1) Hooking and unhooking time: 123 sec per load.
(2) Walking time: 2,7 sec/m

(c) IDLE TIME

Is allowed when there are no logs slipped or when the work is held up due to rain.

Note : The above efficiency data have been accepted by the Department

E. RANDOM OBSERVATIONS

(a) SPECIAL STUDIES OF A 2-MULE TEAM

A number of methods of log slipping by mules under various conditions have been investigated and comparative data obtained. The purpose of the investigations was to determine the number of labourers required and how they should be employed.

Table M 5 shows data for two-mule teams showing the number of men required and log-slipping output. Logs were pulled using chains.

WORKING CONDITIONS

The average distance slipped was 70 m and the average load per trip was 0,17 m^3. The mules averaged a walking speed of from 0,9-1,2 km/hr, 66 trips were done per day, with the output of two mules being 11,3 m^3.

All slipping was carried out on a downhill gradient of 5°, althouth some portions had a gradient of as much as 20°.

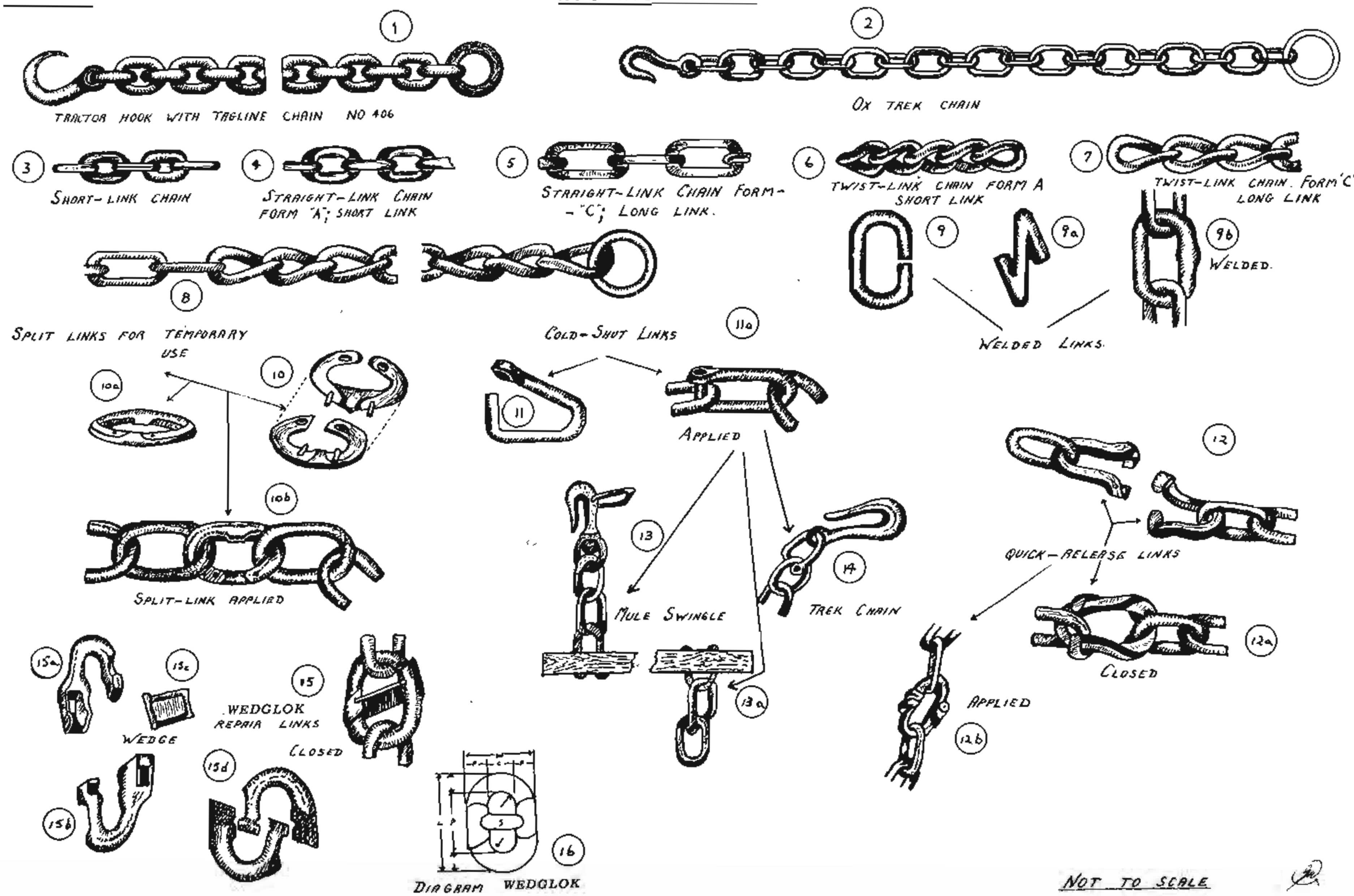
(b) SPECIAL STUDIES OF 4-MULE TEAM

An investigation more or less similar to the above was carried out for a team of 4 mules; the one team slipping chained logs and the other slipping by sledge. The 4-mule team with chains was employed in order to slip large-sized logs or poles which were beyond the pulling capacity of the two-mule team.

In the case of smaller logs, however, assembling a load of suitable volume for a 4-mule team proved cumbersome and uneconomical. Therefore a sledge for slipping shorter logs was tested with the 4-mule team, but little improvement was noted when compared with the smaller logs slipped with chain by single or two-mule teams.

FIG. M. 66

LOGGING CHAINS.



NOT TO SCALE

Sledge slipping is only practicable over smooth, level ground or evenly rolling slopes. On slopes of 10-15° and more, brakes have to be applied to the sledge in the form of logs chained behind the sledge or chains wrapped round the sledge runners. Both methods are time consuming and involve a delay of up to 5 minutes per trip. Besides the above factors, logs must be carried to the selected sledge path over distances of as much as 30 to 40 metres, involving three or more labourers. The number of these labourers depends on the sledge slipping distance. The labourers can carry 5,5-7,0 m^3 per day, the logs being stacked in stacks of 0,5-0,8 m^3. When the mule team arrives, the logs are loaded onto the sledge by the leader and driver of the mule team, who also have to unload and stack the logs manually at the roadside in readiness for loading onto lorries.

It is obvious from the above that the sledge slipping method is out of date and can only be advocated under certain conditions, i.e. for very small-sized logs in small, isolated plantations where long slipping distances are involved.

Further details of log slipping by sledge are as follows:

Three labourers were used to deliver small logs to the selected sledge slip path and stack them, their daily output being 7,08 m^3 per labourer, over a distance of 30 to 40 metres.

(1) Case (i) Third thinning, slope 5-10° down. Log slipping was down to the roadside over an average distance of 70 m
Speed of the towed sledge: 3,2 km/hr
Total distance per day: 7 km
Average sledge load: 0,57 m3
Loading the sledge by leader and driver took 4 min/30 sec.
Unloading and stacking at the roadside took 1 min/25 sec.
The average trip lasted 12 minutes, the daily output being 4,5 m^3 per labour unit.

(2) Case (ii) First thinning, (from 1 330 to 740 s.p.ha) - slope 10° down to the roadside over an average distance of 90 m
The speed of the sledge was 1,6 km/hr
Average sledge load was 19 logs, or 0,92 m^3
Loading occupied 4 minutes, unloading and stacking 3 minutes.
Attachment of brakes (logs) occupied ½ minute.
Detaching and stacking brake logs: 2 minutes.
The average trip took 18½ minutes, the daily log-slipping output being 18,4 m^3 or 3,7 m^3 per labourer.

(3) Remarks

If due consideration is given to the different slipping distances and time lost in case (ii) for the attachment and detachment of brake logs, the output was more or less the same in both cases.

Note : In both cases unloading and log stacking at the roadside was done by the mule leader and driver

(4) Conclusion.

The sledge should only be used to slip small logs over long distances, say over 150 m, when slinging the logs for single mule slipping is inconvenient.

(5) Advantages

A uniform load equal to the capacity of the team can be maintained throughout the operation and the logs delivered will be free of dirt.

F. SAFETY PRECAUTIONS FOR LOG SLIPPING BY MULES

(1) The mule used for log slipping should be well trained, not nervous, not too young and not too old. Young, untrained mules should only be handled by experienced muleteers.

(2) The harness should be in good condition, well oiled, and must fit the mules well, with adjustable traces.

(3) The mule swingle should be of sound wood and preferably fitted with a grab hook so that the log chain can be adjusted easily, lengthened when going down and shortened when slipping on the level, uphill or taking corners.

(4) All fittings and particularly log chains, be inspected at least weekly for cracks and wear, and defective fittings should be mended or replaced.

(5) Under no circumstances may the chain or harness be repaired with wire as this may cause injury to the mule.

(6) Ensure that the mule is inside the traces before commencing actual pulling.

(7) When turning the mule the trace swingle must be lifted to prevent injury to the legs of the animal.

(8) Slipping logs by mule should only be applied in easy slipping conditions, where there is no risk of injury to the animals.

(9) Keep slip paths in good slipping condition.

(10) The chance of loads rolling over the edge or striking an obstruction can be avoided by well-placed fenders along the side of the slip path.

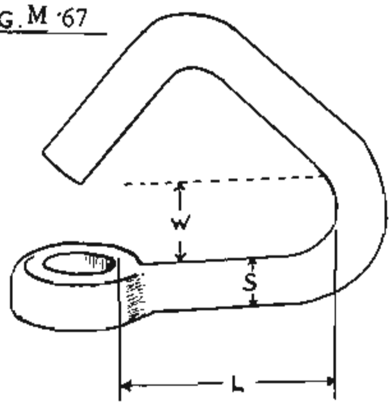
(11) Remove projecting snags and roots in order to reduce hang-ups and danger.

(12) Avoiding uphill pitches and boggy places will lessen strain on both mule and driver and thus reduce accidents.

(13) The mule-driver should never attempt to ride on the load or walk alongside it. If he does a sudden roll or jerk can throw him under the load (Fig. M 58). If he is alongside the load can easily roll towards him and pin him against a tree or bank.

(14) All slipping mules in plantations are driven without reins, some of them responding merely to words of command. In this case the driver stays behind the load and is safe.

FIG. M 67



DROP-FORGED STEEL "COLD-SHUT" LINKS.

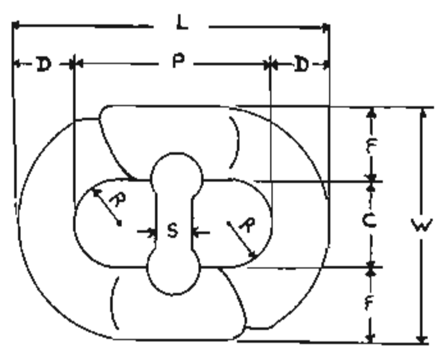
NOTE: FOR CONNECTING AND REPAIRING COIL CHAIN. IN ORDER TO ASSURE AN EXTRA FACTOR OF SAFETY IT IS RECOMMENDED THAT A COLD SHUT BE USED, ONE SIZE LARGER THAN THE CHAIN TO BE REPAIRED OR CONNECTED.

MASSES AND DIMENSIONS ARE APPROXIMATE AND ARE SUBJECT TO A PLUS OR MINUS TOLERANCE OF 4%

FINISH: SELF COLOURED UNLESS OTHERWISE SPECIFIED.

TRADE SIZE. (S) mm	INSIDE LENGTH (L) mm	INSIDE WIDTH. (W) mm	MASS PER 100 PIECES kg
4,8	29	11	1,4
6,3	29	11	2,7
7,9	32	13	4,5
9,5	35	16	8,1
11,1	38	17	12,2
12,7	41	19	17,2
15,9	51	22	38,1
19,0	60	25	63,5
22,2	70	32	104,3
25,4	76	35	158,8

FIG M. 68



STANDARD "WEDGLOK" CONNECTING AND REPAIR LINKS.

HI-CARBON, HI-TEST.

SIZE mm	FOR USE WITH ALLOY CHAIN. mm	APPROX. MASS g	SAFE WORKING LOAD kg	C	D	E	F	L	P	R	S	W
				mm								
9	8–9–11	14	2500	14	9	14	13	54	35	7	8	40

(15) Slipping timber by sledge introduces additional hazards.

(16) It frequently occurs that the sledge runs free down a slope and runs into the mule or mule and driver. Where this danger exists, do not use the sledge without brakes.

(17) One or two logs chained behind the runners of the sledge act as a brake and prove satisfactory to a certain extent. A thick chain wound round one or both runners is also an effective method of braking the sledge.

(18) Loosely-piled loads are highly dangerous.

(19) The driver should ensure that loads are tightly attached to the sledge. Logs can be contained with stakes, preferably of the safety trip type so that the load can be released from the opposite side at the landing.

(20) Pulpwood or millwood, carried on a 2-sledge rig, is normally contained by stakes at the front and rear of the cross-member.

(21) In addition they need to be bound to the frame with a hemp rope or chain going from the front bunk, up and back over the top of the load, and down to the rear bunk. A tightening device should be used on a large load to prevent the logs from shifting.

4. COSTS

A. COSTS OF OWNING A MULE

In determining the costs of owning a mule the following points were taken into consideration:

(1) Average working life: 12 years
240 working days x 12 years = 2 880 possible working days

(2) Average purchase cost	R 75,00
Salvage price	R 3,00
	R 72,00
(3) Losses of mules	R 3,00
Total cost of mule	R 75,00

(4) Depreciation cost per day	
R75 ÷ 2 880 days	2,6c
Interest	1,0c
(5) Stable hand for mule: 75c ÷ 15 mules	5,0c
(6) Cost of harness with logging chain	8,0c
(7) Repair of harness	3,6c
(8) Shoeing and veterinary	3,0c
(9) Fodder: R52,80 ÷ 240 days	22,0c
Daily cost	45,2c

No overhead charges are included

Note: (i) In view of the fact that all mules seldom work every day, i.e. 240 days per year, the cost per mule per working day will be higher.
(ii) No record of the days worked per mule is kept (stable report) so it is not possible to ascertain the exact cost per mule. The departmental hire per mule per month is R5,53, which only covers depreciation, interest and fodder.
(iii) The quality and quantity of fodder to be fed are not yet standardised, so the cost of mules is not uniform throughout the country.

B. COSTS OF LOG SKIDDING BY MULE

Performance norms were calculated for log slipping from stump to roadside, including the pre-assembling of loads and stacking at the roadside, for a single mule per team. These figures were then applied to a team of 6 mules and 13 labourers and the following costs derived:

6 mules @ 45c	R 2,70
13 labourers @ 65c	R 8,45
Total daily cost	R11,15

R11,15 ÷ 6 mules = R1,86 as the daily cost per single mule team. The slipping cost per m^3 over various distances will then be the following:

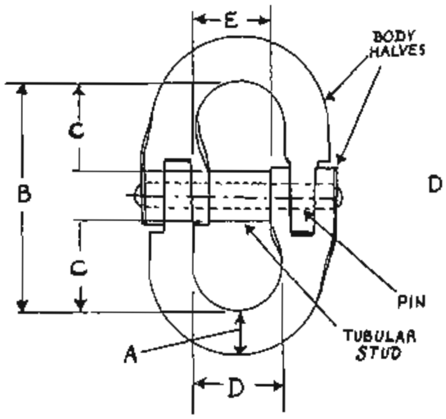
Note : The figures in Table M 6 were derived from, and are related to Table M 1.

TABLE M 6 - Estimated extraction costs by mule

Average distance	Time per load	Estimated slipping cost per m^3 per day according to established norms (cents)			
		6-18° down	1-5° down	0-5° up	6-10° up
m	min				
0 - 25	4	12,3	12,3	16,6	24,9
25 - 40	5	12,3	15,5	20,6	31,1
41 - 50	6	12,3	18,8	24,9	37,2
51 - 60	7	14,4	21,7	29,4	44,0
61 - 70	8	15,6	24,9	33,7	49,8
71 - 80	9	18,8	28,2	37,2	55,9
81 - 90	10	20,6	31,1	41,0	61,8
91 - 100	11	22,7	34,3	46,0	68,4
101 - 110	12	24,9	37,2	49,7	74,5
111 - 120	13	27,4	40,8	54,5	81,6
121 - 130	14	29,5	44,1	58,9	88,3
131 - 140	15	31,0	40,5	62,0	93,0
141 - 150	16	33,9	51,0	67,6	102,0

FIG. M. 69

"HAMMERLOK" COUPLING LINKS



DROP-FORGED ALLOY STEEL - SELF COLOURED -

MASSES AND DIMENSIONS ARE APPROXIMATE AND ARE SUBJECT TO PLUS OR MINUS TOLERANCE OF 4%

CHAIN SIZE mm	WORKING LOAD LIMIT. kg	A. mm	B. mm	C. mm	D. mm	E mm	MASS EACH. kg
9	3 000	11	61	22	23	20	0,22
13	5 100	16	85	32	33	28	0,63
16	7 500	19	103	39	40	34	1,04
19	10 400	22	122	45	48	41	1,66
22	13 000	25	138	51	58	46	2,69

FIG.M 70

CONNECTING LINKS.

DROP-FORGED STEEL WITH INTERLOCKING LUGS.

MASSES AND DIMENSIONS ARE APPROXIMATE AND ARE SUBJECT TO PLUS OR MINUS TOLERANCE OF 4%.

NOTE: THE INTERLOCKING LUGS ARE OMITTED IN THE 8 mm SIZE.

FINISH: SELF COLOURED. IF GALVANISED IS DESIRED, ORDER MUST SO SPECIFY.

INTERLOCKING LUGS IN CONNECTING LINKS SHOULD BE EXACTLY MATCHED IN THE FACTORY: COUNTERSUNK HOLES MUST BE PROVIDED FOR BACKING AND HEADING THE RIVETS. THE LINKS SHOULD NOT OPEN OR SPREAD AND SHOULD PROVE STRONGER THAN THE PROOF CHAIN ITSELF.

TRADE SIZE. mm	OUTSIDE DIMENSIONS. mm	MASS PER 100 PIECES kg
8	44 x 32	4,53
9	50 x 35	9,07
11	60 x 38	13,60
13	66 x 44	19,22

General remarks

The log-slipping norms have been conservatively calculated and it is probable that much more could be slipped per day.

As the labour cost and cost of mule upkeep is comparatively low, the mule will most certainly remain in use in the departmental plantations for a considerable period, particularly where it is most productive, as in thinnings.

5. MULE PRODUCTION POTENTIAL IN SOUTH AFRICA

In recent years the lack of demand for draught mules has reduced breeding to below the requirements of even the prevailing market. Not only has breeding practically ceased, but the country no longer has suitable breeding animals, neither mares nor donkey jacks, in sufficient numbers to revive the industry, now that it is becoming evident that the demand for mules is once again increasing.

The state of affairs occurred previously, shortly after the first World War, when draught mule and horse breeding was at a very low ebb, and the wave of motor mindedness brought about the displacement of animal power. As a result a fresh donkey jack stock was imported from America in 1938 to strengthen the existing Government stud.

At present (1963) the Department has about 700 mules, but this number is to be increased to 1 500 within the next few years, when all the plantations are in full production, and anticipating that oxen in certain areas are to be replaced by mules. If mules work for an average of 10 years, then one tenth of the mule stock will have to be replenished each year, i.e. 150 per year.

Note : 162 mules were required during 1963.

The exact number of mules being used or required by private forests in the future is unknown, but can be estimated according to their softwood production as a requirement of approximately 60 to 70 mules per year at present, increasing to approximately 120 per year in the future.

It is worth mentioning that the Railways, who have used over 1 000 mules in the past, are now completely mechanised. Sugar farmers have also been compelled to resort to mechanisation quite extensively, although mules are best suited for certain types of work.

The market open to farmers whose main venture is horse and mule breeding on a large scale is limited, and they are usually only interested in breeding thoroughbred animals, either for show purposes or to get the highest sale value. For example, at the 1963 show at Goodwood in the Cape Province, the main rendezvous for mule teams, only 9 competitors competed with their teams. At present only two livestock dealers in the country have sufficient mules to permit them to offer animals for sale to the Department. These dealers, apart from breeding mules themselves, comb the Orange Free State and Cape Province to purchase mules, yet despite their having a substantial stock, only 20% of the animals comply with departmental requirements for log slipping. Most mules are either too young, too old, too small, poorly built, or show signs of stubbornness or viciousness and have to be rejected.

It is heartening and encouraging to notice that some farmers are aware of the present situation and have started to revive the breeding of mules. They have, however, encountered a serious shortage of suitable donkey jacks and horse mares of the required quality.

With an assured demand for mules in the future, a revival of mule breeding will either occur, or mules will be imported to meet the demand. Farmers or plantation owners wishing to purchase mules for their own use will probably be able to obtain animals by consulting local agricultural journals or publications.

THE USE OF HORSES IN LOGGING AND COMPARISON BETWEEN HORSES AND MULES

Due to the shortage of mules the use of horses for log slipping is again a matter for consideration. In Canada and Europe the horse has always played an important part in log-slipping operations, particularly during early thinnings and the preparation of small timber for pulpwood. Horses are not used for slipping from clearfellings as the logs are generally considered to be too heavy.

Increasing mechanisation has caused a decline in the mule and horse breeding industry, and a shortage of horses on the market has become evident, to such an extent that certain companies in Sweden and Czechoslovakia have taken to breeding their own horses for log-slipping purposes.

In Sweden horses are only used for logging over short distances in mild terrain, while the same applies to Canada, where the economic slipping distance is considered to be approximately 120 yards (100 metres). Departmental mules in South Africa slip over distances of up to 120 m and sometimes more, the terrain usually being comparatively steep and often rough. Mule loads generally vary from 0,06–0,17 m^3 down slopes ranging from 10 to 18^o, but the Norwegian Fjord horse (medium/heavy) is recorded as pulling loads of up to 0,23 m^3, although terrain conditions are not mentioned, but are assumed to be fairly mild.

There appears to be very little difference between the speed of horses and mules under logging working conditions. Foresters confirm, however, that horses are not suited for heavy work on steep slopes, whereas mules, being lighter, can work on steep slopes under certain conditions, provided that the slopes do not exceed 18° for downhill slipping and 10° for uphill slipping.

Feeding comparisons between horses and mules show that the horse requires more food than the mule, primarily due to its additional mass and natural gluttony. Whereas a hardworking mule can be well fed at a cost of 25c per day, the daily feeding costs of a horse would be approximately 35c. It appears that horses generally receive more food than they actually require, a factor which also contributes to the higher cost of feeding.

The purchase costs of mules range between 70 and 90 rand, but according to recent investigations, Percheron horses, to be used for log slipping, cost between 120 and 160 rand each.

The standard harness may be used for both horses and mules.

Although the total number of horses used for forestry and agricultural purposes has notably decreased of late, the horse still appears to be indispensable for draught (slipping) purposes in forestry. In view of the present shortage of mules, the tendency may be to revert to the use of heavy horses for additional draught power in the future. A number of types of horses may be suitable for the task, but for the present the field has been limited to the medium-heavy Percheron, this type being considered as the most suitable for local conditions.

COMPARATIVE COST, FEEDING AND OUTPUT FIGURES FOR HORSES

(1) Costs of keeping horses

The annual cost of keeping a horse for logging purposes in Scotland amounted to R552, and in Canada R236. Norwegian Fjord horses cost between R1,40 and R2,00 per week, and heavy Netherlands draught horses between R2,80 and R3,23 per week, although costs of up to R3,70 per week were noted.

(2) Feeding

The annual costs of concentrated feed amounted to the following:

a. A medium-heavy horse:	Between R39 and R46 per year
b. A heavy horse:	Between R86 and R118 per year and up to R126 per year

Annual cost of roughage feed:

a. Medium-heavy horse:	Between R35 and R57
b. Heavy horse	Between R48 and R55

(3) Maximum power (tractive) achieved

a. Heavy horse (Netherlands)	=	300 kg
b. Medium heavy (Fjord)	=	170 kg

(4) Normal tractive power which can be maintained

a. Heavy horse	=	239 kg
b. Medium-heavy horse	=	170 kg

(5) Average permissible load (logs)

Loaded on a small wagon		Slipped by chain	
Heavy	Medium heavy	Heavy	Medium heavy
0,59 m^3	0,47 m^3	0,33 m^3	0,23 m^3

The following is the approximate pull in kg created by the types of horses listed below:

	Road length			
	178 m	247 m	330 m	410 m
	kg	kg	kg	kg
Weak	244	199	179	165
Average	274	224	204	185
Strong	309	249	219	210

APPENDIX M 1

Estimated quantity of feed to be ordered for hard-working mules

Feed components	1 mule	1 mule	2 mules	3 mules	4 mules	5 mules	10 mules	20 mules
	Norm for 10 days	Norm for 30 days	Norm for 30 days	Norm for 30 days	Norm for 30 days	Norm for 30 days	Norm for 30 days	Norm for 30 days
(a) <u>Concentrate ration</u> Crushed mealies	32 kg	96 kg=1,2 bags	2,4 bags	3½ bags	4½ bags	6 bags	12 bags	24 bags
or Crushed oats	32 kg	96 kg = 2 bags	(4 bags)	(6 bags)	(8½ bags)	(10½ bags)	(21 bags)	(42 bags)
Wheat bran	9 kg	27 kg	1,2 bags	2 bags	2½ bags	3 bags	6 bags	12 bags
Groundnut or Sunflower oil cake meal	3 kg	9,5 kg	19 kg	29 kg	38 kg	1 bag	2 bags	4 bags
Bone meal or Dicalcium phosphate	0,7 kg	2 kg	4 kg	6 kg	8 kg	10 kg	½ bag	1 bag
Salt	0,2 kg	0,7 kg	1,4 kg	2 kg	2,7 kg	3,4 kg	6,8 kg	13,6 kg
(b) <u>Roughage ration</u> Lucerne	23 kg	68 kg	136 kg	200 kg	270 kg	340 kg	680 kg	1 360 kg
Teff hay or oat hay	23 kg	68 kg	136 kg	200 kg	270 kg	340 kg	680 kg	1 360 kg

Note: This calculation is based on the ration of a hard-working mule (450 kg and over) - receiving 4,5 kg concentrate and 4,5 kg hay a day

APPENDIX M 2

Amount of feed to be given to Departmental Mules

Type of work	Ration for mules of 400-450 kg - 15 hand and over in height		Ration for mules 300-400 kg - between 14 and 15 hand high		Ration for mules below 300 kg - below 14 hand high		Remarks
	Concentrate ration per mule per day	Roughage ration per mule per day	Concentrate ration per mule per day	Roughage ration per mule per day	Concentrate ration per mule per day	Roughage ration per mule per day	
1. Working mules	kg	kg	kg	kg	kg	kg	
(a) Hard-working mules	4,5	4,5	3,6	3,6	2,7	2,7	
(b) Light-working mules	2,2	6,7	1,8	5,4	1,4	4,0	
2. "Sick" mules Mules very thin due to injuries, overwork or diseases	1-2	4,5	1,0-1,8	3,6	1-1,4	2,7	A concentrate and hay ration must supplement grazing till mules are in satisfactory condition
3. Resting mules							
(a) Resting for 1 week	Same ration as when it had been working						
(b) Resting for 2 weeks	½ the ration it had been fed while working						If the grazing is very poor the hay ration must remain the same as the working norm
(c) (i) "Resting ration" - resting longer than 1 month	0	4,5 2,2 0	0	3,6 1,8 0	0	2,7(1) 1,4(2) 0(3)	(1) If the grazing is poor (2) The grazing not entirely sufficient (3) Grazing very good
(ii) Gradual decrease of a working ration to the resting ration	Decrease the concentrate and roughage ration by 0,45 kg respectively per day to the resting ration						(4)
(iii) Gradual increase of the "resting ration", after a long rest, to the working ration	Increase the concentrate and roughage ration by 0,45 kg respectively per day till on the required working norm before the work commences						(4)
(d) Resting for 2-4 weeks	The ration must be gradually decreased, as mentioned in 3c(ii), to the resting ration and then gradually increased again before work commences to be required working norm as prescribed in 3c(iii)						(4)

(4) In cases (c)(ii) and (iii) and (d) the amount of hay fed (and decreasing and increasing of the hay ration), will be in proportion to the quality of the grazing, as set out in (c)(i)

APPENDIX M 3

SPECIFICATIONS FOR MULE HARNESS

(1) Breast, mule, heavy, folded breastpiece with solid large buckles, 3-ply leather sewn and rivetted onto breast piece; neck and backstraps to be heavy, felt lined. Vegetable-tanned harness leather to be used. Leader type. (Refer. Fig. M.26).

(2) Bridles, mule, blocked winkers, with bits.

(3) Halter, mule, solid, rivetted, heavy 30 mm.

(4) Traces, (Fig. M 26), chain leather covered, mule, to be made from 6 mm chain twisted links and to be 198 cm overall with a 7 mm x 45,0 mm i.d. ring at one end and five 58 mm large links at the other end.

(5) Chains, halter, military type to be made from 5 mm twisted link chain and to be 178 cm overall with a 9 x 50 mm i.d. ring at one end and a 6 mm toggle at the other end, with a large link welded into chain 80 cm from toggle end.

(6) Neck bands (strap), mule, double leather.

(7) Reins, mule, wheeler - 25 mm wide, standard length.

Reins, mule, leader - 25 mm wide, standard length.

Note: Not used in log-slipping operation.

(8) Mule swingle: Fig. M 61 refers to medium type swingle, Fig. M 60 to lighter leader type swingle. Drawings give all measurements and shape specifications required for swingles. Swingles made from E. paniculata, E. maculata, or E. diversicolor (karri), but any indigenous hardwoods which are sufficiently strong, such as assegai, white and black ironwood and kershout can be used.

(9) Swingle grab hook (Fig. M 62, 63). The grab hook, with or without swivel, is used. It is attached to the swingle with 11 mm links or with 13 mm shackles. It takes up to 9mm chain, preferably the short link type.

(10) Logging chain assembly used for log slipping with mules and oxen (Fig. M 64). Specification:

(i) 213 cm long chain, 9 mm material diameter. Approximate inside link dimension: 26 mm x 11 mm
Approximate outside link dimension 44 mm x 5 mm

Note : Chain of mild steel, McKinnon No. 25 or equivalent

(ii) One end of chain - ring 13 mm actual material diameter - one only.

(iii) Other end of chain - slip hook - 25 mm actual material diameter - one only.

Note: Slip-hook dimensions as per Fig M 64

(iv) Joiner link, 12 mm actual material diameter. Approximate inside dimensions: 52 x 21 mm Approximate outside dimensions: 76 x 46 mm Required per assembly: 2 only (to join ring and hook at the chain - Fig. M 64).

Note : a. Link McKinnon No. 46 or equivalent.
b. All links and rings must be electrically welded

(11) Logging slip hook (Fig. M 65).

Specification: Drop-forged, self colour, mild steel, 0,79 kg, safe capacity: 1 000-1 500 kg.

General note: The safe working load of the chain assembly is 1 000 kg.

(12) Cold-shut links. For description and specification see Fig. M 67 and for application see Fig. M 66, items 11, 11a, 13 and 13a and 14.

(13) "Wedglok" repair links, for repairing chain: For description and specification see Fig. M 68, and for application see Fig. M 66, items 15, 15a, b, c and d.

(14) Split links or connecting links for chain repair.

See Fig. M 70 for description and Fig. M 66 items 10, 10a and 10b for application.

SHEET No. 1

ANIMAL LOG-SLIPPING DATA

TRIP RECORD

Team No. ______________ Date ______________

Block/compt. ______________ Crew units ______________

TRIP RECORD

Team No. ______________ Date ______________

Block/comp. ______________ Crew units ______________

Time hr min	Logs No.	Towing			Remarks	Time hr min	Logs No.	Towing			Remarks
		Up	Down	Level	Maximum distance metres etc.			Up	Down	Level	Maximum distance metres etc.

Compiler ....

Rank ....

SHEET No. 2

LOG SLIPPING BY MULES

Date ______________ 19 ________

Plantation ______________ Block ______________ Compartment ______________ Kind of felling ______________ Species ______________

Team No. __________ Mule driver __________ Mule ______________ Supplementary equipment ______________ Remarks ______________

Walking time from stable to felling area: From ____________ to ____________ a.m.

Walking time from felling area to stable: From ____________ to ____________ p.m.

Break for breakfast: From ____________ to ____________ a.m.

Break for lunch: From ____________ to ____________

Trip	Walking time from road to logs	Distance metres	No. of logs in the load	Time assem-bling logs	Time chain-ing logs	Time hooking logs	Time slipping from site to road	Time unhook-ing logs	Time for log dispo-sal	Time for log piling logs	Delay time
1	2	3	4	5	6	7	8	9	10	11	12
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

TOTAL Logs ______________ Compiler ______________

Volume (m^3) ______________ Rank ______________

SHEET No. 3

LOG SLIPPING BY MULES

Date ____________ 19 ____

Plantation ____________ Kind of felling ____________ Crew ____________ Serving mule teams :

Bantu ____________ No. ____________

Block ____________ Compartment ____________ Species ____________ Supplementary equipment ____________

Serial No. of log assembling	Walking time from load assembling point to logs	Distance, metres	Time picking up logs	Log-carrying time, from pile to load assembling point	Time of log disposal	Load chaining time	Remarks
1	2	3	4	5	6	7	
1							
2							
3							
4							
5							
I Load							
6							
7							
8							
9							
10							
II Load							
11							
12							
13							
14							
15							

Note: Re. Column 7. Load chaining time is only noted when the mule leader or driver chains the logs

Compiler ____________

Rank ____________

SHEET No. 4 LOG SLIPPING BY MULES Date __________ 19____

Plantation__________________ Kind of felling ____________________ REMARKS

Block ______________ Compartment ______________ species ______________

Total walking time from stable to site ______________________________

Total break time for breakfast and lunch ______________________________

No. of. team	Date	No. of trips observed/ day	Total walking time from road to logs	Average slipping distance metres	Slipped		Total time							
					No. of logs	Total volume m^3	Log assembly	Log chaining	Log hooking	Log slipping	Log unchain -ing	Log dis- posal	Log piling	Delay time
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Compiler ______________________

Rank ______________________

SHEET NO. 5 LOG SLIPPING BY MULES SUMMARY - ADVANCE LOG ASSEMBLING Date ______ 19 ____

Plantation ______ Crew: Bantu: ______ Serving mule teams.

Block ______ Compt ______ Kind of felling ______ Supplementary equipment ______ No/ ______

Total. Drivers ______

Mules ______

Crew	Date	Serial sheet No.	No. of loads	Volume m^3	Total walking time from load-assembling points to logs	Total return distance metres	Total time				Delay
							Picking up logs	Carrying logs	Disposal logs	Chaining logs	
1	2	3	4	5	6	7	8	9	10	11	12

Compiler ______

Rank ______

SHEET No. 6

LOG SLIPPING BY MULES LOG PILING AT THE ROADSIDE

Date __________ 19 _____

Plantation ____________________ Kind of felling ____________________ Crew: Serving team No's __________

Block ____________________ Compartment ____________________ Bantu ____________________ ____________________

Break for breakfast from ________ till ______ a. m. Supplementary

Break for lunch from ________ till ______ p. m. Equipment ____________________

Load No.	No. of logs	Load arrival (disposal)		Time of						Remarks
				Load unchaining		Log piling		Idle time		
		From	till	From	till	From	till	From	till	

Compiler ____________________

Rank ____________________

SHEET No. 7

Date ______________________________ 19____

SLIPPING BY MULES

SUMMARY SHEET

LOG-PILING STATEMENT

Plantation ______________________________ Kind of felling ______________________________

Block ______________________________ Compartment ______________________________

Crew, Bantu ______________________________

Crew, Bantu ______________________________

Serving team No. ______________________

No. ______________________

No. ______________________

No. ______________________

No. ______________________

TOTAL WORKING TIME ______________________________

TOTAL IDLE TIME ______________________________

TOTAL ______________________________

Compiler ______________________________

Rank ______________________________

SHEET No. 8

SLIPPING BY MULES

DESCRIPTION OF SLIPPING CONDITIONS

PLANTATION ______________________ DATE ______________________ 19______

BLOCK ______________________ COMPT. ______________ KIND OF FELLING ______

TOPOGRAPHY ______ a) Flat gentle slope (up to 5^{o})
b) Medium ($5 - 10^{o}$)
c) Steep ($10 - 20^{o}$)
d) Very steep (20^{o} and over - mule not used)

Slipping: With or against the grade ______________________

Surface: Smooth, rocky, dry, wet or muddy ______________________

Onderbos, slash ______________________

Kind of felling: (i) 1st, 2nd or 3rd thinning, clearfelling ______________________

(ii) Number of stems per hectare ______________________

(iii) Espacement of tree planting ______________________

(iv) Number of trees per hectare left ______________________

(v) Regularity of tree rows ______________________

Volume of logs extracted per hectare ______________________

Number of logs extracted per hectare ______________________

Volume per log, minimum __________ maximum __________ average __________

Size of logs, diameter, minimum __________ maximum __________ average __________

length, minimum __________ maximum __________ average __________

Size of load in m^3 (average) ______________________

Number of logs per load (average) ______________________

Supplementary equipment (chains, etc.) ______________________

Length of average haul, metres ______________________

Intervals between the adjoining compartment roads, metres ______________________
(to which logs were slipped)

Average building costs of compartment roads per m ______________________

Method of slipping (description in general)

(1) Single mule with chain or team (number of mules) with sledges ______________________

____

(2) Number of drivers, etc. per mule or team ______________________

(3) Method of assembling the load and its chaining:

(i) by driver alone ______________________

(ii) by driver's assistant ______________________

(iii) by advance assembling of logs per load ______________________

(iv) by advance chaining of logs per load ______________________

(4) The approximate average distance the logs were carried to load assembling point, m ______

Additional remarks ______________________

____

Compiler ______________________

Rank ______________________

SHEET No. 9 Date ______________________ 19 _____

SLIPPING BY MULE

General information

Plantation ______________________ R. c.

A. 1. Average purchase price per mule: (all costs at plantation, including railage) .....

2. Average total working life ______________________ years

3. Salvage price per mule at the end of working life (average) ....

4. Loss of mules from all causes during average working life ____________ per cent
(longer period to be considered)

B. 1. Stable hand (wages, cost of living, rations, housing, etc.) per mule per annum ...

2. Mule driver, do ....

C. 1. Initial costs of harness at plantation per mule ....

2. Average life of set of harness ______________ years ....

3. Repair costs, average per set per annum ....

D. Shoeing service: average expenditure per mule per annum ....

E. Veterinary services: average expenditure per mule per annum ....

F. Costs of food per mule per annum ....
(including grazing)

Actual data per last financial year ______________________ 19 ________

1. Number of drivers and labourers engaged in log slipping with mules ______________

2. Their total wages, with cost of living and ration ....

3. Number of mules engaged in slipping ______________________ mules

4. Cost of feeding mules ....

5. Total number of days worked on slipping ______________________ days

6. Total number of logs slipped ______________________ logs

7. Total volume of logs slipped ______________________ m^3

Additional remarks ____

____

____

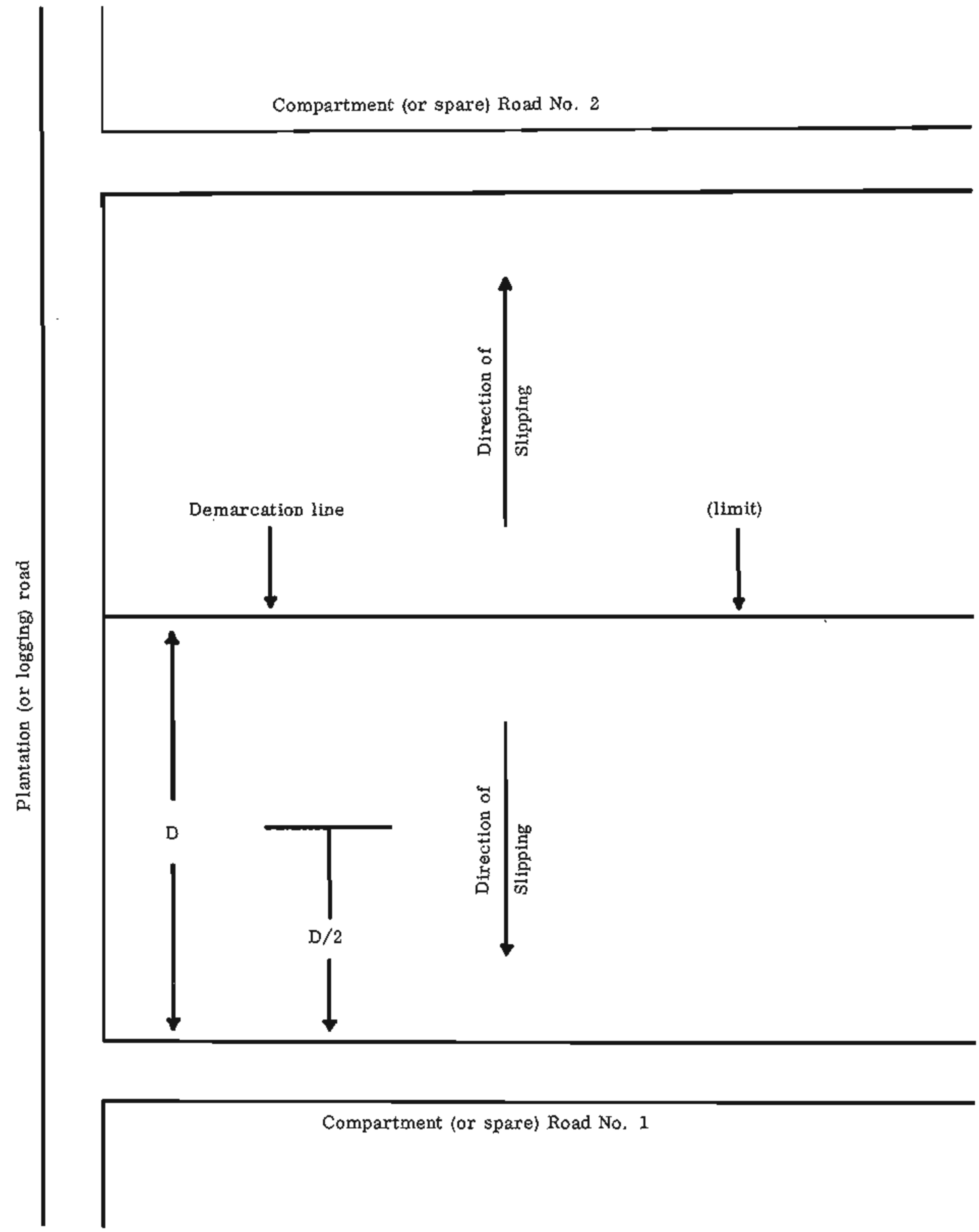
____

Compiler ______________________

Rank ______________________

SHEET No. 10

DETERMINING THE AVERAGE SLIPPING DISTANCE
Flat, or slope up to 10°



D/2 = Average slipping distance

SHEET No. 11

DAILY STABLE (HERD) REPORT

Plantation ______________________ Date ____________________

Animals ______________________

Working No.	Resting No.	Number ill	Number lost	Total number

Work allotted to: 1. No. of animals 2. No. of animals 3. No. of animals	Block/Compt.	Kind of work	Supervisor name and rank

Left stable (grazing) morning ______________

Returned stable (grazing) evening ______________

Fodder given ______________________

Remarks ______________________

DAILY STABLE (HERD) REPORT

Plantation ______________________ Date ____________________ 19 ________

Animals ______________________

Working No.	Resting No.	Number ill	Number lost	Total Number

Work alloted to: 1. No. of animals 2. No. of animals 3. No. of animals	Block/Compt	Kind of work	Supervisor name and rank

Left stable (grazing) morning ______________

Returned stable (grazing) evening ______________

Fodder given ______________________

Remarks ______________________

COMPARTMENT REPORT

SHEET NO. 12

Kind of felling ____________ From ____________ to ____________ stems/hectare

Log slipping by animals

Month ____________ 19 ____ Plantation ____________ Block ____________ Compt ____________

Foreman ____________
His wage and c. o. l.
during work in compartment

Date	Maximum slipping distance m	Slipping level up down	Slope grade degrees	Animals		Equipment used	Return trips NN	Slipped		Average working daily hr/min	Idle		Remarks	Labour				Cash		
				Mules N. N.	Oxen N. N.			Logs	Volume m^3		Lunch etc. hr/min	Delay hr/min		Leaders and drivers	Load assembling	Load chaining and booking	Logs stacking on roadside	Labour R. c.	Animals R. c.	Equipment R. c.

R. c.

Note: Average daily wages and c. o. l. per unit ....

Average daily cost: Mule ....

Ox ....

Daily depreciation of equipment ....

Remarks

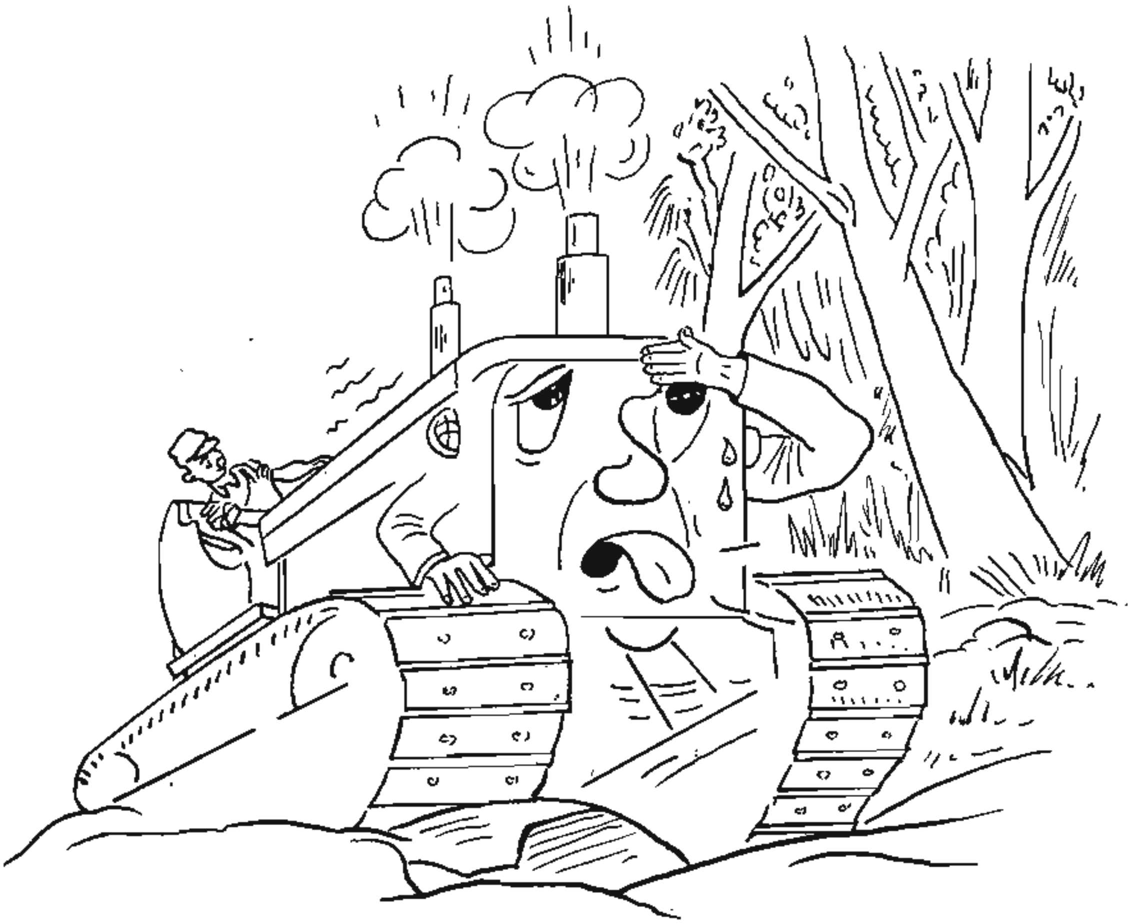
R. c.

Total costs ....

Forester ____________

Date ____________

LOGGING by CRAWLER TRACTOR



1. LOG SKIDDING BY TRACTORS
CRAWLER TRACTOR (Fig. T.S.1)

Crawler tractors are playing an increasingly important part in log-skidding operations as mechanisation progresses in departmental plantations. Their number is steadily growing in conjunction with the increasing volume of large logs being extracted from mature plantations.

DEFINITION

The crawler tractor is a unit of great compactness, combining an engine mounted on a chassis, which is in turn mounted on tracks, the whole being equipped with a drawbar in the rear for pulling.

The crawler running gear consists of two endless bands, one on each side of the machine. Each band passes around two large wheels with teeth or sprockets, which it engages. The band is driven by two rear wheels. There are additional rollers mounted at the bottom of each side to keep the entire lower portion of the band or track pressed against the ground.

The length and width of the tracks depend upon the tractor size, the width being in excess of the actual carrying requirements in order to reduce penetration of the driving mechanism into the ground. Each band or track is made up of a series of plates of hardened steel, linked together and often provided with grousers. The device is, in effect, a "locomotive" running on 'rack tracks' laid out automatically on the ground ahead of the wheels and taken up behind them again in endless repeated succession. None of the wheels are arranged for steering or turning, which is accomplished by braking the track on one side while maintaining speed on the other. With one side held fast, the machine may be turned through 180° in virtually its own length. Some manufacturers provide for reversal of one track and forward motion on the other at the same time, thus permitting instantaneous reversal of the machine exactly within its width (spin). Refer to Fig. T.S. 30.

The crawler tractor has a great versatility as almost anything may be hitched to the drawbar hook and pulled. The machine can move over virtually any surface and negotiate steep grades. The tractor is used in departmental logging operations equipped with a drawbar hook, winch and cable, and line hook and chokers. It may also be used to tow such skidding attachments as sledges, logging pans, and various types of logging arches, and it may be equipped with a bulldozer blade as an aid to log skidding and stacking. Crawler tractors are also used in auxiliary road work for pulling graders, road rollers, etc.

Crawler tractors are generally propelled by diesel engines, which are capable of slow, heavy pulls with independent clutches and brakes for each track. The engine costs virtually double the price of a petrol engine, but the fuel cost is only about 25% that of petrol. Diesel engines are, however, more complicated than petrol engines and require special devices on the engine for starting.

The logging tractor must be equipped with a crankcase guard to protect the under part of the engine and transmission. It should be made of heavy plate steel bolted under the front chassis, and should permit the tractor to slide over obstructions which might otherwise cause serious damage. A safety hook is usually fastened to the crankcase guard. (Refer to Fig. T.S. 65 Appendix T.S. 14)

Crawler tractors can attain speeds of up to 13 km/hr, although the top speed is seldom utilised in log skidding, due to the numerous obstacles encountered in the plantation.

The Department employs tractors mainly from 35 to 41 kW for use in log-skidding operations.

2. CONDITIONS WHICH INFLUENCE LOG SKIDDING BY TRACTOR AND TRACTOR PERFORMANCE

A. PHYSICAL CONDITIONS

(a) TOPOGRAPHY

(1) Plains

Log skidding by tractor can always be carried out on plains, provided that the ground bearing conditions are satisfactory. The ground in departmental plantations is generally firm and passable for tractors the whole year round, with the exception of certain parts of Zululand, where marshy ground sometimes occurs.

(2) Slopes

Slopes of up to 15° to 18° are a definite aid to log skidding by tractor, provided that convenient log landings are available. Where the gradient is too steep the tractor winch or other log-skidding means must be employed. The gradient of the slope controls the stability of the working tractor and the machine cannot be operated with safety on slopes exceeding 16° to 18°.

(b) ALTITUDE

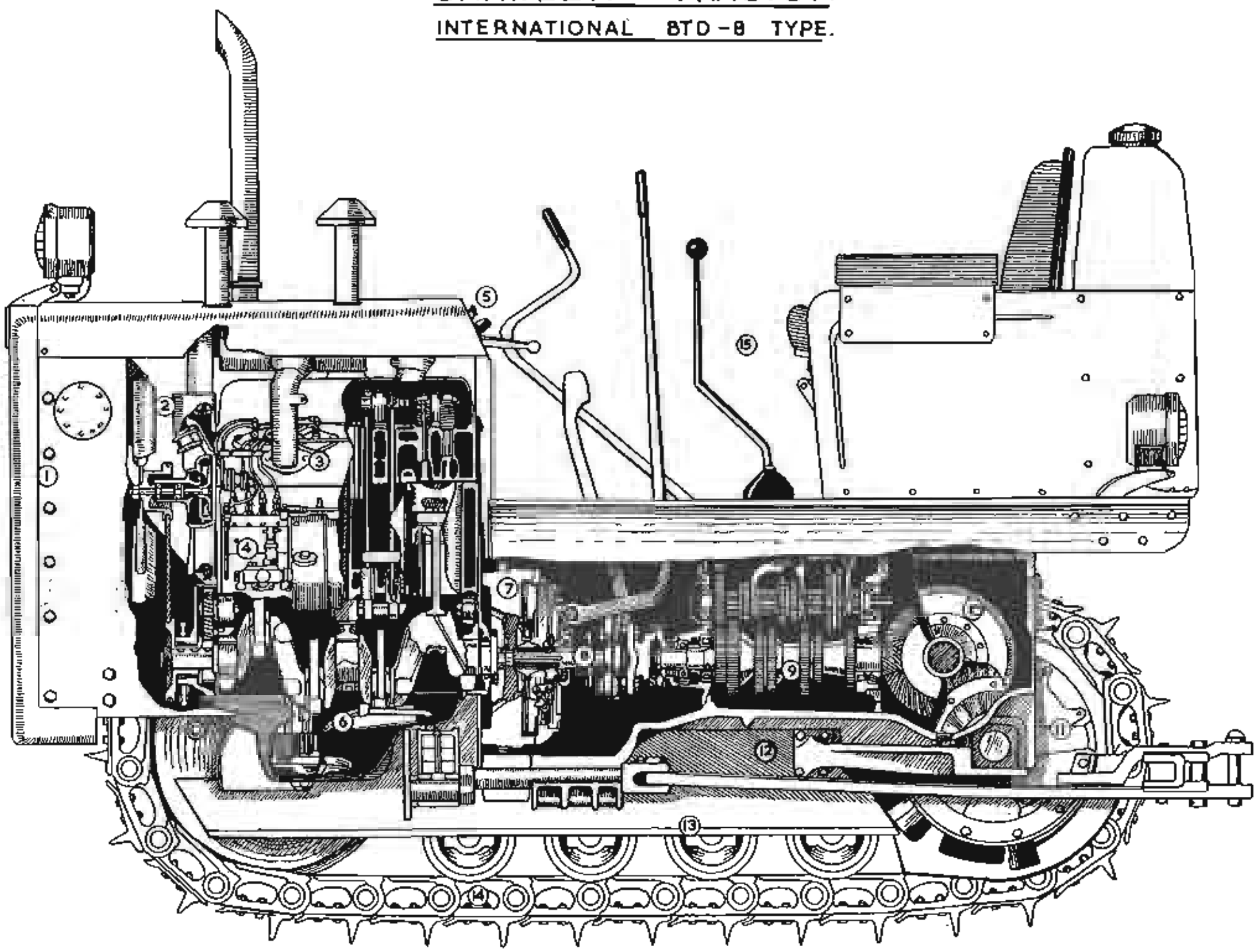
Altitude influences the power of a tractor in so far that a 3% loss of efficiency is experienced for every 300 m rise in altitude after 900 m. This handicap is overcome to some extent in large tractors, which are equipped with turbo-chargers.

(c) CLIMATE

Most departmental plantations are located within the temperate climatic zone. Temperatures vary from 1,7° to 37,8°C and can affect the tractor efficiency by as much as 7%, i.e. the performance improves if the temperature rises. The influence of humidity on performance is insignificant as it depends upon the temperature.

The climatic factors can have a marked effect on log-skidding output although the ground conditions and the labourers are influenced more than the tractor.

FIG. T.S. 1
CRAWLER TRACTOR
INTERNATIONAL BTD-8 TYPE.



1. FRONT FRAME.
2. COOLING SYSTEM.
3. ENGINE.
4. INJECTION SYSTEM.
5. STARTING.
6. LUBRICATING SYSTEM.
7. ENGINE CLUTCH.
8. ENGINE CLUTH COUPLING.
9. TRANSMISSION.
10. STEERING CLUTCHES.
11. FINAL DRIVES.
12. TRACK SUSPENSION.
13. TRACK FRAMES.
14. TRACK COMPONENTS.
15. OPERATOR'S COMPARTMENT.

The tractor efficiency is only moderately reduced by rain. Wind has virtually no effect, apart from indirect influences such as windfalls or adverse felling conditions which may slightly complicate tractor skidding.

(d) GROUND SURFACE

Tractor mobility is affected by the ground surface conditions due to the adhesion between the soil and the tractor tracks, thus influencing the drawbar pull and the resistance to skidding.

The surface of the forest floor is often damp and covered with litter and vegetation, which hampers the movements of the loaded tractor. The soil in departmental plantations is generally sandy loam or sandy, as in Zululand. Crawler tractors are usually used for areas with loamy soil, while wheel tractors are used where sandy soil occurs, to prevent abrasion to the steel tracks of the crawler tractors. In the flat areas of Zululand where sandy soil predominates, the use of wheel tractors is fully justified.

Rocky soil is usually covered with a thin layer of mineral soil and vegetation which moves when coming in contact with the tractor tracks and thus offers very little adhesion, consequently the tractor drawbar pull is greatly reduced. Surfaces covered with small, well-embedded stones give a moderately good adhesion and slightly reduce the log-skidding resistance. Surfaces covered with large, loose stones offer very little adhesion and tractor operations on such surfaces are often dangerous, particularly on slopes (Fig. T.S. 2 and 3).

Calculating the rolling and skidding resistance and adhesion on the rocky surface described above presents considerable difficulty, and is further complicated by unevenness of the terrain. The use of the tractor winch for log skidding is often the solution to skidding problems on rocky terrain, even when slopes of only moderate gradients occur.

(e) SUPPORTING CAPACITY OF THE GROUND IN PLANTED AREAS

The supporting capacity of the soil is usually expressed in terms of the pressure in kilograms per square centimetre that the ground can withstand without being deformed, which in turn is used to determine the type of tractor to be used on that particular soil. The following well-known rules of thumb can be applied:

a) The mass of a man on one foot exerts pressure of about 0,28 kg/cm^2, which is equal to the pressure exerted by a crawler tractor.

b) A horse exerts a pressure of 1,4 kg/cm^2, which is equal to the pressure exerted by a tractor fitted with tyres.

TABLE T.S. 1 - Supporting capacity of resistance of soil

Soil	kg/cm^2
Marshland and peaty soil	0,17
Alluvial tracts of loose sand	0,49
Dry sand	1,98
Wet sand	3,98
Fine gravel	5,00
Coarse gravel	2,59
Packed gravel	7,94
Limestone	1,39
Soft soil	0,99
Semi dry clay	1,99
Dry clay	3,98
Solid rock	2,49
Broken rock	4,97

From the above it is obvious that tractors can move over virtually all types of soil, with the exception of marshland and peaty soil.

(f) RESISTANCE TO ROLLING

Rolling resistance is an important factor which must be taken into account. It is usually represented by a rolling coefficient, which can be defined as the "necessary force (measured in kilograms) parallel to the ground, required to move 1 ton of the given vehicle". This coefficient depends on:

(1) The state of the ground
(2) The kind of equipment used, i.e. whether tracks or tyres

Coefficient of rolling resistance in kilograms - (Figures released by International Harvester Co.)

Type of ground	Crawler tractor kg
Earth road, dry and dusty	40
Open country	54
Ploughed land	60
Earth road, muddy	70
Sand and gravel	85
Very muddy road	110

The formula relating rolling resistance to the mass of the vehicle is:

$R = K.W.$

R = Rolling resistance of the vehicle in kilograms

K = Coefficient of rolling resistance in kilograms

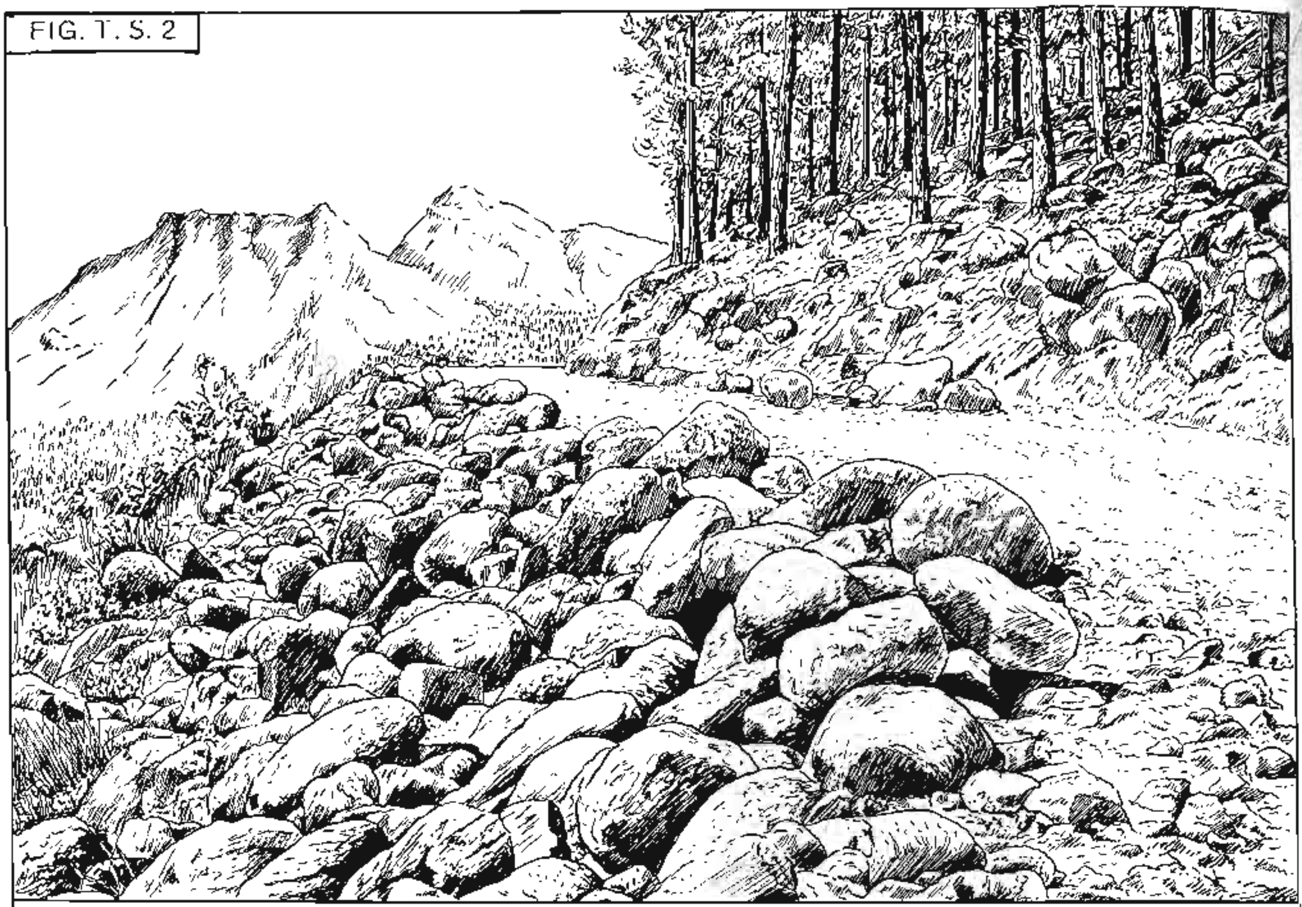
W = Mass of the vehicle in tons

The University of Nebraska (U.S.A.) recommends the use of a standard coefficient of rolling resistance equal to 54 kg per ton, corresponding to movement on cultivated ground which has not been ploughed, for general conditions in forestry.

(g) RESISTANCE TO SKIDDING

In order to move a load, resting on the surface, a force must be applied to it. This force is related to the mass of the load by a constant called the "skidding coefficient", which is usually less than the mass of the load, or log. This coefficient is dependent on the state of the ground and the diameter of the trees to be skidded, as indicated in the following table.

FIG. T. S. 2



STEEP SLOPES WITH LARGE BOULDERS
AND ROCK.

FIG. T. S. 3

MODERATE SLOPE, LITTERED WITH
STONES AND ROCK.

TABLE T.S.2 - Skidding resistance of logs in bark for various soils (figures released by Caterpillar Co.)

Type of soil		Skidding resistance in kg/ton for logs dragged along the ground				
		30 cm	33 cm	36 cm	40 cm	50 cm
Clay	Wet or dry	797	788	779	761	729
Clay	Waterlogged	639	639	621	589	539
Sandy clay	Wet or dry	829	815	810	797	761
Sandy clay	Waterlogged	661	648	639	621	557
Black humus	Wet or dry	761	747	738	720	679
Black humus	Waterlogged	571	548	539	530	489
Sandy black humus	Wet or dry	788	779	761	729	698
Sandy black humus	Waterlogged	589	580	571	539	521
Sandy soil	Dry	699	599	670	661	621
Sandy soil	Wet or waterlogged	720	711	698	679	648

Note: If the heads of the logs are raised the skidding resistance is from 20 to 25% less than that shown in the above table for logs dragged along the ground

(h) COEFFICIENT OF ADHESION

The various skidding coefficients only apply to the pulled load. When a wheel or track is driven by an engine its action on the ground is different because of the rolling coefficient, which slows down the motion of the vehicle and must be taken into account with the motion of the tractor itself, thus the gripping power of the tractor on a given ground must be considered. It is, in fact, not always the power of the motor which determines the drawbar pull available, because if the wheels or tracks start skidding with a certain pull, the extra power available from the motor cannot be used. The total power can only be used when the tractor grips the ground firmly and the motor has attained the required revolutions per minute. The slipping action of moving components is influenced by two factors:

(1) Adhesion of the moving parts to the ground
(2) Mass available on these moving parts

The coefficient may be expressed in kg as a fraction of the mass in tons of the tractor, the formula being:

$$f = \frac{kg}{wr}$$

Where "f" is the coefficient of adhesion in kg per ton, "kg" is the drawbar pull in kg and "wr" is the mass of the moving parts of the tractor in tons. The coefficient depends on the ground surface over which the tractor is moved.

In order to measure the coefficient of adhesion under working conditions the tractor must be loaded until it starts skidding and the drawbar pull then calculated. As the mass of the moving parts will be known it will be easy to determine the coefficient of adhesion by applying the formula previously given.

TABLE T.S.3 - Table indicating coefficient of adhesion in kg/ton

Type of surface	Condition	Coefficient of adhesion kg/t
Clay	Dry	580
Clay	Waterlogged	460
Sandy clay	Dry	560
Sandy clay	Waterlogged	420
Black humus ..	Dry	460
Black humus ..	Waterlogged	290
Sandy humus ..	Dry	530
Sandy humus ..	Waterlogged	270
Sand	Dry	290
Sand	Wet or waterlogged	320
Gravel	-	-
Smooth, bare rock	Dry	200
Smooth, bare rock	Wet	150

Note: The difficulties experienced on the forest floor, are, to a certain extent, taken into account in the above table

Example: An International B.T.D. 6 tractor, having a mass of 4 800 kg, moves over swampy ground, the coefficient of adhesion being unknown, and the dynamometer shows that the tractor starts to skid away when the pull reaches 1 770 kg.

The coefficient of adhesion of the ground is thus:

$$\frac{1\ 770}{4{,}8} = 369 \text{ kg}$$

A formula for tractor traction power has been calculated, based on the foregoing data for uniform conditions existing in agricultural operations where tractors are employed on soil-moving operations, where the load was moved on the same haul, loads being of the same shape and rolling resistance being more or less constant.

In logging, however, conditions differ with every trip and resistance varies considerably thus data worked out for the above conditions would have limited application in logging. The Caterpillar Tractor Co. has worked out a table based on a limited number of field observations and under reasonable traction conditions, which is given below for the tractor size used by the Department for log skidding (Table T.S. 4).

(i) GRADE RESISTANCE

The following tables can only serve as a general guide and their direct application is rather limited. In practice the drawbar pull is further reduced, not only by the grade resistance which is dependent upon the gradient, but by additional reductions as a result of a combination of sliding resistance, the rutting action of the log heads and friction between the load and trees, stumps and rocks.

TABLE T.S.4 - Sizes of loads in tons and percentage of level load on firm ground skidding. Tree-length logs on various grades (based on 2nd gear operation - D.2 tractor)(Figures released by Caterpillar Tractor Co.) - Size of load in 1 000 kg(t)

Percentage of grade (and degrees)	D.B.H. in cm									
	30 cm		40 cm		50 cm		60 cm		70 cm	
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
+28 (+13°)	0,44	43	0,62	40	0,70	39	0,75	39	0,78	39
+24 (+11°)	0,51	50	0,72	47	0,82	46	0,88	46	0,91	45
+20 (+ 9°)	0,58	57	0,83	54	0,95	53	1,02	53	1,06	52
+16 (+ 7°)	0,66	65	0,96	63	1,09	61	1,17	60	1,22	60
+12 (+ 5°)	0,74	72	1,08	71	1,24	70	1,34	70	1,40	69
+ 8 (+ 3°)	0,83	82	1,22	80	1,41	79	1,51	78	1,59	78
+ 4 (+ 2°)	0,92	90	1,37	90	1,59	90	1,71	89	1,80	89
Level	1,02	100	1,53	100	1,78	100	1,93	100	2,08	100
- 4 (- 2°)	1,12	110	1,69	111	1,99	112	2,16	112	2,28	113
- 8 (- 3°)	1,23	121	1,88	123	2,21	124	2,41	125	2,56	126
-12 (- 5°)	1,34	131	2,07	136	2,45	138	2,67	138	2,86	141
-16 (- 7°)	1,45	142	2,27	148	2,72	153	2,98	154	3,18	151
-20 (- 9°)	1,56	152	2,48	162	2,99	168	3,30	170	3,53	174
-24 (-11°)	1,68	164	2,71	177	3,29	185	3,65	189	3,92	193
-28 (-13°)	1,81	178	2,95	193	3,61	203	4,03	208	4,33	214
-32 (-15°)	1,92	188	3,19	209	3,93	222	4,42	229	4,77	235

Note: + refers to uphill skidding; - to downhill skidding

Crawler tractors: specification data

Make	Caterpillar D.2	International harvester B.T.D.6
Fuel	Diesel	Diesel
Mass	3 510 kg	3 700, 3 920 and 4 049 kg
Engine kW	28	39 @ 1 550 r.p.m.
Drawbar kW		31
Approx. drawbar pull	3 678 kg	4 756 kg
Winch line pull:		
Bare drum	6 340 kg	
Full drum	3 000 kg	

Crawler tractor - specification data

Make	Caterpillar tractor D.4
Fuel	Diesel
Mass	5 900 kg
Engine kW	48 @ 1 680 r.p.m.
Drawbar kW	39
Max. drawbar pull	5 900 kg
Winch line pull: Bare drum	8 240 kg
Full drum	4 050 kg

TABLE T.S.5 - Sizes of loads in tons and percentage of level load on firm ground skidding. Tree-length logs on various grades (based on 2nd gear operation - D.4 Cat. Tractor) (Figures released by Caterpillar Tractor Co.) - Loads in 1 000 kg (t)

Percentage of grade (and degrees)	D.B.H. in cm											
	30 cm		40 cm		50 cm		60 cm		70 cm		80 cm	
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
+28 (+13°)	0,74	46	1,04	44	1,18	43	1,26	42	1,31	41	1,35	41
+24 (+11°)	0,84	53	1,19	50	1,35	49	1,44	48	1,51	48	1,56	47
+20 (+ 9°)	0,95	60	1,36	57	1,55	56	1,65	55	1,73	54	1,78	54
+16 (+ 7°)	1,06	66	1,53	65	1,75	63	1,87	62	1,96	62	2,03	62
+12 (+ 5°)	1,19	75	1,72	73	1,98	71	2,13	71	2,23	70	2,31	70
+ 8 (+ 3°)	1,31	82	1,92	81	2,22	80	2,39	79	2,50	79	2,60	79
+ 4 (+ 2°)	1,45	91	2,14	91	2,48	90	2,68	89	2,82	89	2,93	89
Level	1,59	100	2,37	100	2,77	100	3,00	100	3,17	100	3,28	100
- 4 (- 2°)	1,74	110	2,62	110	3,08	111	3,34	111	3,53	111	3,68	112
- 8 (- 3°)	1,89	119	2,89	122	3,34	124	3,70	124	3,93	124	4,11	125
-12 (- 5°)	2,04	128	3,16	133	3,76	136	4,11	137	4,37	138	4,68	143
-16 (- 7°)	2,21	139	3,45	145	4,13	149	4,54	151	4,84	153	5,07	155
-20 (- 9°)	2,38	150	3,75	158	4,52	163	4,98	166	5,33	168	5,61	171
-24 (-11°)	2,56	161	4,10	173	4,98	180	5,53	185	5,93	187	6,24	190
-28 (-13°)	2,73	172	4,46	188	5,46	197	6,08	206	6,54	207	6,92	211
-32 (-15°)	2,91	183	4,82	203	5,94	215	6,67	222	7,20	227	7,63	233

Note: + refers to uphill skidding; - to downhill skidding

These resistances will vary according to the length and diameter of the logs and must be considered in addition to grade resistance.

Further factors influencing the resistance to skidding of tree-length loads are the varying masses of the different species, the shape of the tree, the number and form of knots and whether the trees are skidded butt or top end first.

The ideal is to skid straight, well-trimmed, tree-lengths, top first down a smooth, evenly rolling slope.

B. MECHANICAL FACTORS

(a) DEFINITION OF POWER

Power is defined as the amount of work performed in one second and is measured in kW. (1h.p. = 0,746kW).

(1) Nominal power: The nominal power of a motor is the "maximum power obtainable under conditions of continuous service compatible with good functioning of the engine."

(2) Belt kW power is slightly less than the true power of the motor because there is transmission gearing between the motor and power take-off. Loss of energy power in the gearing from 3 to 10% must be taken into account.

(3) Drawbar power: is the force available in kW at the drawing point of the drawbar hook of the tractor, and is in most cases the power developed in first gear at maximum torque. Drawbar power is less than belt power because it takes into account the power required to move the tractor itself and the loss of efficiency through the transmission system. This power is 60 to 70 per cent of the nominal power of the engine.

(b) LOSS OF POWER DUE TO WEAR

A new tractor can produce 100% of the power specified by the manufacturers, but after a few thousand hours only 80% of the original power is available due to wear on the transmission and the motor.

(c) SUMMARY

The following factors all contribute to reducing the drawbar power of a tractor: altitude, temperature, rolling resistance, grade resistance, the coefficient of adhesion, wear and tear and transmission gearing. The combined effect of these factors is to reduce the drawbar power to 50% that of the nominal power of the tractor.

(d) SPEED OF A TRACTOR

Speed is expressed in terms of kilometres per hour (km. /h). The speed for each gearbox combination of the tractor is given by the manufacturers, but this is not always the practical speed which can be maintained in logging operations. The main factors which lower the efficiency of a tractor, and cause loss of time, are, (1) time spent in gaining access to the logs, (2) hooking them, (3) turning the tractor at the log stack, (4) unhooking. In addition there are incidental losses which occur during the normal course of skidding. Tractor manufacturers recommend that a 15% allowance be made for these factors.

Tractor speeds in the forest are usually expressed in terms of metres per second or metres per minute, i.e.

1 metre per second = 3,6 kilometres per hour
1 km per hour = 17 metres per minute

The tractor can be considered productive only when it is pulling logs. The total cycle time is made up of loaded travelling time plus time required for the 5 elements given above. Assuming that there are sufficient logs and manpower available, there should theoretically be no other reasons for interrupted production. In fact, various contingencies arise and the losses in actual time can be expressed in terms of minutes per hour as follows:

1. Loss per hour for experienced and hardworking team: 4 minutes
2. Loss per hour for a team of average experience, but not interested in improving technique. 7 minutes
3. Loss per hour for an untrained team without any interest in efficiency 10 minutes

In Africa, where the labour is generally unskilled and no undue concern is shown for efficiency or improvement in technique, 10 minutes per hour can be added to the above figures.

(e) REPAIR SERVICES

The following figures express the losses in effective working time in minutes per hour for the organisation of repair services:

	Minutes
(i) Loss per hour for a logging operation with excellent workshop	3
(ii) Loss per hour with moderate workshop performance	5
(iii) Loss per hour with poor workshop performance	7

For South African conditions the above figures may be multiplied by three for enterprises with maintenance sections.

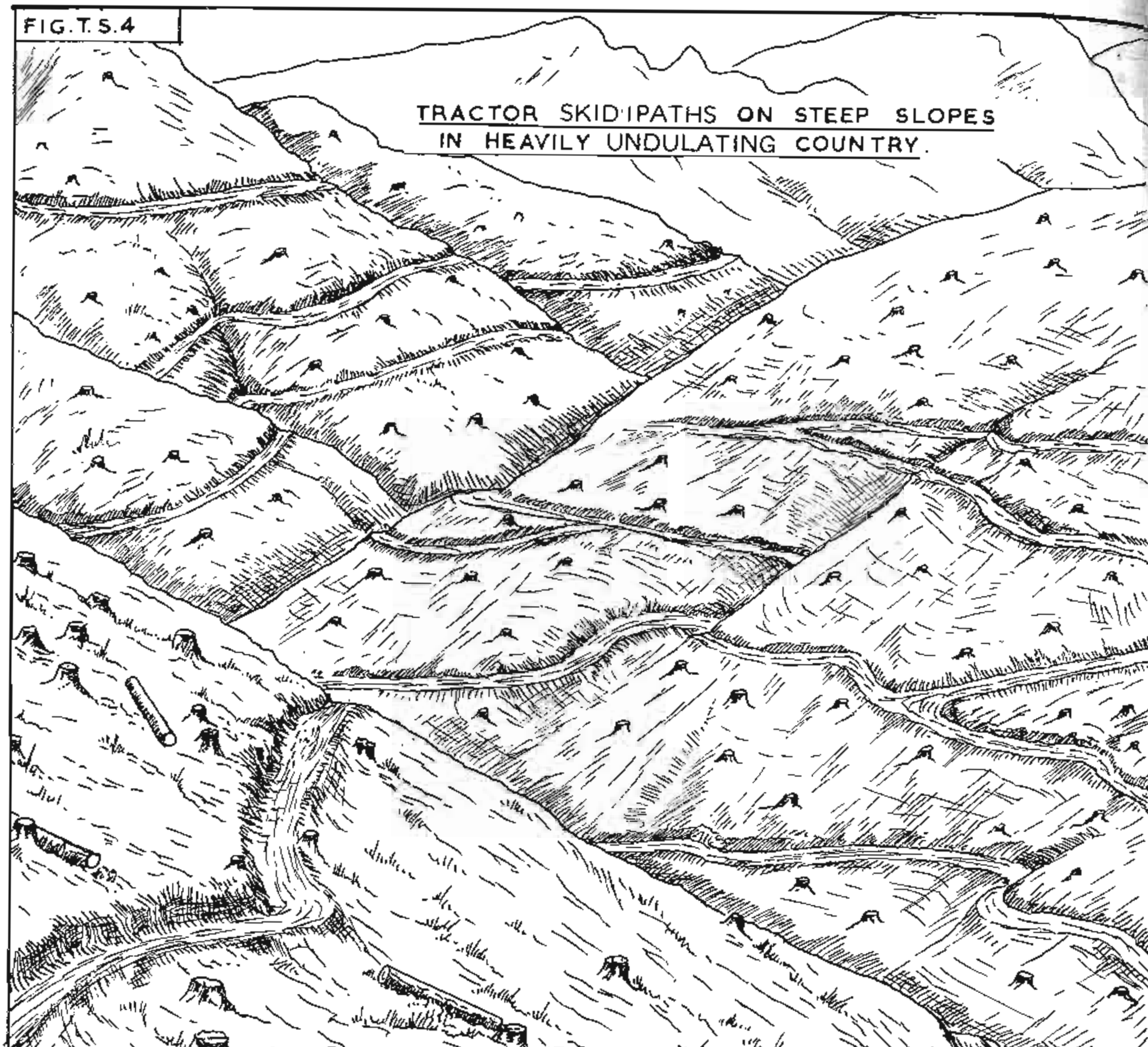


FIG. T. S. 4
TRACTOR SKID PATHS ON STEEP SLOPES
IN HEAVILY UNDULATING COUNTRY.

VARIOUS METHODS OF PRECHOKING LOGS WITH CHOKER SLING ASSEMBLY.

FIG.T.S.5

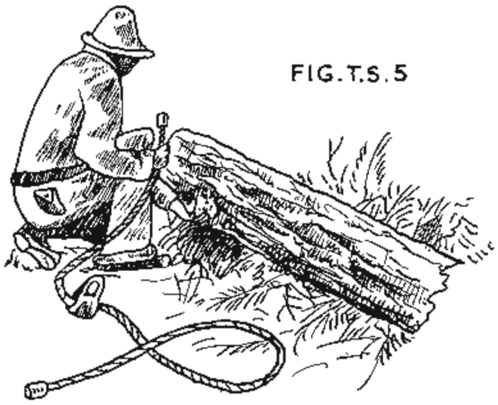


FIG.T.S.6

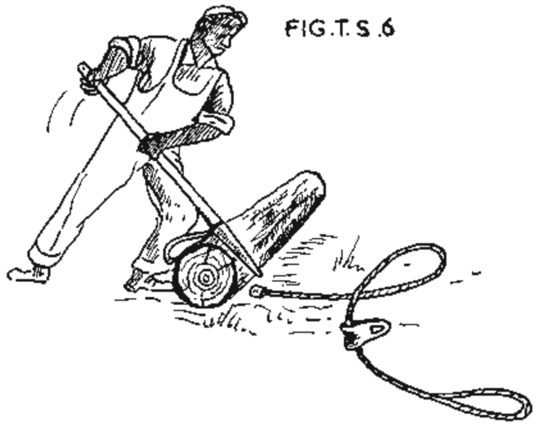


FIG.T.S.7

FIG.T.S.8

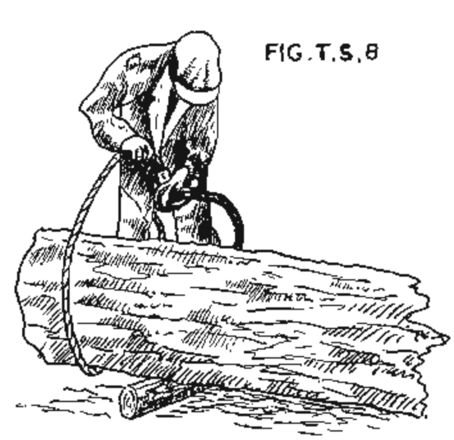


FIG.T.S.9

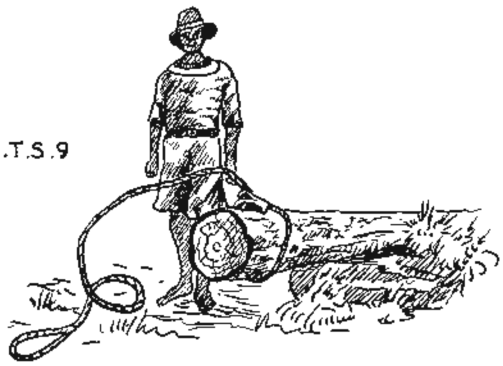
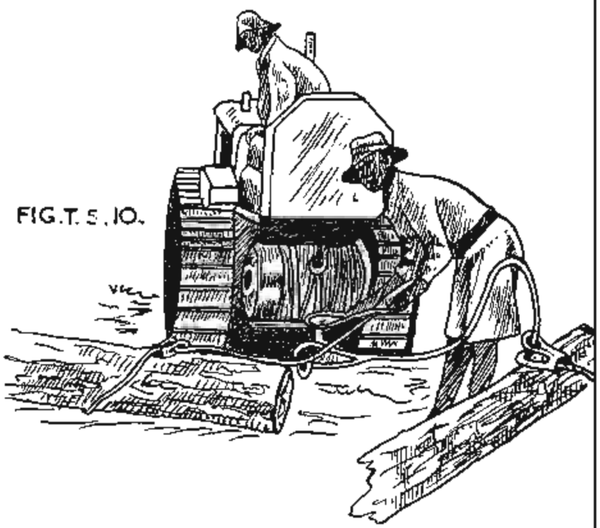


FIG.T.S.10.



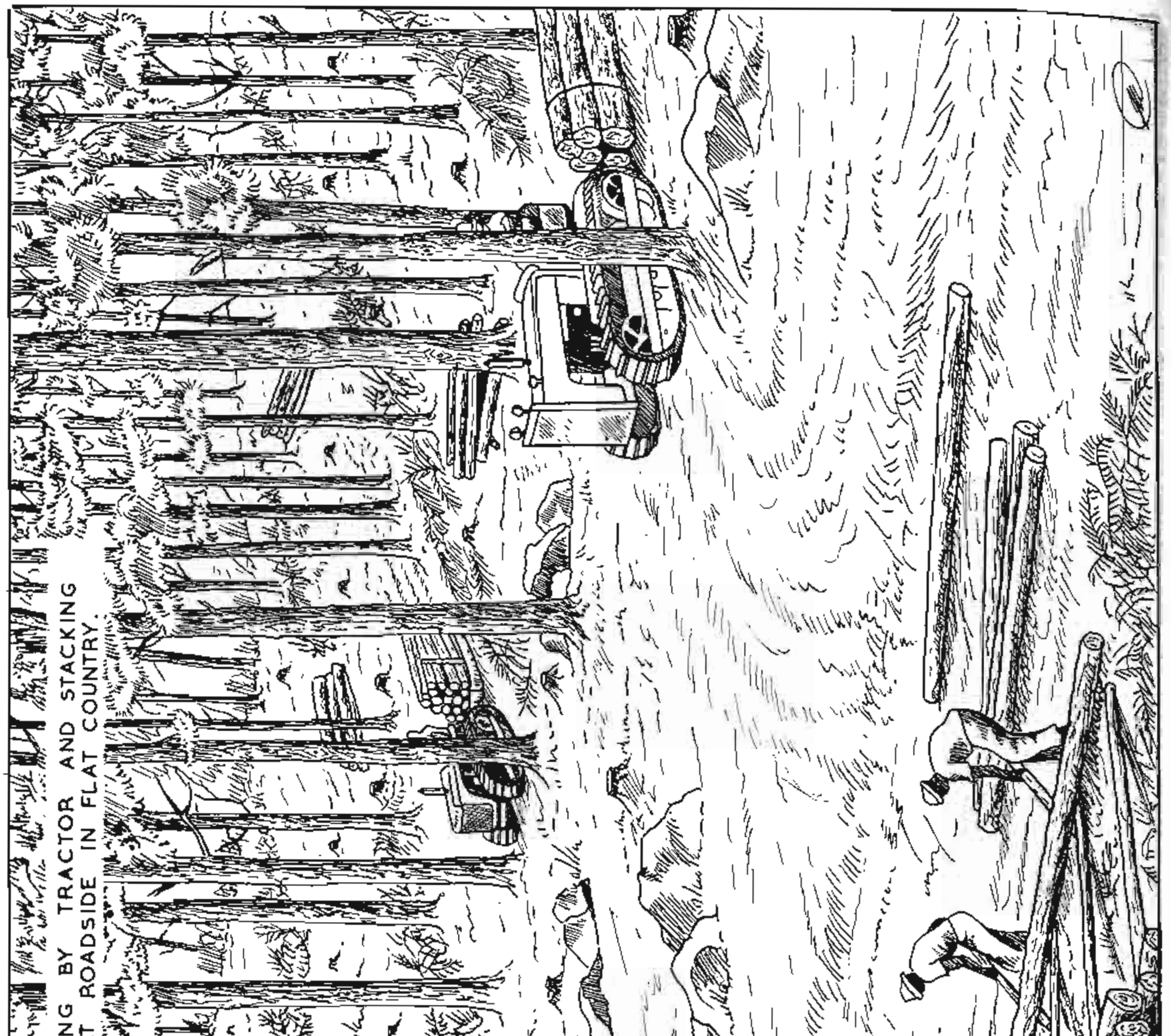


FIG. T.S. 11

SKIDDING BY TRACTOR AND STACKING AT ROADSIDE IN FLAT COUNTRY.

FIG.T.S.12. RELEASING CHOKERS AT THE ROADSIDE.

FIG.T.S.13. BREAKING THE LOAD FOR STACKING.

In summing up the time losses, the following figures reflect the work performance per hour of a team:

A coefficient of 0,85 is considered exceptional
A coefficient of 0,75 is considered to be very good
A coefficient of 0,60 is considered to be fair
A coefficient of 0,50 is considered to be poor

Note: All figures given thus far are those quoted by the Caterpillar Tractor Co.

Time losses for South African departmental working conditions are probably the greatest single factor influencing costs and output for log-skidding operations.

It was observed that in practice the average working tractor is employed for 154 working days per year, thus giving 1600 working hours per year per tractor. Investigation has shown, however, that departmental tractors have an average employment of 800 to 900 working hours per year, or a performance coefficient of between 0,50 and 0,60, which is by no means exceptional for local conditions.

(f) WORKING CAPACITY OF VARIOUS MAKES OF TRACTORS

Various tractor makes were tested under departmental log-skidding conditions to ascertain whether their working capacities were different. The results of the findings were that performances could be regarded as the same for makes of tractors of more or less the same kW, although only on a basis of the actual work performed. Loads and speeds were determined by the terrain and unhooking and hooking times were determined by the labourers employed and not by the tractor make.

3. LOG-SKIDDING OPERATION BY CRAWLER TRACTOR

A. INTRODUCTION

(a) PREPARATORY STEPS TO LOG SKIDDING

Prior to the actual log-skidding operation it is frequently necessary to provide skid paths to facilitate access to the logs by the tractor. In flat or gently rolling areas comparatively free from obstacles it is not necessary to construct skid paths as the tractor develops its own path by repeated trips to and from the logs. Skid paths range from simple clearing of the route by the removal of slash etc. to elaborately excavated slanting skid paths over steep slopes in rough terrain. Care should be taken that skid paths on steep slopes have no sharp turnings which could foul the logs or roll them down the slopes.

Fig. T.S. 4 illustrates the use of skid paths on steep slopes with short "V"-shaped tributary valleys. The area was not suitable for the construction of branch lorry logging tracks with convenient log-stacking and loading decks, so the skid path scheme was developed to skid timber to an existing road not shown in the illustration.

Such an elaborate system of skid paths is the exception rather than the rule in the Department.

Note: Skid paths are usually constructed after the trees have been felled, but correct and systematic felling is in itself a preparatory step to log skidding.

(b) PRECHOKING OF LOGS

Fig. T.S. 5, 6, 7, 8 illustrate various methods which can be employed for prechoking logs.

Fig. T.S. 5	: Digging a hole under the log by means of a short stick.
Fig. T.S. 6	: Rolling the log over the choker by means of a peavy hook.
Fig. T.S. 7, 8	: Rolling the log onto a cross-stick by means of a peavy hook, thus facilitating choking by the choker men.
Fig. T.S. 9, 10	: The log choked and then hooked to the tractor drawbar hook.

(c) SKIDDING

A number of methods is employed to skid logs by towing tractors:

(1) Tractor with chokers
(2) Tractor with winch plus chokers
(3) Tractor with sledge
(4) Tractor with logging pan
(5) Tractor with sulky
(6) Tractor with integral arch
(7) Tractor with "dolly" arch.

The first three of the above methods are mainly employed for log skidding in the Department.

Fig. T.S. 11 illustrates a typical departmental log-skidding operation in flat country for 2nd and 3rd thinnings (dependent on the species), showing prestacked choker-sized loads on cross-sticks, log skidding by tractor with chokers and tractor with sledge, and the method of log stacking at the roadside.

(d) UNHOOKING LOGS AT THE ROADSIDE

(1) Fig. T.S. 12 illustrates the process of removing chokers from logs that have been delivered to the roadside. The logs are invariably squeezed tightly together and some of the choker hooks sometimes are underneath the log heads and difficult to reach. The best solution to the problem is to undo the accessible chokers, then pull the remaining logs to the following stack. As there will

FIG.T.S.14 LOGS UNHOOKED AND LOOSENED.

FIG.T.S.15 ROLLING TO ROADSIDE USING HAND SPARS.

be less logs they will be easier to undo, or roll aside in order to reach the chokers.

The method described above is not always practicable as logs are often sorted according to length and the cumbersome method of rolling the logs aside has to be applied in order to expose the choker hooks. In this case the tractor should reverse slightly in order to slacken the choker slings for easier handling.

(2) Fig. T.S. 13 illustrates how the logs free of their slings are moved to provide access to the chokers of the remaining logs.

(3) Fig. T.S. 14 shows the logs positioned side by side on the landing ready to be rolled to the roadside for loading onto the lorry. Note the tractor leaving with chokers.

(4) Fig. T.S. 15 shows the last of the logs being rolled to the roadside.

General note: The labourers used hand spars in this operation, but peavy hooks would be more suitable for logs with a greater mass.

(e) STACKING

Logs are sorted and stacked in length classes one or more lorry loads per stack. The advantage of this method of stacking is that the lorry need only move once, or at the utmost twice, and a load of specific lengths can quickly be obtained. Loading is tidy and to full capacity. Off-loading at the sawmill is quick and orderly.

Logs should be loaded so that the greatest mass is over the drive wheels i.e. butts to the rear of the rigid bed trucks and forward for articulated vehicles.

Logs are usually stacked by labourers equipped with hand spars or peavy hooks and the logs are rolled onto the stack up skid spars. On occasions log-skidding tractors equipped with bulldozer blades assist with log stacking.

(f) COST OF OWNING A 26kW TO 33kW TRACTOR

Appendix T.S. 13 gives full details of the costs of owning a 26 to 33 kW tractor suitable for log skidding. It may suffice here to state that the cost of owning a log-skidding tractor with standard rig amounts to 176c per hour worked.

(g) TRACTOR STANDARD RIG (Fig. T.S. 65)

Specifications of the standard tractor rig are given in Appendix T.S. 14.

B. DEPARTMENTAL LOG SKIDDING

(a) DEPARTMENTAL NORMS: CRAWLER TRACTOR WITH CHOKERS

Departmental skidding norms have been established for tractor ground skidding with chokers over a firm forest floor, using tractors of the 26 to 33 kW power class.

See Appendix T.S. 1, Table T.S. 9 for daily volumes to be skidded over various distances, times allowed per load, moved to landing. The table also indicates allowances made, times used and the average load sizes for average skidding conditions.

(b) CONDITIONS FOR ACHIEVING PRESCRIBED NORMS

(1) Use tractors of the 26 to 33 kW power class; i.e. D. 2 Caterpillar tractor, B.T.D. 6 International Harvester, or Fiat O.M.

(2) Auxiliary equipment with the tractor:

10 choker assemblies; 5 with tractor, 5 for advance choking.
Tractor drawbar hook.

(3) Eighteen degrees is the maximum gradient for the tractor operation.

(4) Loads of 1, 7m^3 are skidded with comparative ease on down-slopes, over level ground and up to 5^o uphill, and loads of 1,1m^3 uphill to 10^o.

(5) The load width should not exceed 2, 5 metres.

(6) The following routine of slipping is suggested:

(i) Downhill, 0-18^o and uphill 0-10^o for 2nd thinnings, and 0-5^o uphill for third tinnings. All long logs of 3 metres and over are to be skidded by tractors using chokers. The average load should be 10 logs for 3rd thinnings and 12 logs for 2nd thinnings.

(ii) Downhill 0-18^o and uphill 0-5^o for normal clearfellings. The average number of logs per load should be 5, made up of long and short logs, which should, however, be stacked separately.

(7) In order to achieve the allowed times per load and skid the daily volumes, set out in Table T.C. 9 within two thirds of the working day, the tractor team must consist of the following:

1 European tractor operator.
8 Bantu labourers for thinnings and 9 for clearfellings.

The duties of the tractor team are set out in Appendix T.S. 2, Table T.S. 10.

(8) Servicing the tractor: The times which should be allowed for servicing are set out in Appendix T.S. 3, Table T.S. 11.

(9) An example of the tractor idle time sheet is given in Appendix T.S. 4, Table T.S. 12.

(c) APPLICATION OF THE SCHEME

(1) The tractor operator must complete the production and idle time sheets daily.

(2) The tractor team must skid the volume prescribed in Table T.S. 9 daily. Where skidding is done to different stacks with different skidding

distances, allowed times should be calculated for the volumes skidded to each stack.

(3) The average skidding distance is determined as follows:

Measurements are taken at right angles to the road or in natural skidding direction:

(i) From the stack to the nearest load.
(ii) From the stack to the furthest load.

The operator then determines the average skidding distance between (i) and (ii).

(4) By multiplying the number of logs skidded by the average volume per log, the operator can determine the percentage of the daily task achieved.

Note: The volume of the average log can be ascertained from the felling and cross-cutting tests

(5) The forester or his authorised representative should check the operator's work at least every third day.

(6) Idle time must be given if logs are not skidded, but the forester must decide whether idle time is justified.

(7) The following idle times are permissible: (see Table T.S. 12).

(i) Time lost due to mechanical defects.
(ii) Time lost due to rain.
(iii) An allowance of 12 minutes per kilometre is made for time lost when moving from compartment to compartment.
(iv) Time lost when the tractor is employed in pulling down lodged trees.
(v) Time lost during servicing (Table T.S. 11).
(vi) Time lost during inspections by company representatives. Actual watch times are allowed for cases (i), (ii), (iv) and (vi).

(d) TRACTOR LOADS, NORMAL DISTRIBUTION OF THE NUMBER OF LOGS IN THE LOAD

The following figures from log-skidding tests indicate the percentage of the number of logs comprising a load.

2nd thinnings - Pinus elliottii

(i)	12 logs per load	85%	
(ii)	8 logs per load	9%	Average: 11,5
(iii)	5 logs per load	5%	logs per load
(iv)	3 logs per load	1%	

3rd Thinnings - Pinus taeda

(i)	12 logs per load	29%	
(ii)	8 logs per load	24,5%	
(iii)	5 logs per load	26,8%	Average: 7 logs
(iv)	3 logs per load	14,8%	per load
(v)	2 logs per load	4,2%	
(vi)	1 log per load	0,7%	

Clear felling - Pinus patula

(i)	12 logs per load	18,5%	
(ii)	8 logs per load	13,4%	
(iii)	5 logs per load	20,6%	Average: 5,5
(iv)	3 logs per load	27,8%	logs per load
(v)	2 logs per load	15,4%	
(vi)	1 log per load	4,3%	

(e) PERFORMANCE OF DEPARTMENTAL CRAWLER TRACTORS

(Before the establishment of the efficiency scheme).

Observations made during 12 trips by a towing tractor in log-skidding operations revealed the following:

(1) The tractor moved slower over short distances than over longer distances, i.e.

30 metres	1,3 seconds per metre
60 metres	1,0 seconds per metre
125 metres	0,9 seconds per metre
300 metres	0,6 seconds per metre
466 metres	0,6 seconds per metre

This is explained by the fact that the same skid path is used more often and consequently becomes wider and more accessible with each succeeding trip, thus permitting a faster run as the distance increases.

Note: The average speed of the tractor in motion was 3,2 km/h

(2) The daily distance run by the tractor increases as the skidding distance increases. The following distances were covered daily over the given average distances:

60 metres	3,86 km/day
110 metres	8,0 km/day
300 metres	11,3 km/day
466 metres	11,9 km/day

It is obvious that the daily distance covered is very irregular and cannot be used as a basis for any calculation.

(3) The following time percentage distribution was noted over an average skidding distance of 180 metres.

(i)	From the roadside to the logs	26%	
(ii)	In motion with the load	27%	
(iii)	Hooking and slinging logs	19%	
(iv)	Unhooking	12%	
(v)	Assembling the load (4 loads only)	6%	(Actually 28% for the few trips observed)
(vi)	Delay	10%	
	Total	100%	

Note: The total time in motion was 53%

(4) The average trip duration over a distance of 180 metres was 8 minutes 48 seconds.

(5) The average number of logs per load was 4.

FIG.T.S.16

SKIDDING TREE LENGTHS AND CROSSCUTTING AND STACKING AT ROADSIDE.

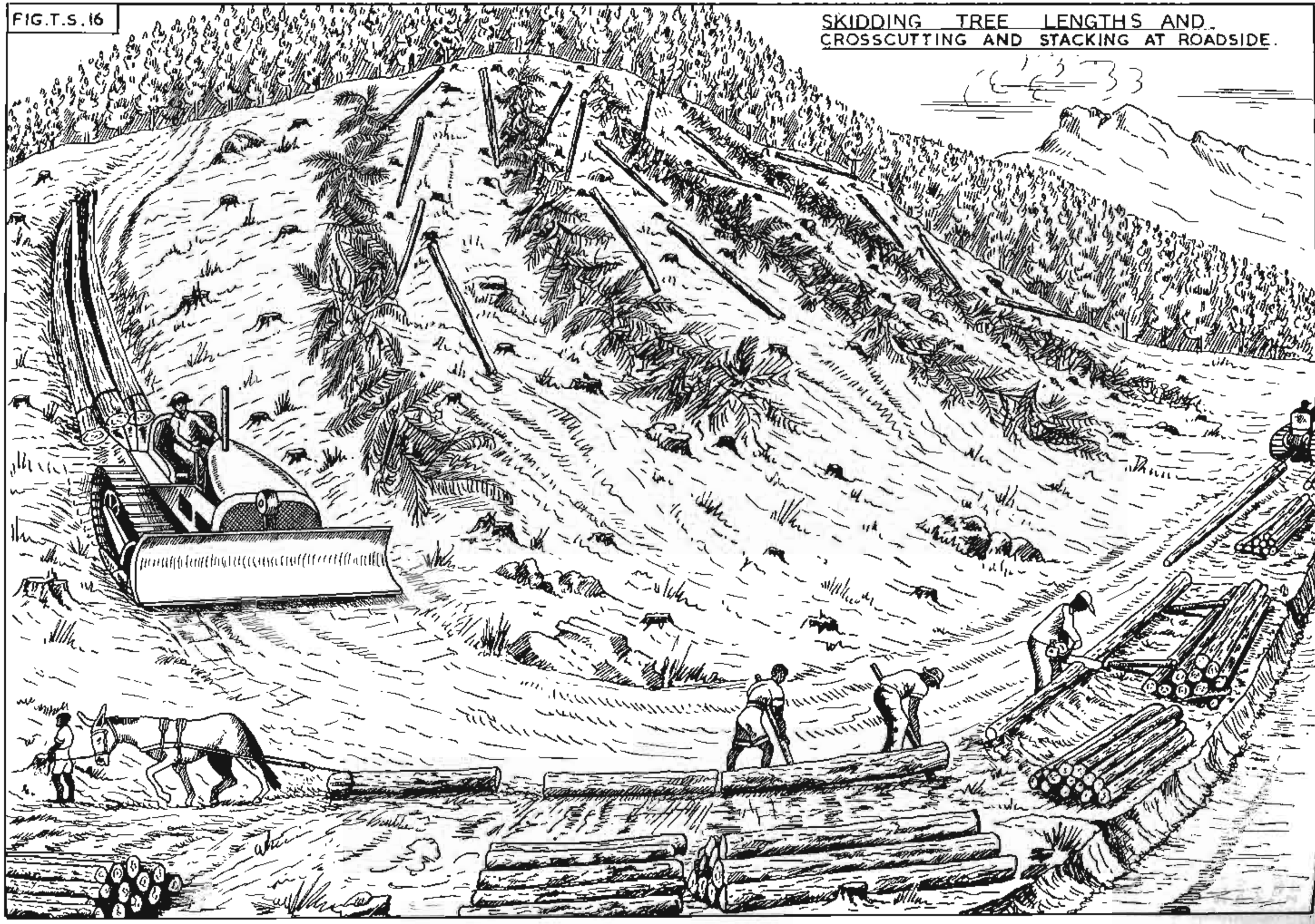


FIG.T.S.17 DISPOSAL AND CROSSCUTTING OF TREES AT A LIMITED LANDING.

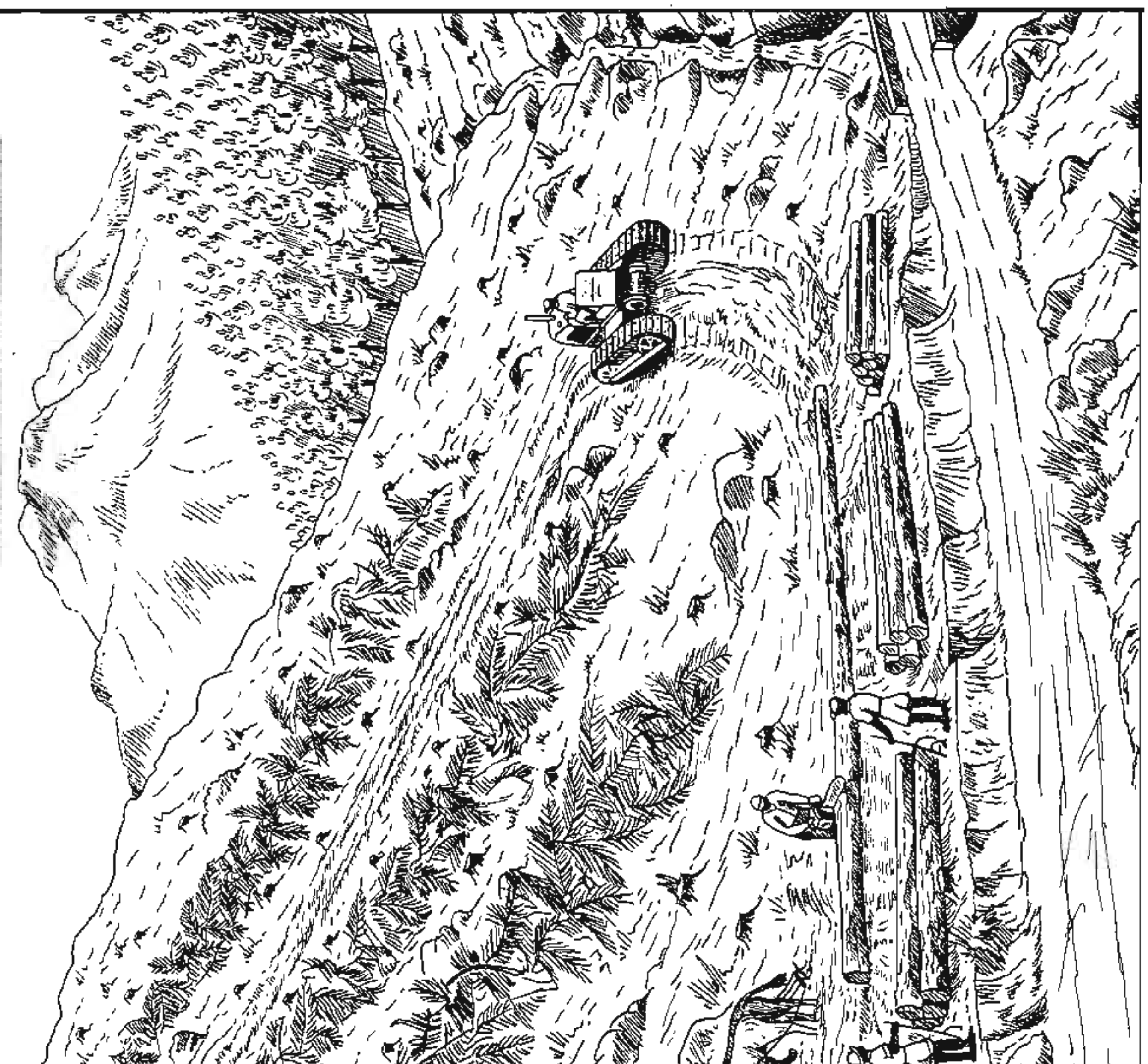


FIG.T.S.18 APPLICATION OF CROTCH AND TRAILER GRAB.

FIG.T.S.19 SIMULTANEOUS USE OF TRACTOR DRAWBAR AND WINCH CABLE FOR SKIDDING SMALL LOGS.

CROTCH AND TRAILER GRABS

FIG. T.S. 20

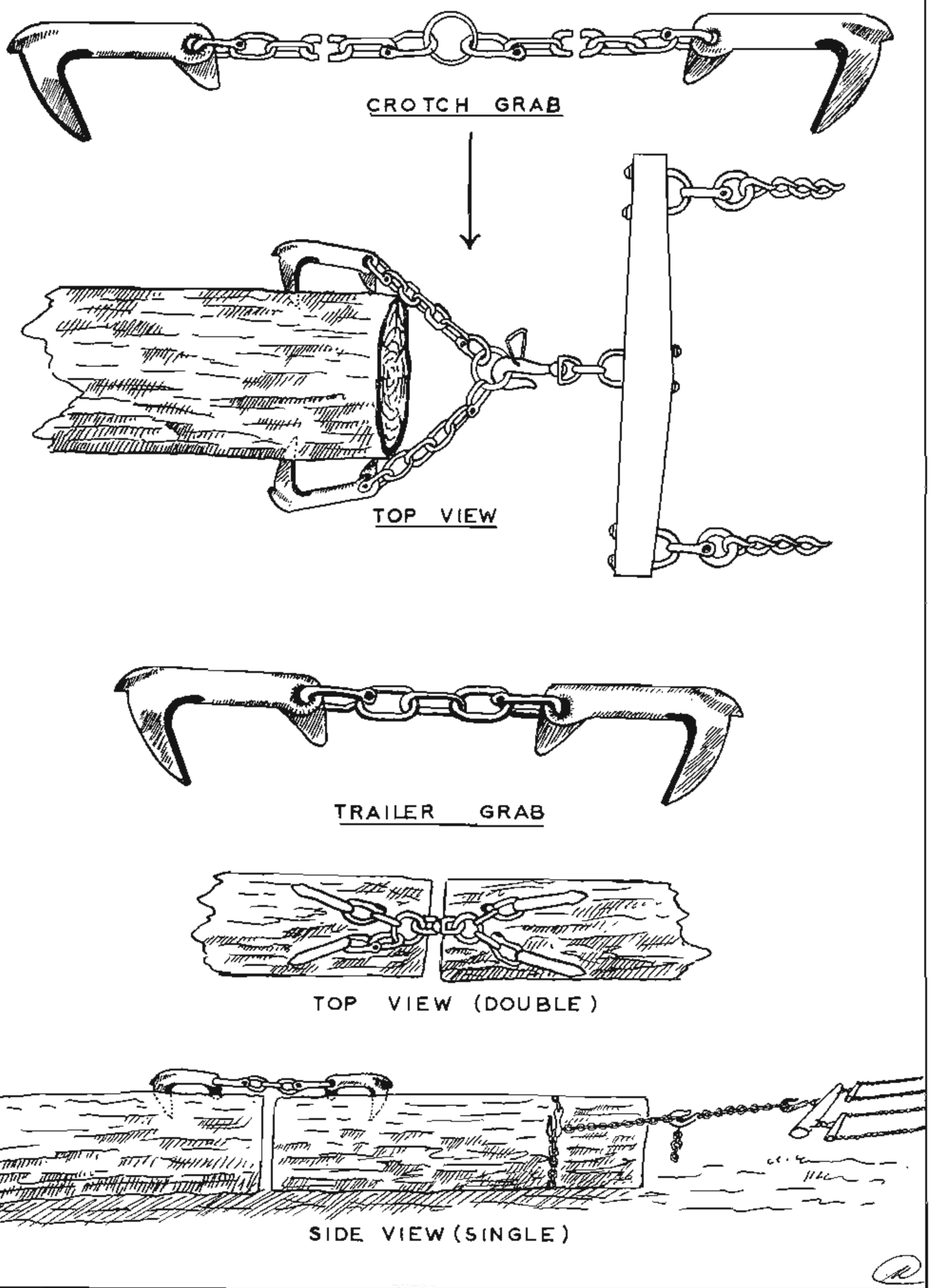
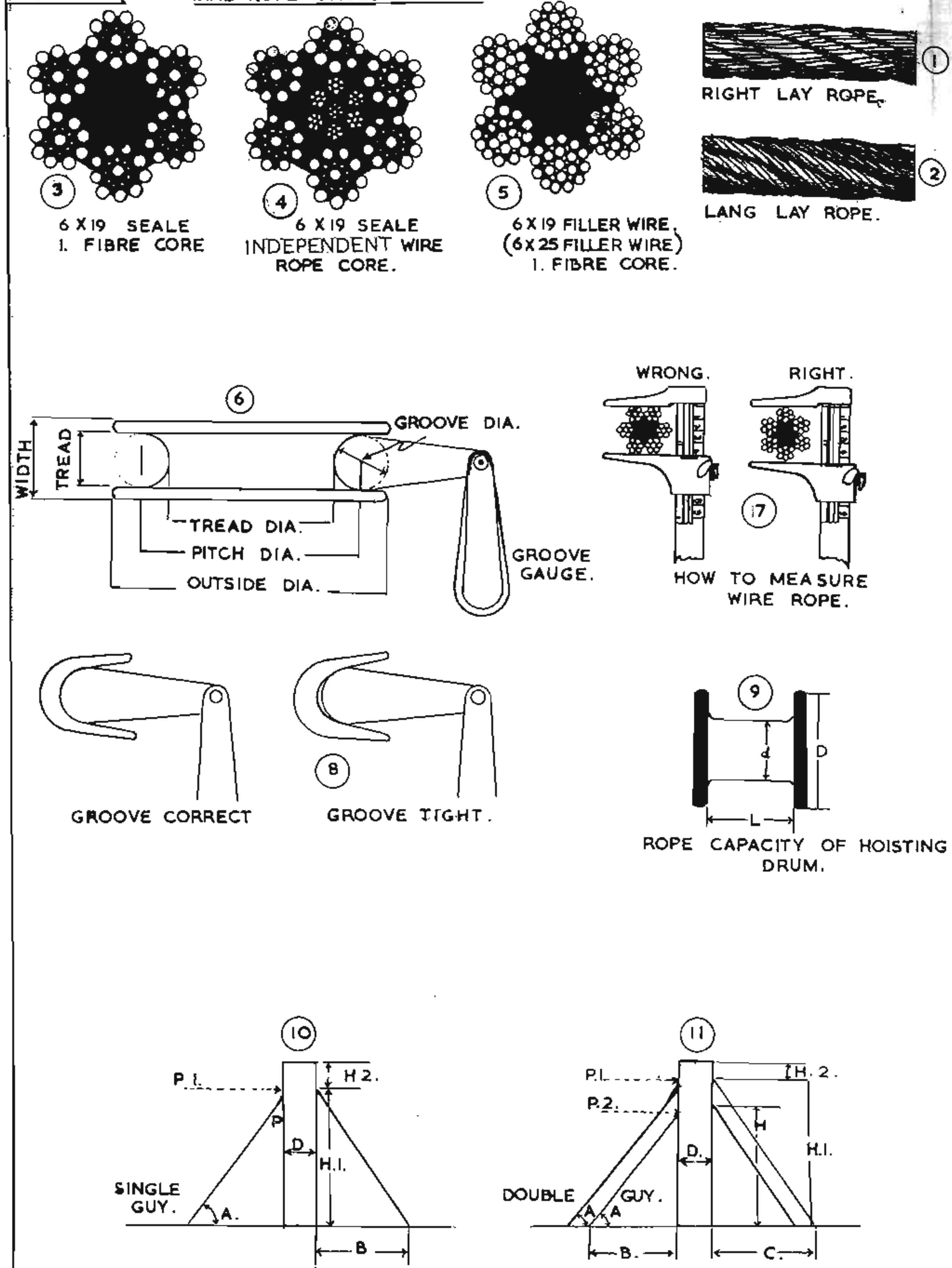


FIG. T. S. 21 WIRE ROPE CROSS SECTIONS.



STRESSES IN STACK GUYS.

(6) The average volume per load was $0{,}78m^3$.

(7) The average number of trips per day was 65.

(8) Average output per day: $45m^3$.

(9) Labour with the tractor:

1 European tractor operator.
2 Bantu slinging and hooking.
3 Bantu unchaining and stacking.

(f) SKIDDING TREE LENGTH BY CRAWLER TRACTOR AND CHOKERS

Whenever possible crawler tractors with chokers should skid tree length in preference to skidding logs, especially for longer distances, as this operation has the following advantages:

(1) Twenty per cent more volume can be skidded with tree length than is the case with log skidding.

(2) The labour force required for slinging and hooking logs can be reduced by 75%. The operation is, however, not always possible for the following reasons:

(i) Tree lengths are frequently subject to damage and "fouling up" as the tractor manoeuvres between obstacles.

(ii) There is not always a suitable site at the roadside for locating a landing, loading and stacking deck which can accommodate tree lengths.

(iii) Cross-cutting tree length at the roadside after skidding requires additional labour, organisation and planning, as well as ample space for log swinging sorting and stacking. The Department does not transport tree length, but if this were done the following problems would be encountered:

(iv) The permanent cableways available in the Department can only accommodate medium-sized logs.

(v) Roads are narrow, for the most part, and their curves often of such small radius that the long semi-trailers used for transporting tree length cannot always be accommodated.

(vi) Some plantations direct their logs of different diameters to different sawmills, which would not be possible if tree lengths were to be loaded and transported.

(vii) No cross-cutting facilities are available at the sawmill off-loading decks.

(viii) Should cross-cutting be done at the sawmill off-loading decks, there will be an undesirable accumulation of waste off cuts which will require additional labour and time for removal.

Fig. T.S. 16 and 17 illustrate the skidding of tree lengths by crawler tractor.

For a comparison between skidding logs and tree lengths see Table T.S. 13, Appendix T.S. 5.

(g) SPECIAL CASES

Fig. T.S. 18 and 19 illustrate two special cases of log skidding by towing tractor:

Fig. T.S. 18 shows towing of medium-sized logs in tandem by winch, using the trailer grab assembly with swivels. This method is employed where a number of obstacles prevents the logs from being pulled side by side with chokers, but the winch can accommodate a load of more than one log at a time.

Fig. T.S. 20 gives further details of the trailer grab.

Fig. T.S. 19 shows two lots of small logs being towed in tandem in a number of choker-sized loads, the front lot being hooked to the tractor drawbar hook and the rear lot being hooked to the winch drum cable hook.

This method is applied where the width of the skid path in thinnings prevents towing of wider loads, but the load size is well below the tractor capacity. The method illustrated can be employed in 2nd thinnings for fast-growing species and in 3rd thinnings for slow-growing species.

C. LOG SKIDDING BY CRAWLER TRACTOR AND WINCH

(a) THE WINCH

Towing winches are mounted on crawler tractors to give them greater versatility and mobility. A good tractor winch should be:

(1) Rear mounted, reversible, or non-reversible if required, single speed, direct gear driven and with an over- or underwinding drum. The drum should be free spooling.

(2) Conveniently mounted, i.e. deeply set between the tracks and located as low as practically possible so as to be able to operate with maximum efficiency under all conditions. A difference of a few centimetres in the height of a winch mounting can have a marked effect on the tractor performance in logging operations. When the cable on the winch drum is underwound its pull should be level with the regular tractor drawbar. This will ensure that the tractor is well balanced and always in full grip with the ground.

(3) Easily controlled, with all winch levers within easy reach from the operator's seat.

(4) Able to develop a desirable pull under the required load.

Note: The winch is powered by the tractor power take-off

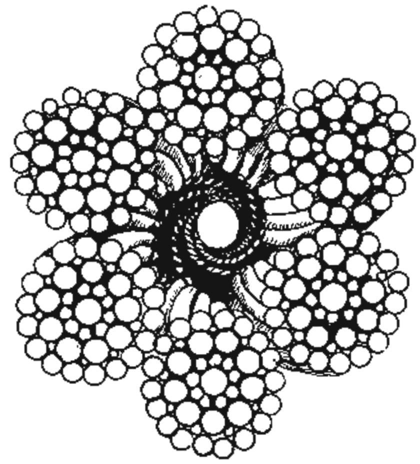
Specification: See Appendix T.S. 8.

(b) WIRE ROPE FOR TRACTOR LOGGING WINCH

(Refer to illustrations, Fig. T.S. 21, items 1, 2, 3, 4).

Wire rope is one of the most important items in modern logging operations. Of all the qualities which are required in a good logging rope, ruggedness and toughness are the most essential.

FIG. T.S.22



VIEW OF CROSS SECTION AND INSIDE OF WIRE ROPE.
6 X 46 FILLER WIRE.

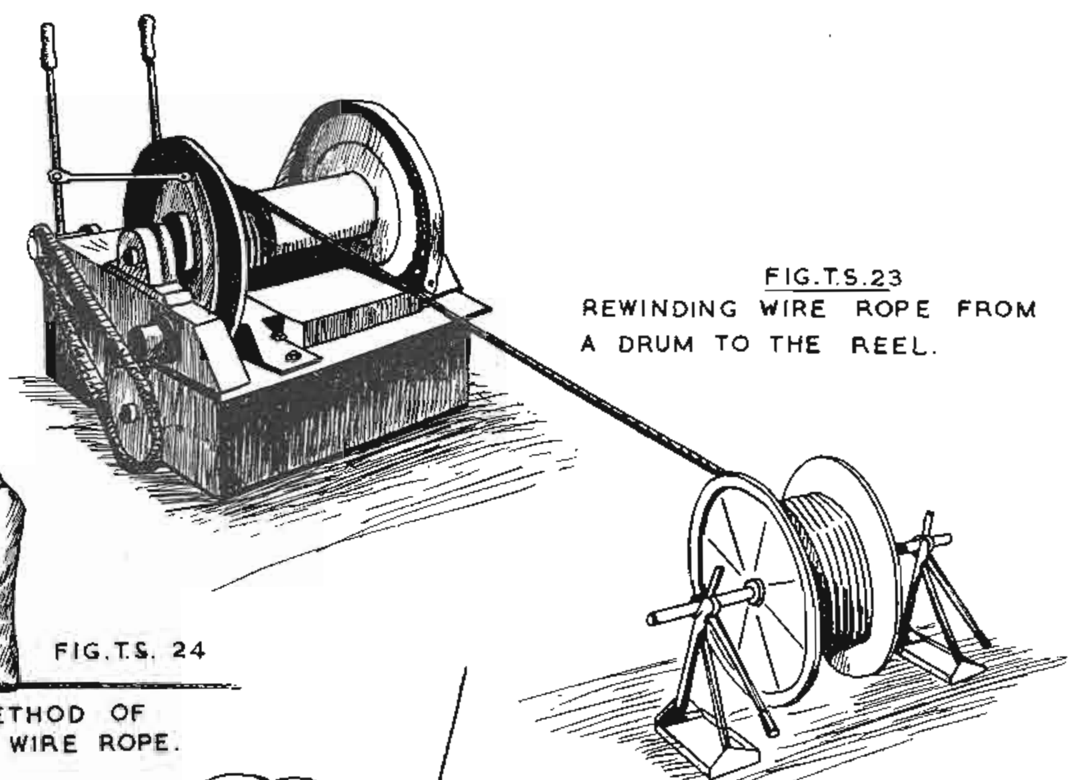
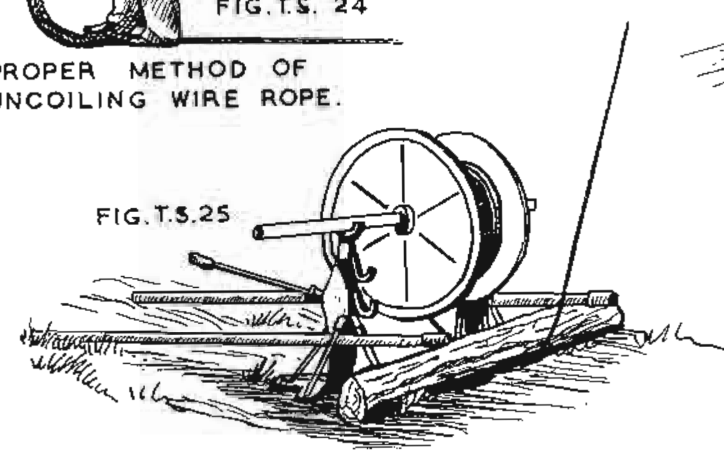


FIG. T.S.23
REWINDING WIRE ROPE FROM A DRUM TO THE REEL.

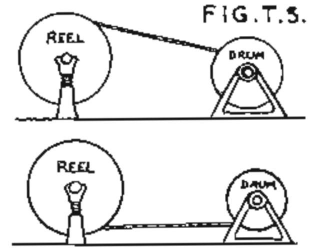
FIG. T.S. 24
PROPER METHOD OF UNCOILING WIRE ROPE.

FIG. T.S.25



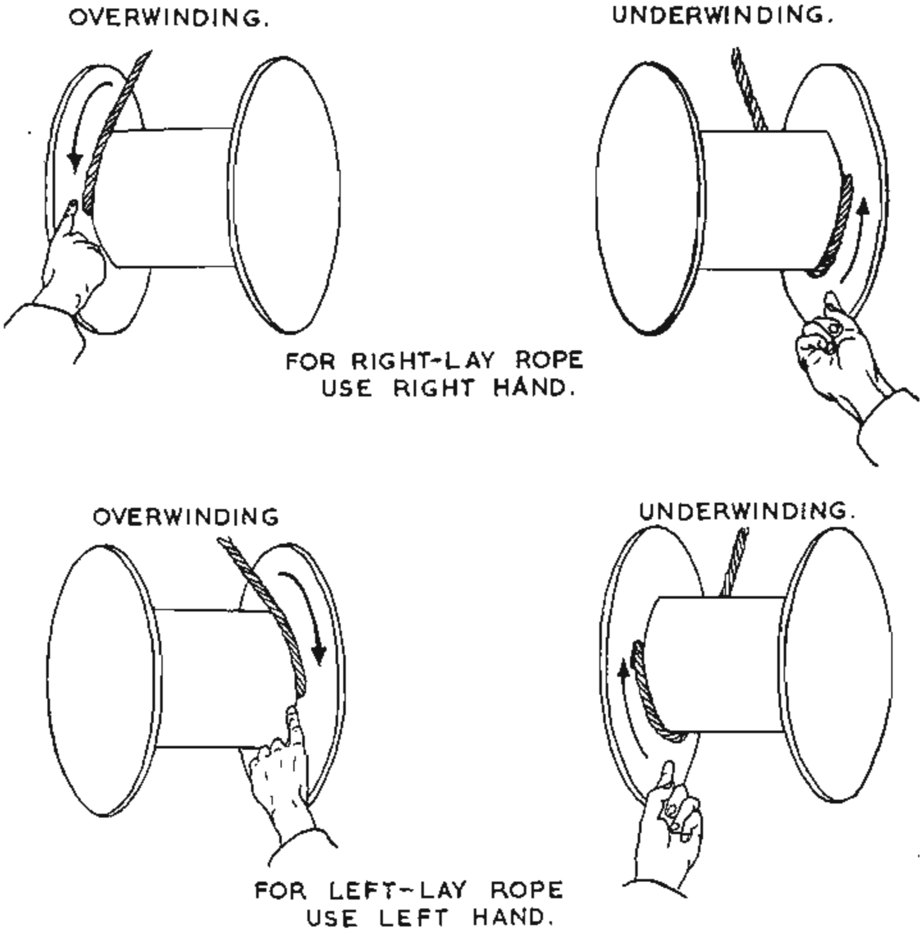
ROPE KEPT TAUT DURING REWINDING BY MEANS OF A LOG AND SPARS.

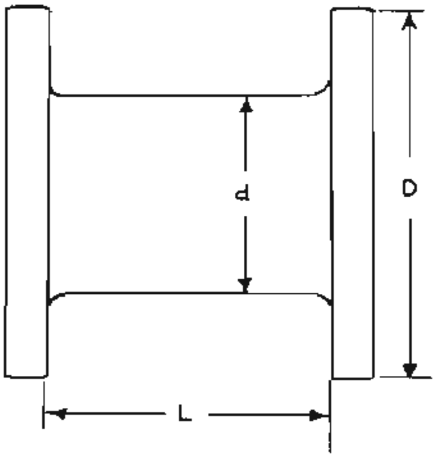
FIG. T.S. 26



RIGHT WAY OF TRANSFERRING ROPE FROM REEL TO DRUM.

FIG. T.S. 27.





TO FIND THE WIRE ROPE FULL CAPACITY OF A DRUM

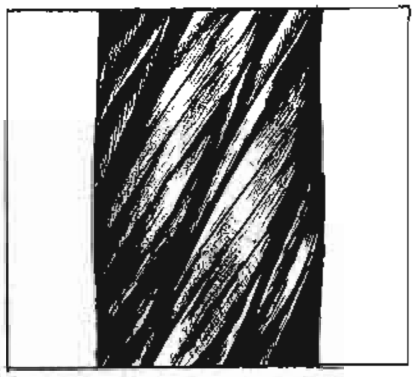
LENGTH OF WIRE ROPE (METRES) THAT A DRUM WILL HOLD $= (D^2 - d^2)\,L\,X$

$D =$ DIAMETER OF FLANGE IN cm
$d =$ DIAMETER OF DRUM IN cm
$L =$ INSIDE WIDTH OF DRUM IN cm
$X =$ ROPE FACTOR - SEE TABLE BELOW

ROPE DIAMETER	ROPE FACTOR	ROPE DIAMETER	ROPE FACTOR
0,6cm	0,018888	1,5cm	0,0031247
0,9cm	0,00866726	1,9cm	0,0021576
1,0cm	0,0063426	2,6cm	0,0012089
1,2cm	0,0048732		

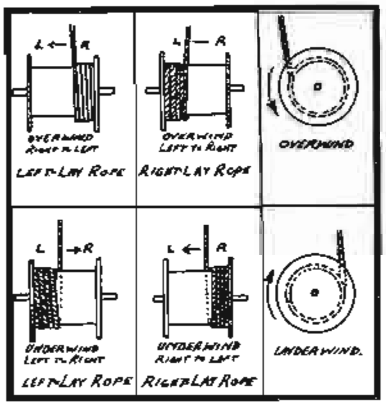
FIG. T.S. 28.

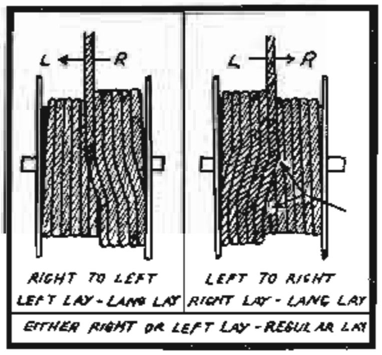
PARTIALLY WORN REGULAR LAY.



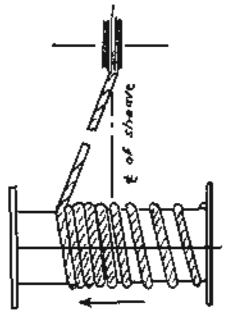
PARTIALLY WORN LANG LAY.

ROPE LAY FOR ONE-LAYER WINDING.

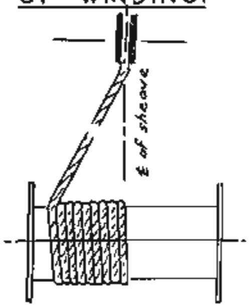




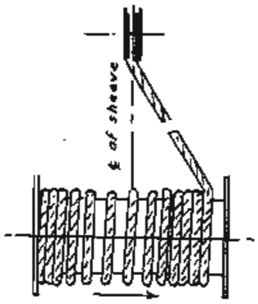
EFFECT OF WINDING ROPES ON DRUMS AS THE RESULT OF DIRECTION OF WINDING.



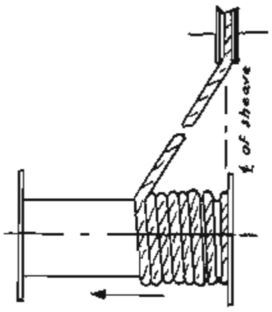
RIGHT TO LEFT OVERWIND.



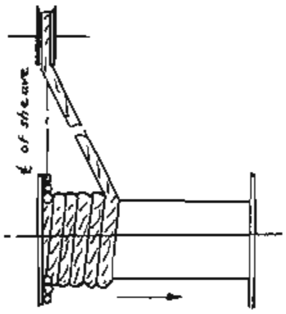
OVERWIND



LEFT TO RIGHT



RIGHT TO LEFT OVERWIND



LEFT TO RIGHT OVERWIND.

In logging, probably more than in any other industry, it is necessary to use ropes best suited to do a particular job. When ordering logging rope it is important that the use to which the rope will be put should be stated where possible, so that a rope particularly designed and built for that purpose can be supplied.

Seal construction is used, i.e. 6 x 19, which is 6 strands of 19 wires each, expressed as "9 x 9 x 1." This construction is most suited to logging operations where the rope is subject to heavy wear, severe crushing loads and excessive shock.

Ordinary, regular or cross lay type of wire rope is used for logging operations. With this type of rope the wires of the strands are laid in one direction and the strands are laid into the rope in the opposite direction.

Preformed wire rope is the next important step in the manufacturing of logging rope. Preformed rope will resist unstranding and reduces internal stresses to the minimum. Ropes made by this process are more easily handled, can be more readily spliced and are less liable to kink.

The core of logging rope is independent wire rope core (I.W.R.C.).

(1) Coiling wire rope

The general rule for coiling wire rope onto a drum is shown in Fig. T.S. 23, 24, 25, 26 and 27.

All ropes should be correctly started on the drum, and the illustration shows how a simple rule can be applied to determine how coiling should commence. Use the doubled up fist to represent the drum and the index finger to represent the flange. For a right-lay rope use the right fist and for a left-lay rope the left fist. Place the back of the hand uppermost for overwinding rope and the palm uppermost for underwinding rope. The index finger then indicates how the rope should lead from the drum and from the flange.

(2) Method of determining maximum load on wire rope

In many applications such as log skidding over uneven ground and rough surfaces it is not possible to accurately estimate the maximum load handled due to the many variables involved. In such cases an approximation may be made by the method set out below.

In order to determine the maximum conditions, the speed at which the rope moves should be determined under the maximum condition of loading.

$$\text{Rope tension} = \frac{1,5 \,.\, \text{kW}}{\text{vc}}$$

Where 1,5 is the factor providing the 50 per cent overload of the motor -

kW - is the power of the motor
vc - is the rope speed of 1 m per second

Example: A winch mounted on a tractor with 30 kW engine, with the rope travelling at a speed of 1 m per second -

$$\text{Rope tension} = \frac{1,5.\ \text{kW}}{\text{vc}} = \frac{1,5.30}{1} = 45\ \text{kN}$$

Note: Special improved plough rope has a breaking load, on 16 mm wire rope, of 16 tons = 150 kN. When tractor power is expressed in kW the resulting rope tension will be expressed in kN.

Specification: See Appendix T.S. 9 for wire-rope specification.

(c) WINCH CABLE HOOK

A 45mm material diameter line hook is attached to the free end of the winch rope by means of a 19 mm or 22 mm bow shackle with screw pin and hexagonal head (see Fig. T.S. 36 and 37).

(d) APPLICATION OF THE TOWING WINCH

The tractor winch is employed when direct towing is either uneconomical or impracticable. The winch is used to pull loads while the tractor is stationary. After the load has been spooled in, the tractor can recommence skidding without any further consideration as to the position of the load. Thus, with a properly designed towing winch, a log winched to the tractor and then hauled to the landing need only be handled once, which is when the log is choked in the compartment.

The towing winch also makes the tractor a more versatile unit. If deep mud or steep slopes are encountered on the skid path the load can be dropped, the tractor moves forward to firmer and easier ground, paying out the rope as it moves. When on a firmer footing the tractor stops, winches in the load, and then resumes skidding.

(e) LOG SKIDDING OPERATION BY TOWING WINCH

(1) POINTS FOR CONSIDERATION

(i) The operator should carefully follow all maintenance and operating instructions.

(ii) The tractor must always be stationary when the winch is in use.

(iii) The tractor should be settled parallel to the line of pull wherever possible so as to minimise rope drag on the drum flanges.

(iv) The rope should not be allowed to build up on one side of the drum but should spool as evenly as possible. This can be accomplished during spooling by releasing the appropriate tractor track brake and slewing the tractor from side to side.

(v) All fixing bolts must be frequently checked and kept tight.

There are two typical winch operations, the first being a single stage operation and the second a two or more stage operation with the same load.

Plantation conditions are not always suitable for a complete single stage operation of pull by the cable. In many cases the skidding distance is partially covered by pulling with the winch and the balance of the distance is completed by towing with the drawbar hook. In the latter case the size

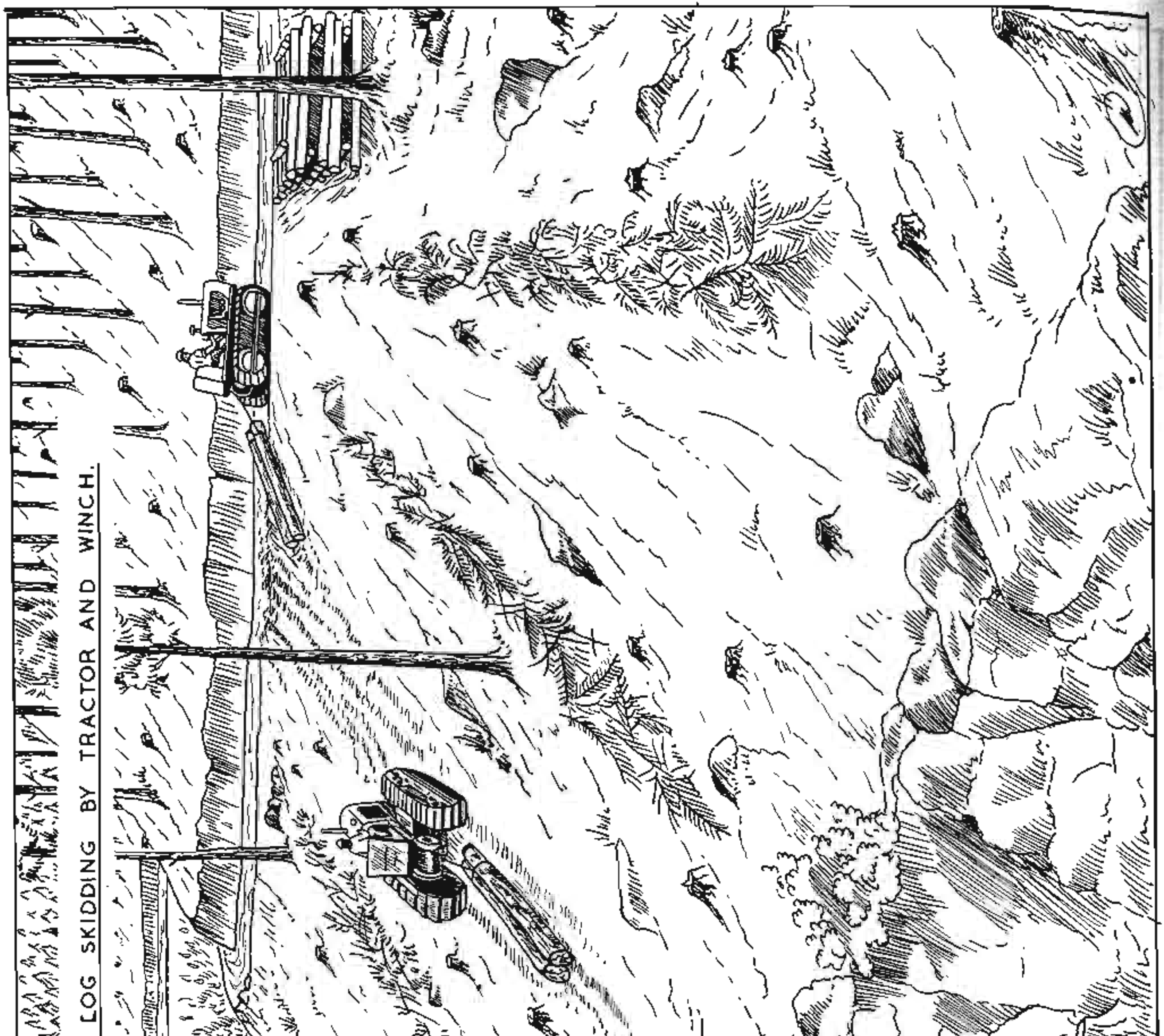


FIG.T.S.29.

TWO STAGE LOG SKIDDING BY TRACTOR AND WINCH.

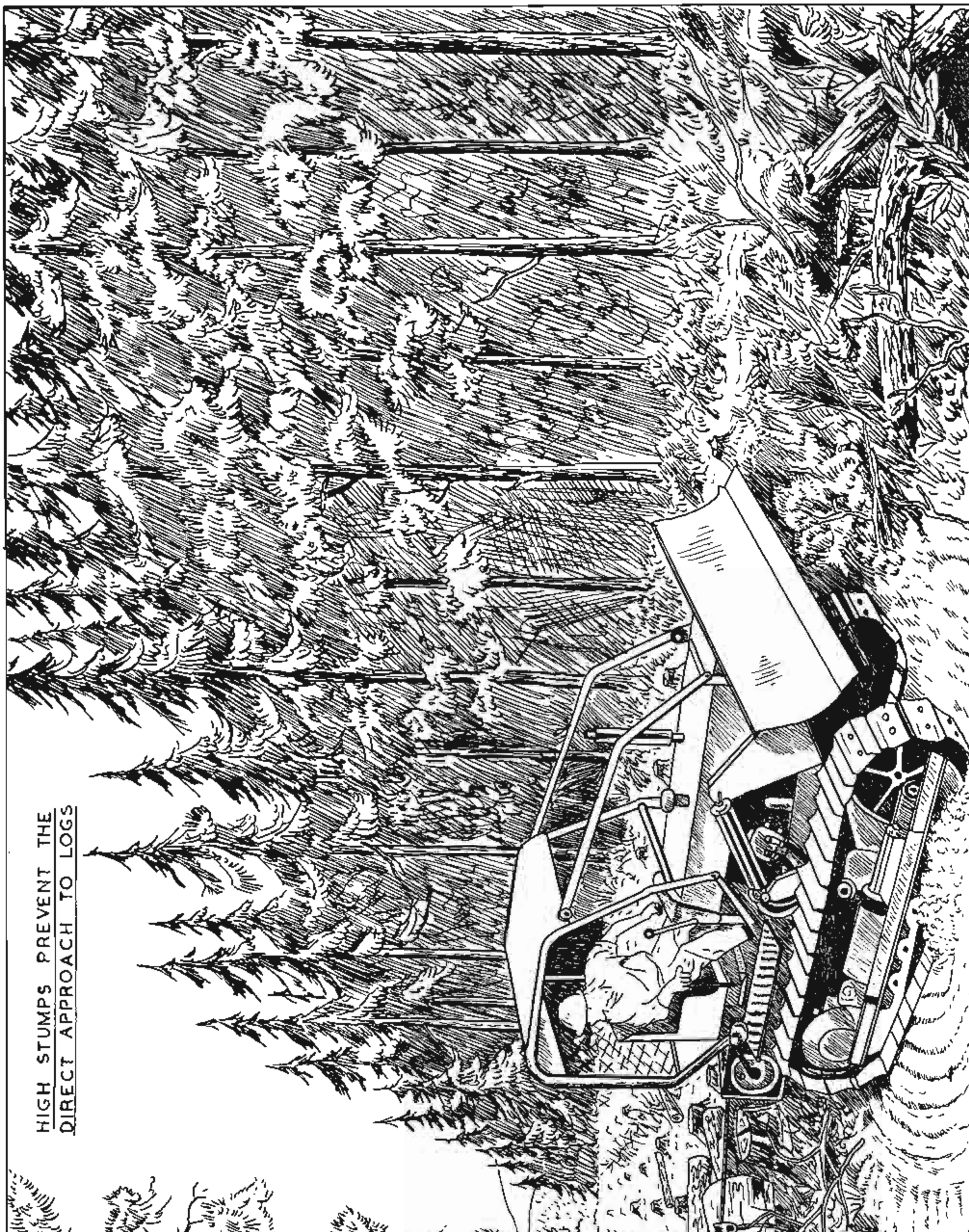


FIG.T.S.30

HIGH STUMPS PREVENT THE DIRECT APPROACH TO LOGS

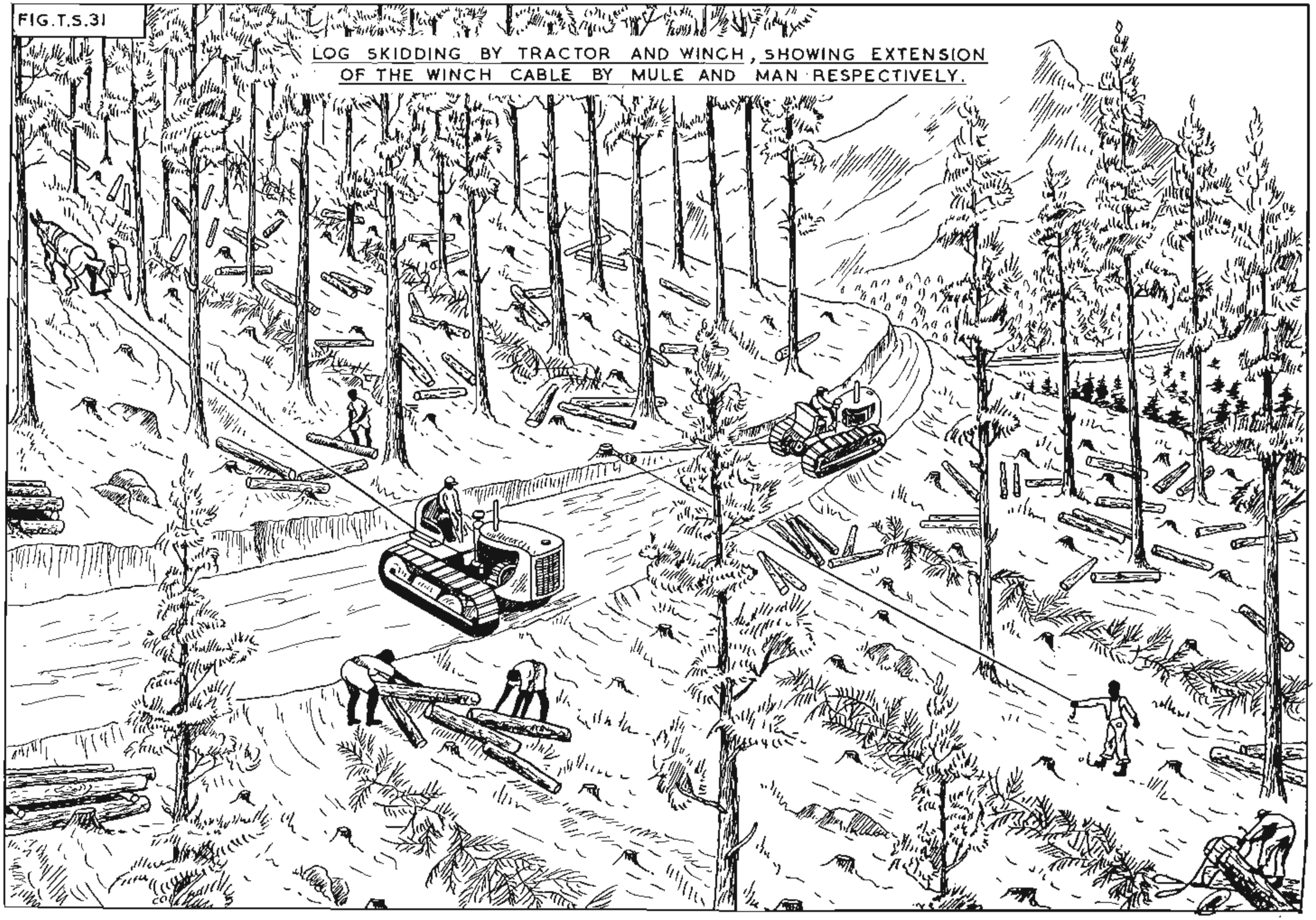


FIG. T.S. 31

LOG SKIDDING BY TRACTOR AND WINCH, SHOWING EXTENSION OF THE WINCH CABLE BY MULE AND MAN RESPECTIVELY.

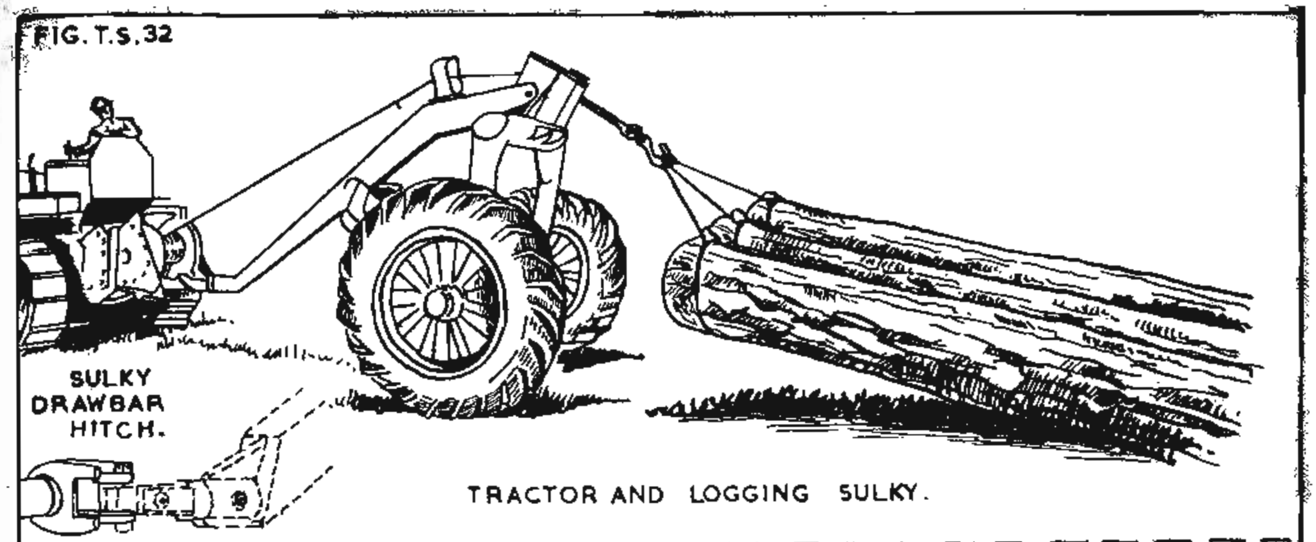


FIG. T.S.32
SULKY
DRAWBAR
HITCH.
TRACTOR AND LOGGING SULKY.

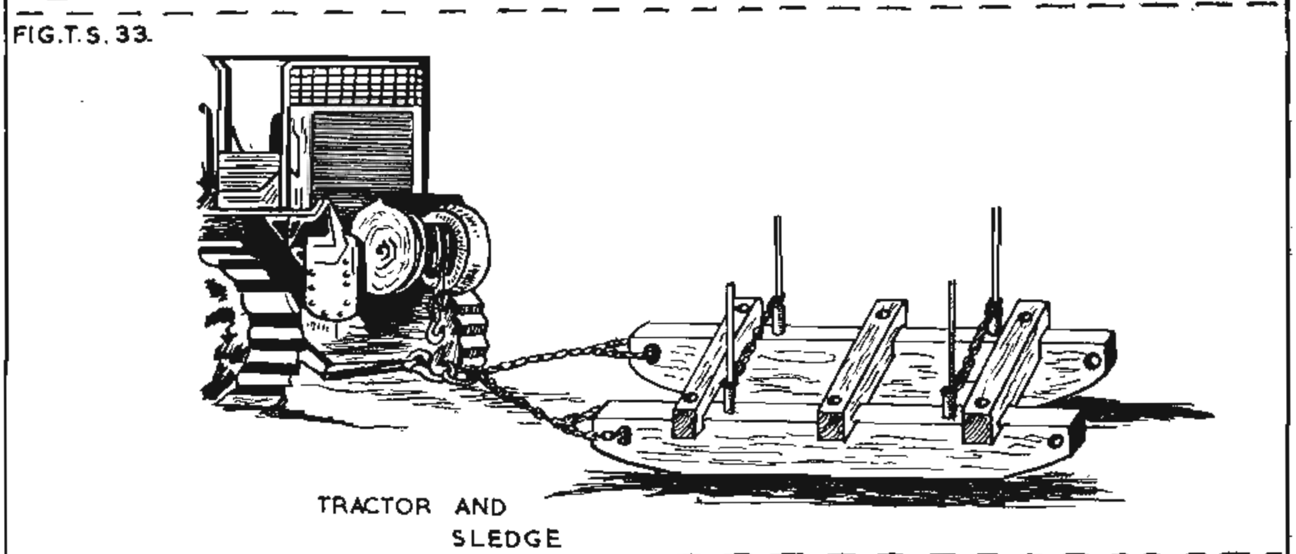


FIG.T.S.33.
TRACTOR AND
SLEDGE

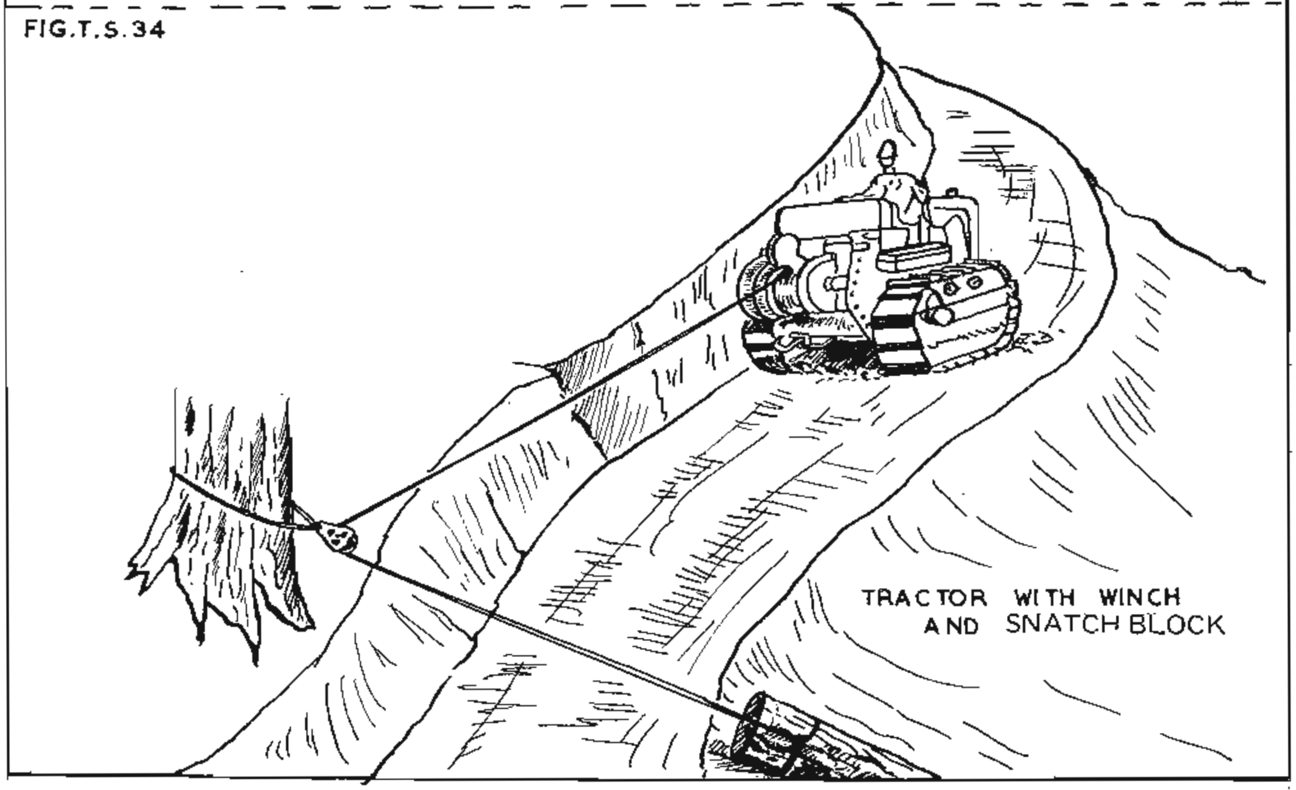
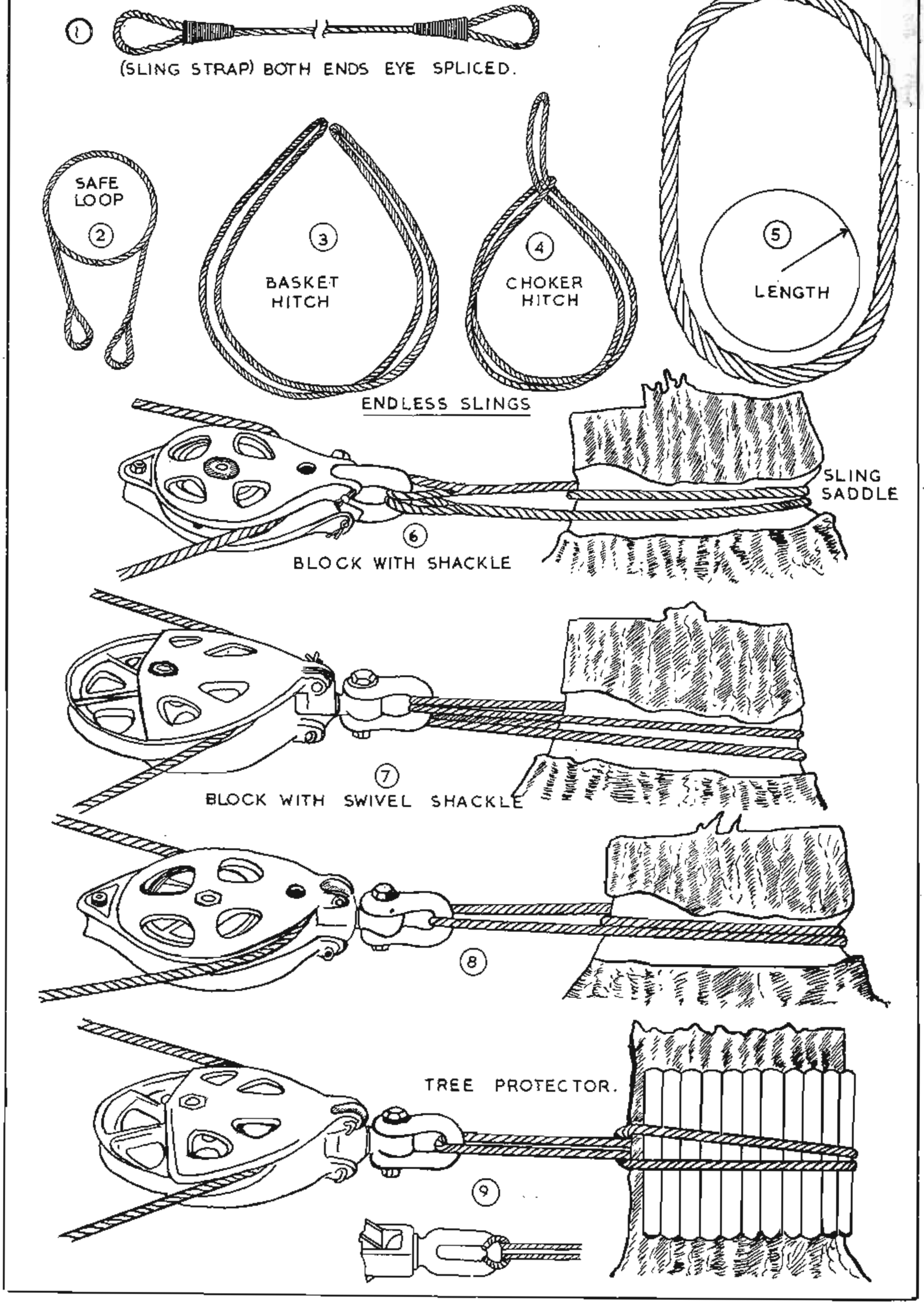


FIG.T.S.34
TRACTOR WITH WINCH
AND SNATCH BLOCK

FIG. T. S. 35



TRACTOR BLOCK ATTACHMENTS TO STUMPS

of the load is adjusted to suit the tractor towing capacity (Fig. T.S. 29).

It should be noted that surface obstacles often prevent the skidding of large loads of tree length, especially in thinnings. The tractor winch is not located very high above the ground, so any stump or rock may present an obstacle which can reduce the speed of travel or size of the load (Fig. T.S. 30).

Severe undulation of the slope may often compel the operator to apply two stages of winching and then the final stage by towing the logs with the tractor. In this event the tractor changes position at least three times, involving considerable loss of time. Apart from this, the tractor position must be constantly adjusted to ensure even spooling of the winch cable on the drum, although a man with a stick can be of assistance to ensure even spooling.

The winch cable is usually pulled from the winch drum to the logs by a man who has to wend his way through the slash, tops and off-cut logs left behind after the log-preparation operation, and this is a further delaying factor when winching (Fig. T.S. 31).

Observations have shown that the average speed of movement for pulling the winch cable out by hand is 2 seconds per metre, as opposed to the tractor movement speed of 1,2 seconds per metre when moving down a gentle gradient.

It should be noted that a tractor can pull more by cable and winch than by direct towing on the drawbar hook, particularly when the winch drum is bare, or only half filled with cable and the tractor is firmly anchored to a tree stump. In addition the winch can pull a greater load when skidding tree length than when skidding logs.

Considering the time lost when rehooking the logs after each stage, even without rechoking, log skidding by tractor winch takes almost a third of the time longer than direct towing with the tractor and drawbar hook.

(2) SUGGESTED METHOD OF USING THE TRACTOR WINCH

The winch is employed for uphill skidding when slopes exceed 5^{o}, or 10^{o} in 2nd thinnings, and for downhill skidding when slopes exceed 19 to 23^{o}. Chokers are used with the tractor winch. The winch cable is pulled out downhill by labourers and uphill by mule, assisted by labourers if the ground is not too rough (Fig. T.S. 31).

The average load can be made up of 5 logs, both long and short logs inclusive.

Table T.S. 6 compares production rate when towing with the drawbar hook and when winching.

(f) LOG SKIDDING BY TRACTOR WINCH AND SNATCH BLOCK (Fig. T.S. 34, 35)

The tractor is positioned on the road with the winch obliquely facing the upper road bank. The winch cable is passed through a snatch block attached to a stump on the upper road bank, then across the road and down the lower slope to the logs to be skidded. In all other respects the operation is similar to that of a single stage winching operation.

(1) Advantages

(i) When the tractor is correctly positioned in relation to the snatch block it requires no side adjustment to ensure even spooling of the winch cable, provided that the distance between the tractor and snatch block is correct. This distance should not be less than 6 metres, but 12 metres is ideal.

(ii) The tractor position is more secure, as its direction of pull is towards the road bank and not towards the downhill slope, which often drops abruptly, presenting possible danger.

(iii) When necessary the logs can be pulled to a point above the road. In this case the snatch block must be attached to a stump or tree some distance above the upper road bank.

(2) Disadvantages

(i) When the tractor site is changed, removal of the winch rope from the snatch block and moving and reslinging the snatch block in the new position is a time consuming operation.

(ii) Swinging the winched logs to the log stack by direct towing causes considerable delay if no other swinging means is available, as the winch cable must be disengaged from the block for each trip and then refitted for skidding the next load.

TABLE T. S. 6 - Comparison of winching and towing

Winching		Towing	
Skidding distance	43 m	Skidding distance	43 m
Pulling rope down by hand, speed	1 m/2, 5 sec	Tractor speed	1 m/1, 2 sec
Winching the load, speed	1 m/1, 2 sec		
Time to pull the rope out by hand	2 min 29%	Out empty to the logs	1 min 20%
Time to winch load	1 min 14%	In, loaded	$1\frac{1}{2}$ min 30%
Time for hooking and slinging	3 min 43%	Hooking and slinging	2 min 40%
Time, unhooking	1 min 14%	Time, unhooking	$\frac{1}{2}$ min 10%
Total time per trip	7 min 100%	Total time per trip	5 min 100%

Note: Conditions were the same, except for the gradient

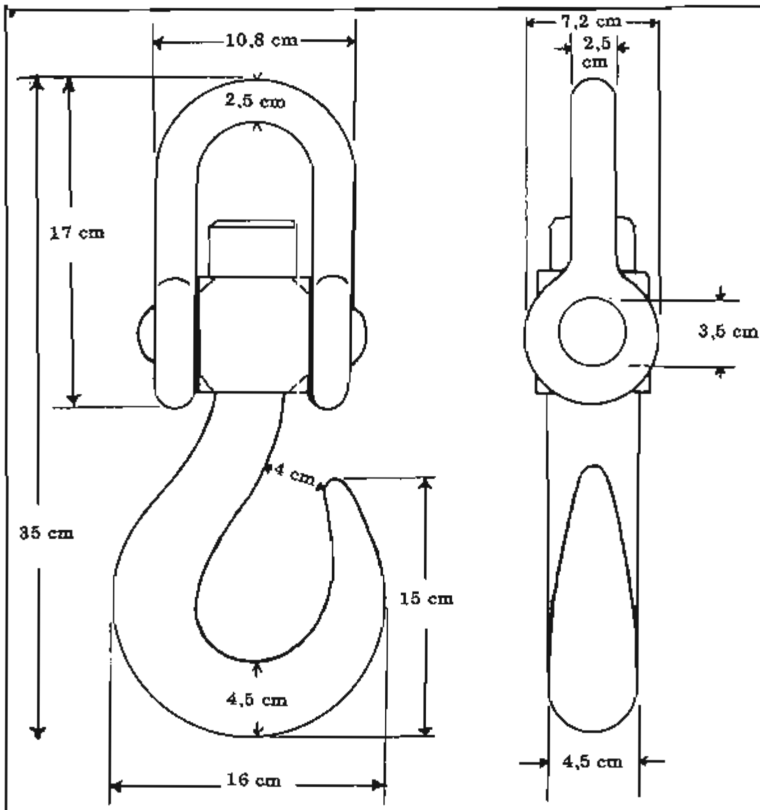


FIG. T. S. 36

LINE HOOK WITH SWIVEL AND SHACKLE.

HOOKS OF TOOL STEEL.

CROSSHEADS AND SHACKLES OF MACHINERY STEEL.

MASS : 8 kg

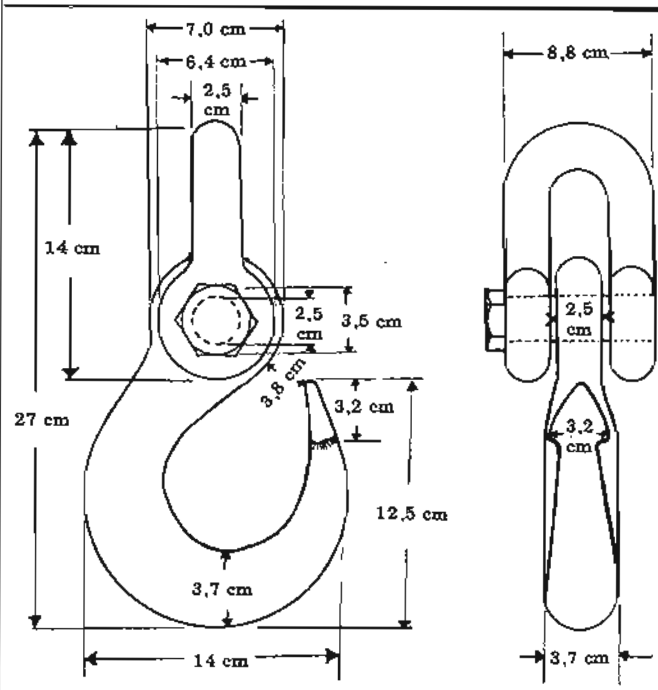


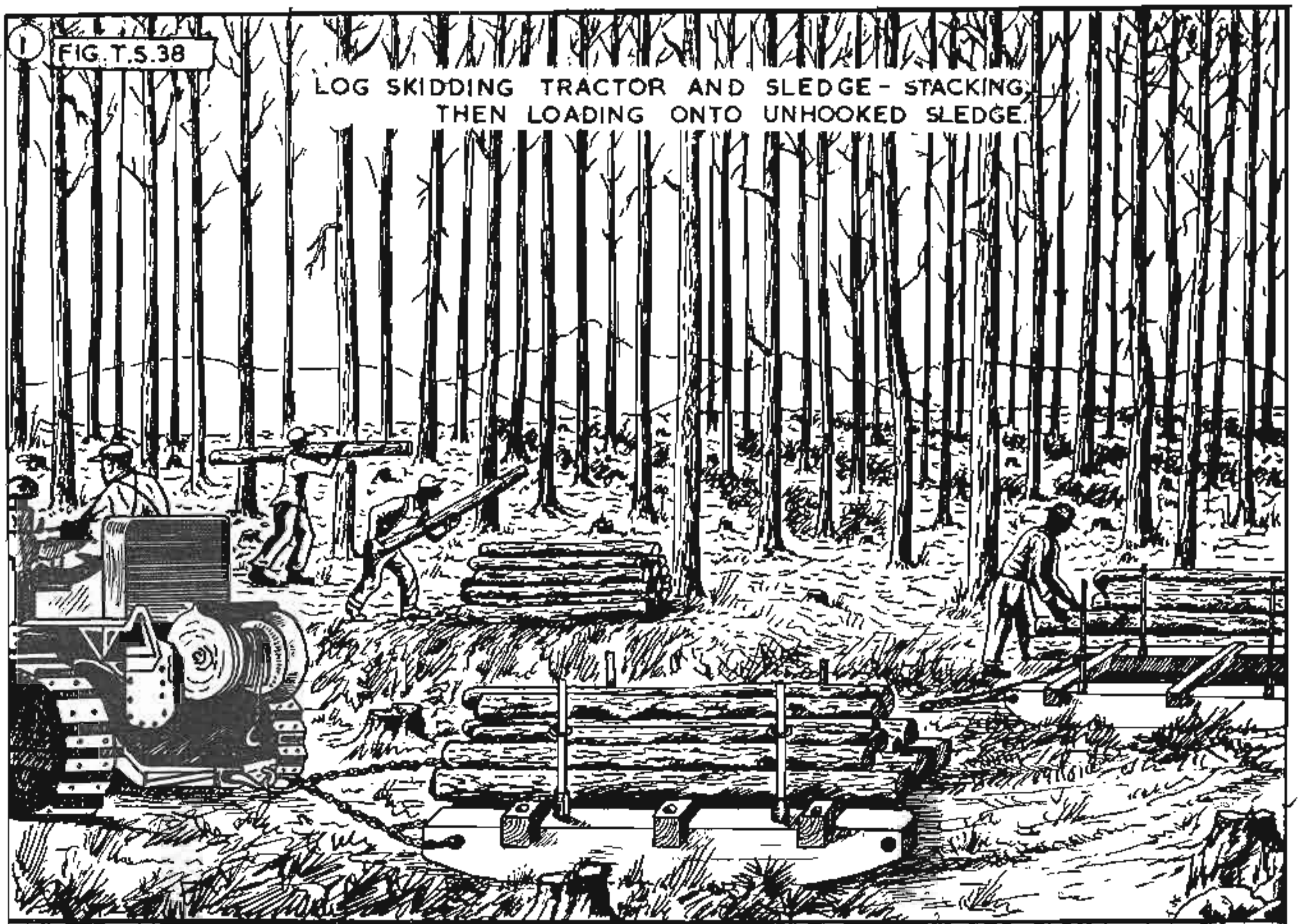
FIG. T. S. 37

"ARROW POINT" LINE HOOK WITH SHACKLE.

FORGED OF SPECIAL ALLOY STEEL.

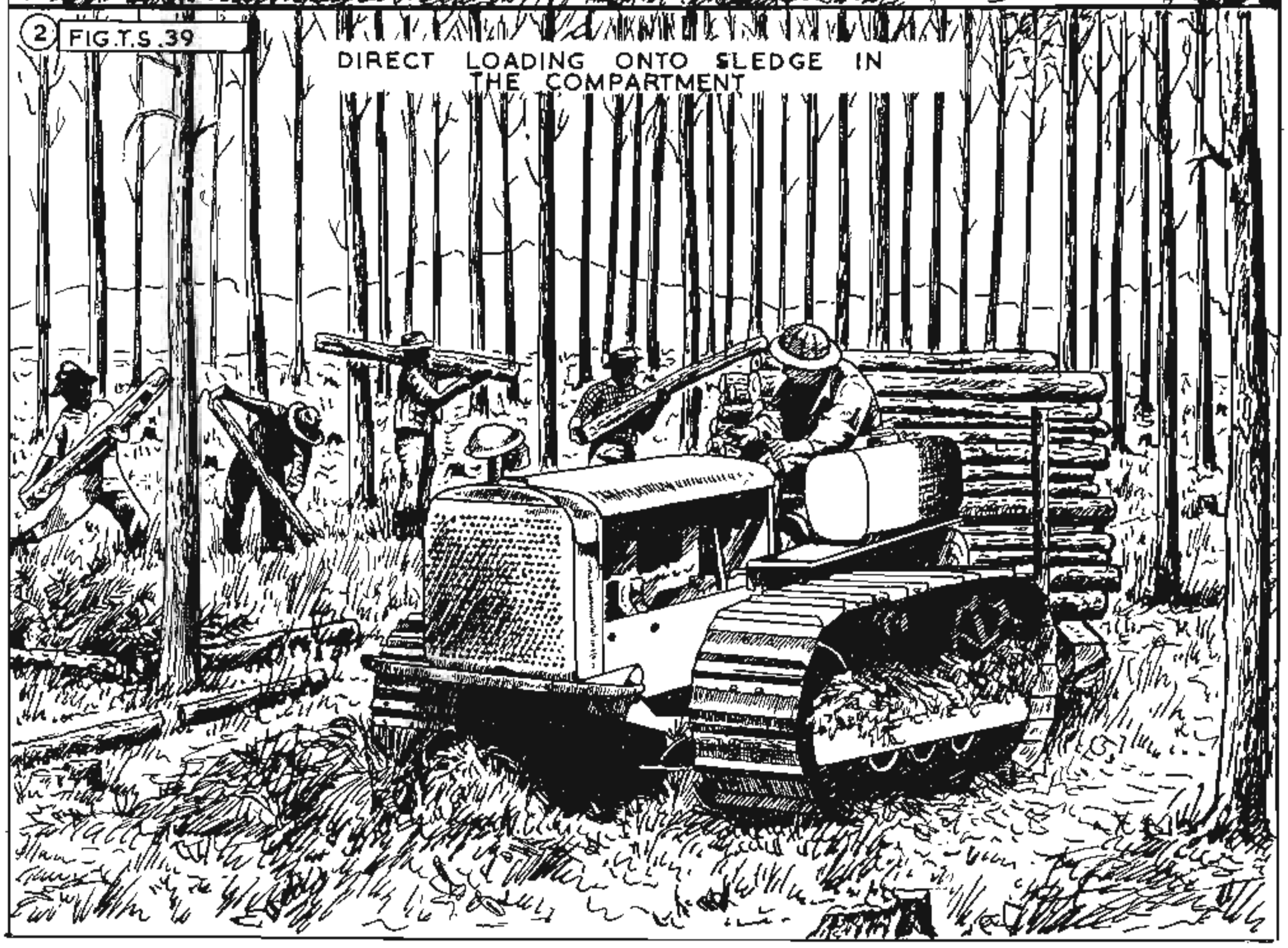
CAREFULLY HEAT TREATED.

MASS : 5 kg



1 FIG. T.S. 38

LOG SKIDDING TRACTOR AND SLEDGE – STACKING THEN LOADING ONTO UNHOOKED SLEDGE.

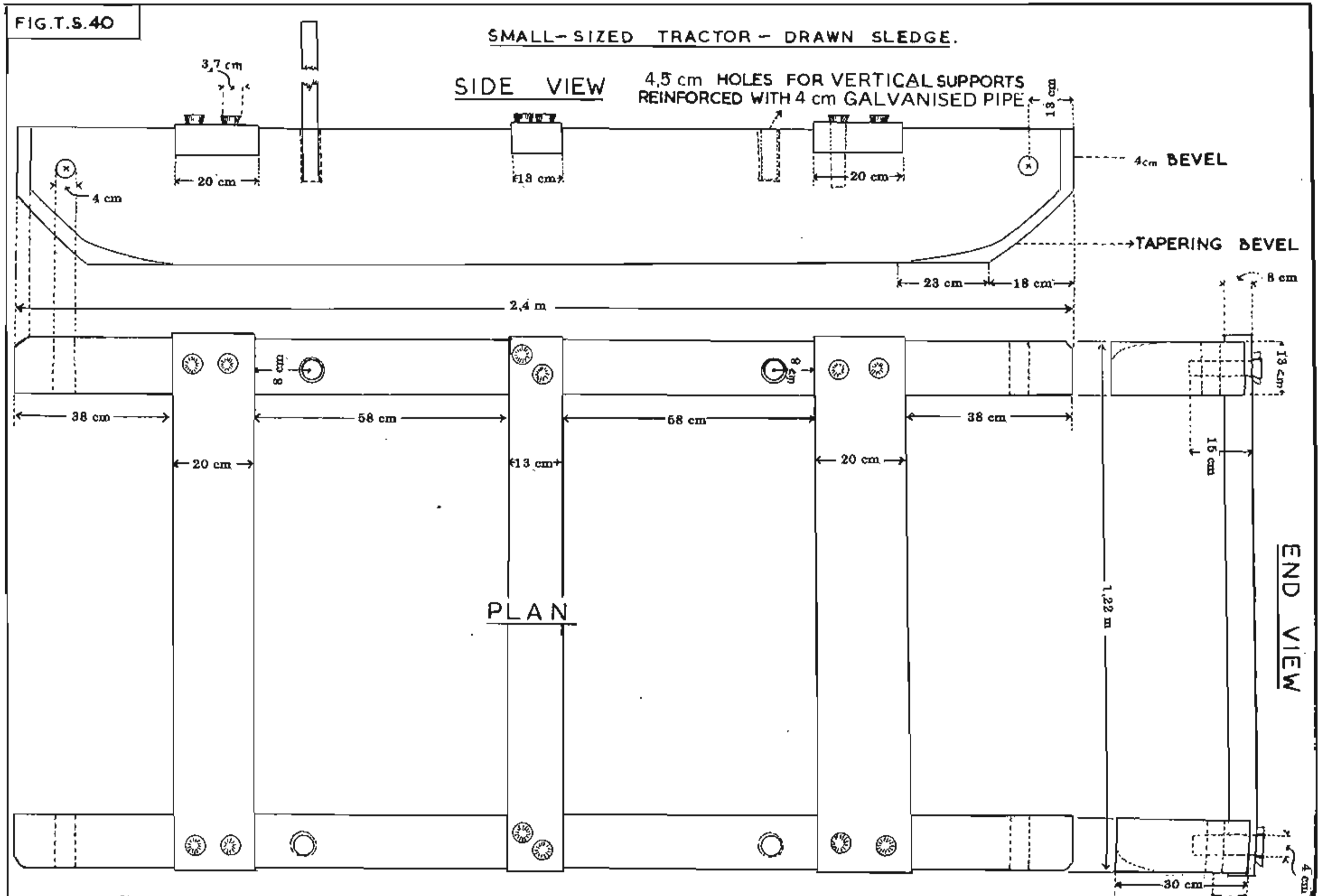


2 FIG. T.S. 39

DIRECT LOADING ONTO SLEDGE IN THE COMPARTMENT

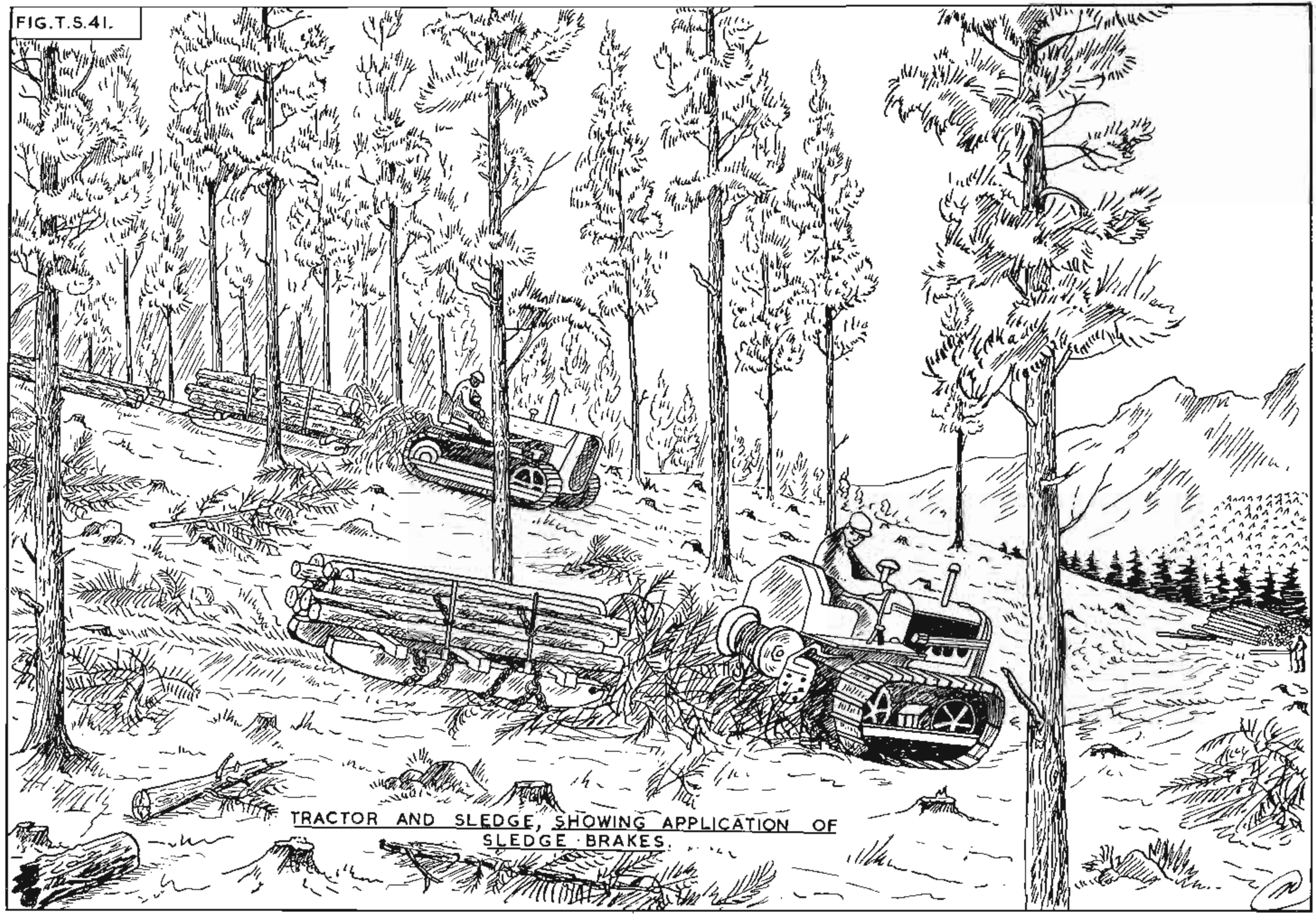
FIG.T.S.40

SMALL-SIZED TRACTOR-DRAWN SLEDGE.



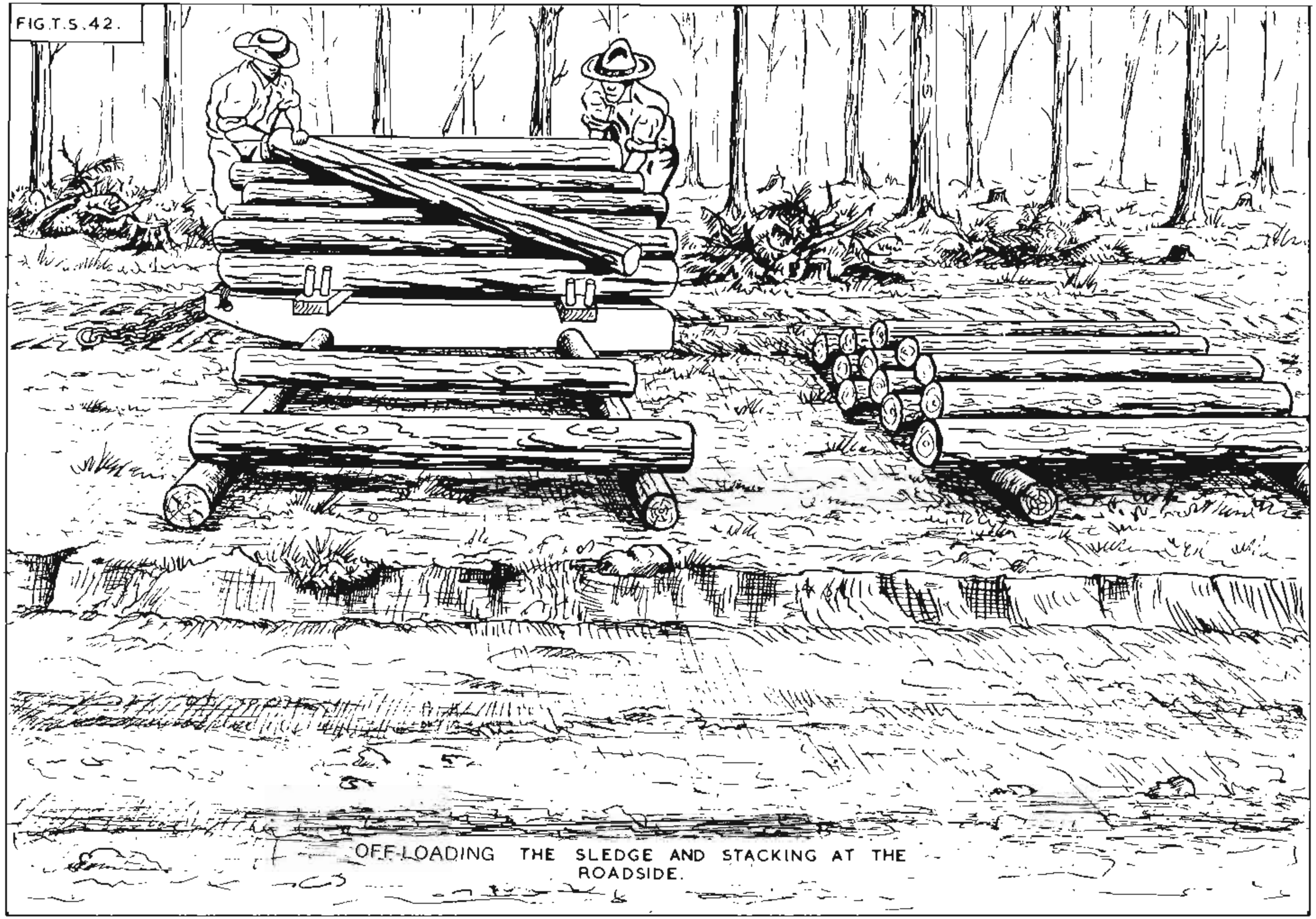
SCALE:- 25 mm = 0,3 m

FIG. T.S.41.



TRACTOR AND SLEDGE, SHOWING APPLICATION OF SLEDGE BRAKES.

FIG.T.S.42.



OFF-LOADING THE SLEDGE AND STACKING AT THE ROADSIDE.

LOG SKIDDING BY CRAWLER-TRACTOR AND PALLETS.

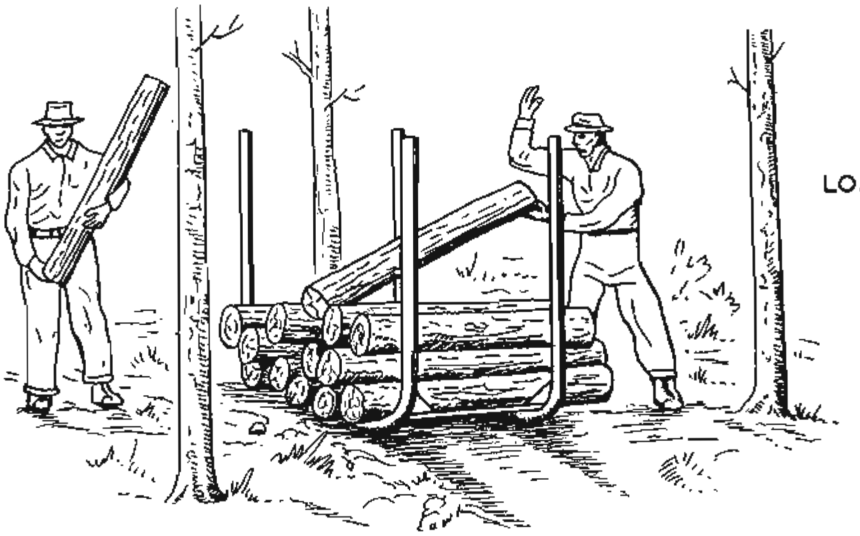
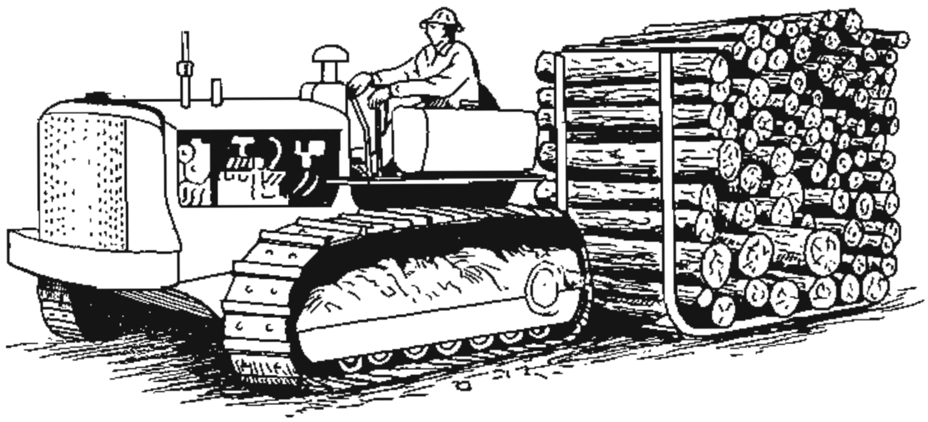


FIG. T.S. 43.a
LOADING THE PALLET.

FIG. T.S. 43 b.
TRACTOR TOWING LOADED PALLET.



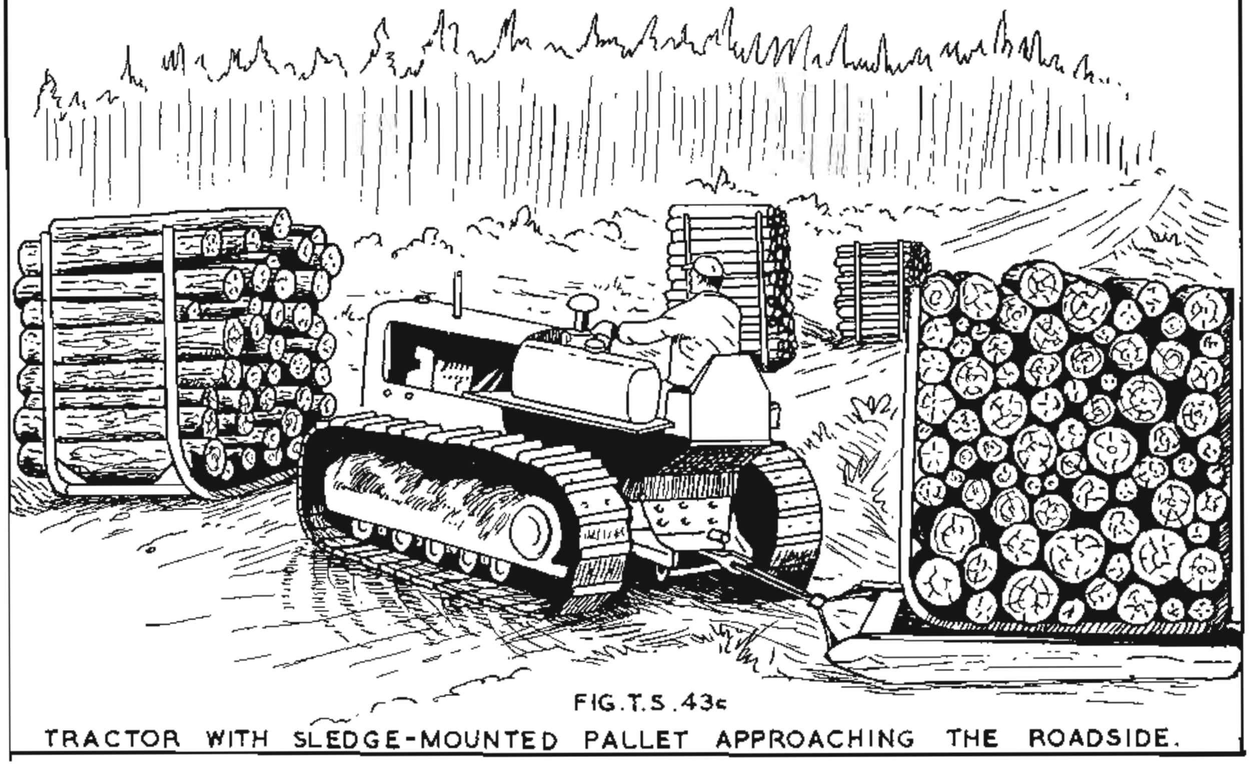
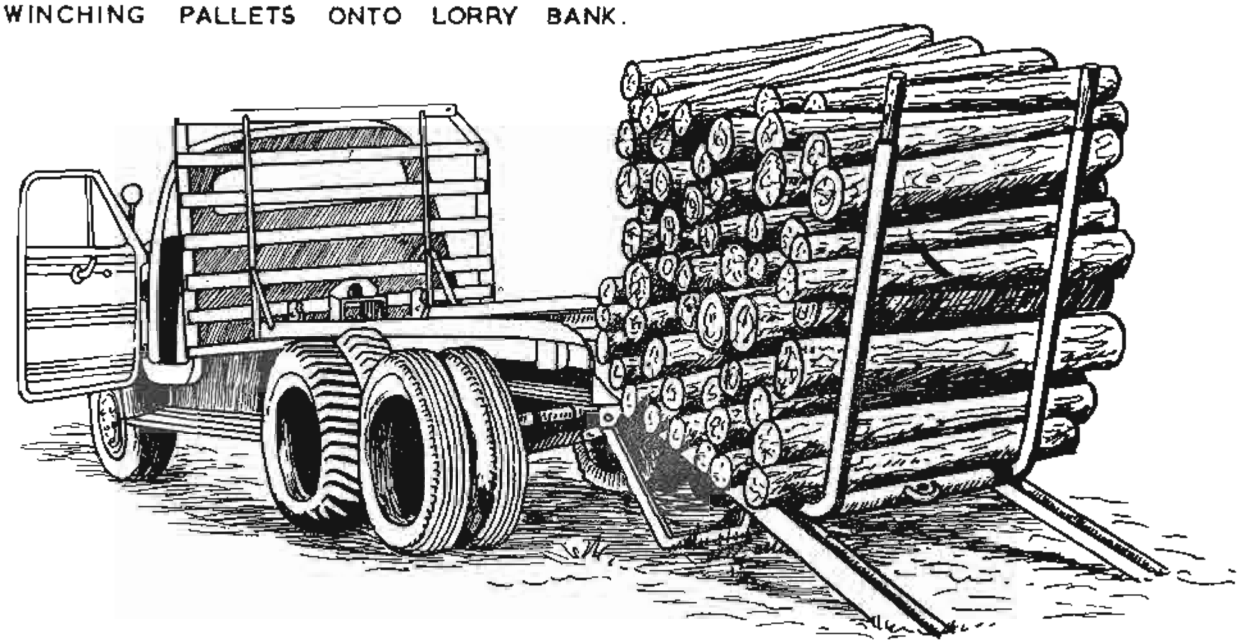


FIG. T.S. 43c
TRACTOR WITH SLEDGE-MOUNTED PALLET APPROACHING THE ROADSIDE.

PALLET SKIDDING.

FIG. T.S. 44 a
WINCHING PALLETS ONTO LORRY BANK.



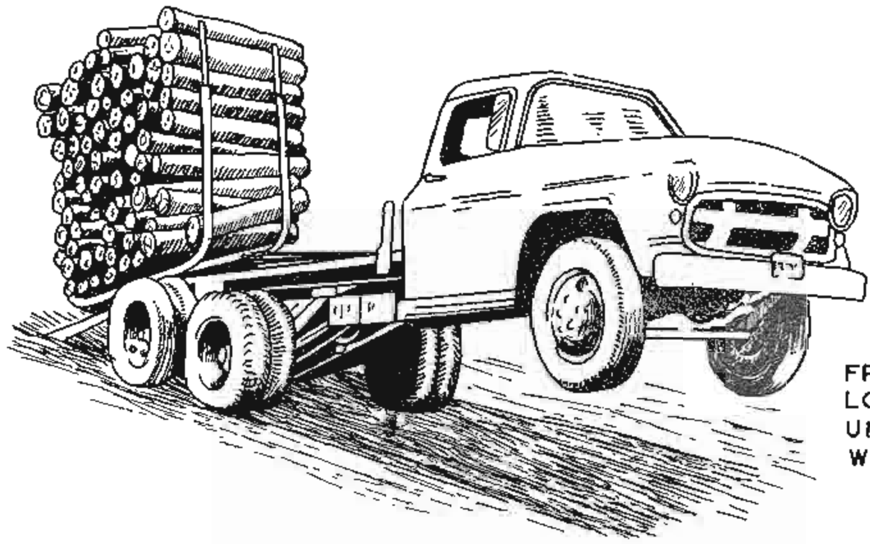


FIG. T.S. 44 b.
FRONT OF SMALL LORRY TIPS UP UNDER MASS OF WINCHED PALLETS.

FIG. T.S. 44 c.
LORRY FULLY LOADED WITH PALLETS.

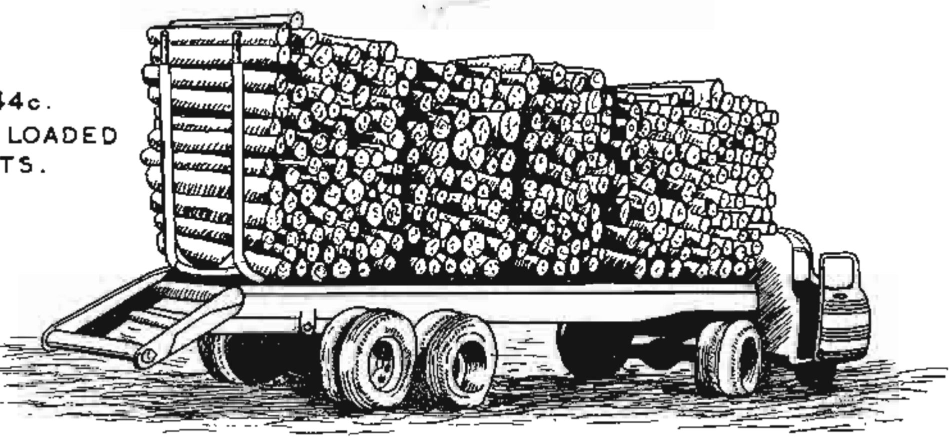
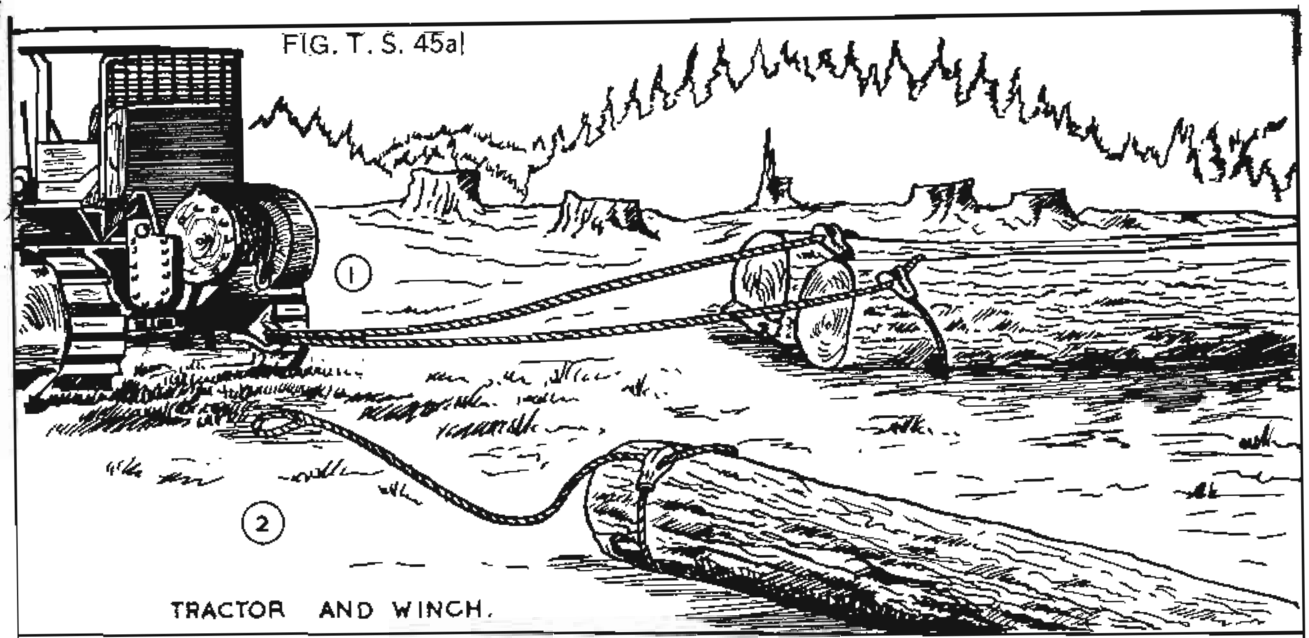
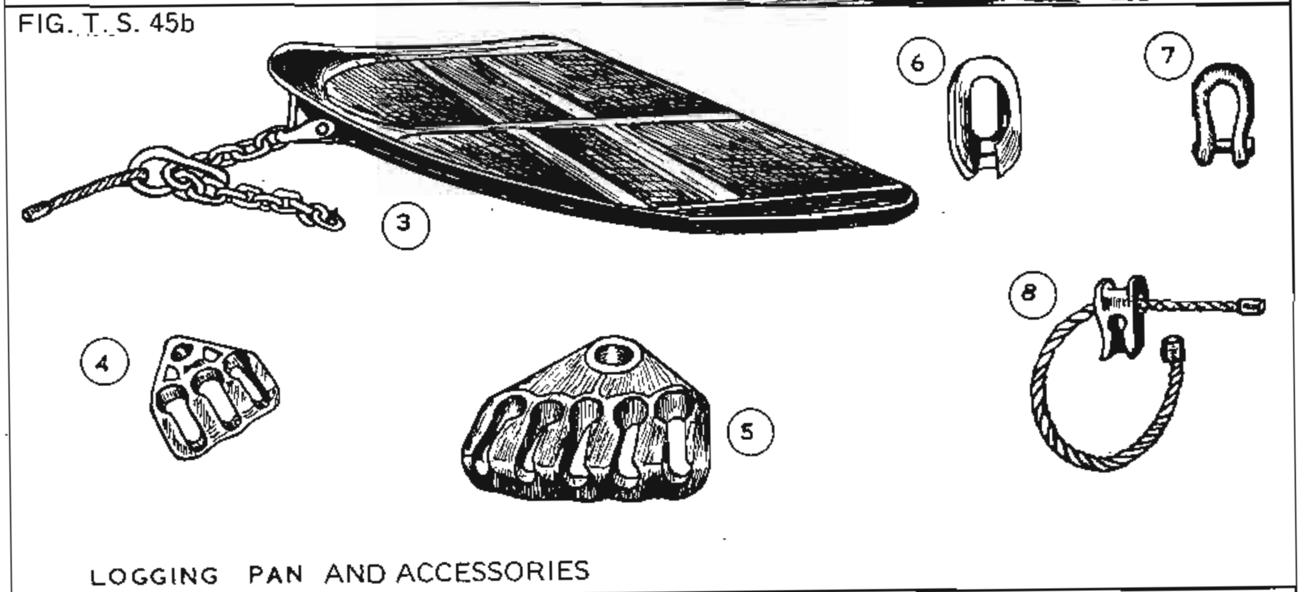


FIG. T. S. 45a



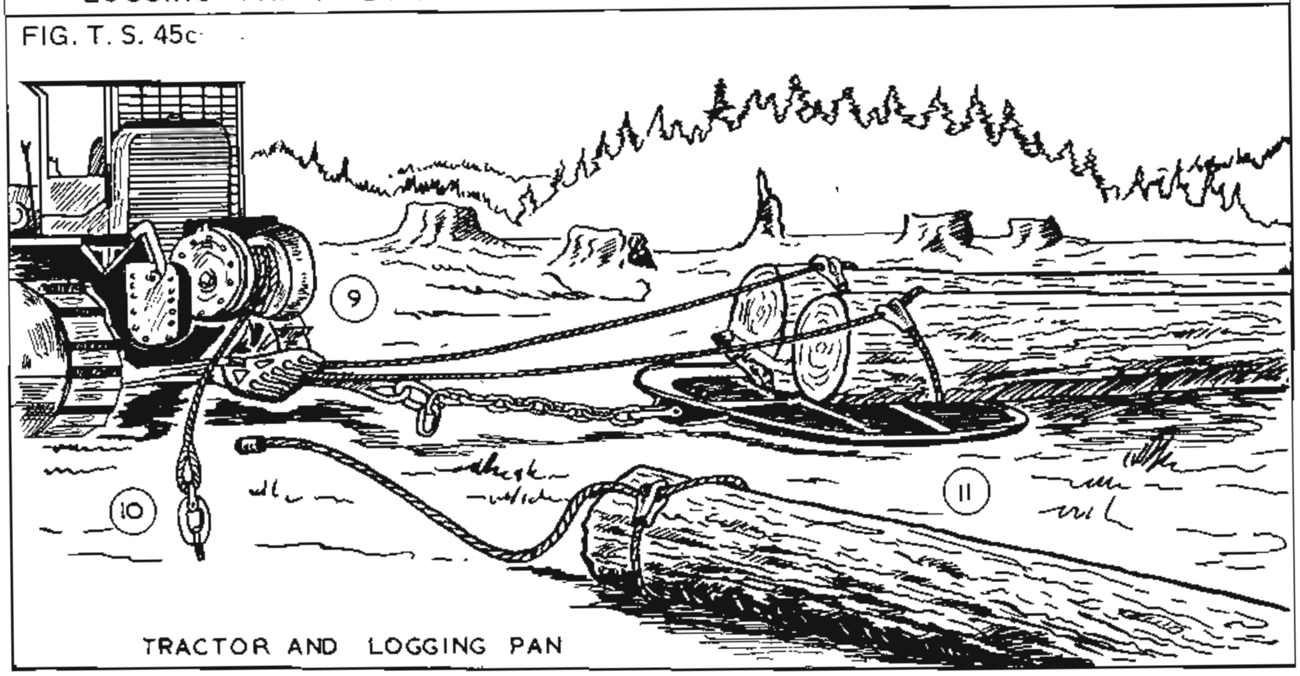
TRACTOR AND WINCH.

FIG. T. S. 45b



LOGGING PAN AND ACCESSORIES

FIG. T. S. 45c

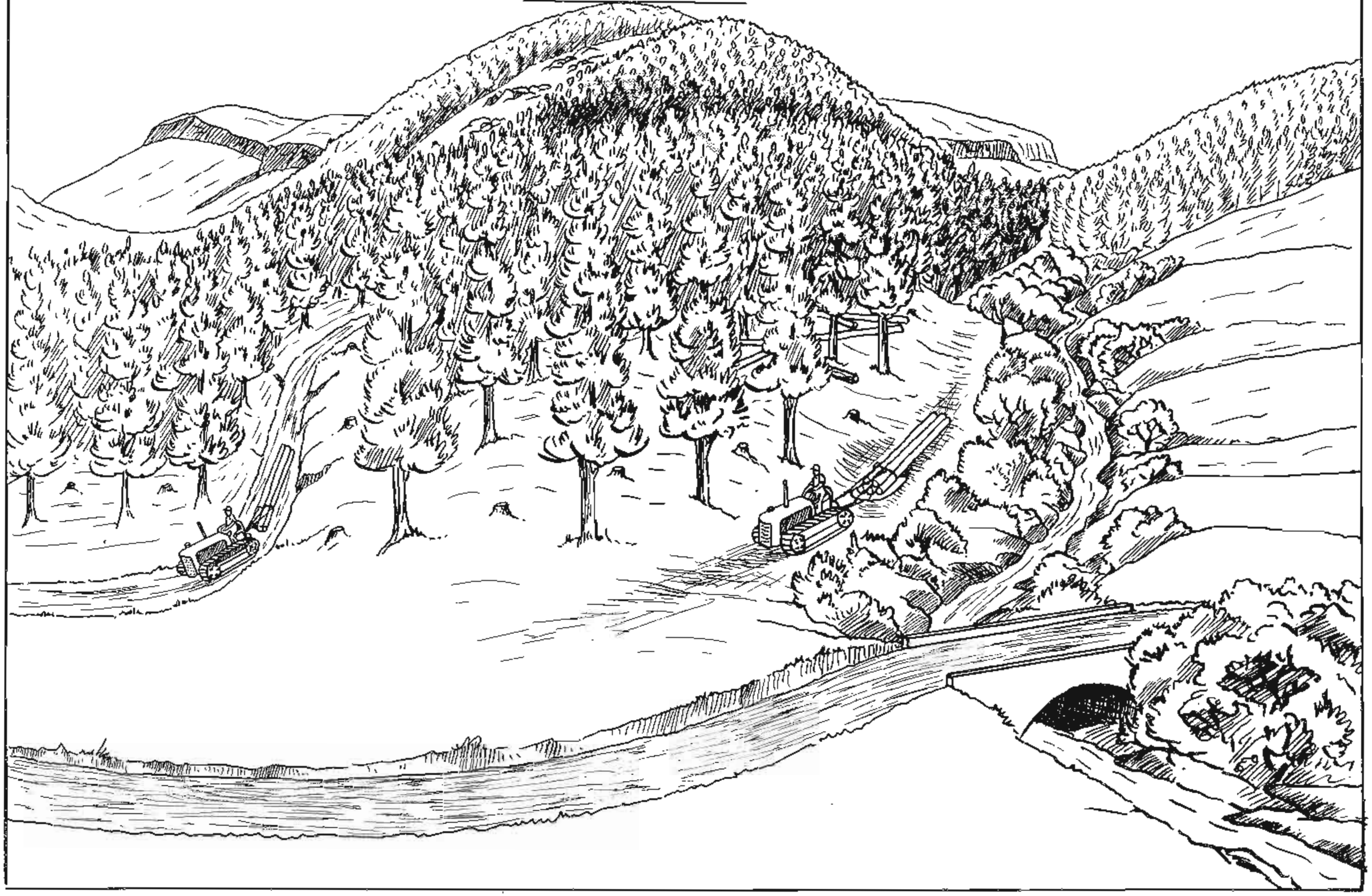


TRACTOR AND LOGGING PAN

TRACTOR TOWING RIG ASSEMBLIES

FIG.T.S.46

LOG SKIDDING BY TOWING TRACTOR AND SKIDDING PAN.



(g) NORMS AND COSTS FOR LOG SKIDDING BY TRACTOR WINCH

See Appendix T.S. 6, Table T.S. 14.

(h) TRACTOR TEAM AND THEIR DUTIES

See Appendix T.S. 7, Table T.S. 15.

D. LOG SKIDDING BY CRAWLER TRACTOR WITH TOWED SLEDGE

Refer to Fig. T.S. 33, 40.

(a) OPERATION

During the early stages of logging development, log skidding by tractor-drawn sledges was a popular method. Logs from thinnings were small and easy to handle and load. The maturing plantations and increased sizes of logs derived from thinnings necessitated the introduction of new methods of skidding. As a result the use of tractor-drawn sledges decreased, and they have only a limited application under present day conditions.

The use of sledges is restricted to extracting small logs from early thinnings or the small top logs from trees in clearfellings. Sledges have proved to be most economic when employed in long distance skidding operations.

The main drawback of the sledge is evident when it is being loaded or unloaded, as logs must be lifted onto the sledge and removed from it when unloading by hand (Fig. T.S. 38, 39, 40). This manual operation is not only time consuming and expensive, but also places considerable strain on the men employed.

Two methods of skidding by tractor-drawn sledge are possible:

(i) Logs are carried to the skid path and prestacked, then later loaded onto the sledge. Two sledges are used with the tractor to reduce time wastage, the one being loaded from the skid path stack while the tractor tows the other to the roadside. This method is most efficient in second thinnings for fast-growing species or in third thinnings for slow growing species (Fig. T.S. 38).

Note: For clarity the two stacks in the illustration are shown close together, but in practice they should be further apart

(ii) The tractor towing the sledge moves slowly throughout the area while the crew carries small logs and stacks them directly onto the sledge, thus avoiding prestacking. This method is the most practical for use with small logs derived from clearfellings or second thinnings for fast-growing species (Fig. T.S. 39).

When operating on steep slopes the possibility exists that the sledge may over-run the tractor. This is prevented by braking the sledge:

(i) by securely wrapping chains round the sledge runners;

(ii) by chaining additional logs behind the sledge (refer to Fig. T.S. 41).

A frequent occurrence with sledge skidding is for large quantities of debris and forest litter to accumulate between the sledge and the tractor due to the low clearance of the sledge. This litter must be removed before the sledge can be unhooked, resulting in large quantities of debris ultimately accumulating at the stacking sites, and cluttering up the landings.

Sledges should not be unnecessarily dragged over heaps of slash or branches as they severely hamper the sledge movement.

(b) NORMS FOR LOG SKIDDING BY TRACTOR-DRAWN SLEDGE

See Appendix T.S. 10, Table T.S. 16.

(c) TRACTOR TEAM AND DUTIES

See Appehdix T.S. 11, Table T.S. 17.

(d) SPECIFICATIONS FOR HEAVY LOGGING SLEDGE

See Appendix T.S. 12, and Fig. T.S. 40.

Note: The use of tractor-drawn pallets for skidding small logs is shown in Fig. T.S. 43, 44, but these have not been used in the Department

E. USE OF THE LOGGING PAN FOR TRACTOR LOG EXTRACTION

(Refer to Fig. T.S. 45a, b, c and 46).

(a) DESCRIPTION

The logging pan is a plate of wear-resisting manganese steel, built to withstand the strenuous service encountered in log skidding where it frequently strikes against rocks and stumps, or is run over by the tractor when backing or turning. The pan is sufficiently curved up in front to prevent rutting and, when drawn over the same skid path a number of times, it has the effect of "packing" and improving the path.

The pan is attached to the tractor 5- or 3-way drawbar hook by means of the ferruled end of the hitch. The other end of the hitch is spliced to a grab link, through which a chain is threaded, which is in turn connected to the pan itself by means of a shackle. The chain must be continually adjusted to keep the pan in the correct position relative to the length of the chokers and size of the logs skidded.

(b) USE OF THE LOGGING PAN

The logging pan is recommended by the manufacturers for use in the skidding of several logs or poles at a time without the necessity of bunching. A choker is attached to each log and hooked onto the drawbar hook and the tractor then moves on

FIG. T.S. 47.

TRACTOR AND SULKY WITH LOAD IN TOW.

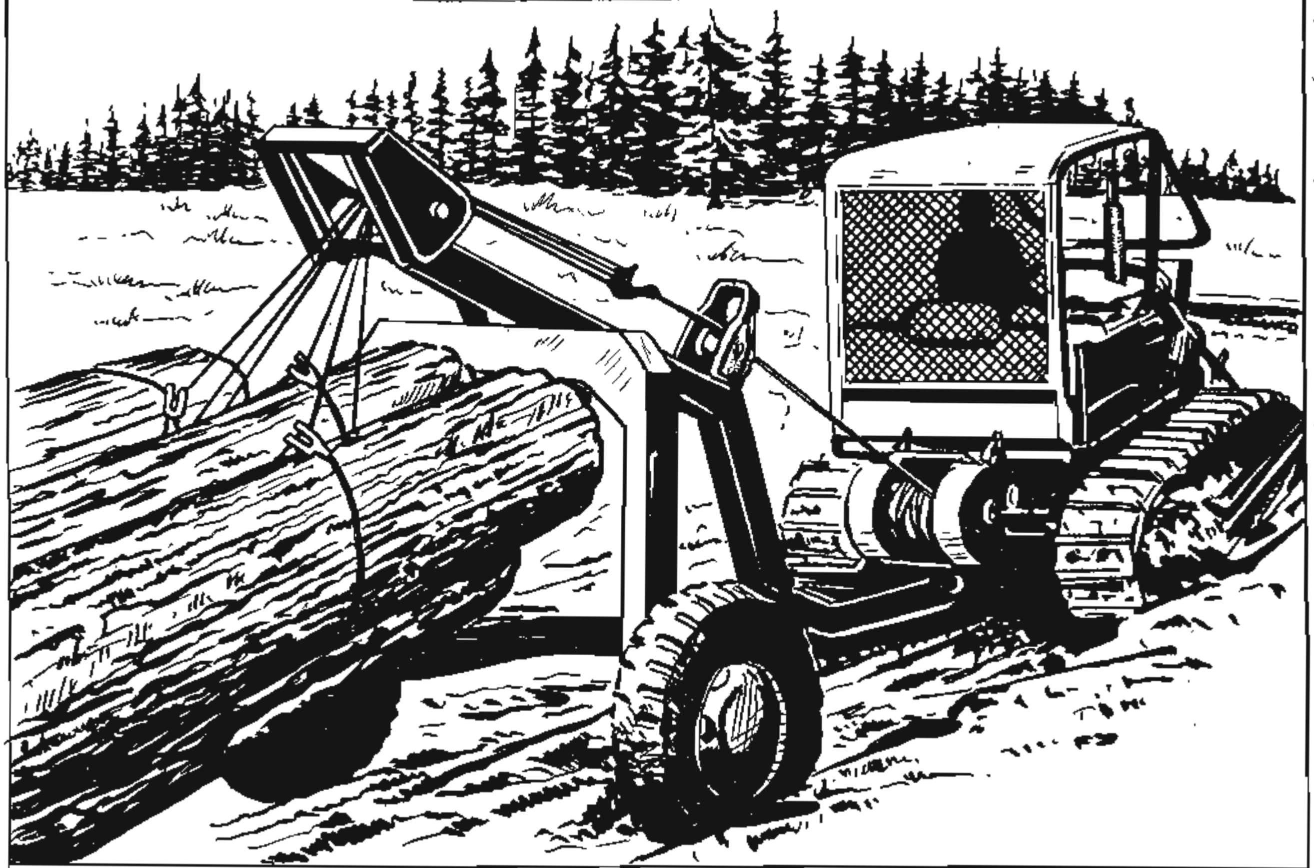


FIG. T.S. 48

ASSEMBLING A LOAD.

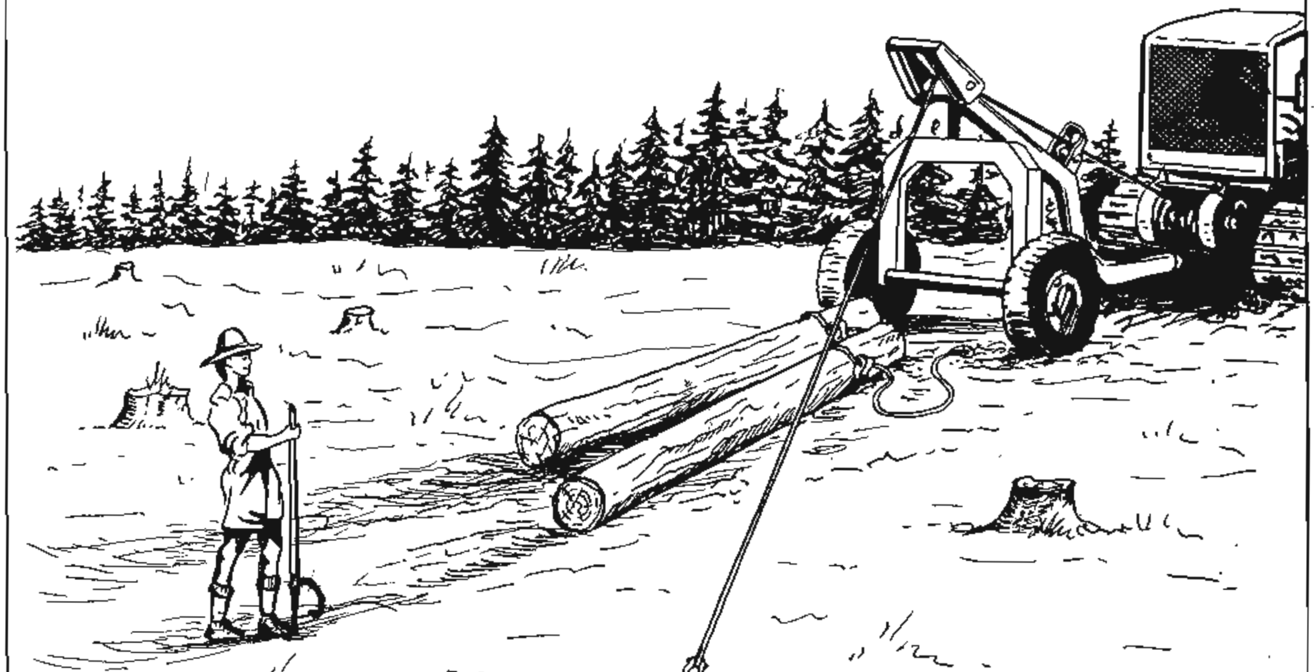


FIG. T.S.49

LOG SKIDDING BY TRACTOR AND SULKY.

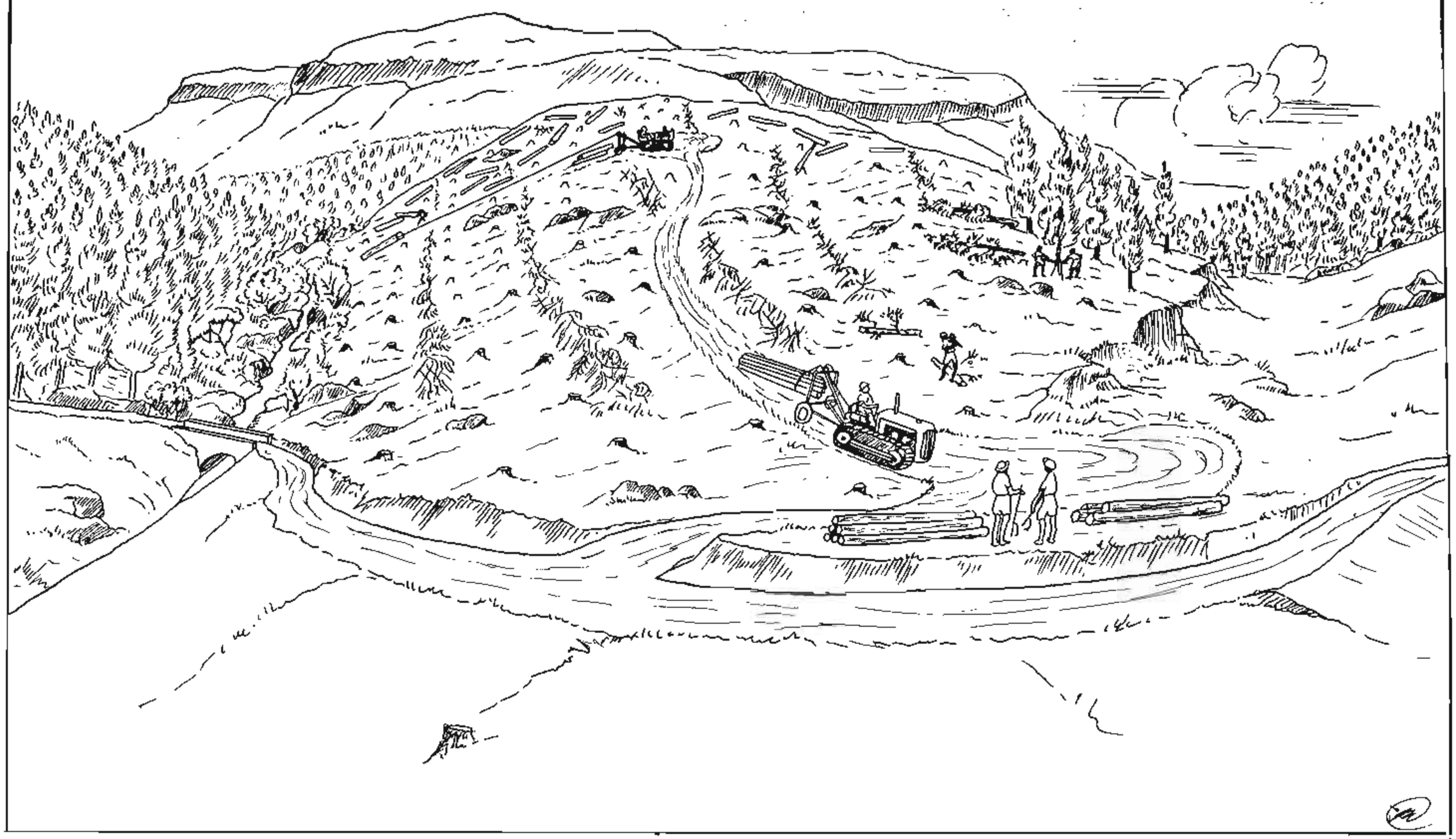
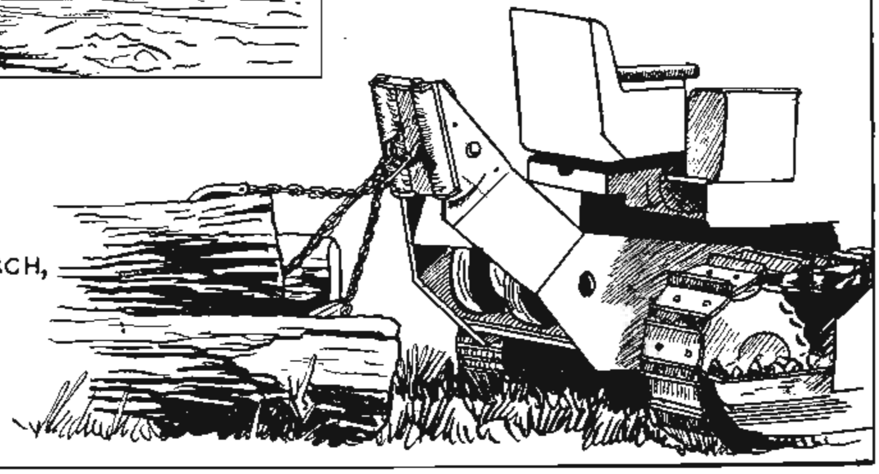


FIG. T. S. 50

TRACTOR—ATTACHED "DOLLY ARCH", LOADED

FIG. T. S. 51
ARCH IN UPRIGHT POSITION FOR RETURN TO WOODS.

FIG. T. S. 52.
TRACTOR INTEGRAL ARCH, LOADED.



to the next log. The purpose of the logging pan is to raise the log heads slightly to prevent rutting and permit easy skidding over low surface obstacles, in addition to which it prevents the embedding of grit in the log heads.

A certain amount of skill and experience is necessary to roll the logs onto the pan without manual assistance. By correctly positioning the pan against the choked logs and properly positioning the choker on the log heads, the logs can be rolled onto the pan as the tractor moves forward with the log (Fig. T.S. 45 c)

Choker slings are usually of equal length (3-4 metre long). When there is a radical difference in the diameter of logs skidded, some of the logs will extend beyond the forward rim of the pan while the heads of others will drag behind the pan. In this case it is difficult to adjust all the logs so that their heads rest uniformly on the pan.

The use of a logging pan does not appreciably increase the size of the load which can be skidded and it has the additional disadvantage that load assembly is a time consuming operation. When the pan is being towed with a load it may strike violently against an obstruction and spill the logs out, in which case more time is lost, as the load must again be positioned in the pan.

The logging pan is occasionally used on plantations to skid large logs, usually gum logs, over level surfaces or slopes of easy gradient (Fig. T.S. 46).

(c) SPECIFICATIONS (Fig. T.S. 45 b,c)

The size of the logging pan used in the Department is 1m x 1,5m and has a mass of 213kg. The connecting chain is of 19mm material diameter and 1 metre long.

The five-way Bantam Special drawbar hook has a mass of 19 kg (item 5). When this hook is used, the basket hook (items 6 and 10) is attached to the free end of the winch cable. The slings of the choker assemblies have both ends ferruled.

The thickness of the 5-way drawbar hook plate should be such that it can be accommodated by the tractor drawbar jaw.

F. USE OF THE LOGGING SULKY FOR TRACTOR LOG SKIDDING

(Refer to Fig. T.S. 32 for details, T.S. 49 for application, and T.S. 47 and 48 drawings of load in tow and load assembly),

The logging sulky is an arch with fairleader and hitch, mounted on wheels with rubber tyres. It is towed by the tractor and used for log skidding in conjunction with the tractor winch cable with a special hook and chokers.

The winch cable is threaded through the fairleader mounted on top of the arch, and is used to lift the heads of choked logs. This effectively eliminates rutting of the log heads into the ground, keeps the logs comparatively dirt free and permits the load to be increased by 25%. Ideal conditions for a logging sulky operation are found in flat areas or areas with smooth, gentle slopes, where the tractor run is virtually straight or turnings are of a large radius.

(1) Disadvantages

(i) Numerous difficulties are encountered when approaching logs to be hooked and towed, as the sulky hampers the manoeuvrability of the tractor. Assembling a load of several logs by means of the winch cable is also a time consuming operation.

(ii) The sulky is apt to capsize when taking sharp turns with a load of logs with raised heads in tow. To avoid this the tractor must either follow a curve of large radius, or stop, drop the slinged load, turn itself and move forward with the sulky while paying the winch cable out, stop again, winch the logs to the sulky, raise their heads, and then proceed further. It has been observed that long logs cause more trouble on turnings than do short logs.

(2) Advantages

The sulky can be used to good advantage on flat or gentle slopes for skidding large-sized timber over long distances in indigenous forests. If the distance is long enough, the increased load size can be used to the full advantage.

G. THE INTEGRAL ARCH (Fig. T.S. 52)

The integral arch is a fairleader mounted on a frame fitted to the tractor chassis or winch shaft. The attachment works in conjunction with the winch cable and chokers.

Tests have shown the following:

(1) The fairleader support generally proved to be too short to accommodate the balance of the choker sling length, thus the heads of the logs are not always lifted off the ground.

(2) The tractor is inclined to tip under the mass of the dragged logs suspended by chokers from the fairleader which gives undesired leverage. This occurs in spite of counterweights mounted on the front of the tractor.

In view of the above this attachment has not proved popular in South Africa.

H. DOLLY ARCH

This attachment is shown in Fig. T.S. 50 and 51 as an item employed in log skidding. It is a frame-mounted fairleader on wheels attached to the tractor winch shaft. When free of a load it can be lifted clear off the ground by the tractor winch cable for better manoeuvrability of the tractor when returning empty to the logs (Fig. T.S. 51).

This item has not been purchased or tested by the Department so no information can be given regarding its performance.

FIG.T.S.53

ADVANTAGES OF USING A LOG-SKIDDING TRACTOR WITH BLADE

FIG.T.S.54

LOG-SKIDDING TRACTOR WITH BLADE CLEARING A SPACE BETWEEN ROWS FOR LORRY ACCESS

FIG. T.S.55. TRACTOR WITH BLADE SKIDDING AND STACKING LOGS

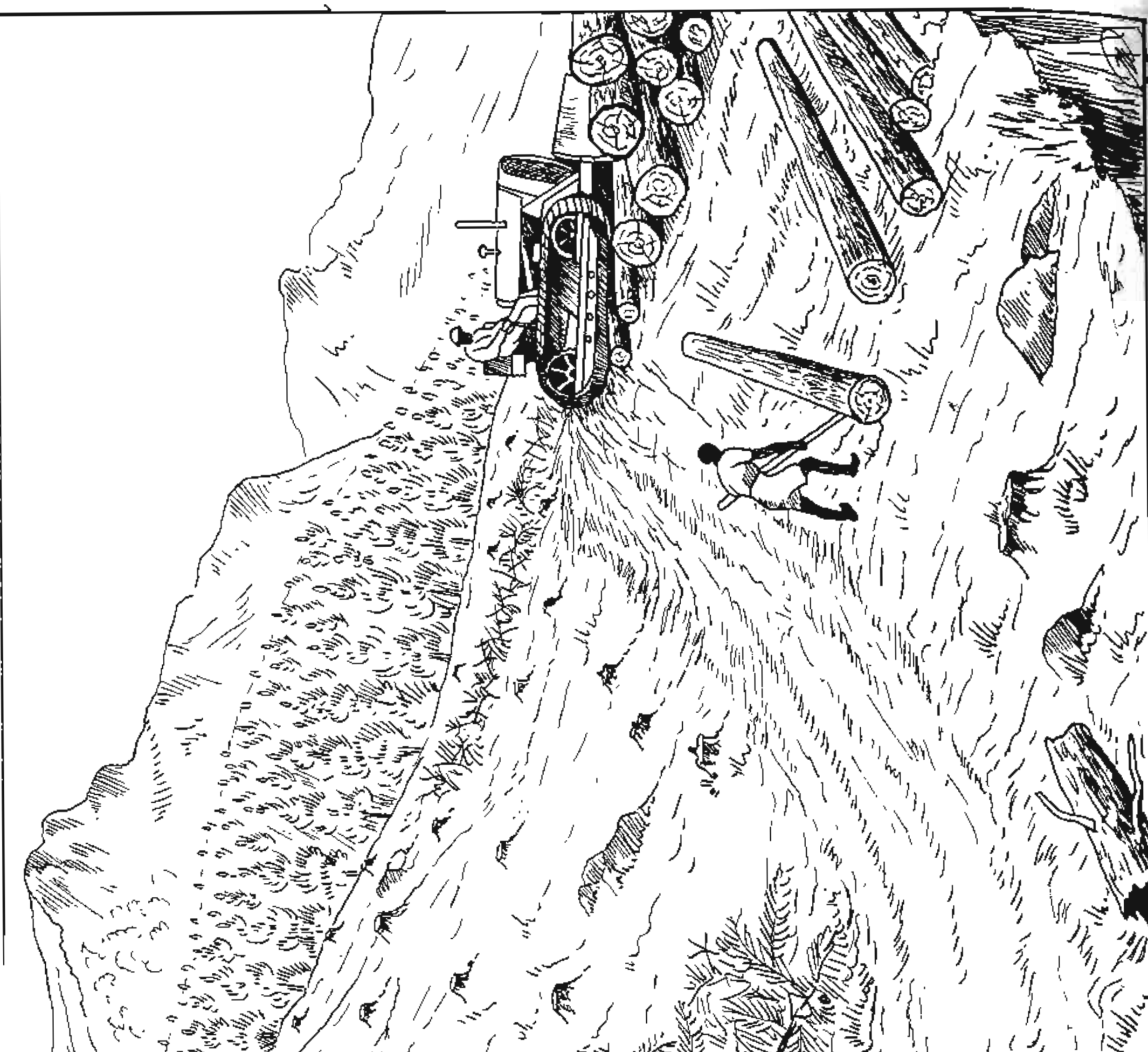
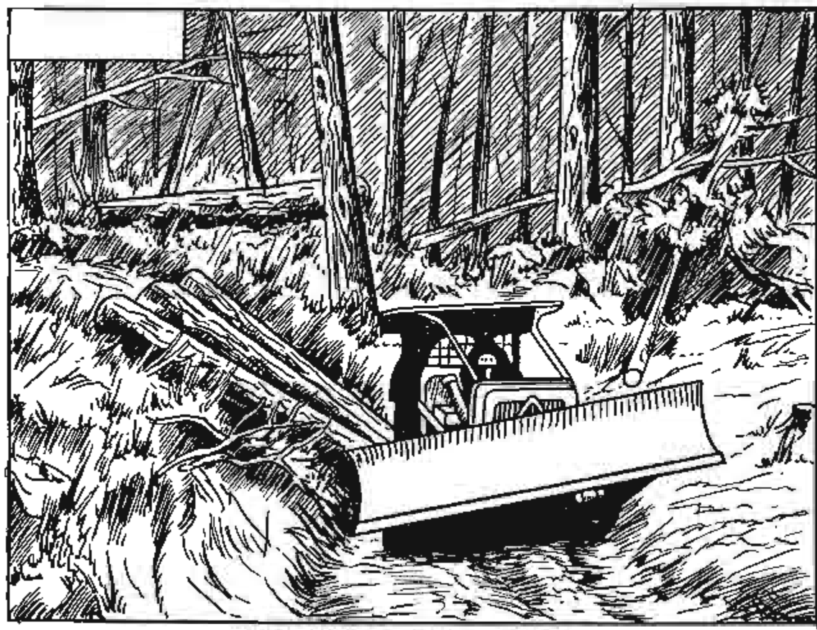
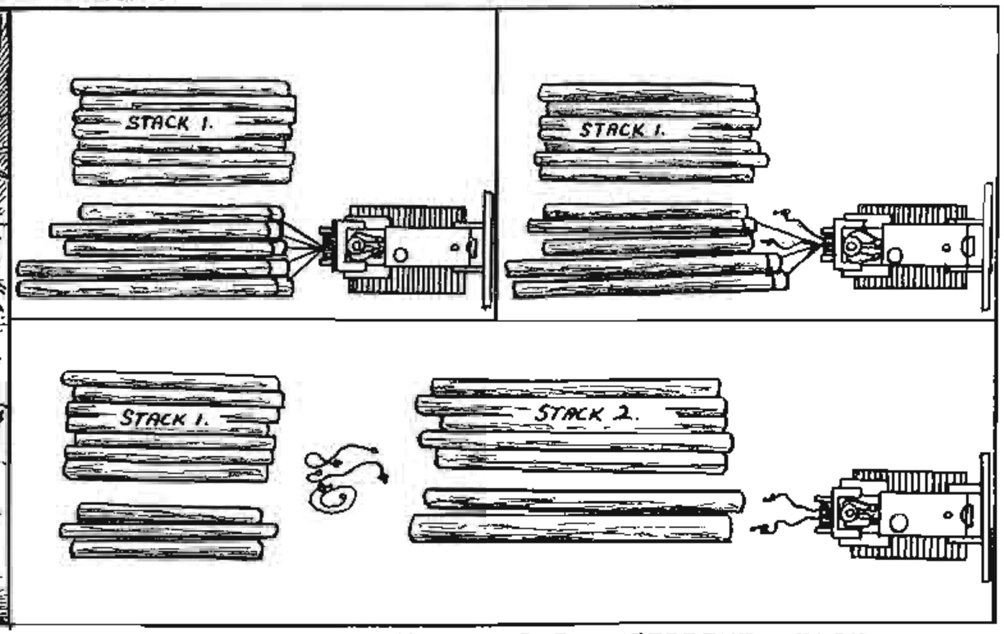


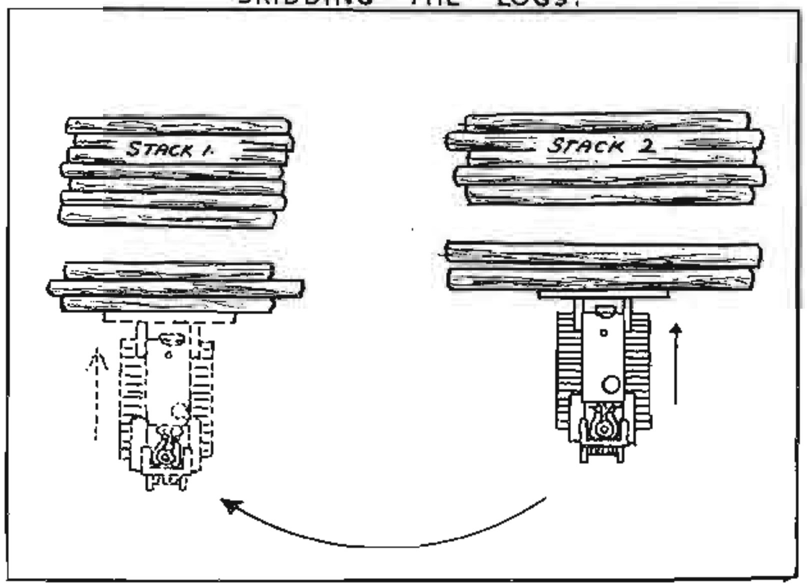
FIG. T.S. 56.



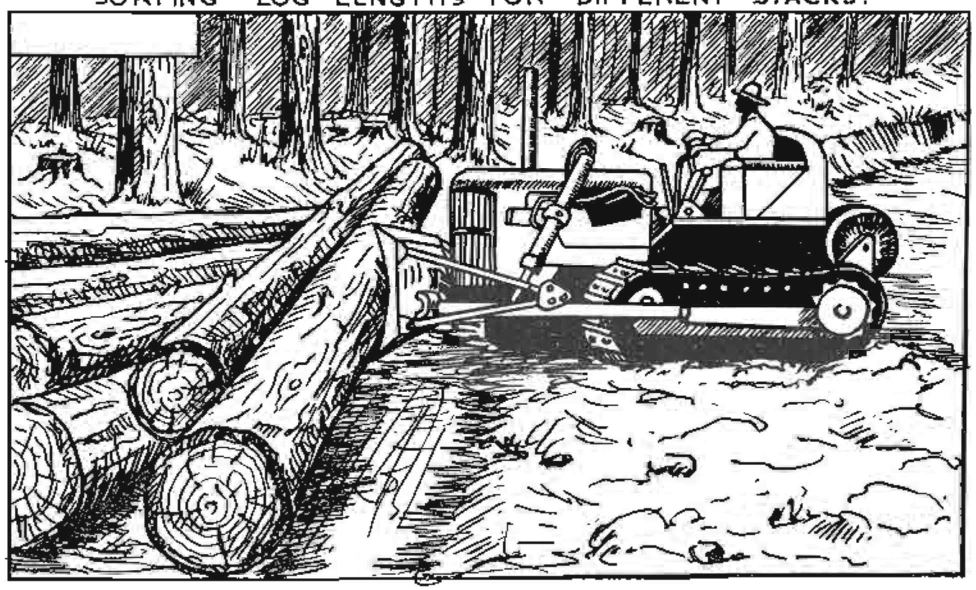
SKIDDING THE LOGS.



SORTING LOG LENGTHS FOR DIFFERENT STACKS.



PLAN OF STACKING OPERATION.



STACKING LONG LOGS BY BLADE

(I) TRACTOR WITH BULLDOZER BLADE

Fig. T.S. 53 illustrates the use of a logging tractor, mounted with a bulldozer blade, in a log-skidding operation using chokers. Its movement through the debris and slash is easy and its approach to the logs is fast and convenient.

The tractor on the left of the illustration is not equipped with a blade and is attempting to struggle over the piled slash to reach the logs. A return to the stack via a devious route will be time consuming and uneconomical.

Fig. T.S. 54 illustrates the use of a tractor equipped with a blade for pushing logs to the side in rows. This operation is fast, and can be applied where the area is flat and the ground sufficiently firm to permit a lorry to drive along the rows for loading. The operation is only possible where the trees have been planted in regular rows and the space between the rows is generally free of stumps or other obstacles.

The advantage of this method is that the skidding of logs to the roadside is avoided, there being no time involved in choking, hooking, removing the chokers at the roadside and stacking. The logs loaded are also cleaner.

(J) STACKING BY CRAWLER TRACTOR AND BLADE

(Refer to Fig. T.S. 55, 56).

The present trend in the Department is to use crawler tractors equipped with bulldozer blades for log skidding so that the tractors may, if necessary, assist in log-stacking by using their blades. The procedure in this case is for the tractor to skid the logs to the stack where they are unhooked, and the chokers removed from the drawbar hook. The tractor then turns, approaches the logs with blade lowered and pushes them up onto the stack, after which the chokers are again hooked to the drawbar hook and the tractor returns to the compartment for another load. It is obvious that this operation will involve a considerable loss of time and corresponding decrease in the log skidding output, but there are times when it is economically justified.

Log stacking by towing tractor with bulldozer attachment may be done economically under the following conditions:

(1) Whenever the stacking crew lags behind, the tractor should occasionally assist with the stacking, or its skidding production drops as the tractor waits for access to the front of the stack, barred by the unstacked logs from the previous load.

(2) When there is a shortage of labour, or when labour costs are excessively high.

(3) Whenever large logs are to be stacked.

(4) When the tractor must be employed for log skidding but cannot be kept fully occupied in skidding throughout the day.

If tractors are used for log stacking under normal conditions other than the above, both a financial loss and a decrease in production will be experienced. Assistance in stacking by the tractor will under present conditions only be financially justified when daily labour costs exceed R1,05 per day per unit.

Table T.S. 7 indicates the financial and log-skidding production losses which would be experienced over various skidding distances where the blade is used for stacking and where the average labour cost per manday is 50c.

TABLE T.S. 7 - Financial losses incurred by stacking by bulldozer blade when labour costs 50 cents per day

Average distance	Decrease in volume skidded	Increased cost per m^3	Increased cost per m^3
m	%	c	%
75	28	3,9	26
150	20	5,3	23
225	16	5,3	19
300	13	6,4	16
375	11	6,7	13
450	10	7,1	10

Table T.S. 8 indicates the log-skidding production losses, but financial gains which would be experienced over various skidding distances where the blade is used for stacking and where the average labour cost is R3,00 per day (as in the Cape Midlands).

TABLE T.S. 8 - Financial gains made by stacking by bulldozer blade when labour costs R3,00 per day

Average distance	Decrease in volume skidded	Decreased cost per m^3	Decreased cost per m^3
m	%	c	%
75	28	3,9	10
150	20	5,3	11
225	16	15,5	25
300	13	20,8	26
375	11	26,5	29
450	10	36,0	31

Note: Losses in tractor-skidding production may be more important than the economic considerations

(K) PRECAUTIONS FOR LOG SKIDDING BY TRACTOR

(1) To reduce hazards along skid paths and particularly around landings, dead trees or branches that might be jarred by the machine or its load should be felled or pulled down. Otherwise the tractor operator and others will be in danger of having an entire tree or heavy branch come down on them.

(2) For safe operation, the tractor operator should be well trained and always alert. Tractor

drivers should be carefully selected. They should be taught that to work efficiently they must guard against danger to themselves, their machines, and others working in the woods.

(3) Tractor operators should not wear slippery-soled boots.

(4) No person should be allowed on the tractor or its accessories, except in the seat provided.

(5) The tractor should work up and down the slope as much as possible. Working on side slopes with a tractor is dangerous. The tractor is likely to side slip and then, when it comes up against a stump or rock, to turn over.

(6) A substantial metal guard for the protection of the driver should be installed on every tractor used in logging or road construction in timbered areas. This guard should be strongly constructed to afford adequate protection for the driver against trees being pulled over, brush and branches. It should be of sufficient width and height so that it will not impair the movements of the driver or prevent his immediate escape from the tractor in emergencies. Tractors used for skidding should be provided with a guard behind the seat to protect the driver.

(7) Logging sulkies (or arches) should be equipped with line guards. These line guards shall be kept in place and in good repair at all times when the tractor is in use.

(8) The mechanical condition of the tractor should be good to ensure the safety of the driver and other workmen. Operating a tractor with unsafe brakes or steering devices is strictly prohibited.

(9) Tractors should be started only by the operators or by competent men.

(10) Tractors shall not be operated on grades upon which the tractor cannot be adequately controlled. Skid paths should be bulldozed where there is danger of the tractor slipping, or tipping over on steep side slopes.

(11) Tractor brakes should be sufficient to hold the tractor on any grade over which it is being operated and should be in good repair.

(12) When tractors are near workmen, all movements should be regulated by hand signals.

(13) Tractors should not be moved until all men are clear of the machine.

(14) The operator should use caution in backing the tractor or logging arch (sulky) towards workmen.

(15) Particular care should be taken to prevent overturning the arch (sulky).

(16) Tractor, logging arch (sulky) or logs should not be permitted to rub against anchor lines or tail hold stumps of cable machinery.

(17) Surfaces of decks, fenders and bulldozer arms of tractors shall be of material and/or design to effectively eliminate slippery conditions. In lieu of this, footwear should be used which will effectively prevent slipping. Persons not so equipped are not allowed on the tractor.

(18) Tractors shall not be left standing on steep grades without first setting the brakes, shifting into a low gear, stopping the engine, and lowering the blade.

(19) No person shall go under a tractor, or in a hazardous position around the tractor or attached equipment without first definitely notifying the driver or making certain that the equipment cannot move.

(20) Chokers should be attached near the end of the log when tractor skidding.

(21) Riding on logging arches (sulkies), logging pans, logs or any part of the tractor or attached equipment, except in the driver's seat, is prohibited.

(22) Logs shall not be swung over the tractor by a loading machine.

(23) A workman shall not stand upon the track of a tractor or arch unless he is required to do so by the nature of the work which he is doing, and then only when the engine has been stopped.

(24) In tractor operations workmen should watch at all times for rolling logs, snags, or other hazards caused by the movements of tractors, logs or lines.

(L) PRECAUTIONS FOR WIRE ROPE AND CHAINS USED WITH TRACTORS

(1) The logs are first choked or chained by chokers or logging chains before hooking to the power unit.

(2) Tractor choker assemblies consist of wire rope slings with one end eye-spliced (socketed or wedge socketed) and the other end ferruled. The Bardon choker hook slides on the sling between the eye-splice and ferrule.

(3) Dwarf size chocker hook ferrule D. 5 and 16 mm wire rope are used for 26 to 33 kilowatt tractors and the bantam-size choker hook ferrule B. 6 and 19 mm wire rope for 45 to 60 kilowatt tractors.

(4) The choker slings should be in good order.

(5) The wire rope slings should not be kinked or damaged.

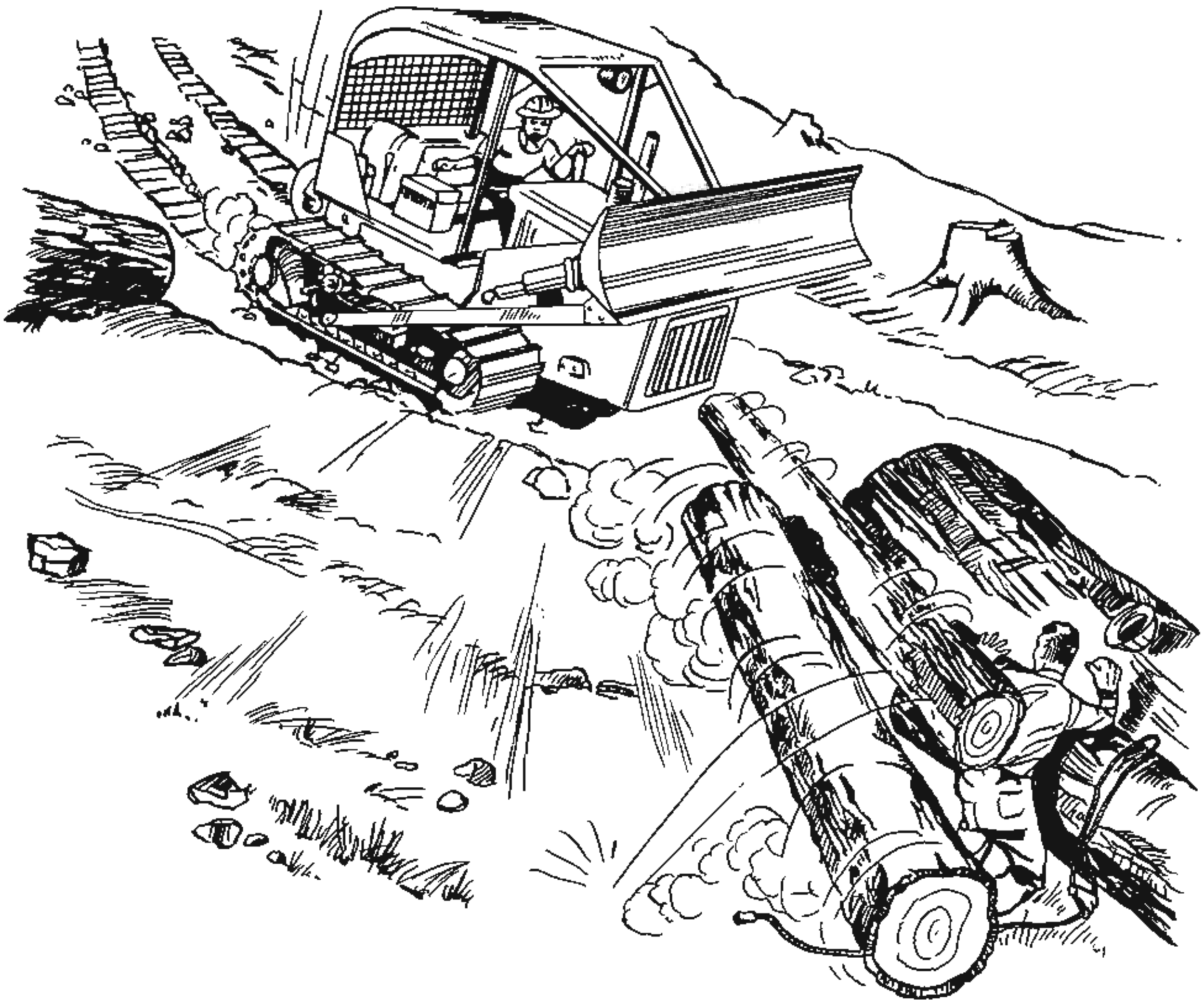
(6) Eye splices should be properly constructed, or sockets fitted that will make a fitting that will be as strong as the rope itself.

(7) A choker wire sling shall not be used when 10% of the wires is broken within a distance of one wrap (lay).

(8) Tractor chain fittings should be attached with welded screw pin clevises, and not with split links, cold shuts, etc.

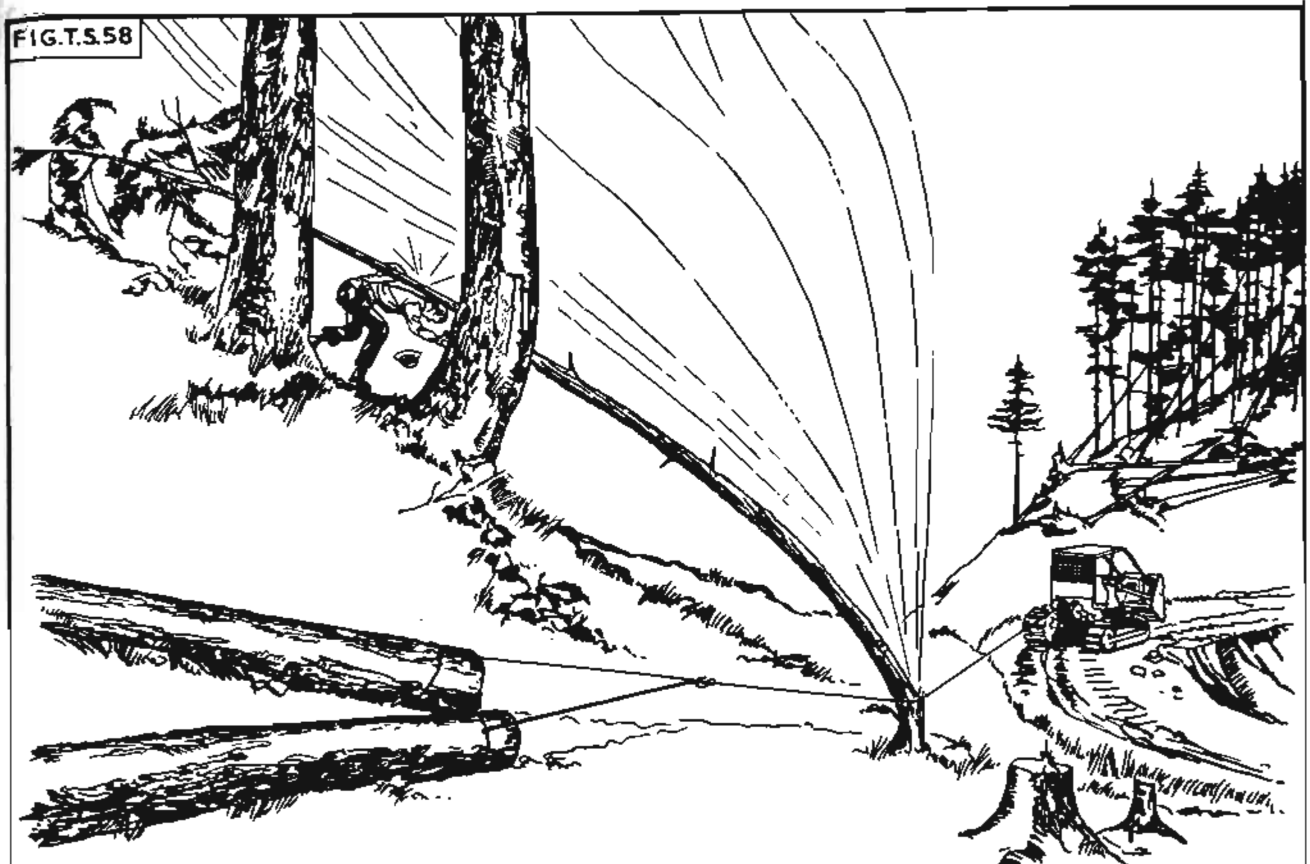
(9) Wire rope on the tractor winch drum should be of suitable length: The crushing stress on a too full winch drum has a destructive effect on the rope.

FIG. T. S. 57.



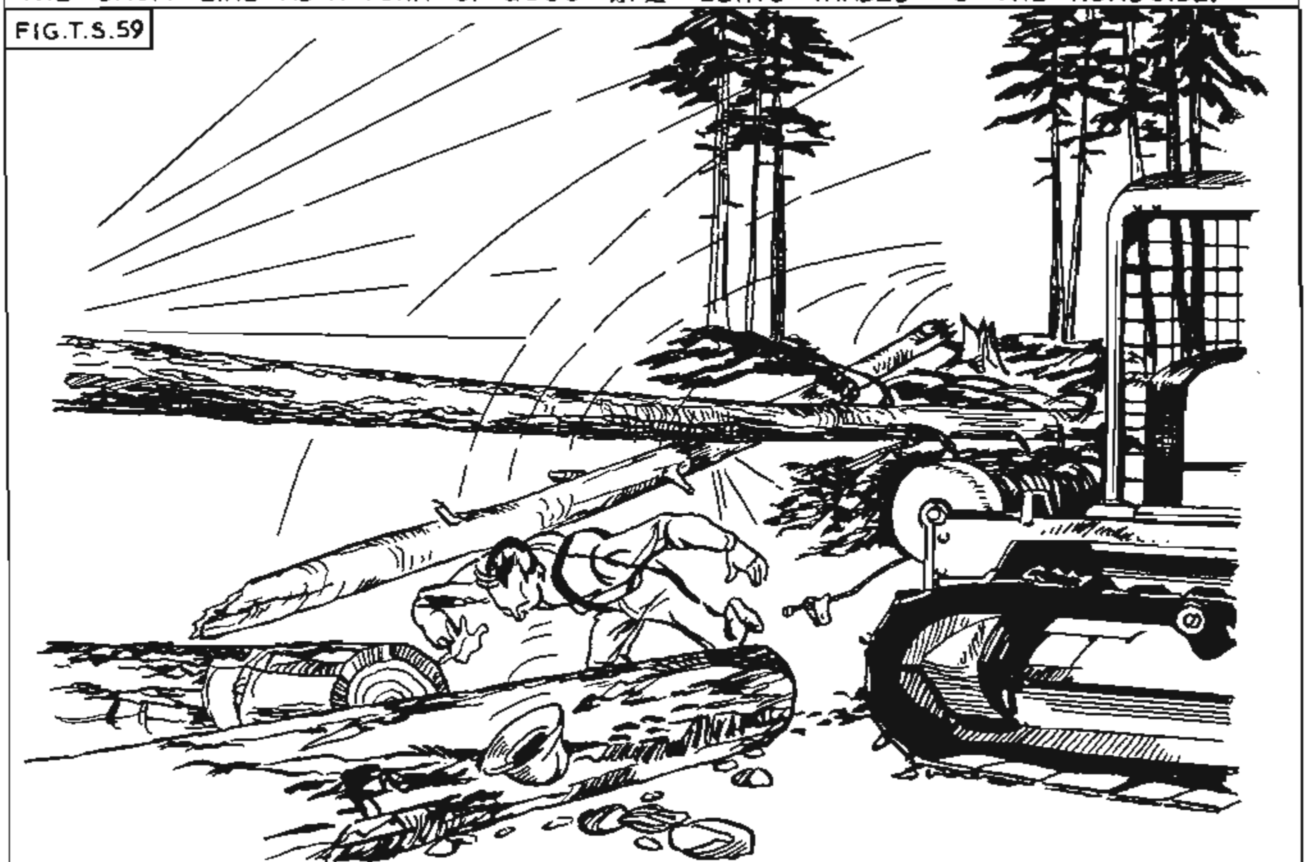
CHOKER SETTER KILLED WHEN CRUSHED BY LOGS THAT ROLLED DOWN THE HILLSIDE ONTO HIM AS HE WAS SETTING A CHOKER. IT IS BELIEVED THAT THE FIRST LOG WAS STARTED ROLLING BY THE VIBRATION CAUSED BY THE MOVEMENT OF THE TRACTOR.

FIG.T.S.58



CHOKER SETTER STRUCK ON HEAD BY A SAPLING THAT WAS KNOCKED OVER BY THE DRUM LINE AS A TURN OF LOGS WAS BEING YARDED TO THE ROADSIDE.

FIG.T.S.59



A CHOKER SETTER WAS KILLED WHEN STRUCK BY A SNAG THAT WAS KNOCKED OVER WHEN STRUCK BY THE BUTT OF A TREE THAT WAS FELLED BY THE TIMBER FELLER

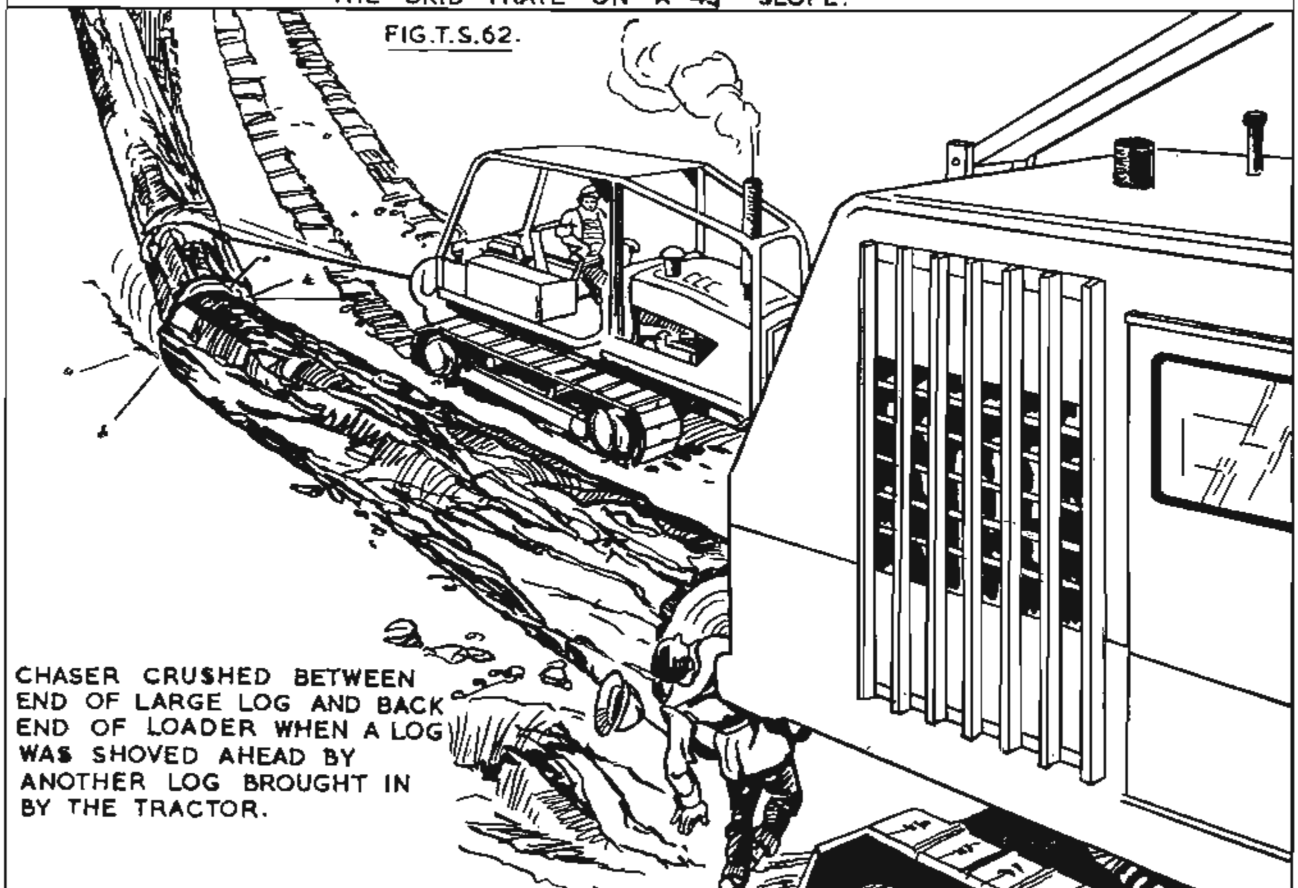
FIG. T.S. 60.

A SHORT LOG, TOWED BEHIND THE TRACTOR, HUNG UP ON A STUMP AS THE TRACTOR MOVED FORWARD. THE LOG SWUNG IN AN ARC AND STRUCK THE CHOKER SETTER IN THE CHEST, KILLING HIM. HE WAS STARTING TO SIT DOWN A SHORT DISTANCE TO THE SIDE OF THE SKIDPATH.

FIG.T.S. 61

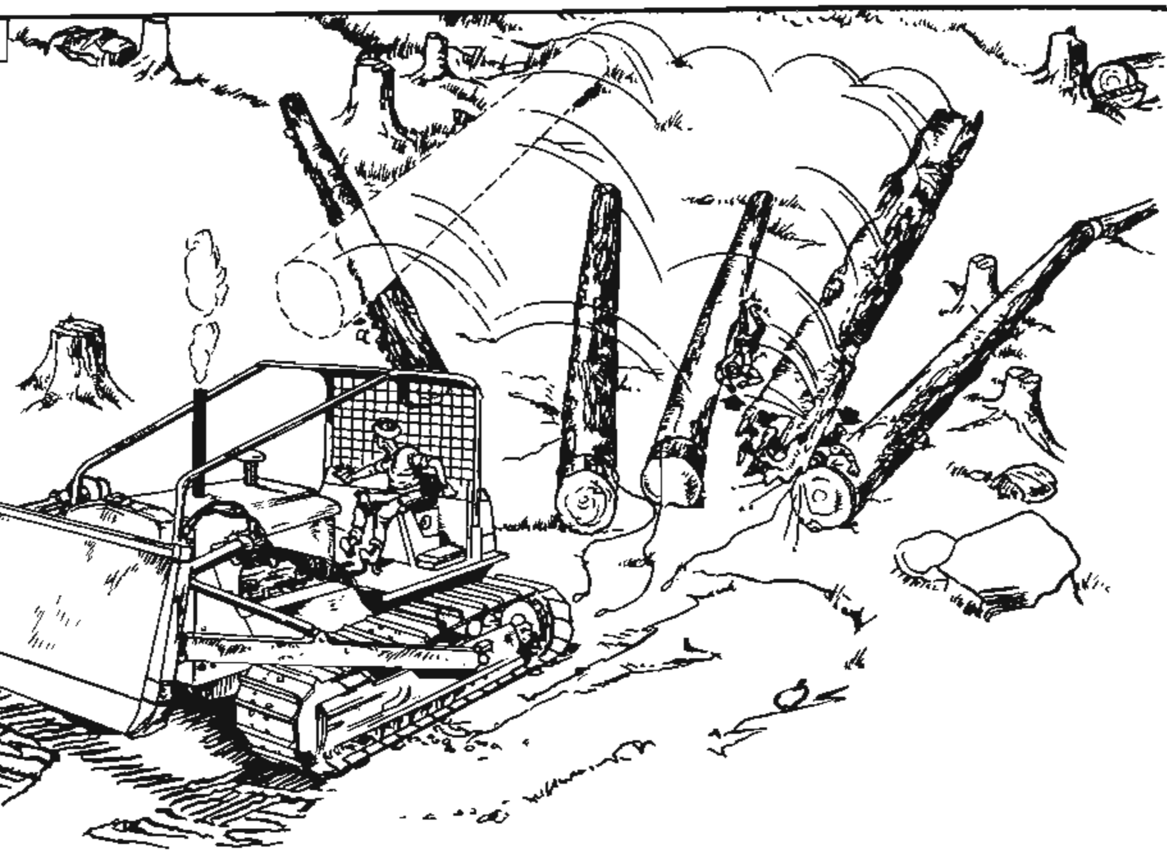
CHOKER SETTER KILLED WHEN CRUSHED AGAINST THE DRUM OF THE TRACTOR BY A LOG THAT ROLLED BACK, THEN SLID FORWARD AFTER BEING PUSHED OUT OF THE SKID TRAIL ON A 45° SLOPE.

FIG.T.S.62.



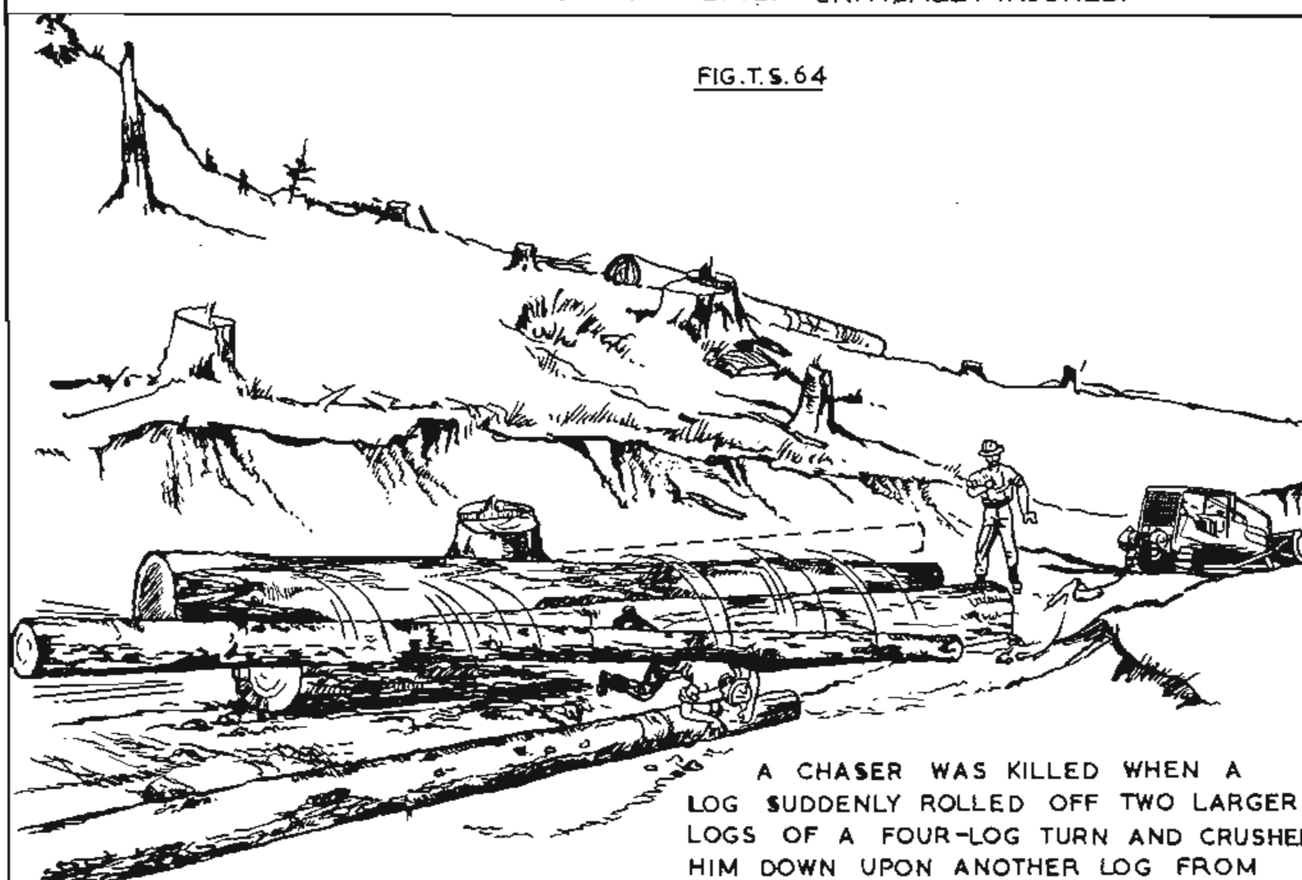
CHASER CRUSHED BETWEEN END OF LARGE LOG AND BACK END OF LOADER WHEN A LOG WAS SHOVED AHEAD BY ANOTHER LOG BROUGHT IN BY THE TRACTOR.

FIG.T.S.63

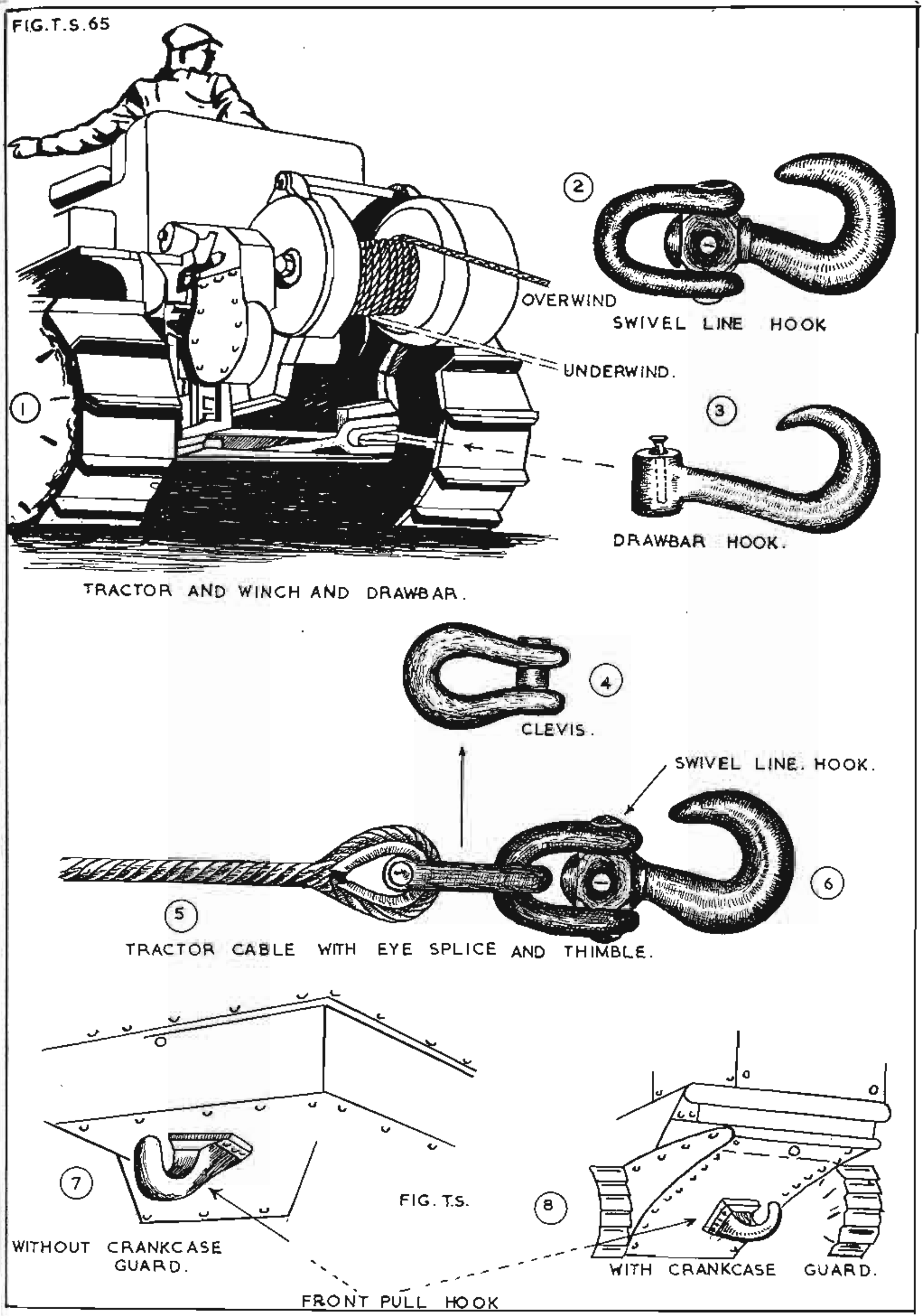


A CHOKER SETTER WAS CRUSHED BY A LARGE WINDFALL LOG THAT ROLLED DOWN THE SLOPE ONTO HIM. THE OTHER CHOKER SETTER CRITICALLY INJURED.

FIG.T.S.64



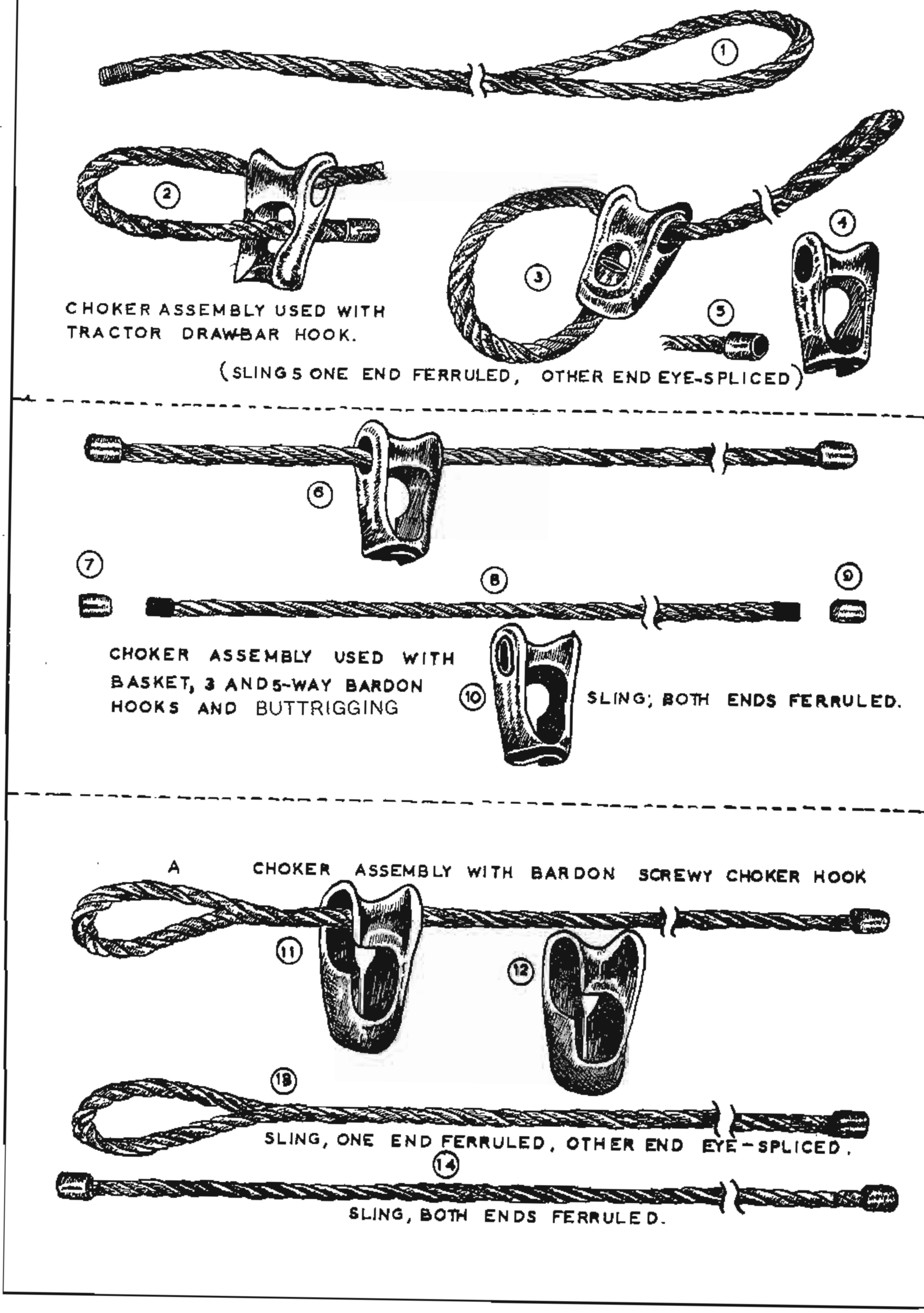
A CHASER WAS KILLED WHEN A LOG SUDDENLY ROLLED OFF TWO LARGER LOGS OF A FOUR-LOG TURN AND CRUSHED HIM DOWN UPON ANOTHER LOG FROM WHICH HE WAS TRYING TO FREE THE CHOKER.



TRACTOR HOOK ATTACHMENTS

FIG. T. S. 66

CHOKER ASSEMBLIES.



(10) All fittings should be of the right size and type. The line hooks should be of the swivelling type, preferably with an "arrow" point.

(11) A snatch block should be used when cable pull is applied in difficult conditions, such as above a steep drop, etc.

(12) The tractor should be tied safely to an anchor point in especially dangerous winching conditions.

(13) All shackles used for joining the fitting should have a strength of not less than one and one half times that of the line they join.

(M) ACCIDENTS IN LOGGING - LOG SKIDDING BY CRAWLER TRACTOR

The drawings and incidents related in this section are reprinted by courtesy of the Oregon Safety Commission, U.S.A., and are accounts of accidents which actually occurred in logging operations. Similar accidents have already occurred in Departmental plantations.

(1) Choker setter killed by rolling logs (Fig. T.S. 57)

A choker setter was killed instantly when crushed by logs that rolled down the hillside onto him as he was setting a choker. It is believed that the first log was started rolling by vibration caused by the movement of the tractor.

Preventive measures

(i) Provide supervision and plan the work so as to avoid working on hillsides below loose logs.

(ii) When possible remove or make secure loose logs that might roll, before working below them.

(2) Choker setter fatally injured by falling sapling (Fig. T.S. 58)

The choker setter died two days later as the result of injuries received when he was struck on the head by a sapling that was pushed over by the winch rope as a turn of logs was being yarded to a road.

Preventive measures

Make certain that workmen are in the clear before moving lines.

(3) Choker setter killed by falling snag (Fig. T.S. 59)

The choker setter died about an hour later as the result of injuries received when he was struck by a tall snag that was knocked over when struck by the butt of a large tree that was felled by a timber feller.

Preventive measures

Separate the yarding from the felling and cross-cutting crew so that they will not be endangering each other.

(4) Choker setter killed by swinging log (Fig. T.S. 60)

A short log in a turn of logs behind a tractor hung up on a stump as the tractor moved forward. The log swung in an arc, a 1 metre limb on it struck the choker setter in the chest, killing him. He was starting to sit down a short distance to the side of the turn of logs.

Preventive measures

(i) If using skid paths, trim down all stumps which may cause logs to 'hang-up'.

(ii) Make sure that workmen are well in the clear before commencing to haul the logs. Workmen should not sit down until well in the clear of moving logs.

(5) Choker setter killed by rolling/sliding log (Fig. T.S. 61)

The choker setter died about two hours later, while en route to the hospital, as the result of injuries received when he was crushed against the drum of the tractor by a log that rolled back and slid forward after being pushed out of the skid trail on a 45 degree slope.

Preventive measures

Make certain that logs are secure before permitting workmen in the area below them.

(6) Unhooker crushed between log and loader (Fig. T.S. 62)

The unhooker was instantly killed when he was crushed between the end of a large log and the back end of the loading machine when the log was shoved ahead by another log that was being brought into the landing by tractor.

Preventive measures

(i) Move logs to a position where they will not be shoved forward by incoming turns of logs.

(ii) Train workmen to stay in the clear as logs are being brought onto the landing.

(7) One choker setter killed, another seriously injured (Fig. T.S. 63)

A choker setter was instantly killed when his head and shoulders were crushed by a large, rotten windfall that, without warning, suddenly rolled down the hillside and over him, and the other choker setter, who was seriously injured.

Preventive measures

(i) Make certain logs are secure before working below them.

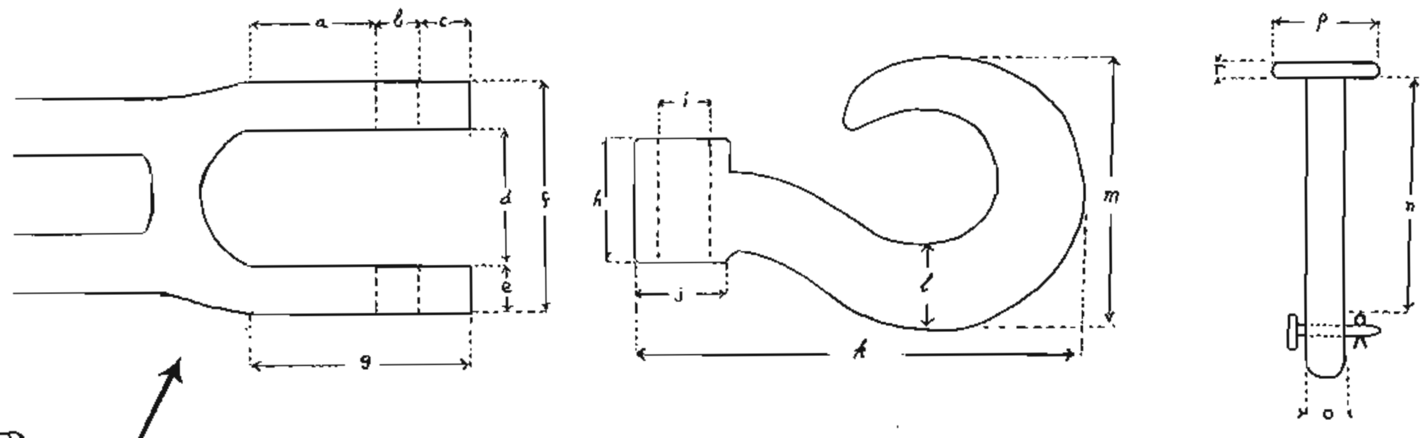
(ii) Don't work below insecure logs: block them or pull another log over them to move them into a secure position.

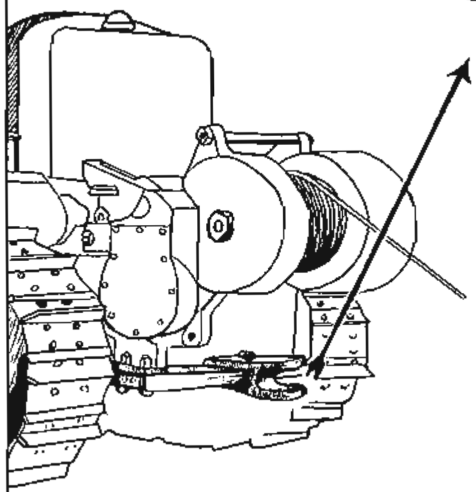
(8) Unhooker killed by rolling log (Fig. T.S. 64)

The unhooker was killed when a large log, 35cm in diameter and 12m long, suddenly rolled off two larger logs of a four log turn and crushed him down upon another log, from which he was trying to free the choker.

FIG. T.S. 67

TRACTOR DRAW-BAR HOOK AND HOOK ATTACHMENT





SPECIFICATIONS

TRACTOR MAKE:-

MODEL:-

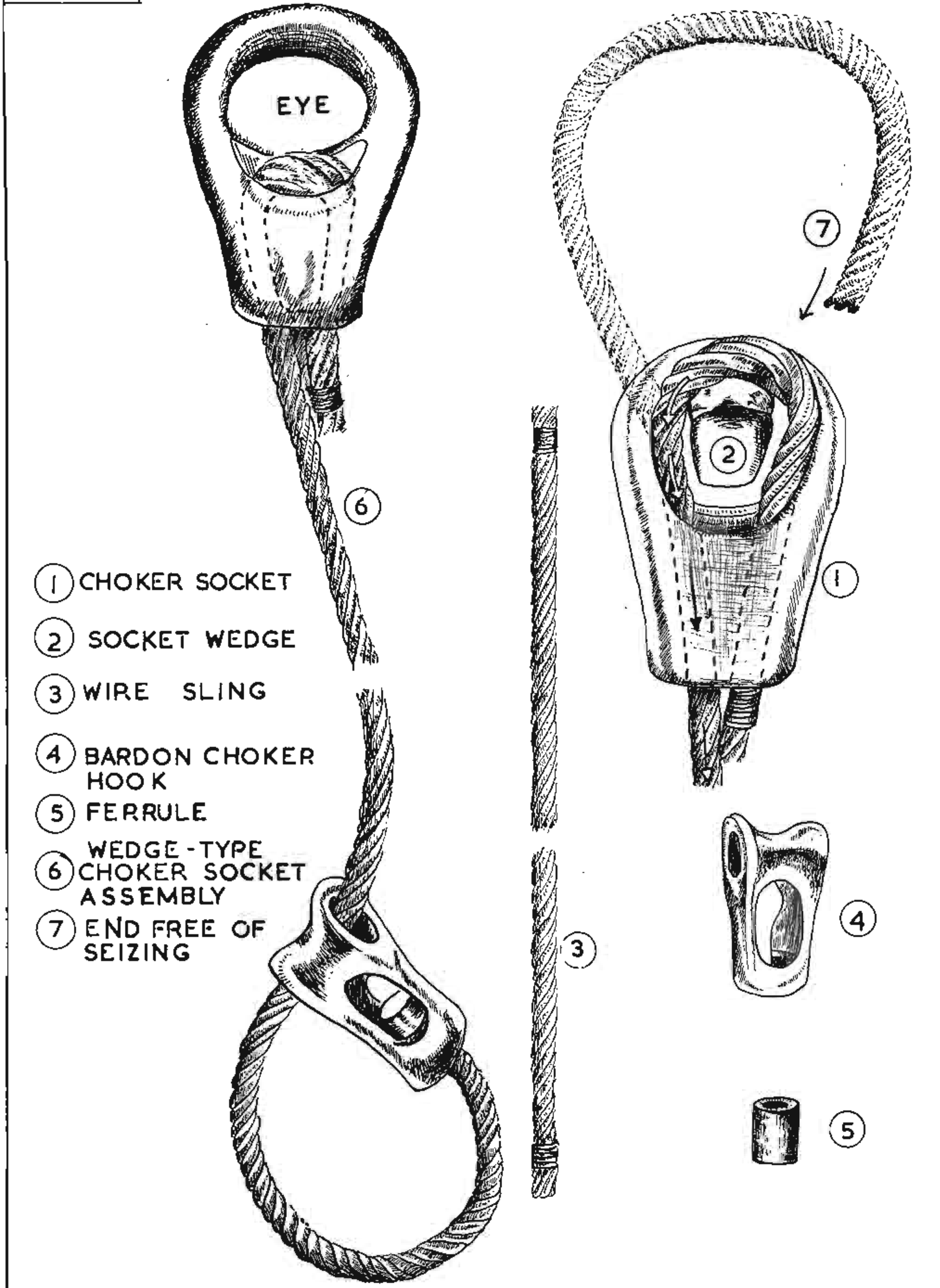
SERIAL NO:-

D.B. NO:-

MEASUREMENTS.

DRAWBAR HOOK ATTACHMENT		DRAWBAR HOOK		PIN	
a.	----------------	h	----------	n	--------
b.	----------------	i	----------	o.	--------
c.	----------------	j.	----------	p.	--------
d.	----------------	k.	----------	r.	--------
e.	----------------	l.	----------		
f.	----------------	m.	----------		
g.	----------------				

FIG. T. S. 68


EYE
1 CHOKER SOCKET
2 SOCKET WEDGE
3 WIRE SLING
4 BARDON CHOKER HOOK
5 FERRULE
6 WEDGE-TYPE CHOKER SOCKET ASSEMBLY
7 END FREE OF SEIZING
1
2
3
4
5
6
7

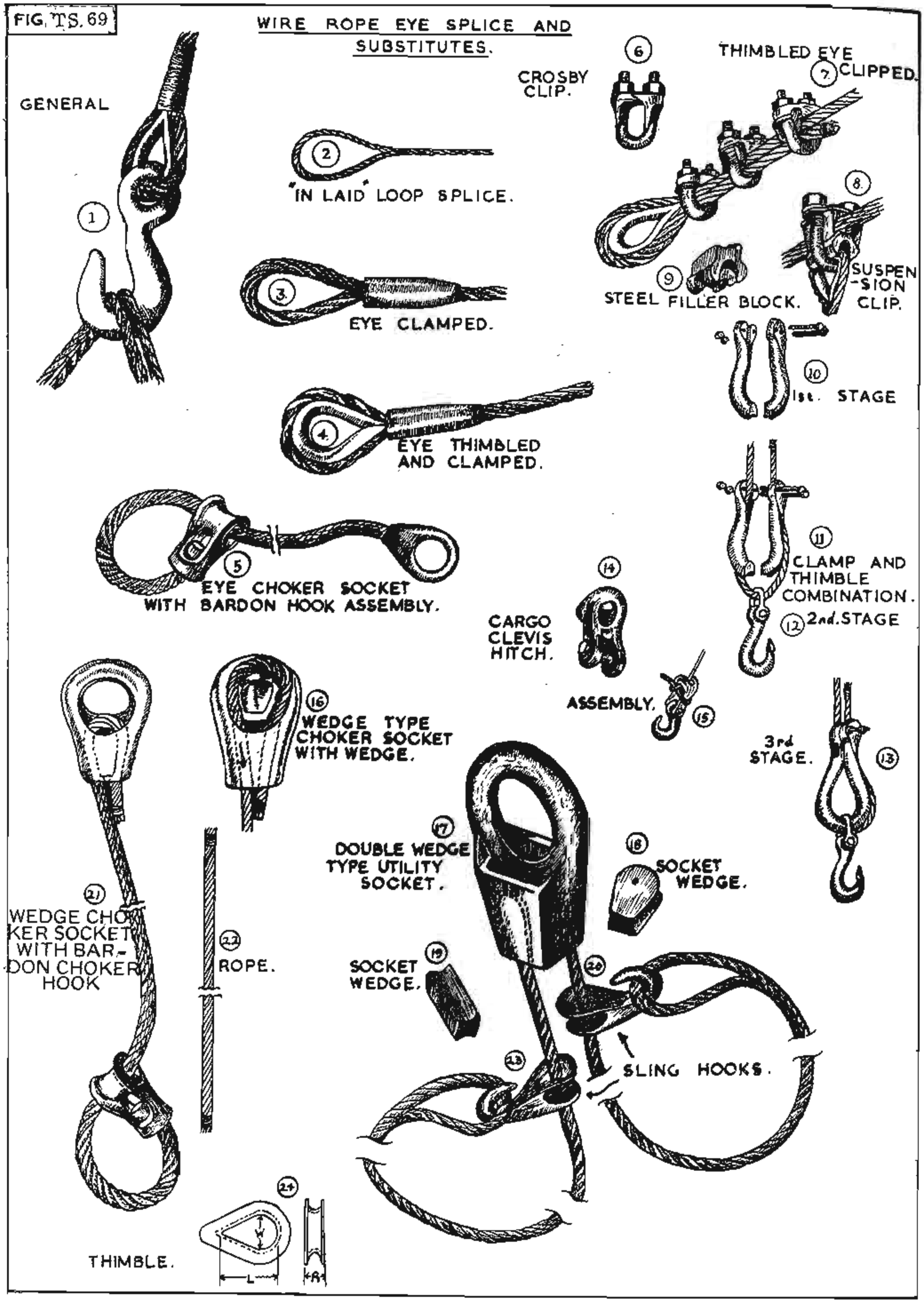


FIG. TS. 69
WIRE ROPE EYE SPLICE AND SUBSTITUTES.
GENERAL
1
2
"IN LAID" LOOP SPLICE.
3
EYE CLAMPED.
4
EYE THIMBLED AND CLAMPED.
5
EYE CHOKER SOCKET WITH BARDON HOOK ASSEMBLY.
6
CROSBY CLIP.
THIMBLED EYE
7 CLIPPED.
8
9
STEEL FILLER BLOCK.
SUSPEN-SION CLIP.
10
1st. STAGE
11
CLAMP AND THIMBLE COMBINATION.
12 2nd. STAGE
3rd STAGE.
13
14
CARGO CLEVIS HITCH.
ASSEMBLY.
15
16
WEDGE TYPE CHOKER SOCKET WITH WEDGE.
17
DOUBLE WEDGE TYPE UTILITY SOCKET.
18
SOCKET WEDGE.
19
SOCKET WEDGE.
20
SLING HOOKS.
21
WEDGE CHOKER SOCKET WITH BARDON CHOKER HOOK
22
ROPE.
23
24
THIMBLE.
W
L
R

FIG. TS 70

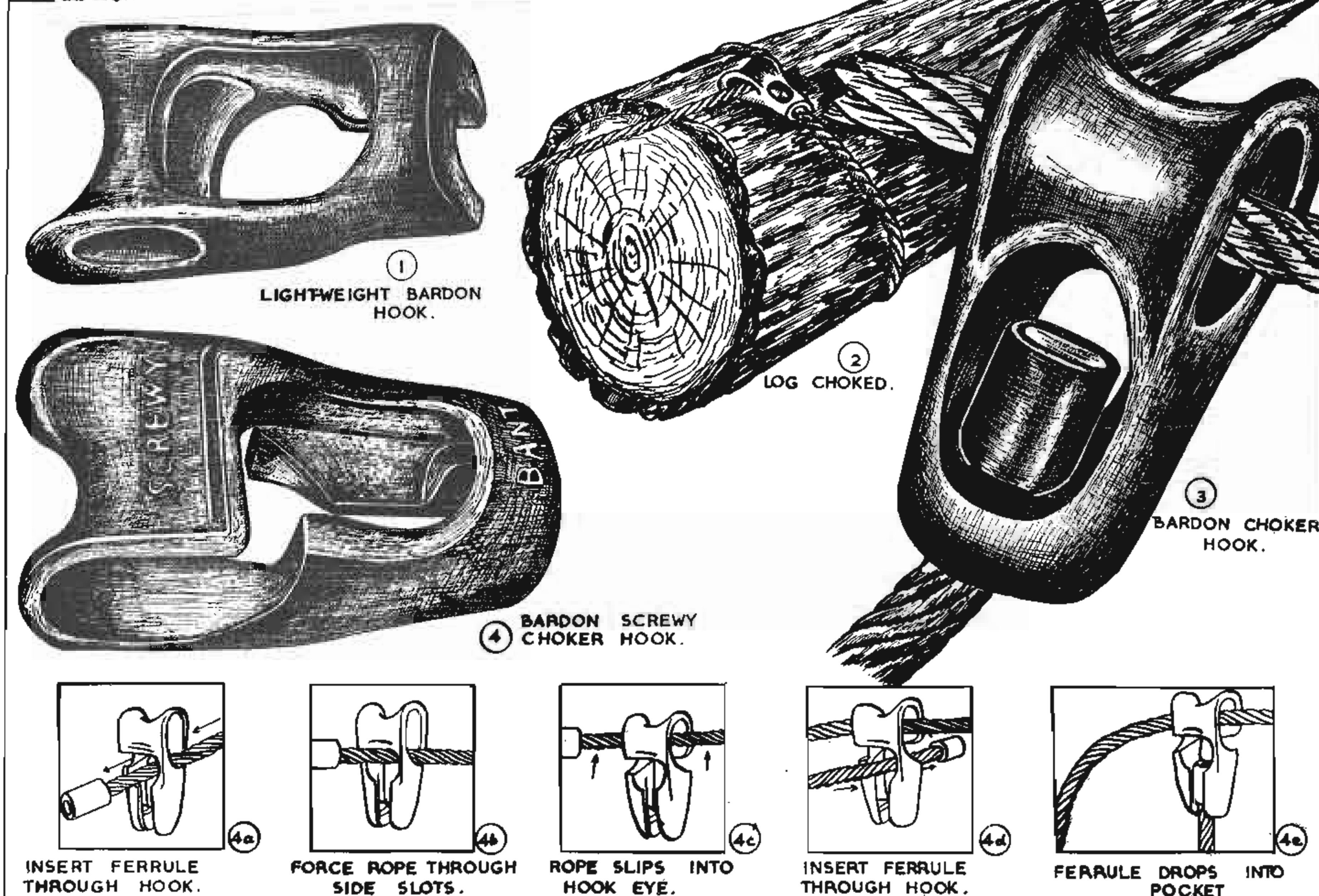
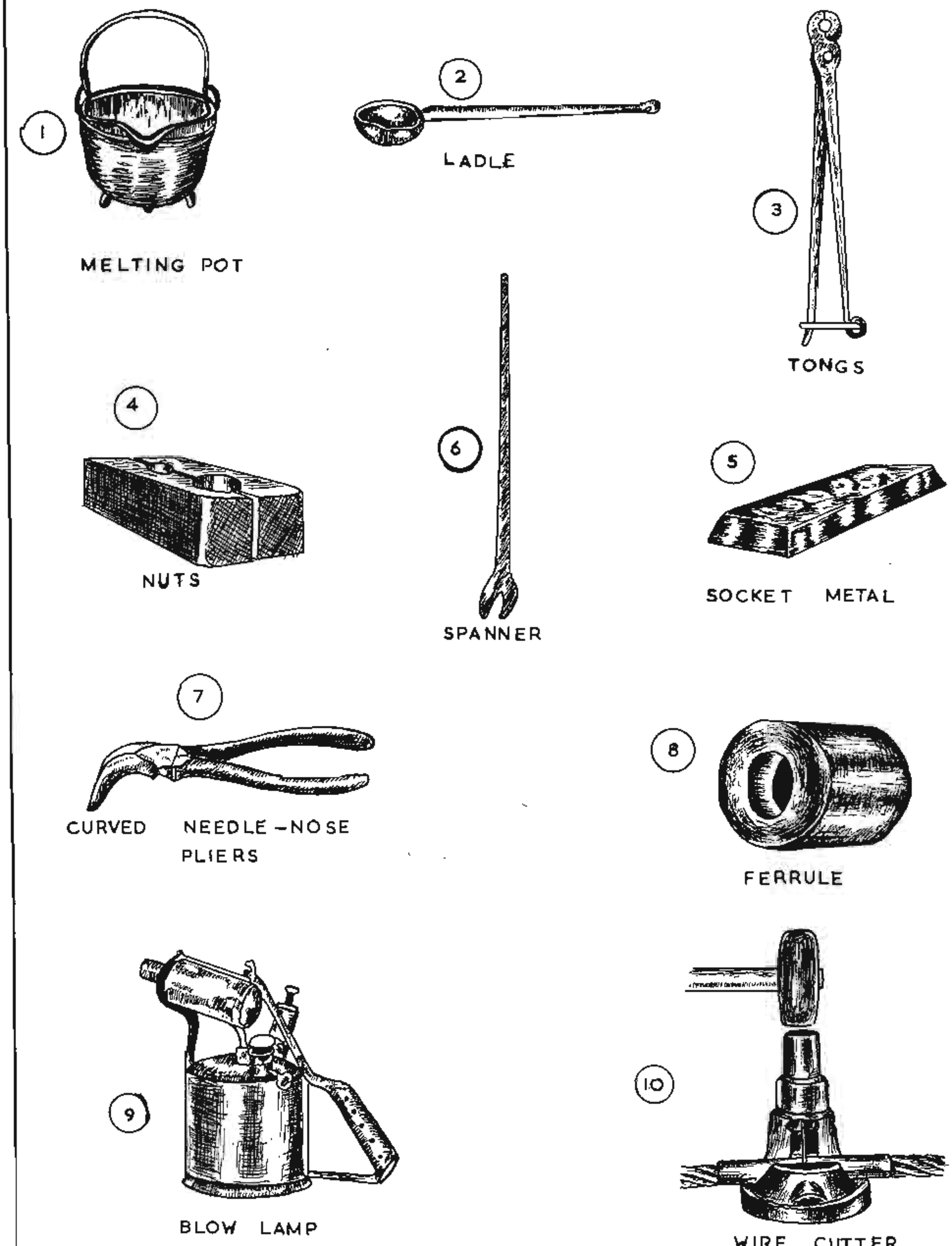

① LIGHT-WEIGHT BARDON HOOK.
② LOG CHOKED.
③ BARDON CHOKER HOOK.
④ BARDON SCREWY CHOKER HOOK.
SCREWY
BANT
4a INSERT FERRULE THROUGH HOOK.
4b FORCE ROPE THROUGH SIDE SLOTS.
4c ROPE SLIPS INTO HOOK EYE.
4d INSERT FERRULE THROUGH HOOK.
4e FERRULE DROPS INTO POCKET

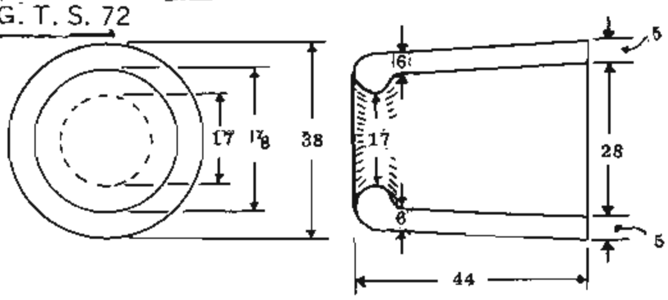
FIG. T. S. 71

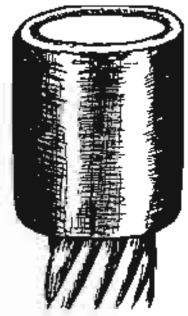
TOOLS USED FOR ATTACHING FERRULE TO WIRE ROPE



NOT TO SCALE

FIG. T. S. 72



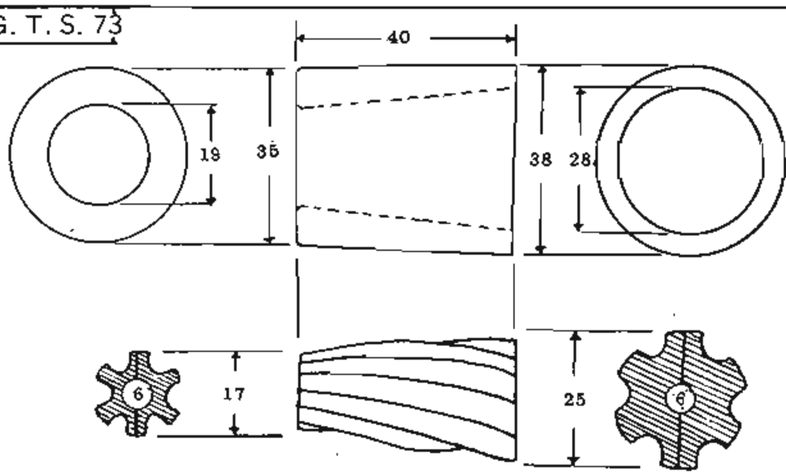


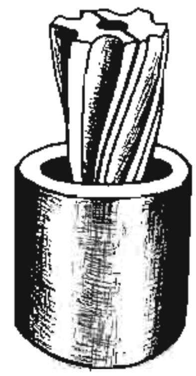
DWARF FERRULE FOR WIRE ROPE SLINGS.

MATERIAL: HEAT-TREATED, SHOCK-RESISTANT ALLOY STEEL

ALL DIMENSIONS IN mm

FIG. T. S. 73





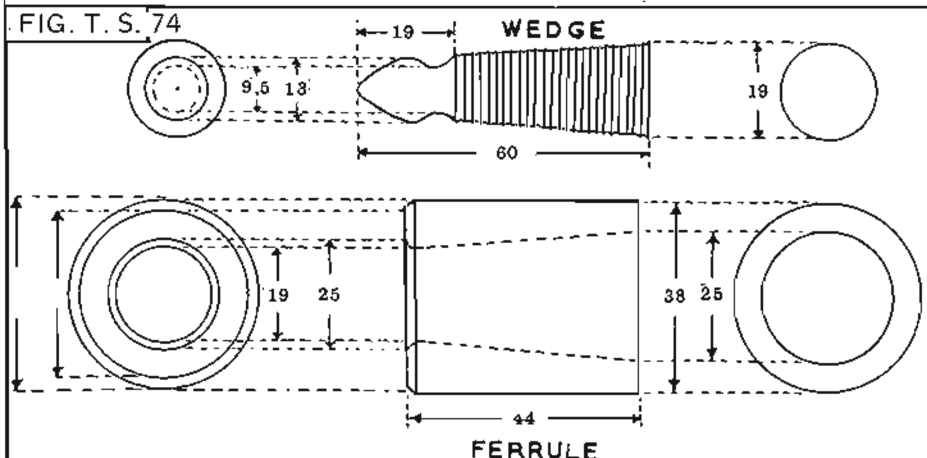
SPIRAL WEDGE FERRULE FOR WIRE ROPE SLINGS.

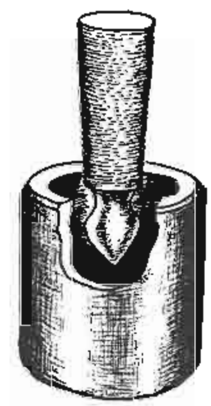
MATERIAL: HEAT-TREATED, SHOCK-RESISTANT ALLOY STEEL.

WEDGES: MANGANESE STEEL

ALL DIMENSIONS IN mm

FIG. T. S. 74





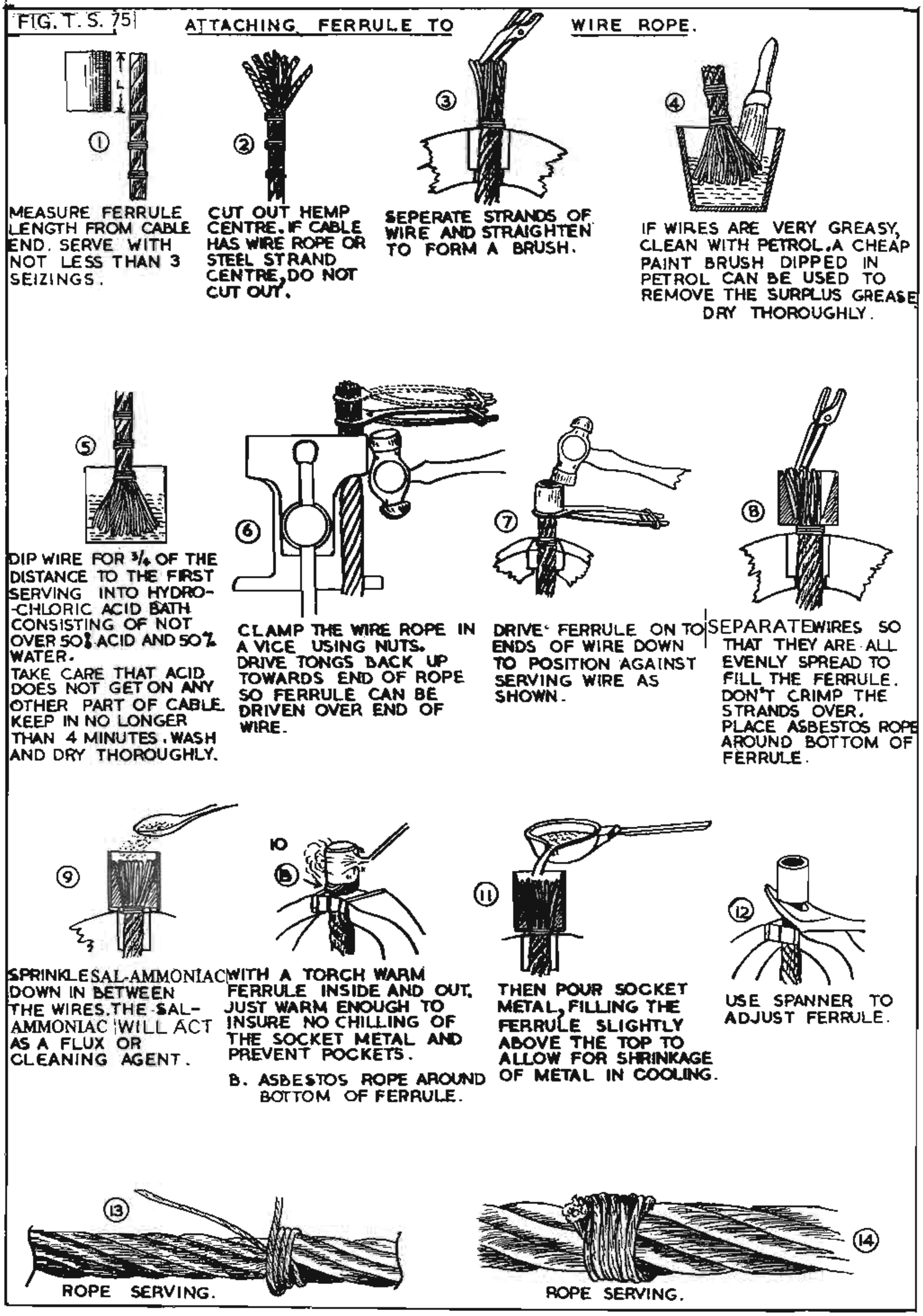
WEDGE FERRULE FOR WIRE-ROPE SLINGS

MATERIAL: HEAT-TREATED, SHOCK-RESISTANT ALLOY STEEL

WEDGES: MANGANESE STEEL

ALL DIMENSIONS IN mm

FIG. T. S. 75 ATTACHING FERRULE TO WIRE ROPE.



1. MEASURE FERRULE LENGTH FROM CABLE END. SERVE WITH NOT LESS THAN 3 SEIZINGS.

2. CUT OUT HEMP CENTRE. IF CABLE HAS WIRE ROPE OR STEEL STRAND CENTRE, DO NOT CUT OUT.

3. SEPERATE STRANDS OF WIRE AND STRAIGHTEN TO FORM A BRUSH.

4. IF WIRES ARE VERY GREASY, CLEAN WITH PETROL. A CHEAP PAINT BRUSH DIPPED IN PETROL CAN BE USED TO REMOVE THE SURPLUS GREASE DRY THOROUGHLY.

5. DIP WIRE FOR 3/4 OF THE DISTANCE TO THE FIRST SERVING INTO HYDRO-CHLORIC ACID BATH CONSISTING OF NOT OVER 50% ACID AND 50% WATER. TAKE CARE THAT ACID DOES NOT GET ON ANY OTHER PART OF CABLE. KEEP IN NO LONGER THAN 4 MINUTES. WASH AND DRY THOROUGHLY.

6. CLAMP THE WIRE ROPE IN A VICE USING NUTS. DRIVE TONGS BACK UP TOWARDS END OF ROPE SO FERRULE CAN BE DRIVEN OVER END OF WIRE.

7. DRIVE FERRULE ON TO ENDS OF WIRE DOWN TO POSITION AGAINST SERVING WIRE AS SHOWN.

8. SEPARATE WIRES SO THAT THEY ARE ALL EVENLY SPREAD TO FILL THE FERRULE. DON'T CRIMP THE STRANDS OVER. PLACE ASBESTOS ROPE AROUND BOTTOM OF FERRULE.

9. SPRINKLE SAL-AMMONIAC DOWN IN BETWEEN THE WIRES. THE SAL-AMMONIAC WILL ACT AS A FLUX OR CLEANING AGENT.

10. WITH A TORCH WARM FERRULE INSIDE AND OUT. JUST WARM ENOUGH TO INSURE NO CHILLING OF THE SOCKET METAL AND PREVENT POCKETS.

B. ASBESTOS ROPE AROUND BOTTOM OF FERRULE.

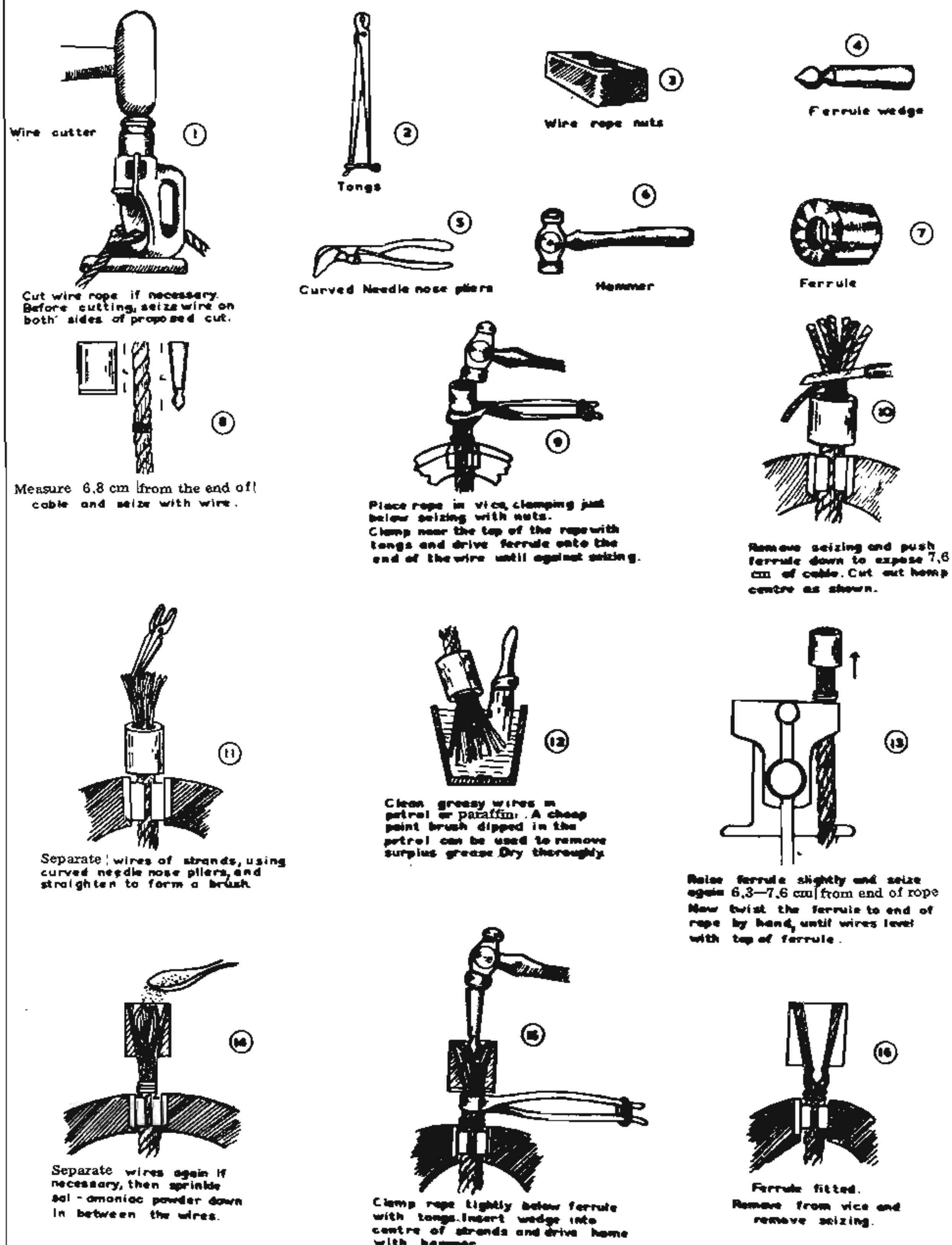
11. THEN POUR SOCKET METAL, FILLING THE FERRULE SLIGHTLY ABOVE THE TOP TO ALLOW FOR SHRINKAGE OF METAL IN COOLING.

12. USE SPANNER TO ADJUST FERRULE.

13. ROPE SERVING.

14. ROPE SERVING.

FIG. T. S. 76 **ATTACHMENT OF WEDGE-TYPE FERRULE TO WIRE ROPE**



Preventive measures

(i) Watch carefully for logs that are likely to roll and do not go into the danger area.

(ii) Unhook the choker from the tractor when it is unsafe to unhook it from the log, then have it moved into a safe position by tractor or loader.

4. LOG SKIDDING BY RUBBER-TYRED WHEEL TRACTORS

A. GENERAL

Refer to Fig. W.T. 1.

In the previous chapters relating to crawler tractors, a brief mention was made of the characteristics of wheel tractors, but some additional and more specific information will be given in this chapter showing the adaptability of this machine to log-skidding operations.

Pneumatic tyres are used with wheel tractors operating in plantations, so it is important to consider the air pressure in the tyre and effect of this tyre pressure on the ground surface, as well as the tyre surface area in contact with the ground, expressed in square centimetres. Practice has shown that the ground-supporting capacity should be one-half greater than the air pressure in the tyre. This condition permits greater play of the tractor springs, which permits the vehicle to negotiate ground obstacles more easily.

Some formulae have been developed to facilitate calculations of the tyre pressure required with respect to the ground supporting quality, so that the best tractor performance can be achieved. Rolling resistance of the tractor is affected by the internal tyre pressure and also the friction of the ball bearings of the tractor wheels.

The coefficient of rolling resistance of the tyres on uniform hard ground is approximately 18 kg/t, and with each 3 cm of penetration of the tyre into the ground the resistance increases by approximately 13 kg/t. For forestry purposes it is advantageous to have the lowest practical rolling resistance, which may be achieved with a tyre pressure of 1,7 kg/cm^2. When the load to be drawn is known, tyres are selected for the work which can operate at a pressure of 1,7 kg/cm^2.

Note: The above applies to specially built tyres which can work under low pressure

In industry, special tables are issued for the purpose of establishing tyre pressure, thus permitting the selection of suitable tyres with the correct pressure for the required load and speed.

Concerning skidding resistance, what has been said previously with regard to the crawler tractor also applies to the wheel tractor. When the wheel tractor is used, however, it is a great advantage if the front end of the load can be lifted, and for this reason every wheel tractor used for log skidding should be equipped with a three-point hydraulically operated lifting attachment mounted on the rear of the tractor. By lifting the front end of the load the skidding resistance is reduced by approximately 25%, while the grip (adhesion) of the tractor wheels on the ground is considerably increased.

When using wheel tractors, the diameter of the wheels, the dampness of the ground and the adhesion of the tyres play an important role. Tractors should have sufficient power to tow the load of logs, but when the wheels start skidding any surplus power is useless.

Data for calculating the coefficient of adhesion are available, but are not really applicable to the forest floor where stones, brush, slash, litter and stumps will upset all calculations, and may even influence the choice of tractor.

The above remarks, which are mainly applicable to tractors working in uniform agricultural or industrial conditions, are not always applicable to forestry log-skidding operations.

B. WHEEL TRACTORS IN LOGGING

Refer to Fig. W.T. 2 to 8.

The Department has made numerous attempts to introduce wheel tractors for log skidding. Some tractors were equipped with a slotted logging drawbar mounted on the three-point lifting attachment, (Fig. W.T. 3 and 7), while others were tried with front or rear-mounted winches (Fig. W.T. 4, 5). Both two and four-wheel driven tractors were tested, propelled by either diesel or petrol engines, ranging from 33 to 48 kW.

Wheel tractors, although fast on the road, are comparatively slow when working in timber felling areas. They frequently have to reverse in order to approach logs due to the difficulties involved in turning among the logs and forest debris. In addition the tractor tyres are subject to puncturing when rolling over roughly cut stumps with jagged splinters, or over sharp stones. The tractor can skid over level ground or mild slopes, but turning round on steep slopes and uphill skidding are out of the question.

Departmental roads are generally not spaced far apart, which means that if wheel tractors are used, their higher speeds cannot be used to much advantage. Hooking and assembling loads for wheel tractors are slow and often cumbersome. The Department seldom uses wheel tractors for log skidding, except in certain plantations where they have been found to be well suited to local conditions. Consequently no accurate data are available with regard to the skidding potential of wheel tractors, but the figures available will be given for consideration.

There are, however, occasions where wheel tractors can be put to work in areas with easy terrain free of obstacles, provided that good supervision is available. Medium diameter logs, too large for slipping by mules, but too small for economic skidding by crawler tractor, provide the optimum working conditions for wheel tractors (Fig. W.T. 8). Wheel tractors can also be used for carting trailer or semi-trailer loads of poles or pulpwood (Fig. W.T. 6).

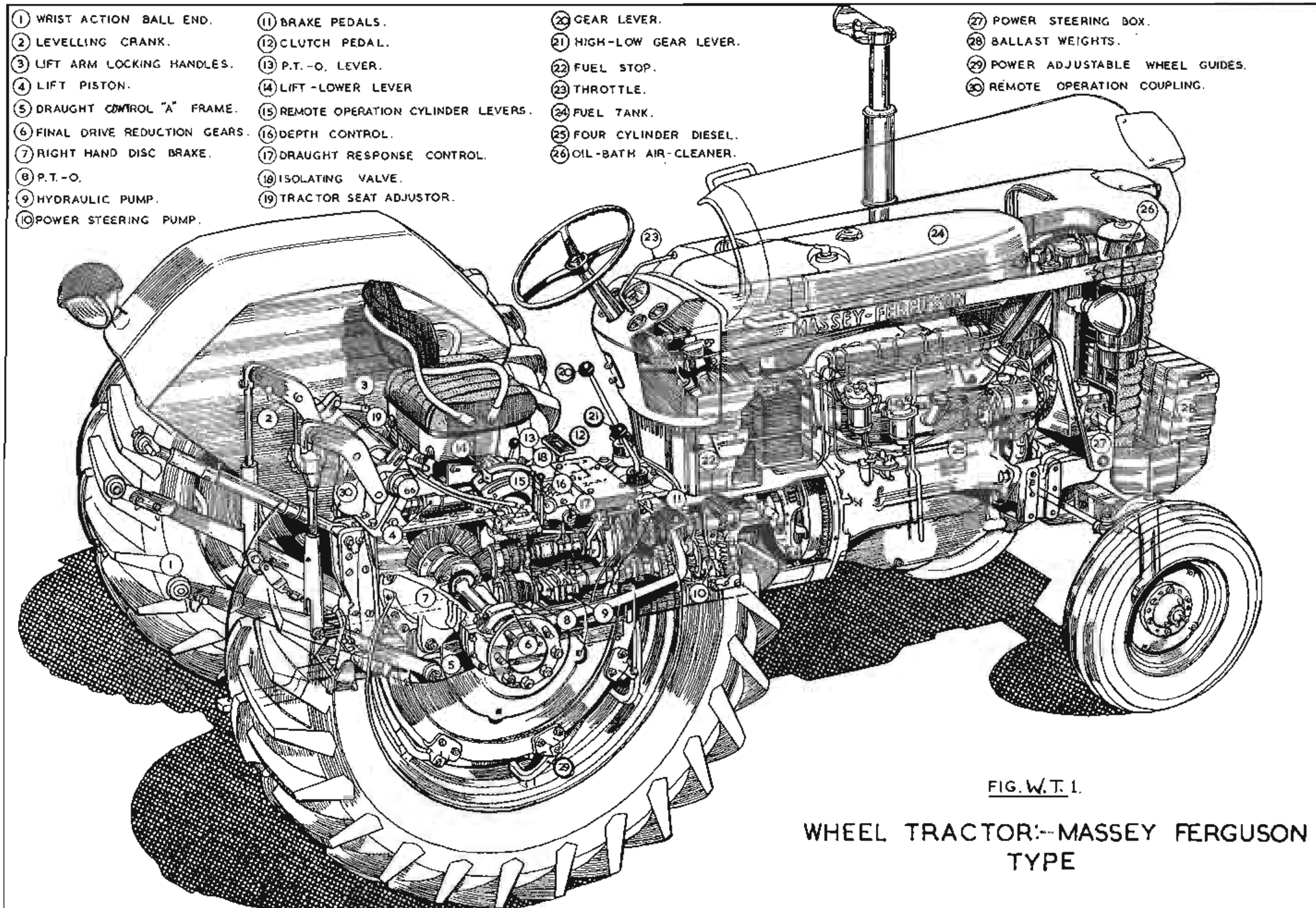
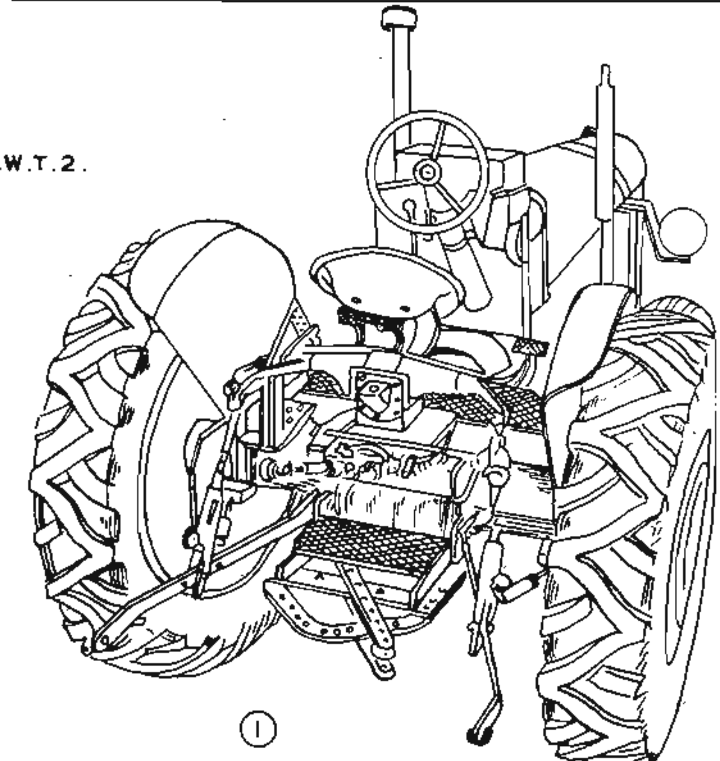


FIG. W.T. 1.

WHEEL TRACTOR:- MASSEY FERGUSON TYPE

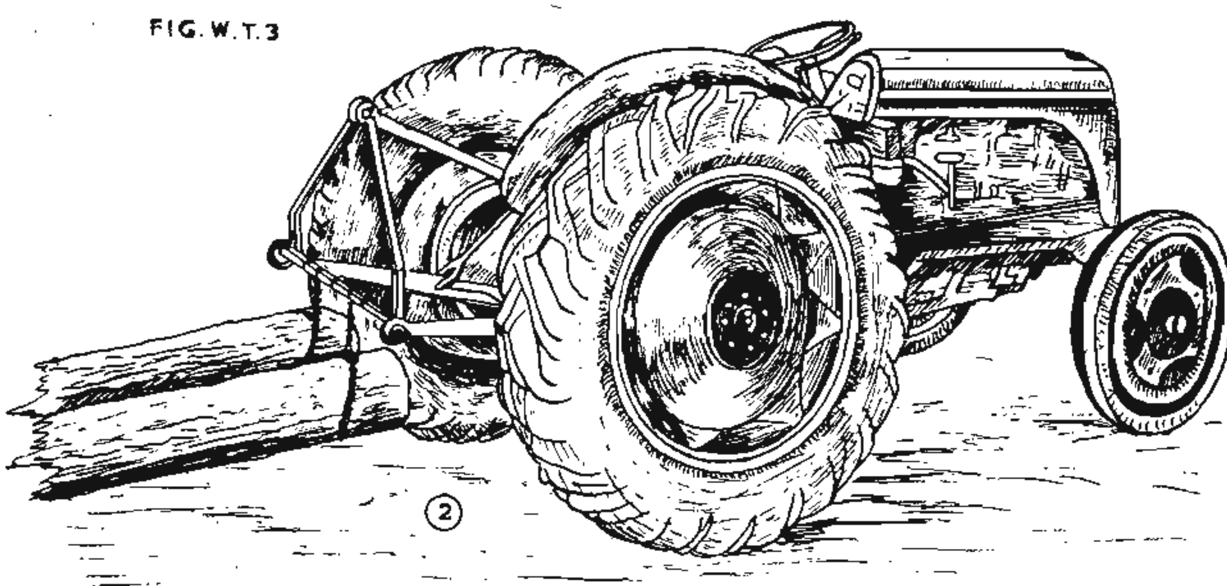
WHEEL TRACTOR FITTED WITH LOG-SKIDDING ATTACHMENT.

FIG. W.T.2.



THREE POINT HYDRAULIC LIFTING ATTACHMENT.

FIG. W.T.3



TRACTOR DRAWBAR IN LIFTED POSITION.

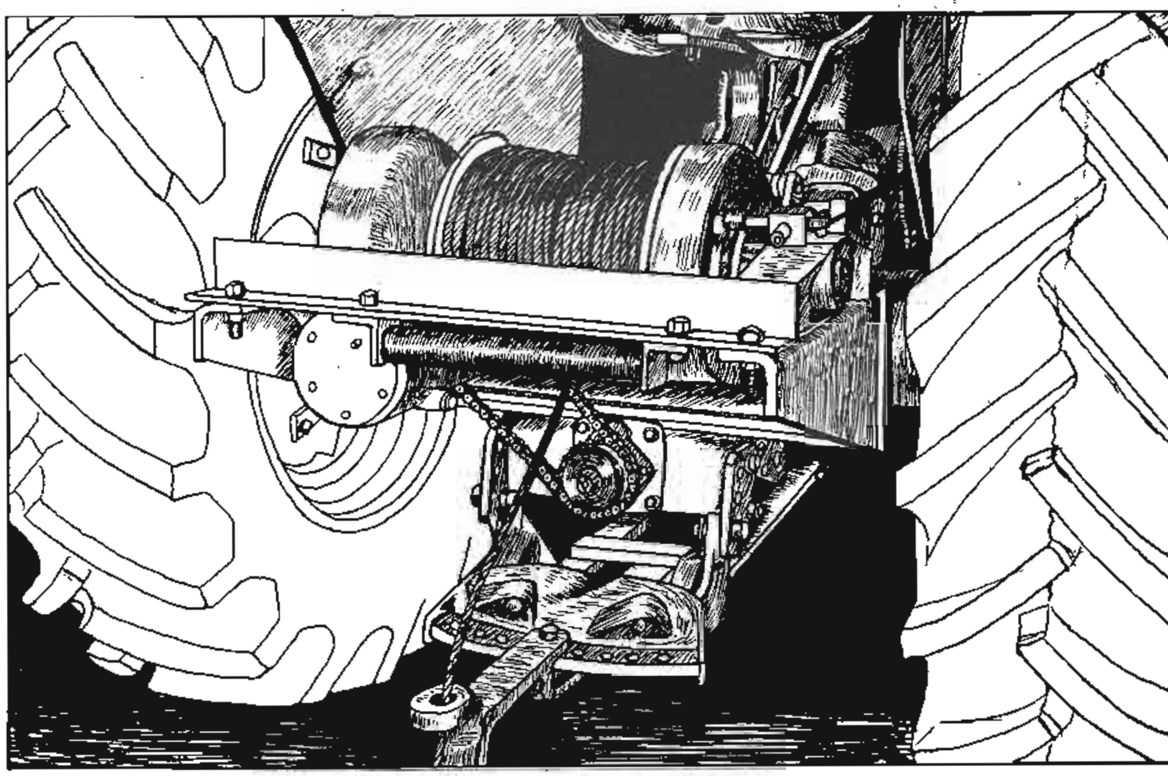


FIG.W.T.4 REAR-MOUNTED WINCH ON WHEEL TRACTOR.

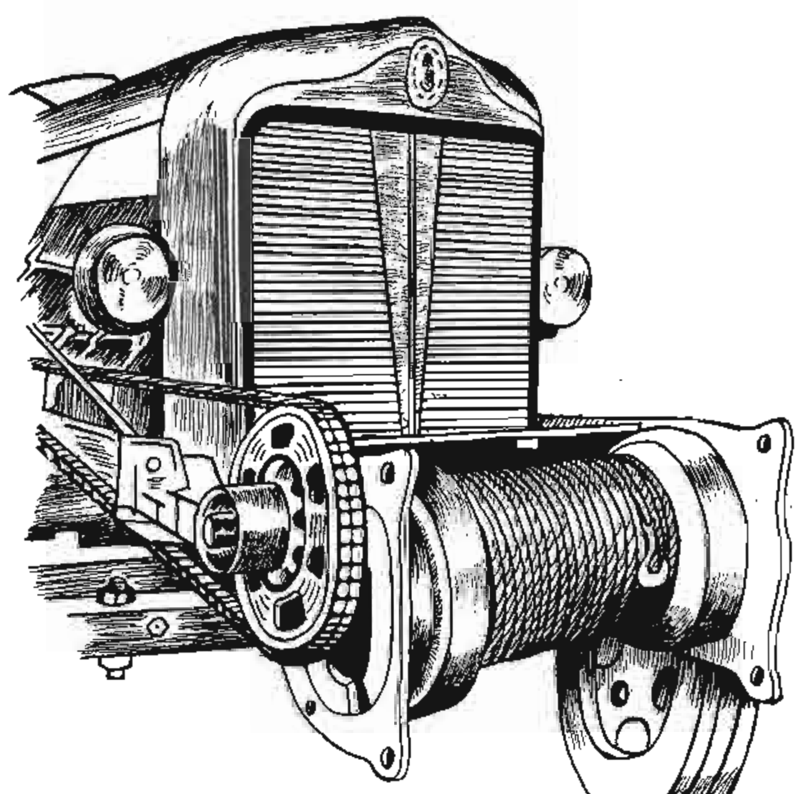
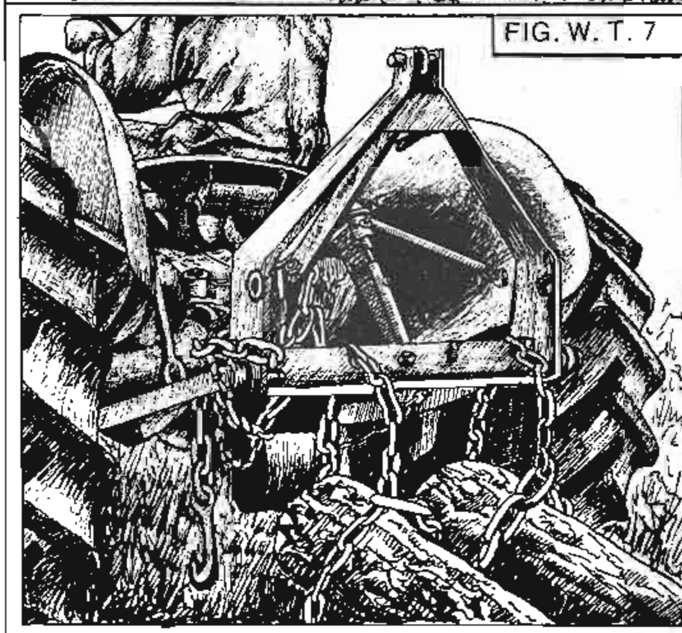


FIG.W.T.5 FRONT-MOUNTED WINCH ON WHEEL TRACTOR

FIG. W. T. 6

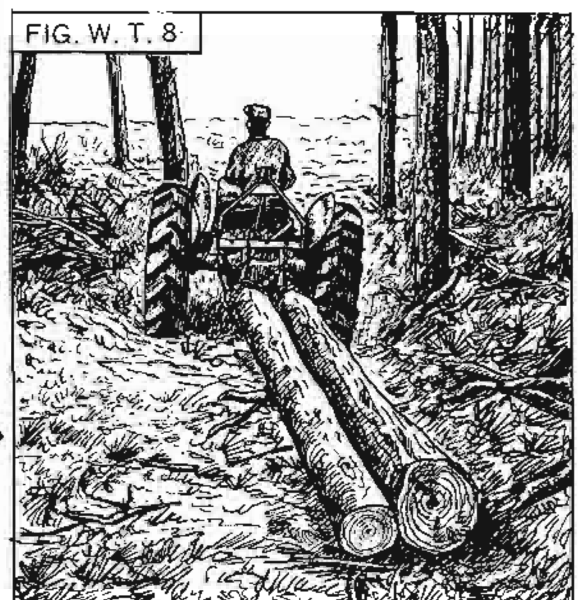
A: TRACTOR WITH SEMI-TRAILER, 6 TON CAPACITY, LOADED WITH SMALL POLES.

FIG. W. T. 7



B: TRACTOR WITH THREE LINKAGE DRAWBAR SUSPENSION FOR LIFTING THE HEADS OF THE LOGS.

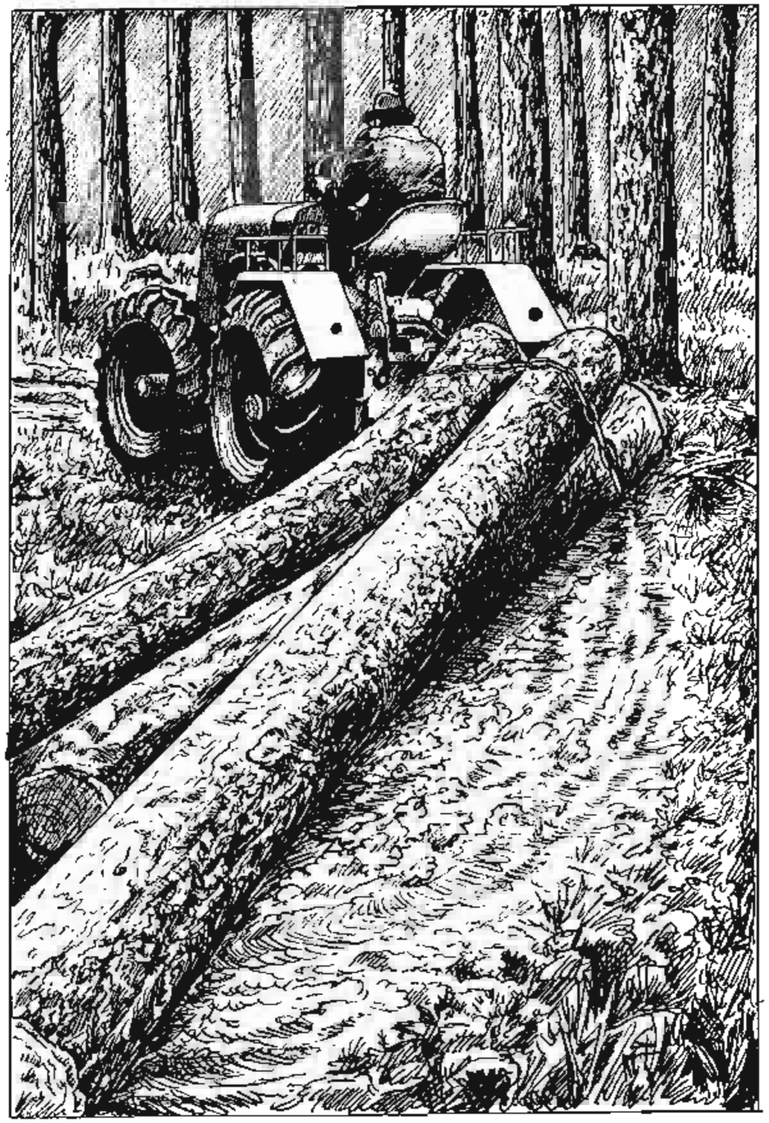
FIG. W. T. 8



C: TRACTOR TOWING LOGS SUSPENDED ON THE DRAWBAR.

UNIMOG WHEEL TRACTOR.

FIG. W.T. 9.



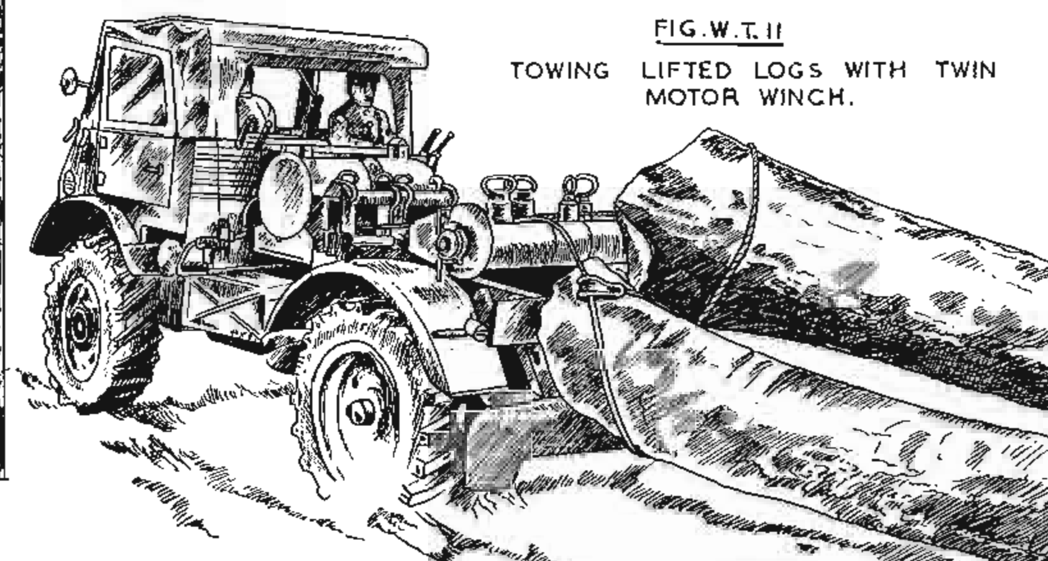
TOWING CHAINED LOGS.

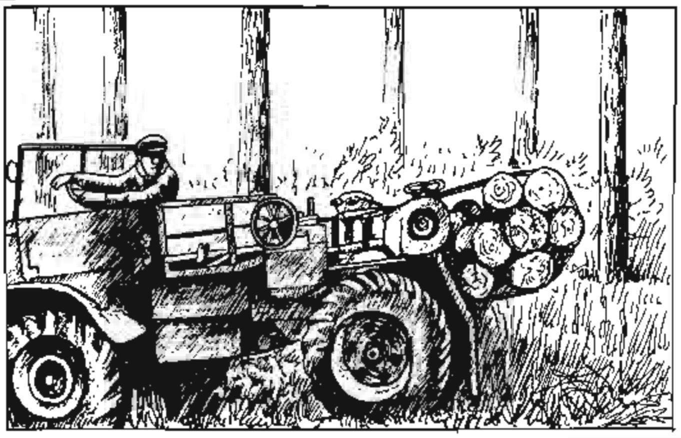
FIG. W.T. 10.

WINCHING WITH STANDARD REAR-MOUNTED DRUM.

FIG. W.T. 11

TOWING LIFTED LOGS WITH TWIN MOTOR WINCH.





UNIMOG
WHEEL TRACTOR

FIG.W.T.12
TRANSPORTING LOGS SUSPENDED BY WINCH CABLE

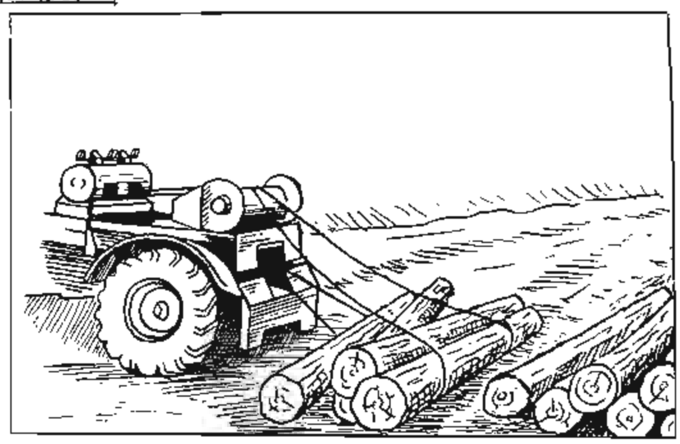
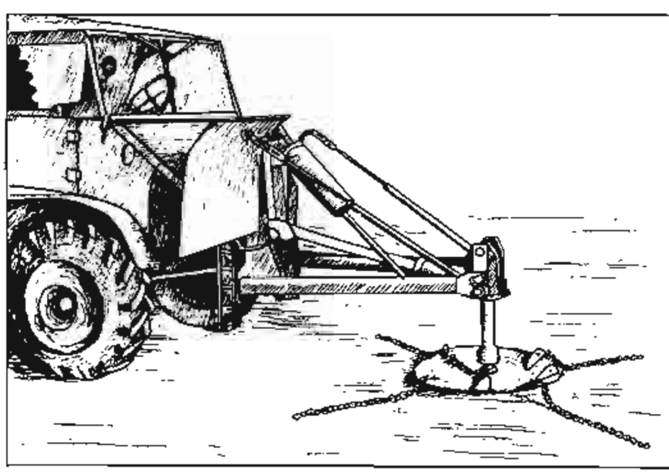
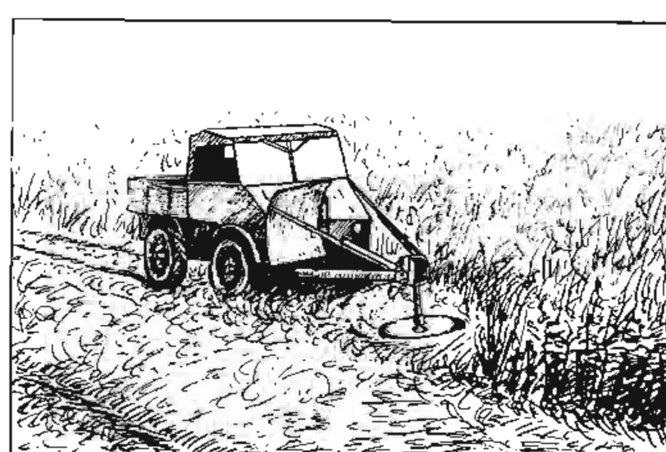


FIG.W.T.13

1. DISPOSAL OF LOGS AT ROADSIDE



2a. FRONT MOUNTED ROTARY CHAIN GRASS CUTTER ATTACHMENT FOR UNIMOG.



2.b. ROTARY CHAIN ATTACHMENT IN ACTION

An abbreviated specification for the type of wheel tractor generally employed for log skidding may be found in Appendix W.T. 1. The following features of interest deserve further mention:

(1) Adjustable wheel tracks in steps, i.e. if used with a trailer, the tractor wheels can be adjusted to the trailer wheel tracks.

(2) A good ground clearance is available, which means that higher surface obstacles may be ridden over.

(3) Supplementary weights may be fitted to the tractor wheel hubs, which improves adhesion to the ground.

(4) Special low pressure tyres are used, permitting the tractor to move over soft soil surfaces.

(5) The strength and high lifting capacity of the hydraulically operated three-linkage points are of great advantage, as the lifted load head adds to the tractor rear wheel adhesion, at the same time reducing the load-skidding resistance (Fig. W.T. 3).

C. OUTPUT AND COSTS

No complete data for operations performed by various wheel tractors are available, but a rough estimate may be made of the skidding costs.

Refer to Fig. W.T. 9 to 11.

(a) UNIMOG DIESEL TRACTOR

Unimog Diesel tractor, four-wheel driven, with double-drum winch.

Purchase cost		R3 683,66
Machine hire	-	R2,19 per hour
During 3 months	-	231 working hours - skidded 1 009 m^3, i.e. 4,36 m^3 per working hour

Exact costs per m^3 for this machine are not available.

Note: The Unimog has the following attachments for log skidding:

(i) Drawbar for ground skidding
(ii) Rear-mounted winch for log winching (Fig. W.T. 10).
(iii) Double-drum winch mounted behind the cab, and roller in the rear (above the wheels) with a special apron (plate) below the roller. This arrangement permits lifting the front of the load for easier towing (Fig. W.T. 11), or permits bundle skidding of small logs (Fig. W.T. 12, 13).

(b) FORDSON SUPER MAJOR

Fordson Super Major fitted with the logging slotted bar on the three-point hydraulic lift and drawbar.

Purchase costs:	R2 243,13
Machine hire:	81c/hour.

(1) Clearfelling

P. elliottii, 32 yr old. Average log: 0,35 m^3. Skidded during 12 full working days: 1 521 logs; 529 m^3. Average per day: 44 m^3.

Maximum skidding distance - 100m (estimated).
Gradient of slope: Easy.
Estimated cost:

Assuming that the tractor worked 6 hours daily

Hiring charges for 12 days @ 6 hr x 81c	-	R58,32
Operator's wages: R5 x 12 days	-	R60,00
Labour: 2 @ 65c x 12 days	-	R15,60
Total	-	R133,92

R133,92 ÷ 529m^3 = 25,3c/m^3

(2) Thinnings

(i) P. taeda, 26 years old. Average log: 0,18m^3. Skidded during $3\frac{1}{2}$ full working days: 505 logs; 92m^3. Average skidding output per day: 26,4 m^3.

(ii) P. elliottii, 26 years old. Average log: 0,2m^3. During $7\frac{1}{2}$ working days skidded 1 159 logs; 231/m^3. Average skidding output per day: 30,9 m^3.

(iii) Average log: 0,24 m^3. Skidded during $1\frac{1}{2}$ days: 173 logs; 35,4 m^3. Average skidding output per day: 23,6 m^3.

(iv) Average log: 0,17 m^3. Skidded during 3 days: 359 logs: 63,5 m^3.

Average cost for all thinnings as above

Total days worked: 15,5

Tractor hire: 81c x 6 hr x 15,5 days	-	R75,33
Operator's wages: 15,5 days @ R5	-	R77,50
Labour: 2 @ 65c x 15,5 days	-	R20,15
Total	-	R172,98

R172,98 ÷ 423m^3 = 40,9c/m^3

Note: (a) 40,9c is for skidding alone, without considering the costs of load prestacking before chaining, and log stacking at the roadside

(b) 81c hiring cost for the machine is for the machine with fuel, lubricant, maintenance, etc., but without auxiliary equipment costs (i.e. chains, peavy hooks, etc.)

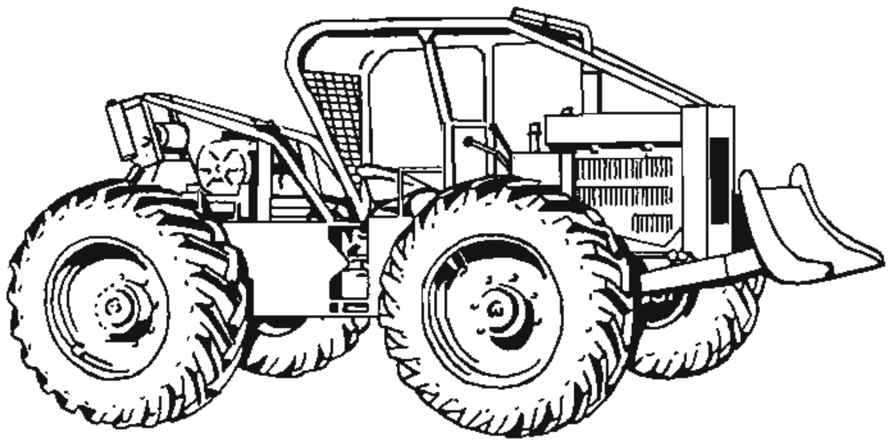
D. RANDOM OBSERVATION OF LOG SKIDDING WITH PRIVATELY OWNED WHEEL TRACTOR

(a) Tractor: Massey Ferguson, 43 kW, model M.F. 65, industrial type, with logging slotted bar, for hooking chained logs, fitted to the three-point hydraulic lift. No winch.

(b) Basic price: R2 290.

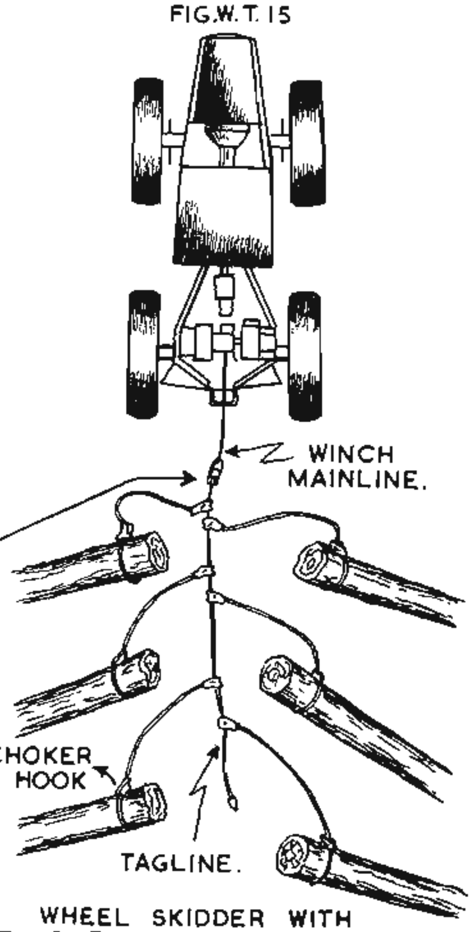
(c) Auxiliary (minor) equipment: 9mm logging chains, short link, of mild steel. Chains 2,4m long, fitted with the standard logging slip hook of 25 mm material diameter at one end, and a ring at the other end.

FIG. W.T. 14.



WHEEL SKIDDER

FIG. W.T. 15



WHEEL SKIDDER WITH ATTACHED LOADED TAGLINE.

FIG. W.T. 15 a.

NUBBIN.

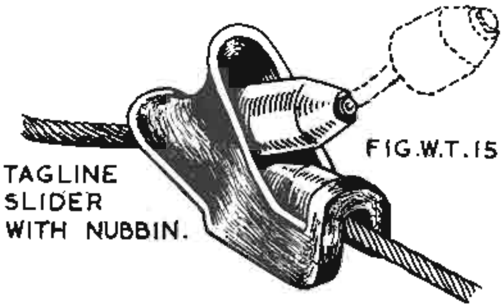


FIG. W.T. 15 b

TAGLINE SLIDER WITH NUBBIN.

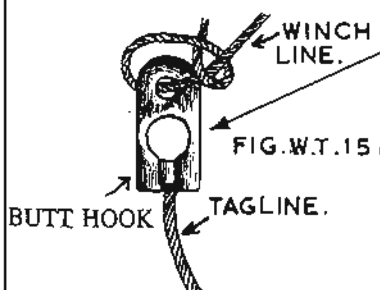


FIG. W.T. 15 c

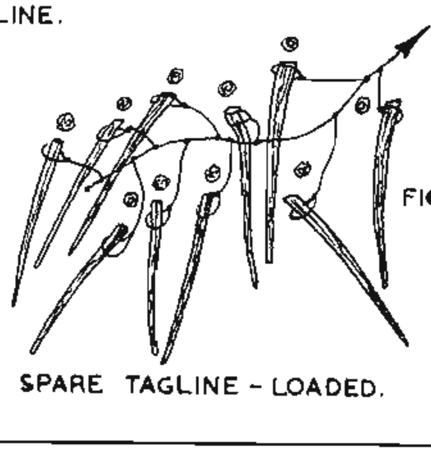


FIG. W.T. 15 d.

SPARE TAGLINE - LOADED.

(d) Labour: 1 Bantu driver, 6 Bantu labourers.

(e) Labourers' duties: 2 labourers chaining and hooking logs and providing easy access for the tractor to the logs. The other 4 labourers were engaged in unchaining the logs at the landing and stacking the logs at the roadside.

(f) Timber: Clearfelled 25 year old P. patula. The compartment was clearfelled in two stages; 50% of the trees was removed during the first stage, with an even distribution over the compartment, and after these logs had been skidded out, the balance of the compartment was clearfelled. This method was adopted in order to minimise accumulation of debris and to facilitate wheel tractor movement. Off-cut tops, slash and litter were stacked in heaps.

The first stage of the log-skidding operation was observed, i.e. 50% of the trees remained standing after the balance had been felled. There were approximately 147 stems/hectare. Only the heavier logs were skidded by tractor, the balance being slipped by mules.

(g) Site: Slope a maximum of 18° to 20°. Roads approximately 130 metres apart. Soil: clayey loam; soil carpeted with litter and fine debris; soil surface: damp.

METHOD OF WORKING

(1) Logs were skidded with the gradient down a slope of from 12 to 18°, over a distance ranging from 25 to 60 metres, then slightly uphill over a gradient of 2,5° and finally level along the road for 25 metres to the log stack. The tractor moved to the logs, turned around, hooked the logs, and then proceeded to the road. Loads varied from 3 to 5 logs, with a volume of from 0,8 - 1,4 m^3. The maximum possible load appeared to be 1,47 m^3; the limiting factor being the short uphill with a damp surface.

The load mentioned above consisted of 5 logs as follows

2 logs,	3,6m x 30cm	= 0,59m^3
1 log,	5,5m x 25cm	= 0,33m^3
1 log,	4,2m x 28cm	= 0,27m^3
1 log,	5,5m x 23cm	= 0,30m^3
5 logs		1,49m^3

(2) Skidding up a gradient of 7°, approximately 25 metres to the roadside and approximately 10 metres along the road to the stacks. The maximum load on the slope was 0,8 m^3.

(h) Technique adopted. When observing the log skidding, it became apparent that the best method was to lift the head of the load with the three-point hydraulic lift to slightly above the litter layer. Excessive lift of the load tended to cause the front wheels of the tractor to lift. The driver of the tractor was very skilled and experienced and manoeuvred the tractor perfectly at speed, but considerable delay occurred when choking, assembling the logs into a load and hooking. If a rear-mounted winch could be installed, without the necessity of removing the three-linkage point, it would be of considerable assistance.

Production figures are not available.

E. POSSIBLE APPLICATION OF THE WHEEL TRACTOR IN THE DEPARTMENT

Wheel tractors are not popular among the field staff due to their limited application in log skidding with regard to terrain, surface, size of logs, etc. None the less, if the wheel tractor is used in the right place at the right time these difficulties would be minimised. The best place to employ the wheel tractor would be in a plantation in the early stages of development without mature timber, particularly as the wheel tractor can also be used for many other operations besides log skidding, in combination with several accessories now available on the market.

F. THE WHEEL SKIDDER (Fig. W.T. 14)

The wheel skidder tractor was designed in Canada for skidding pulpwood timber, in tree length, over long distances from compartments not readily accessible by lorries. The main features of the tractor which was demonstrated to the Department are the following:

(a) (1) Powered by a 43kW engine.
(2) Four-wheel driven with four-wheel steering.
(3) Large wheels with low pressure tyres.
(4) The differential can be automatically locked on the rear wheels to secure even action of the driving wheels.
(5) Well balanced rear-mounted integral arch with fairleader. The chassis is pivoted in the middle and is actuated by a single hydraulic cylinder.
(6) The tractor is highly manoeuvrable.
(7) The rear wheels follow the tracks of the front wheels on turns.
(8) Travelling speeds up to 24 km/hr.
(9) Ground clearance of 45,7 cm.
(10) Bulldozer blade, front mounted, enables the operator to clear a way through obstacles, and assists with log stacking at the roadside if adequate room for tractor movement is available.

(b) Auxiliary equipment (Fig. W.T. 15). Auxiliary equipment for the wheel skidder consists of a number of devices resembling Bardon choker hooks twisted at an angle as illustrated in Fig. W.T. 15b, which slide along the winch cable or on the detachable tagline (Fig. W.T. 15), facilitating hooking the logs by means of choker assemblies. The tagline is merely an extension of the winch cable. If a spare tagline is used (Fig. W.T. 15d) and 5 or more spare chokers and sliding devices are available, advance log slinging and pre-choking is possible. Fig. W.T. 15 illustrates some of the minor tractor auxiliary equipment, such as the butt hook for attaching the tagline to the winchline (Fig. W.T. 15c), the nubbin at the end of the tagline (15a) and the tagline slider with nubbin (15b).

(c) The maximum load which could be towed over level ground, without obstacles, by the tractor in low gear, was three tree length trees of the following dimensions:

38 cm average diameter - 17,3 m long - approximately	$1,92m^3$
30 cm average diameter - 16,8 m long - approximately	$1,22m^3$
30 cm average diameter - 17,1 m long - approximately	$1,22m^3$
Total volume of three trees	$4,36m^3$

The purchase price of the wheel skidder is approximately R7 500.

(d) (1) As there were too few choker assemblies and no tagline available for the test, there was considerable delay during choking and assembling the logs into a load.

(2) The short skidding distance did not provide the tractor with the opportunity to attain its maximum skidding speed, or even to return empty from the roadside at a reasonable speed.

(3) The road width at the point where the logs were stacked was insufficient to permit the tractor to conveniently stack the logs with its bulldozer blade.

(e) There is no doubt that this tractor possesses a number of attractive advantages where working under the conditions for which it was designed, i.e. long skidding distances through a planted area with few roads spaced far apart. Some of the plantations in Zululand may be suitable for the employment of this machine, as the country is flat with few obstacles, and the stabilisation of road surfaces is a costly affair in this region.

APPENDIX T.S. 1

TRACTOR SKIDDING - DEPARTMENTAL NORMS

CRAWLER TRACTOR TOWING LOGS BY CHOKER(S) ATTACHED TO THE DRAWBAR HOOK BEHIND THE MOVING TRACTOR AND OVER A FIRM FOREST FLOOR

The following log-skidding norms have been determined and accepted for 28 to 33 kW class tractors.

TABLE T.S. 9

Average single distance	Allowed time per load	Volume of logs per day in m3		
		2 nd Thinnings	3rd Thinnings	Clearfellings
m	min			
0 - 15	4	75,60	114,75	135,00
16 - 30	5	60,48	91,80	108,00
31 - 45	6	50,40	76,50	90,00
46 - 60	7	43,12	65,45	77,00
61 - 75	8	38,08	57,80	68,00
76 - 90	10	30,24	45,90	54,00
91 - 105	11	27,44	41,65	49,00
106 - 120	12	25,20	38,25	45,00
121 - 135	13	23,52	35,70	42,00
136 - 150	14	21,84	33,15	39,00
151 - 165	15	20,16	30,60	36,00
166 - 180	16	19,04	28,90	34,00
181 - 195	17	17,92	27,20	32,00
196 - 210	18	16,80	25,50	30,00
211 - 225	19	15,68	23,80	28,00
226 - 240	20	15,12	22,95	27,00
241 - 255	21	14,56	22,10	26,00

Particulars used for calculations

a) Travelling time 2,13 sec per metre
b) Hooking and unhooking time 190 sec per metre
c) The distance used for the calculation is the largest number in each range, i.e. for 16 - 30m range, the calculations were based on 30m. e.g. (30x2) x 2,13 + 190,00 = 317,8 sec. = 5 min per load

Allowances made

(a) All times were normalised.
(b) Twenty per cent allowance was made for rest and incidentals.
(c) Six per cent was allowed for refueling and daily maintenance.
(d) Time per day in minutes: 540.

Average load size

2nd thinnings - 0,56 m^3 on slope 18^o down to 10^o up.
3rd thinnings - 0,85 m^3 on slope 18^o down and 5^o up.
Clearfellings - 1,0 m^3 on slope 18^o down and to 5^o up.

Note: The maximum volume that the tractor team can handle per day is 102 m^3

APPENDIX T.S.2

TABLE T.S. 10–Duties of the tractor team

Team No.	Number of labourers	Equipment	Duties
1	Operator (European)	Tractor	Responsible for: a. Maintenance and reporting of mechanical defects. b. Completion of the production sheets and idle time sheets, and any other tractor sheets or statements required. c. Supervision of the team.
2	3 Bantu	2 axes 1 cant hook	Responsible for choking and hooking logs, clearing the skid paths, and for the chokers themselves. They must assist with rolling logs to the stack if a new stack is commenced.
3	5 or 6 Bantu	1 axe 1 fork 5 handspars	Responsible for stacking skidded logs, unhooking and replacing the chokers on the tractor and removal of any litter brought in by the tractor.

APPENDIX T.S. 3

TABLE T.S. 11–Servicing the tractor

Mantenance details	Allowed time min	Remarks
1. Daily servicing	30	Time allowances are included in the output table.
2. Weekly servicing	100	This time must be included in the daily time earned.
3. Monthly service	135	Includes weekly service. Must be included in daily time earned.
4. Quarterly service	200	Includes monthly service. Must be included in the daily time earned.

5. Should representatives of firms check or repair the tractors, the actual working time must be included in the daily time earned.

APPENDIX T.S.4

TABLE T.S.12 - Idle time sheets

Section:____________________ Date:____________________

Time		Time in minutes	Details of idle time
From	To		

OPERATOR'S SIGNATURE__________________ FOREMAN'S SIGNATURE __________________

APPENDIX T.S.5

TABLE T.S. 13 - Log skidding by tractor and chokers: comparison between skidding logs and tree-length.

Details	Logs	Tree-length
Kind of felling	Clearfelling	Clearfelling
Gradient	12^{o}–16^{o} down	Level
Average distance	50 m	60 m
Speed of tractor	3,5 km	3,2 km
Total daily distance	9,0 km	9,0 km
Total time daily to logs	1 hr 31 min	1 hr 11 min
Total time daily to logs %	19%	15%
Total time daily with load	1 hr 48 min	1 hr 28 min
Total time daily with load %	22%	18%
Total time daily - hooking and slinging logs	2 hr 34 min	3 hr 3 min
Total time daily - hooking and slinging logs %	32%	38%
Total time daily - unhooking	1 hr 44 min	1 hr 56 min
Total time daily - unhooking %	22%	24%
Total time daily for delays	23 min	22 min
Total time daily for delays %	5%	5%
Total time for average trip	8 min	6 min 39 sec
Number of logs skidded	392 logs	320 trees (904 logs)
Volume skidded daily	66,6 m^3	84 m^3
Number of trips daily	53	63
Auxiliary equipment used	4 chains	9 chains
Crew: Tractor driver	1 unit	1 unit
Bantu: Assembling and hooking	2 units	1 unit
Total time of actual operation	8 hours	8 hours

APPENDIX T.S. 6

TABLE T.S. 14 - Norms for log skidding by tractor winch

Average load 0,57 m^3

Average distance	Time per load	Log skidding output per day
m	min	m^3
16 - 25	4	76.4
26 - 35	5	61.2
36 - 45	6	51.0
46 - 55	7	43.6
56 - 65	8	38.5
66 - 75	9	34.0
76 - 85	10	30.6
86 - 95	11	27.7
96 - 105	12	25.5

Conditions: Slope: down 19^{o} - 23^{o}
up: 6^{o} and over in 3rd thinnings and clearfellings
up: 10^{o} and over in thinnings.

Time used: a. Slinging, hooking and unhooking - 104 sec per load
b. Skidding (winching) - 3,05 sec per metre.

Allowances made: a. All times were normalised
b. Twenty per cent allowances made for rest and incidentals
c. Six per cent allowed for refueling and maintenance.

APPENDIX T.S. 7

TABLE T.S. 15 - Tractor team and their duties for log skidding by winch

Team No.	Operator	Labourers	Duties
1	1		The operator's duties and responsibilities will be the same as those previously described for the operation of tractor with chokers as in Table T.S. 7.
2		4	1 labourer to pull the winch cable down to the logs. 3 labourers to roll logs to cable and hook them.
3		4	Responsible for stacking all logs. One or two of these labourers to be responsible for securing and moving the snatchblock if skidding is applied.

Equipment: Team No. 2. - axe.
Team No. 3. - 1 axe, 1 fork, 4 hand spars.

APPENDIX T.S. 8

SPECIFICATIONS

LOGGING WINCH USED BY DEPARTMENT FOR LOG SKIDDING

Drum size: Barrel diameter: 15 cm
Flange diameter: 30 cm
Between flanges: 30 cm

Cable capacity: 16 mm wire rope diameter - 70 metres recommended.

Height above the ground: To centre of barrel: 65 cm

Line pulls and speeds:

Bare drum,	underwinding	8 300 kg	at	20 m per min.
Full drum,	underwinding	4 150 kg	at	40 m per min.
Bare drum,	overwinding	6 570 kg	at	25 m per min.
Full drum,	overwinding	3 280 kg	at	50 m per min.

Note: The above figures are based on 28 kW at 862 r.p.m.

APPENDIX T.S. 9

SPECIFICATIONS

WIRE ROPE FOR WINCH CABLE: TRACTOR-MOUNTED WINCH

Logging ropes used with towing tractors are made from special improved plough steel wire of 19 - 20 t/cm^2 tensile breaking strength. The diameter of the rope is 16 mm of 16,00 tons breaking load, i.e. 5 times more than the winch pulling capacity if mounted on a 37 kW tractor.

The length of the rope supplied is 80 m, with one end thimbled spliced and the other end ferruled. The ferrule is 5 cm x 4 cm with an opening to accommodate 16 mm wire rope.

Rope construction: Seale
Number of strands: 6
Number of wires per strand: 19 (9 x 9 x 1)
Lay, ordinary
Core: Independent Wire Rope Core (I.W.R.C.)
Preformed
Plain (Not galvanised)
Note: The wire rope is made in South Africa

APPENDIX T.S.10

TABLE T.S. 16 - Daily norms for log skidding by tractordrawn sledge

Average distance	Time per load	Volume slipped
m	min	m^3
80 - 95	14,0	42,5
100	15,0	39,0
125	15,5	38,2
140	16,0	36,8
155	16,5	36,0
170	17,0	34,8
185	17,5	34,0
200	18,0	32,8
215	18,5	32,0
230	19,0	31,1
245	19,5	30,3

Conditions: (1) Slope: Up: 0 - 10°, down: 0 - 10°.
(2) Time used: a. Loading and off-loading: 614 sec per load.
b. Slipping: 1,1 sec per metre (i.e. towing).
(3) Volume of logs per sledge: 1,1 m^3 - 1,7 m^3 (average 1,4 m^3).
(4) Allowances: All times normalised.
Six per cent allowed for incidentals.
Six per cent allowed for refueling and maintenance.

APPENDIX T.S.11

TABLE T.S. 17 - Tractor team and their duties for log skidding by tractor-drawn sledge

Team No.	Operator	Labourers	Duties
1	1		Responsible for the same duties as previously described for the operation of tractor and chokers as in Table T.S. 10.
2		3	Off-loading the sledge and stacking the logs.
3		5	Prestacking logs and loading the sledge. If stackers cannot keep up with the sledge, one labourer from team 2 must assist with the stacking. This will only occur over short distances.

Equipment used: Team No. 2. 1 axe, 3 hand spars.
Team No. 3. 1 axe.

APPENDIX T.S. 12

SPECIFICATIONS FOR HEAVY LOGGING SLEDGES

1. Runners

2,5m x 30cm x 13cm cut from Olea laurifolia (black ironwood) logs. Two runners are cut from a log.

The pith of the log is placed on the outside, to give this side the rigidity of the heartwood, and the combination of elasticity and toughness of the more mature sapwood on the wearing surface.

No bark should be included in the runners except when unavoidable. Both ends are cut at an angle of 35^{o} to 45^{o} to the horizontal, starting approximately 15cm from the end. A 4cm bevel is cut on the "stump nose" of the runner, to avoid splitting when it catches on an obstacle.

Lower down a tapering bevel is cut to allow the sledge to climb over minor obstacles and roots. The maximum face of this bevel is 8cm. A hole 5cm in diameter is drilled with its centre 13cm from the front and 10cm from the top of the runner, through which the trek chain is passed. It is sometimes necessary to drill the hole slightly larger and to reinforce it with 5cm inside diameter galvanised piping.

2. Cross bars

Two of 1,2m x 28cm x 8cm, and one of 1,2m x 13cm x 8cm (centre).

These are made from Olea laurifolia sapwood, to give them the elasticity required for the strain placed on them. They are sunk 6 cm into the runners and secured with two Eucalyptus microcorys pegs each (two per runner).

The pegs are made of E. microcorys timber of about 8 years of age, 22cm long and 5cm in diameter. The holes are first drilled to a depth of 15cm (8 cm through the cross bar and 7 cm through the runner) and the hole filled with water to let the end of the pegs swell. The pegs are then driven with a mallet and sawn off 3-5cm above the cross bar. The peg is then hammered with a ball hammer to give it a slight brush. The taper of these pegs should be kept to a minimum, and grooves may be cut along their length to avoid their working out.

3. Trek chains

(Refer to Dreadnaught Chain Handbook)
Ladder link No. 45 for use with tractor or with a team of 8 mules.

4. Vertical supports

Holes are drilled with their centres 8cm from the broad cross bars and reinforced with 38mm galvanised piping (inner diameter). They are made 15-20cm deep. The vertical supports consist of old compressor drills, 3,2cm in diameter. Chains with large links are placed over these sledge uprights when the sledge is half full, and, in addition a sledge load binder may be used, especially when skidding over uneven terrain.

ESTIMATED COST OF OWNING A 26 - 33 kW CRAWLER TRACTOR WITH WINCH

(1) Purchase cost and freight R4 289,00
Transport in South Africa 211,00

Total cost at delivery R4 500,00

Depreciation per hour : $\frac{R4\ 500,00}{10\ ,000}$ = 45 cents

(2) Cost of repairs, spares and labour per hour : 68 cents

(3)	Petrol per hour	0,05	l
	Diesel oil per hour	4,5	l
	Engine oil	0,6	l
	Transmission oil	0,07	l
	Grease and other	7,7	g

Departmental charges for fuel and lubrication per hour :	33 cents
Interest	13 cents
Total charge for tractor per hour :	159 cents

(4) Operating cost of tractor auxiliary equipment

Drawbar hook - 1 only - R22	÷ 5 000 hr	per hour:	0,44c
Line hook, 45 mm with swivel, 1 only R19	÷ 5 000 hr	per hour:	0,32c
Hook, choker, Bantam No. 500, 10 only R3,26 ea	÷ 1 000 hr	per hour:	0,32c
Ferrule for choker hook: 10 only - R0,74 ea	÷ 500 hr	per hour:	1,50c
Clevis, 22 mm - 1 only - R0,80	÷ 5 000 hr	per hour:	0,02c
Sling, choker, 10 only - R2,54 ea	÷ 400 hr	per hour:	6,35c
Snatch block, Skookum No. 208 1 only - R52,76	÷ 5 000 hr	per hour:	1,06c
Wire rope, 16 mm x 80 m - R28,24	÷ 500 hr	per hour:	5,65c
Sling, wire rope. Both ends eye spliced. 12 mm x 3 m - R2,68	÷ 400 hr	per hour:	0,67c
Total cost of auxiliary equipment per hour :			16,33c

Grand total : 159c + 16,33c = 175,33c say 176c per meter hour

NOTE : The equipment listed above is accepted as the standard equipment for log-skidding operations in departmental plantations

TRACTOR STANDARD RIG. (FIG. T.S. 65)

The standard rig of a towing tractor consists of :

1. The drawbar hook
2. Choker sling assemblies (Fig. T.S. 66)

Note: The winch and cable with line hook on the winch drum has been dealt with under "Log skidding by tractor with winch"

Drawbar hook. (Refer to Fig. T.S. 65, item 3, and Fig. T.S.67)

The drawbar hook is fitted to the tractor drawbar jaw and secured with a drop pin. Fitting the hook to the drawbar should be done before the cable is spooled onto the winch drum, as fitting is impossible with some makes of tractors if the drum is fully spooled with rope.

The drawbar jaw measurements should be given when an order is placed for the drawbar hook, as different makes of tractors have different drawbar jaw measurements.

The drawbar hook should be of sufficient size to accommodate 5 eye-spliced choker slings.

Choker sling assemblies used in plantations, with towing tractor

The choker sling assembly consists of:

(i) The wire rope sling (ii) The choker hook (iii) The ferrule
(Refer to Fig. T.S. 66 and 70)

Wire rope sling. (16 mm wire rope diameter, overall length 3-4 metres)

When used in conjunction with the drawbar line hook, one end of the sling may be:

(i) Soft eye spliced - Fig T.S. 66 item 1
(ii) Soft eye clamped - Fig. T.S. 69, item 3
(iii) Fitted with a wedge choker socket - Fig.T.S.68, T.S.69, items 16, 21 and 22

When used in conjunction with the 5- or 3-way tractor drawbar hook, both ends of the sling shall be ferruled. Fig. T.S.66, items 6 to 10.

Wire rope sling specification:

Wire rope diameter	16 mm
Construction	Seale
Number of strands	6

Number of wires per strand: 19 (9 x 9 x 1)
Type of steel in wires: Special Improved Plough
Breaking strength of wire: 19 - 20 ton cm^2
Lay: Ordinary
Core: Fibre core
Preformed
Plain (not galvanised)

Note: Wire ropes are made in South Africa

Choker hook (Patented) See Fig. T.S. 70

Bardon Choker hook, Dwarf, Standard, No.500, consisting of:
Body, sleeve and ferrule pocket
The wire rope passes freely through the sleeve. The ferrule pocket serves to accommodate the ferrule fitted to the end of the sling

Choker hooks are cast of special, heat-treated, high-strength alloy steel. They are compact, low mass, easy to unhook and they choke tightly to the heads of the logs.

<u>Ferrule</u>: (Fig. T.S. 72, 73, 74)

Ferrule, Dwarf No.188, R5 for 16 mm wire rope
Size: 45 mm long, 38 mm outside diameter

The ferrule hole can accommodate 16 mm wire rope, but these ferrules can also be used with 13 mm diameter wire rope.

There are three types of ferrules:

(i) Standard type. (Fig. T.S. 72)
(ii) Wedge type. (Fig. T.S. 74)
(iii) Spiral wedge ferrule. (Fig. T.S. 73)

The standard type of ferrule is attached by means of anti-friction Babbitt-metal. Refer to Fig. T.S. 71 and 75.

The wedge type of ferrule is attached by using a conical wedge, which is driven in between the strands of wire. Refer to Fig. T.S. 76.

The spiral wedge ferrule is similar to the ordinary wedge ferrule, except that the wedge has grooves to accommodate the strands of the rope, thus providing more friction and resistance to pulling out.

Ferrules are made of special alloy steel and are heat treated for maximum durability in service.

MONTHLY OR COMPARTMENT - LOGGING REPORT

Plantation ______________________

Log skidding unit ______________________

Make ______________________ F. D. No. ______________

Block or compartment ______________ area ____________ hectare

Stems/ha ______________ Total volume per hectare ____________ m^3

Clearfelling or thinning: (From - to) ______________________

Total volume expected for extraction: ______________________ m^3

Tree length or log skidding operation: ______________________

Approximate average size of trees or logs skidded:

L ____________ m D ____________ cm V ____________ m^3

Topography: ______________________

Gradient of slope: ______________ (Degrees)

Undergrowth, slash and stumps (description) ______________________

____

____

____

Surface ______________________

Single or double skidding operation ______________________

Kind of landing ______________________

Access to the landing from existing road ______________________

Method of load assembling (advance, cross stick, etc.)

____

Supplementary equipment used and number ______________________

____

Advance log choking, if ______________________

Weather ______________________

Average wages, including cost of living and ration:

European ______________ Bantu ______________

Average number of crew: European ______________ Bantu ______________

FORESTER ______________

LOG SKIDDING BY TRACTOR

TRACTOR FIELD SHEET

Trip record

Tractor F.D. No. ____________ Date ________ Tractor F.D. No. ____________ Date ________

Block/Compt ____________ Number of crew ____________ Block/Compt ____________ Number of crew ____________

Time hr. min	Logs No.	Towing: Winching Up - down - level	Remarks Maximum distance metres, etc.	Time hr. min	Logs No.	Towing: Winching Up - down - level	Remarks Maximum distance metres, etc.

COMPILED BY ____________

RANK ____________

LOG SKIDDING BY TRACTOR

DAILY SUMMARY LOG SKIDDING REPORT

Tractor F.D No.	Left garage, time ______
Plantation	Start work ______
Block/Compartment	Finish work ______
Number of labour units:	Return to garage, time ______
a. Load assembling	Speedometer reading ______
b. Choking	a. Morning ______
c. Hooking	b. Evening ______
d. Unhooking	Number of mechanical stops ______
e. Stacking	Mechanical stops, hours ______
Auxiliary equipment used and No.	State yes, or no:
	a. Load prepared ahead
	b. Advance chaining done
	Maximum skidding distance ______m
Trips: Towing: No. ______	Weather ______
Winching: No. ______	Enclosed field pages No. ______
Skidded logs: No. ______	Date ______
Skidded trees: No. ______	Driver ______
Skidded m^3: ______	

Remarks: Grade, surface, delays, etc. ______

______

______

______

______

LOG SKIDDING BY TRACTOR

LOG STACKING AT THE ROADSIDE

Date ______________ 19___

Plantation ______________ kind of felling ____________ Crew: Bantu ______________ Serving team No's ______________

Block ______________ Compartment ______________ European ______________ ______________

Break for breakfast from ____________ till ____________ a.m. Supplementary equipment ______________

Break for lunch from ____________ till ____________ p.m. ______________

Load No.	Number of logs	Time of								REMARKS
		Load arrival (dispersal)		Load unchaining		Log stacking		Idle time		
		From	Till	From	Till	From	Till	From	Till	

Compiler ______________

Rank ______________

LOG SKIDDING BY TRACTOR

MONTHLY TRACTOR LOG SKIDDING REPORT

Month________________ 19____ Plantation____________ Vehicle ____________ F D. No. ____________ Driver ____________

Date 19__	Block Compt.	Max. skidding distance m	Skid-ding level com-pleted	Return trips com-pleted	Skidded		Actual work-ing time hr min	Machine idle			Lunch break etc. hr min	Delays hr min	Remarks	Labour units NN.		
								Local changes								
					Logs No.	Volume m^3		Site hr min	line hr min	Erecting hr min				Un & hook Choke signal	Log deck canters stackers	Load assem-bling in area
1																
2																
3																
4																
5																
28																
29																
30																
31																
Total																

Compiled by ____________________

Rank ____________________

APPENDIX W.T. 1

ABBREVIATED SPECIFICATIONS FOR WHEEL-TRACTORS

The Department employs tractors of approximately 50 kW. The tractor consists of three main parts assembled in a common rigid structure as follows:

(1) The engine and front axle assembly; (2) Front transmission - gearbox assembly
(3) Rear transmission - rear axle

The main parts of the industrial wheel tractor are shown in Fig. W T 1, in the assembled form, and the main components of the tractor are named and indicated in the illustration.

The most important features of the specifications are the following:

Engine: Diesel - 4 cylinders
Capacity: 3 606 cm^3
Compression ratio: 16 to 1
Lubrication: Pressure fed by gear type pump
Lubricant: For temperatures of 7 - 30°C Diesel oil S A.E. 20
Cooling system: Thermo-syphon, impellor assisted system
Fan - single 'V'-belt driven
Fuel system: Excess fuel control on injector pump
Fuel capacity: 67 l
Clutch (standard) - Dry single disc, 33 cm diameter
Gearbox: 6 forward, 2 reverse speeds.
Rear axle: semi-floating, four pinion differential running on roller bearings.
Shafts: 4 cm diameter, 48 cm spline.
Hydraulics: Manually operated.
Pump: Gear driven from the p.t.o.
Wheels and tyres: All pneumatic.
Front: 19-41 cm
Rear: 33 x 91 cm to 38 x 76 cm
Tyres, rear: land work, minimum 0,844 kg. /cm^2
Tyres, front: 1,97 kg. p. cm^2
Brakes: Mechanically operated disc brakes.
Adjustable drawbar: Vertical and horizontal adjustment.
Electrical system: 12 volt, 2-brush generator.

Masses and dimensions:

Wheelbase: 203 cm
Front wheel track: Adjustable in 10 cm
Pneumatic - 128 cm to 189 cm
Rear wheel track: for pneumatic 132 cm to 183 cm
Overall width: Maximum 216 cm
Minimum 165 cm
Height to top: 164 cm
Ground clearance: Under drawbar - 33,4 cm
Under axle housing (front) 58,4 cm
Tractor: Approximately 2 720 kg

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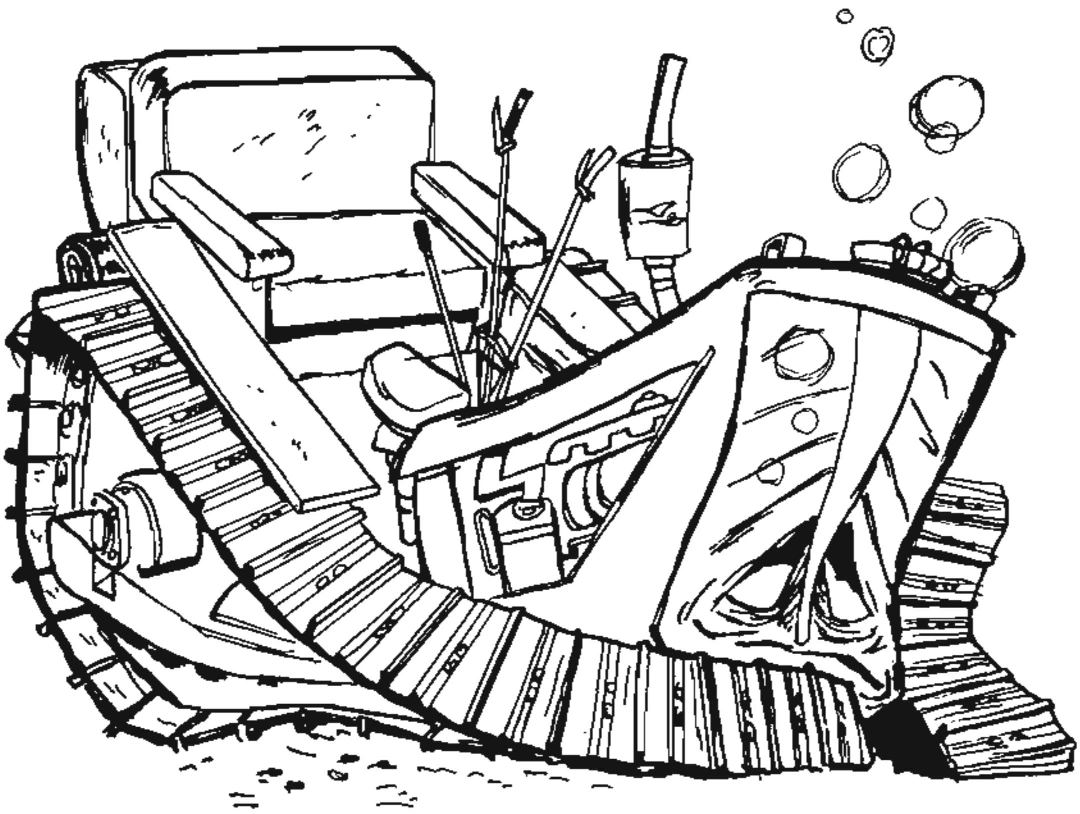

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