BULLETIN NO. 39.

WESTERN AUSTRALIA.

THE FORESTERS' MANUAL.

PARTS II., III., IV., AND V.

Prepared under the direction of
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Issued under the authority of the Minister for Forests:
The Hon. PHILIP COLLIER, M.L.A.

PERTH:
BY AUTHORITY: FRED. WM. SIMPSON, GOVERNMENT PRINTER.

1927.

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FOREWORD.

The object of the Foresters' Manual is to supply a handy reference work for officers of the non-professional division of the Forest Service of Western Australia.

It makes no claim to be a text-book of the elements of silviculture or any other branch of forestry. General discussion of principles has been avoided, and instructions in the practice of forestry as applied to the regeneration of jarrah forests and the establishment of softwood plantations have been set out in the simplest terms, for the guidance of field staff.

The publication, originally issued in the form of mimeographed circulars, has all the faults of a compilation prepared at odd intervals by a few senior officers already overloaded with rapidly expanding administrative work. In the present edition no attempt has been made to deal with special problems arising in other classes of Eucalypt forest being brought under management, such as Karri, Tuart and Mallet.

As these are all species of restricted habitat, circulars will meet the need of the smaller staff concerned, until the time arrives for the publication of the second edition of this Manual, when silvicultural practice in each forest type should be sufficiently standardised to justify inclusion.

The first volume, dealing with "General District Work," was issued in 1926, and to complete the series it is proposed to issue, at some future date, a third volume dealing with special features of all branches of work outside the "South-West" division of the State, including sandalwood reforestation.

S. L. KESSELL,
Conservator of Forests.

Perth, June, 1927.

THE FORESTERS' MANUAL.

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THE FORESTERS' MANUAL.

PART II.

Reforestation.

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SECTION 1.

PRELIMINARY OPERATIONS.

(1) TOPOGRAPHICAL SURVEY AND SUBDIVISION.

339.

The topographical survey of forest country and the collection of field data for the preparation of maps and the compilation of Working Plans preceding reforestation operations are carried out by survey camps consisting of three men. (The survey instruments in use by the Department are:—Plane table, Verschoyle transit prismatic compass, military sighting vane, and forester's compass.)

Details of the organisation and running of such camps, and the instruments used, are not given in this Manual.

340.

Subdivision into Compartments is based on roads, tracks, ridges, creeks and tramway formations. A Compartment, which forms the unit of working, and of subdivision, contains approximately 500 acres (Jarrah). Larger sections ("Blocks") are formed by grouping a number of Compartments together for convenience in administration. The boundaries of Blocks are based

Compartment.

Block.

mainly on topographical features, and each receives a local proper name (*e.g.*, "Kalamunda Block"). The area of such blocks is from 7,500 to 15,000 acres.

This permanent subdivision work is carried out by specially trained men, and in consequence, all that is required of the forester is a knowledge of the use of the ordinary prismatic compass in locating the boundaries of cut-over or treated areas after the comparatively detailed maps are prepared. In view of the number of "reference trees" established in the topographical survey, the use of a hand compass and pacing gives a sufficient degree of accuracy. From time to time it will be found necessary to secure additional information from districts concerning the location of works of a permanent nature such as new railway formations, roads, etc. This work shall not be delegated to an assistant forester to be carried out by pacing and compass. If a qualified officer with special training in topographical survey work is not available, application shall be made to Head Office for the services of a suitable man, and the survey plot sheet shall be signed by the Divisional Forest Officer before the work is entered on Head Office compilation plans.

Instruments.

341.

Prismatic compass

Prismatic Compass.—The prismatic compass consists essentially of a compass card, a sighting vane, and a prism. By means of the prism, the compass card is reflected to the eye of the observer, thus enabling him to take a sight and read the bearing at the same time.

342.

Compass card.

The compass card, which is contained in a brass or aluminium case, protected by glass cover, varies somewhat in different types of compass. The standard type in use here is a green card mounted above a magnetised bar or needle and pivoting on a fine steel point.

343.

Numbering.

The card is divided into 360 degrees, the numbering being reversed so that 180° is opposite the North point on the card, 270° opposite the East point, 360° opposite South, and 90° opposite West. Further subdivisions mark the half degrees.

344.

Prism and sighting vane.

The prism is mounted on a hinged joint, so that it can be swung over the glass cover for a reading, and swung back when not in use. The sighting vane is also mounted on a hinged joint so that it can be raised to a vertical position for a sight, or folded flat over the glass cover. In the latter position, the sighting vane depresses a spring catch which automatically lifts the compass card off the pivot, and so clamps it. The sighting line on the vane is usually a horse hair which can be readily picked up through the vertical sighting slit in the prism. When sighting, this hair should be absolutely vertical, cutting

the peg in the centre, so that the eye of the observer, the hair on the sighting vane, and the peg are in one straight line.

345.

Care of compass.

Prismatic compasses, before being issued to the field staff, are adjusted. Every reasonable care should be taken to keep the compass in adjustment, protect it from the weather and see that the compass card does not swing when not in use.

346.

Repairs of compass.

When a compass is out of adjustment, it must be forwarded to Head Office for repairs. No attempt is to be made by the local forester to adjust it by taking it to pieces. The only repair to be done locally is to replace the horse hair in the sighting vane.

347.

Magnetic variation from true north.

Magnetic variation means the deviation (declination) of the magnetic needle from the true north meridian, owing to the fact that the magnetic North Pole appears slightly to the west of the geographic North Pole to an observer in the South-West of Western Australia.

A compass needle always points to the magnetic north.

In the South-West of Western Australia we have a westerly variation of about 5°, so that, when a sight is taken on a point true north, the compass reading (providing the compass is true and not affected by local magnetic attraction) is not 360° (or 0°) but 5°E. If we read 360°, we are sighting on a point in line with magnetic north (i.e., 5° west of true north). From this position, therefore, we must swing the compass eastwards through 5° to sight on true north.

348.

Determination of magnetic variation.

The magnetic variation should be checked periodically by comparing the forward and backward reading at several points along a survey line, with the true bearing of that line. True bearings of any location or surveyed line can be supplied from Head Office.

349.

Conversion of magnetic to true bearing.

All bearings (or readings) taken with a prismatic compass are "magnetic bearings," and plotting is always done in relation to a true north and south line. Before plotting, therefore, magnetic bearings must first of all be converted to true bearings. In the case of 5° westerly variation, the true bearing is obtained by subtracting 5° from the magnetic bearing.

By the method adopted by the Department for plotting the above is done automatically by use of protractor sheet and parallel ruler.

350.

Local magnetic attraction.

The compass needle may be deflected from its natural direction by the attraction of any magnetic substance near it, such as iron ore, the rails of a railway, the chain band or arrows, a bunch of keys, etc. Local attraction is very often

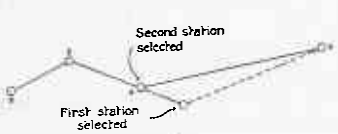
met with, and special pains must be taken to avoid the errors and loss of time to which it may give rise. When the bearing determined by a foresight does not agree with the reverse bearing of a backsight, the usual cause of the variation is local magnetic attraction.

351.

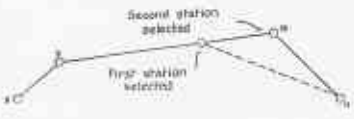
Determination of local attraction by backsighting and adjustment.

From the first peg or tree a backsight should be taken to the starting point and bearing noted. It should be equal to the foresight + or — 180°, *e.g.*, (a) with foresight of 64° (*i.e.*, under 180°) the backsight should be 64° + 180° = 244°, (b) with foresight of 322° (*i.e.*, over 180°) the backsight should be 322° — 180° = 142°.

If the backsight agrees with the reverse of the foresight, the bearing is correct and the traverse may be continued. For this work, if there is a difference of up to 2°, half the mean may be assumed to be correct. But, if the difference is greater, some adjustment becomes necessary. In many cases it will be found that the local magnetic attraction is confined to a very small area and, by selecting some other "turning point" or "station" along the line (see sketch A), or in prolongation (see sketch B) of the line already run, the local magnetic attraction becomes negligible, if not altogether avoided.



A



B

If the attraction is still apparent, the difference between the bearings at any one point will give the correct angles and the correct magnetic bearings may be deduced.

352.

Rule for deducing bearings.

It will prove useful to commit the following rule to memory:—

To obtain the angle between traverse lines, subtract the back bearing from the forward bearing (increasing by 360° if necessary).

To obtain the magnetic bearings as desired from an accepted datum (*i.e.*, the last traverse accepted as correct) add the angles to the back bearings at each angle of the traverse (decreasing the bearings by 360° when necessary).

The following diagram and calculation will serve to illustrate the application of these rules. As the difference in this particular instance is within the 2° referred to above, in practice half the mean would serve in this case, but with a greater difference the correct magnetic bearing would need to be calculated.

Example at station No. 1, above sketch.

Angle = forward bearing = 356° — back bearing 156° = *200° angle.*

Correct back bearing 338° — 180° = 158°.

Back bearing 158° + < 200° = 358° = correct forward magnetic bearing of traverse line 1 to 2.

Example at station No. 2, above sketch.

Angle = forward bearing 36° — back bearing 174°, *i.e.* 36° + 360° = 396° — 174° = *222° angle.*

Correct back bearing 358° — 180° = 178°.

Back bearing 178° + < 222° = 400° — 360° = 40° correct forward bearing of traverse line 2 to 3.

Approximate Survey by Compass and Pacing.

353.

Traversing by prismatic compass and pacing.

The degree of accuracy required in topographical survey work is not essential in the compass surveys for temporary lines on progress plans which the forester will normally be called upon to do.

The following quick and easy method is, therefore, adopted as likely to give results sufficiently accurate for the purpose.

354.

Test walking pace.

Before starting the traverse, run the five-chain band out and test your number of walking paces to the chain. The pace should be the natural walking pace of the person. Do not try and pace even yards.

355.

Traversing.

The starting point of the traverse must be one that is known, such as a survey peg or a "reference tree." From this point a foresight is taken with a prismatic compass to some prominent object in the direction in which the proposed traverse is to proceed. Usually a dead or well-defined tree is taken as a "turning" or "station point" in this type of survey. The bearing being recorded in the field book, the distance to the tree is obtained by pacing, and it is then entered in field book. The observer then moves to station No. 1, takes a backsight to the starting point to check the previous foresight. He then takes a foresight to the second station, paces the distance and continues as before.

N.B.—If agreement cannot be obtained in the first fore and back sight bearings, it would be advisable to select some other starting point.

356.

Tie lines.

To obtain reasonable accuracy in this work, not more than two miles of traverse should be run without effecting a tie to a survey peg or reference tree.

Plotting.

357.

Plotting.

Plotting is to be done direct on to the forest map or plan by means of a paper protractor (with centre cut out) and parallel ruler in the following manner:—

The North-South square reference lines, the true bearing of which is 1½°, are used as plotting lines. For plotting purposes, to this bearing is added the magnetic variation of the compass. For example: 1½° + 5° = 6½°.

358.

Setting the protractor.

The protractor is now set so that the 6½° mark is aligned on the northern end of the plotting line and the 186½° mark on the southern end. When accurately set, the protractor is fixed firmly into position by means of weights or drawing pins. The centre of the protractor is ascertained by placing the parallel ruler on the magnetic east and west line (*i.e.*, aligned on 96½° and 276½°) and drawing a short line to cut the plotting line. The intersection of the two lines marks the centre of the protractor.

All magnetic bearings plotted with the protractor set in this position are automatically reduced to true bearings on the plan.

359.

Plotting the traverse line.

Having next established the starting point of the traverse (not necessarily at the centre of the protractor) the traverse lines are now plotted. If the bearing of the first traverse line is, say, 73°, the parallel ruler is placed across the protractor and one edge is aligned from 73° to 253°. This edge must also cut the intersection point already marked as the centre of the protractor. The parallel ruler is now rolled into position so

that this edge is directly over the starting point of the traverse, and a line is drawn (with a hard pencil) in the direction of 73°. The distance is then scaled off according to the chainage recorded for that traverse line in the field book.

The bearings and distances of successive lines are plotted in the same way until the traverse is completed.

360.

Plotting direct on plot sheets.

Another method of plotting which may be necessary pending the issue of forest maps is to plot direct on plot sheets, in the centre of which is imprinted a protractor. The system of plotting is the same as before, but magnetic bearings used. If it becomes necessary to transfer this work to a litho., it is done by the medium of a tracing, and the whole work swung to true bearings and carboned to the litho.

361.

Calculating areas.

A diagram in the form of a transparent sheet ruled in squares for estimating acreages may be obtained from Head Office by quoting F.D. Plan No. 188.

Planimeters are issued only to special officers.

362.

Table lineal measure.

12 inches = 1 foot.
3 feet = 1 yard.
1 chain = 22 yards, 66 feet, or 100 links.

Square measure.

40 perches = 1 rood.
4 roods = 1 acre.
1 acre = 10 sq. chains, 4,840 sq. yards, or approx. 70 yards square.
1 sq. mile = 640 acres.

Cubic measure.

1 gallon of water = 10 lbs.
1 cubic foot = 6¼ gallons or 62½ lbs.
1 cubic yard = 27 cubic feet, or 168¾ gallons, or 1,687½ lbs., or approx. ¾ ton.
1 lb. = 16 ounces.
1 quarter = 28 lbs.
1 cwt. = 4 quarters or 112 lbs.
1 ton = 20 cwt., 80 quarters, or 2,240 lbs.
A tank 4 feet cubed contains 400 gallons.

Circular measure.

Area of circle = radius squared x $3\frac{1}{7}$
= diameter squared x $\frac{11}{14}$ or ·7854.
Circumference of a circle = $3\frac{1}{7}$ times its diameter.

(2) TRACK CLEARING.

363.

Among the first operations to be carried out on Working Circles, after the topographical survey has been completed, will be a thorough clearing of tracks.

364.

Method of clearing.

The tracks and formations to be cleared will be decided by the Divisional Forest Officer. Special attention must be paid to those tracks which form compartment boundaries.

The actual tracks and formations must be cleared of all debris, including large logs, and only in exceptional cases are detours allowable.

All scrub over eighteen inches in height, and all young tree growth such as Jarrah, Marri, Blackbutt, Banksia, etc., which has developed since the track or formation was last used, must be grubbed right out and not merely cut down, with the object of avoiding any maintenance work in the form of sucker bashing.

The debris must be thrown clear of the track, and not piled up immediately alongside.

It must be clearly understood that all tracks must be made passable for horse-drawn traffic, such as spring carts, drays, etc. In some cases washouts need filling in, and where sidelings are rather steep, a little levelling may be required, but this should rarely be necessary.

It is anticipated that the Department, by keeping these tracks cleared and fit for vehicular traffic, will induce timber workers and others to use them, and thus help to keep them clear and open, increasing their value in connection with fire control measures. Attention is directed to Regulation 75, whereby authority is given to direct the tracks which may be used by any traffic passing through a forest.

365.

Culverts and bridges to be repaired and cleared around.

Where possible at small cost, all existing culverts and bridges must be repaired and put in working order, and all debris, litter, and scrub removed from around all woodwork to a distance of six feet. Raking and light skimming with a spade or shovel may be necessary to do this satisfactorily. If the expenditure necessary to put any bridge or culvert in good order exceeds £2, special authority must be obtained before the work is undertaken.

366.

Crossings and fords.

Creek crossings and fords should also be put in order, and any cutting away of the banks, etc., necessary to make the approaches reasonably easy should be carried out, if not too expensive an undertaking.

367.

Permit holders' responsibility.

It should be noted that, under Section 88 of the Forest Regulations, it is the duty of all persons working in the bush to keep roads and tracks clear of debris resulting from their falling operations. This condition is only insisted upon in regard to tracks which are in use or have been cleared or opened by the Department.

SECTION 2.

REGENERATION OPERATIONS.

SCOPE AND SEQUENCE OF OPERATIONS.

368.

Natural regeneration of the forest follows the removal of the old trees, and therefore trade cutting is the first step in regeneration operations.

In every Eucalypt forest there are a varying number of worthless trees and trees of useless species which are unsuitable for trade purposes, and, in consequence, trade cutting operations must be supplemented by other work which we term regeneration cleaning.

The sequence of operations, according to existing practice in Western Australian Jarrah forests, is as follows:—

(1) Advance burn.
(2) Tree marking.
(3) Trade Cutting (of all mature and overmature trees).
(4) Regeneration cleaning.
    (a) Removal of useless trees and understorey on blanks where regeneration is desired, with the retention of certain worthless trees where needed as seed trees.
    (b) Final burn.
    (c) Removal (by complete ringbarking) of worthless seed trees after regeneration is secured.

It may be accepted as desirable that the operations set out above shall follow in an orderly sequence during a period of not more than two or three years. In practice, it will be found that problems of management render this impracticable, and exceptions will be found in a number of Working Plans, for example:—

(a) Where a large sawmill is operating the rate of Regeneration Cleaning may not be maintained to deal with the large area worked over for logs by the fallers each year.

(b) On heavily cut-over bush Regeneration Cleaning may be undertaken without provision for the prior removal by hewing of the limited number of mature and over-mature logs remaining.

(c) Long haulage and low market prices may render certain trees unprofitable at the time, although they contain a certain volume of sound timber. These trees must be held and not destroyed.

It will be readily understood, therefore, that careful supervision of Regeneration Cleaning is required on the part of the forester to ensure that no trees containing a quantity of sound timber are ringbarked through lack of appreciation of the probable future value of jarrah timber. These trees will be cut dur-

ing the second cycle. A feature of regeneration work which must not be lost sight of is that, under the "selection" system adopted, each and every compartment may be worked through for logs at regular intervals of possibly 20 to 30 years.

(1) ADVANCE BURN.

369.

Controlled burning, which it is very necessary to have carried out before trade cutting commences, is dealt with in Part III. (Fire Control), paragraphs 417-419.

(2) TREE MARKING.

370.

Tree marking in the Jarrah forest is carried out in accordance with the Group Selection System. Tree marking is the marking for removal for trade purposes of mature and overmature trees which possess utilisation value.

Relation of tree marking to regeneration cleaning.

It is important that officers doing tree marking should realise the part their work plays in inducing a new crop. As tree marking is a vital part of regeneration operations, it must not be regarded as entirely independent of, or of secondary importance to, regeneration cleaning.

Vigorously growing immature trees, whether occurring in groups or *isolated*, must on no account be marked for cutting.

Officers must realise that it is obviously not economical to remove an existing good immature tree or group of such trees to make room for a new crop which will take much longer to reach maturity. It will be realised that no definite girth measurement can be given to indicate when a tree may be regarded as mature, and in tree marking the rate at which a tree is growing must be given due consideration irrespective of size.

Tree marking must be regarded primarily as a silvicultural operation and not an effort to secure a quantity of timber for milling or hewing from a specified area.

371.

Method of marking.

The trees will be marked by branding in an axe-cut at the foot of the tree. The brand will be F.D. over a number; the number signifying the authorised officer using the brand. All branding axes are issued by Head Office and the name of the officer holding each number is registered. No branding axe may on any account be lent or transferred.

372.

Size of coupes.

Marking is done by coupes, the sizes of which are determined by the area sufficient to provide one week's cutting for the mill, or for sleeper hewers operating on the area.

373.

Boundaries to be blazed by forester.

The coupes must be blazed by the Forester or Assistant Forester in Charge. On no account may this work be left to an overseer.

374.

Forester to inspect coupe.

The Forester, or Assistant Forester in Charge, must make regular inspections of coupes claimed to be cut out before allowing fallers or cutters to move on to the next coupe.

375.

Tree marker to deal with bush boss.

In marking for mills employing a number of fallers, the tree marker shall deal only with the bush boss and not with individual fallers. In the event of any difference of opinion arising between the tree marker and bush boss, the question in dispute shall be referred to the Forester in Charge and Mill Manager.

376.

Importance of supervision.

It is not in the best interests of either the Forest Department or the sawmiller that useless timber shall reach the mill landing. The responsibility for preventing this lies with the company concerned, and is among the duties of the bush boss. Strict supervision of fallers is necessary to prevent avoidable damage due to careless falling causing split butts and broken crowns. The bush boss will find it necessary occasionally to condemn a log which is seen after falling to be valueless. He must also see that logs are long-butted when necessary and properly headed off.

Should it appear to any officer that neglect of these matters is likely to give rise to complaints by the mill management concerning quality of timber or recovery, a report should be made to the Forester in Charge, who will take the matter up with the Mill Manager or report to Head Office as he may think fit.

377.

Responsibility for marking axe.

An officer holding a tree-marking axe must on no account lend it to anyone, or suffer it to leave his possession. He is personally responsible for the axe while it is issued in his name.

(3) TRADE CUTTING OPERATIONS.

378.

The main features of departmental control under the "Forests Act, 1918," and "Forest Regulations" are discussed in Part I. of this Manual. For permits for which a Working Plan has not been prepared specifying the location and extent of forest to be cut over each year, it is necessary for the Forester in Charge to know at all times that portion of the permit area which will be worked over during the ensuing twelve months.

Not later than August 15th each year such information must be set out on a plan. This plan will form the basis for advance burning, irrespective of whether tree marking and regeneration cleaning or merely top disposal operations will follow the trade cutting.

379.

For the purpose of preparing this programme of work, the Forester shall obtain in July of each year a plan showing approximately the log lines to be constructed or location of cutting

for the ensuing twelve months from mill managers concerned. In this connection, the attention of Foresters is drawn to Regulation 29, by virtue of which the Department is empowered to confine operations on a permit area to certain defined sections. Accordingly it is the duty of the local officer to see that operations are strictly confined to the sections agreed upon, and that no departure from this is allowed except by express permission in writing from the Conservator.

In the near future all permits will be brought on to a uniform basis and made subject to annual renewal.

Regulations have been drafted which will render it necessary for the permit holder, when applying for renewal, to submit each year an application, through the Forester in Charge, setting out the area over which he desires to operate for the ensuing twelve months, and showing on a plan the tramlines it is proposed to maintain and construct.

This application will be forwarded to Head Office by the Forester in Charge with his recommendation, and before such papers are sent to Head Office he will extract the information referred to above. When such Regulations are gazetted it may not be necessary to apply for the information in July as instructed above, but a map of the annual logging proposals for each permit area must be prepared by the Forester at the beginning of August each year as a basis for controlled burning operations.

(4) REGENERATION CLEANING.

380.

System adopted to be "Selection by Groups."

The Silvicultural System, or method by which the bush is treated, is called "Selection by Groups."

The actual work carried out by departmental employees is termed "Regeneration Cleaning," which is a supplementary operation to "Trade Cutting"—the first phase of Regeneration Operations.

Regeneration Cleaning consists in clearing up or forming "blanks" (or openings) in the forest in order to encourage the development of regrowth.

Formation of blanks.

These "blanks" are formed either by ringbarking worthless Jarrah and useless species, or by enlarging existing openings in the same way. Where an underwood, or lower cover, composed of such species as Banksia, Wattle, large shrubs, and Blackboys, exists in the openings so formed, this growth must be felled.

In forming, cleaning up, and extending these blanks, the following points should be noted:—

Good centres for the commencement of blanks are to be found in the openings caused by the removal of trees either in trade cutting operations, or through natural causes such as fire and wind.

Size of opening.

No opening or blank will be made if it will be less than one chain (66ft.) across its smallest dimension (*i.e.*, a blank must be more than one chain wide).

Details of Work in the Blanks.

381.

All malformed or seriously damaged saplings and poles which cannot possibly develop into satisfactory logs if less than 15in. B.H. will be felled at one foot from the ground, except that such saplings less than 12in. at ground level will be cut as close as possible to the ground to induce self-rooted coppice growth. Jarrah.

All Jarrah trees above 15in. diameter at B.H., and which are unlikely ever to possess utilisation value, will be ringbarked.

Officers should realise that with the coming scarcity of timber, many immature trees of poor form met with in this work will be of value in years to come. Careful consideration is, therefore, necessary before deciding to ringbark a tree. In other words, a tree must be judged not on the standard of present milling or hewing value, but rather on possible future value.

Where regeneration from seed is necessary, the ringbarking must be only *partial*, leaving at least one half of the bark not severed.

Where regeneration is to be secured from advance seedling and coppice growth, the ringbarking may be completed in one operation.

The larger Marri will be "sap-rung," and any Marri below one foot diameter will be ringbarked. Marri.

In the case of Marri below six inches diameter, the bark, when it strips freely, should be knocked off with the back of the axe.

Groups of good Sheoak will be left intact; other Sheoak, Banksia, large shrubs, and Blackboys will be felled. *Banksia grandis* and other species which coppice vigorously should be cut off at a height of several feet above the ground. Other species.

All trees felled should have their limbs cut so as to lie more or less flat on the ground. Care must be taken to fell trees clear of tracks. Lopping.

Groups of good immature trees, pole stands, etc., should not be disturbed, and no cutting must take place in such groups. A single good growing immature tree should be regarded in the same light as a "group." Groups.

No cutting or ringbarking of suppressed trees, worthless trees, useless species, Blackboys, scrub, etc., which stand *under* the trees in these groups will be carried out.

The tops of fallen trees, and any other litter, will be cleared away for a distance of about three feet from around the good trees, piles and poles, which are left standing. Top disposal.

All groups of good Jarrah saplings remaining unharmed after advance burning will be preserved.

382.

Diagrams showing Group Selection.

In bush carrying plenty of good immature timber the relation of the openings to the groups left standing would be as in Figure 1.

In bush which is carrying a very large proportion of overmature trees, and little immature growth, the relation would be as in Figure 2 (*i.e.*, the position is the reverse of that shown in Fig. 1).

The outside strip represents the untreated break adjoining the compartment boundary.

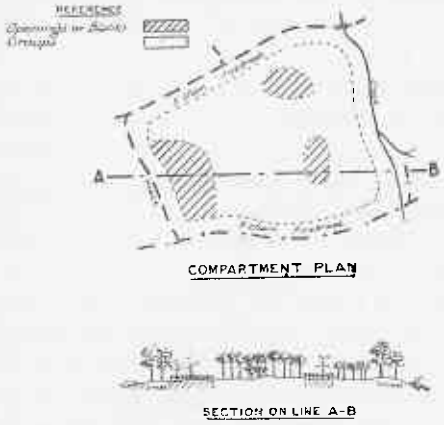


Fig. 1.

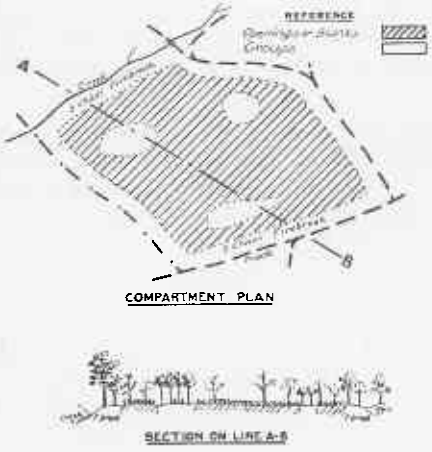


Fig. 2.

383.

Final burn.

Areas treated, whether whole compartments or portions of compartments, will be burnt by as severe a fire as possible in the summer following, but no burning may be carried out without directions from the Divisional Forest Officer, who will specify

the area to be burnt. If there is not sufficient advance seedling and coppice growth for full stocking, the subsequent burning must be delayed until immediately prior to seed fall in a good seed year. In the cases where regeneration from seed must be relied upon, all Jarrah trees partially ringbarked in the first operations must be completely ringbarked after the seedling growth is established on the ground, and before the summer following.

Final ringbarking.

General Points. 384.

(1) It is important to remember that the object of this work is to develop regrowth on the non-productive patches in the forest.

By non-productive patches is meant those parts, often many acres in extent, which carry only worthless jarrah, or trees of useless species.

(2) When in doubt, it is better to err on the light side. It is always possible to go back and cut trees which should have been destroyed, but the converse is not possible.

An officer should not be afraid to leave patches of forest severely alone if he is doubtful. He should go to a centre where a small opening has been caused by "falling operations," or by other means, and start again.

(3) Good saplings, piles, poles and immature trees are preserved because obviously they will reach maturity more quickly than the seedlings which would replace them if they were destroyed.

(4) Worthless Jarrah and useless species (in blanks) are destroyed because they will never be of any value, and the sooner the ground they occupy is supporting a useful crop the better.

(5) A group of men working under the one overseer must not be allowed to work on the same coupe. Each man must be established on a separate coupe.

SECTION 3.

IMPROVEMENT WORK (IN GROUPS).

385.

There is considerable scope for improvement work in existing groups. This work falls naturally into two main divisions:—

(a) Removal by trade cutting of merchantable over-mature Jarrah and removal by ringbarking of useless over-mature Jarrah and large Marri which are over-shadowing and tending to suppress young growing Jarrah.

(b) Thinning of poles, piles and saplings in groups of different ages.

The removal of large over-mature trees suppressing young growing Jarrah is work requiring early attention, and the extent to which it is to be carried out simultaneously with regeneraton cleaning will be a matter for direction on each Working Circle. More intensive improvement work in groups, such as thinning, although needing attention, will, generally speaking, be held over until a crop is established on the blanks. Where started in exceptional cases, during the next few years, it will be the subject of special instructions.

SECTION 4.

ARTIFICIAL REGENERATION.

386.

Regeneration of a forest by natural means (*i.e.*, from seed trees standing on the area) is the primary aim and object of all regeneration operations. Artificial regeneration as an operation of any extent must be undertaken only as a last resort when the natural regeneration secured is insufficient to fully stock the area. The presence of advance seedling growth on any area should be determined before the burn, and where it is considered portions of a compartment will require spot sowing such portions should be definitely pegged before burning.

Methods of artificial regeneration adopted by the department include spot sowing (sowing *in situ*), planting bamboo tube and tray stock reared in nurseries, and transplanting natural seedlings in the field by means of the semi-circular transplanting spade. The two latter methods have so far been adopted only in the Tuart forest, but the former method is of sufficiently general importance to warrant a detailed description here.

Spot Sowing.

387.

Laying out area.

The lay-out of an area for spot sowing will be carried out in the same way as for planting.

388.

Cultivation.

Spots 8in. x 8in. x 4in. deep are cultivated with a grub hoe at a spacing which may vary from 7ft. x 7ft. to 12ft. x 12ft. The surface of the cultivated spot should be made as level as possible, and the soil compacted so that the seed can be dropped in without any further preparation. The cultivating gang will move in eschelon formation.

A small pinch of seed representing from 3 to 6 seeds is dropped into each spot and pressed lightly into the ground with the sole of the boot. This method, rather than the burying of the seed by covering with soil, is followed in order to prevent too deep sowing, which is the greatest fault. The amount of seed required per acre will vary from ¼ to ½ lb.

389.

Time of sowing.

Spot sowing should be carried out within three months of the burn, *i.e.* the following autumn. Any attempt made to secure a better stocking by sowing in the second winter is not likely to give satisfactory results, as the seedlings will suffer from competition with the surrounding shrubs.

THE FORESTERS' MANUAL.

PART III.

Fire Control.

TABLE OF CONTENTS.

SECTION 1.

INTRODUCTORY.

390.

The problem of fire control is intimately bound up with the question of reforestation and afforestation, and the ultimate success of the Department's efforts in these directions is entirely dependent on a strong measure of public sympathy and co-operation in tackling the fire problem.

Of almost equal importance is the proper use of controlled fires in silvicultural and protective operations. The extent to which controlled burning is desirable and necessary is completely set out in the following pages, but there is a vast difference between a controlled fire started with the object of burning a specified area of country in a definite manner and a so-called creeping fire set alight by an irresponsible individual in the hope that such fire will burn with a minimum of damage until the next shower of rain occurs. To light up an area of bush without adequate precautionary measures is a criminal act for which severe penalties are provided.

The work of fire control falls into two main branches:—

(1) Fire Prevention.

(2) Fire Suppression.

Preventive measures are the primary aim.

SECTION 2.

PREVENTIVE MEASURES.

(1.) INDIRECT.

(a) *Legislation.*

"Bush Fires Act, 1902" (with amendments).

391.

The attention of all forest officers is called in particular to Clauses 5, 6, 7, 7a, 10 and 12 set down hereunder.

Clause 7a is of particular importance to this Department as it enables fire protected areas to be gazetted where extensive fire control measures have been inaugurated, and renders it necessary for any persons desirous of burning on private property to obtain permission from the local Forest Officer. It is not proposed to declare such fire protected areas in any district except where look-out towers are established, and extensive fire control measures are in operation, *e.g.,* Collie, Mundaring.

The clauses of the Act quoted hereunder are for general guidance of officers only, and may not be quoted in connection with any proposed prosecution. In such cases reference to a printed copy of the full text of the Act is necessary.

Governor may declare prohibited times.

5. (1) The Governor may, by notice in the *Gazette*, declare the times of the year during which it shall be unlawful to set fire to the bush within any district or part of the State mentioned in the notice.

(2) A copy of the *Gazette* containing any such notice shall be received in all Courts of Justice and elsewhere as evidence of the prohibited times within the district or part of the State named in such notice.

(3) The Governor may, from time to time, suspend the operation of any declaration made under this section, so far as such declaration extends to any railway reserve or any land under the control of the Conservator of Forests, for any period not exceeding six weeks in any one year.

Penalty for lighting fire during prohibited times.

6. Every person who shall wilfully or negligently set fire to the bush within any district or part of the State during the prohibited times for that district or part shall be liable to a penalty not exceeding Fifty pounds.

Provided that, subject to section seven, it shall be lawful during such prohibited times for any owner or occupier of land to burn off the bush between two plough breaks or spade breaks, between the hours of eight o'clock in the evening and twelve o'clock midnight, for the purpose only of protecting any dwelling-house or other building or stack of hay, wheat, or other produce within ten chains of a dwelling-house or other building.

Provided also that the outer break shall not be distant more than ten chains from the property to be protected.

No bush to be burnt unless precautions taken.

7. No person shall burn any part of the bush at any time during the months of October to April, both inclusive, unless—

(a) he has delivered or caused to be delivered personally to each owner or occupier of all adjoining lands four days' previous notice in writing of such intention; nor unless

(b) he keeps at least three men in attendance until all grass, stubble, or scrub has been burnt, to prevent such fire extending beyond the limit of his own land or land occupied by him.

Every person acting contrary to this section shall be liable to a penalty not exceeding Fifty pounds.

Nothing in this section contained shall authorise any act or thing contrary to section six.

Fire protected areas.

7a. (1) The Governor may, by notice published in the *Gazette*, declare any defined portion of the State to be a fire protected area.

(2) Within any such area it shall be unlawful for any person to set fire to the bush on any land, or at any time, without the permission of the Minister, or an officer acting with his authority. Penalty: Fifty pounds.

(See Section 3 of the Regulations—page 27.)

Provided that such permission shall be granted subject only to the compliance by the applicant with such conditions as may be prescribed by regulations under this Act to restrict the fire to the land on which the burning off is carried out.

(3) Section five of this Act (page 25) shall not apply to a fire protected area, but section seven (page 25) shall apply.

(4) Notwithstanding that permission is granted as aforesaid, nothing in this section shall be deemed to relieve any person from liability for any actionable damage sustained by any other person in consequence of the burning off operations.

10. (1) No person—

No fire to be lighted or used in open, unless precautions taken.

(a) shall light or use any fire in the open air for the purpose of cooking, camping, or for any other purpose, without a space of ground around the same of a radius of ten feet at least having been previously cleared of all grass, bushes, and leaves or branches of trees; or

(b) having lighted or used any such fire, shall neglect to fully and completely extinguish the same before leaving the place.

Every person acting contrary to this section shall be liable to a penalty of not less than Two pounds nor more than Twenty pounds.

(2) Every person who is discovered or proved to have been in any party which has lighted or used any such fire, or to have been present when the same was lighted or used contrary to this section, shall be deemed guilty of having acted contrary to this section.

12. Whosoever shall—

Penalty for lighting or attempting to light a fire with intent to injure.

(a) light or cause to be lighted, or attempt to light any fire; or

(b) put or place any matches or combustible matter or thing in such a position that the same may directly or indirectly be ignited by the sun's rays, or by friction or other means, or be exploded or set on fire, or whereby any fire may be lighted or caused,

under such circumstances as to be likely to injure or damage any person or property shall, whether such fire shall be caused or not, be guilty of an offence, and liable on summary conviction to be imprisoned for any term not exceeding one year, with or without hard labour, or to a fine not exceeding One hundred pounds.

392.

In order to give effect to the provisions of "The Bush Fires Act, 1902" (Amendment Act, 1925), the following Regulations for the control of fire protected areas have been gazetted:—

1. These Regulations may be cited as "The Bush Fires Regulations, 1926."

"Permit to Burn."

2. No person shall set fire to the bush at any time on land within any portion of the State that has been declared to be a fire protected area, without first obtaining a "Permit to Burn" from the Minister for Lands or a person acting with his authority.

3. For the purpose of these Regulations any officer of the Forests Department shall be deemed to be an officer acting with the authority of the Minister for Lands. Such officers are hereinafter referred to as "authorised officers."

4. An application for a "Permit to Burn" shall be in writing, in the Form No. 1 of the First Schedule, and shall be lodged with an authorised officer for the fire protected area in which it is desired to burn. An application may be accepted in the form of a letter, provided the full information required in Form No. 1 is supplied in such letter.

5. A "Permit to Burn" shall be issued by an authorised officer, provided he is satisfied that proper precautions will be taken by the applicant to confine the fire within the boundaries of his own land or land occupied by him, and that there is no undue risk of the fire getting out of control. Such permit shall contain such conditions relating to the precautionary measures to be taken by the permit holder as may be considered necessary at the time by such authorised officer.

6. A "Permit to Burn" in the Form No. 2 in the First Schedule shall be issued to every person obtaining permission to burn off within a fire protected area.

7. The holder of a "Permit to Burn" shall produce such permit to any officer of the Forests Department or other authorised person on demand.

8. Any person acting under instruction from an authorised officer may enter upon any land over which application has been made for a "Permit to Burn" for the purpose of—

(a) investigating the dangers likely to arise by burning;

(b) being present at burning operations;

(c) investigating steps taken to prevent the spread of fire subsequent to the main burning.

9. The holder of a "Permit to Burn" shall not burn any part of the bush at any time during the months of October to April, both inclusive, unless—

(a) he has delivered, or caused to be delivered, personally to each owner or occupier of all adjoining land, four days' previous notice in writing of such intention;

nor unless—

(b) he keeps at least three men in attendance until all grass, stubble, or scrub has been burnt, to prevent such fire extending beyond the limits of his own land, or land occupied by him.

10. The holder of a "Permit to Burn" shall take such precautions as may be prescribed by any officer of the Forests De-

partment for the purpose of preventing the spread of fire from his own land, or land occupied by him, on to any State forest, timber reserve, or other Crown land.

11. If any fire escape beyond the boundaries of the area over which a "Permit to Burn" is held, the holder of the permit shall, if possible, immediately notify the nearest Forest Officer, and, furthermore, shall, within twenty-four hours of the suppression of such fire, report the full circumstances to the authorised officer by whom the "Permit to Burn" was granted.

12. Any person who shall commit a breach of any of the foregoing Regulations, or shall contravene or fail to comply with any provision or condition contained in any "Permit to Burn" issued in pursuance of these Regulations shall, for every such offence for which a penalty is not specially provided by the "Bush Fires Act, 1902" and the amendments thereof, be liable to a penalty not exceeding £20.

THE FIRST SCHEDULE.

Form No. 1.

Application for a "Permit to Burn."

I,.....of....., being the owner or occupier of....., Location No....., hereby apply for a permit to burn over.....acres within the above location, for the purpose of.....(clearing land, destroying undergrowth, burning firebreaks, etc.), between the hour of....., on the.....day of....., 19 , and the hour of..... on the.....day of....., 19 .

I will have.....men in attendance during burning off operations.

Date.....

.....

Signature of Applicant.

Form No. 2.

Permit to Burn.

Bush Fires Act, 1902.

No.....

Authority is hereby granted to.....of....., the owner or occupier of....., Location No....., to burn over.....acres within the above-mentioned location, for the purpose of.....(clearing land, destroying undergrowth, burning firebreaks, etc.), between the hour of....., on the.....day of....., 19 , and the hour of....., on the.....day of....., 19 , under

and subject to "The Bush Fires Act, 1902," and amendments thereof, and the Regulations thereunder in force for the time being and the observance and performance by the holder of the conditions set out on the back hereof.

If any fire escape beyond the boundaries of the area over which a "Permit to Burn" is held, the holder of the permit shall, if possible, immediately notify the nearest Forest Officer, and furthermore shall, within twenty-four hours of the suppression of such fire, report the full circumstances to the authorised officer by whom the "Permit to Burn" was granted.

Nothing contained in this "Permit to Burn" shall be deemed to relieve any person from liability for any actionable damage sustained by any other person in consequence of the burning off operations.

Landholders, in their own interest, are warned against lighting fires should the day prove too dangerous on account of hot, strong winds, or for other reasons.

In the event of it being inadvisable or impossible for the holder of this permit to burn off during the period stated above, a fresh permit must be applied for and obtained.

Date.....

.....

Authorised Officer.

393.

Fire clauses, Forest Act.

"Forests Act, 1918."—The attention of all forest officers is also called to:—

Section 46—Penalty for unlawfully lighting fires (Min. 1/20th of Max.).

Section 47—Forest officers calling for assistance to extinguish fires.

Section 48—Setting fires to bush without notice to forest officers.

(b) *Education and Propaganda.*

394.

The most effective means of fire prevention is popular education.

395.

Poster advertisement.

Posters are to be displayed at railway sidings and other public places in Working Circles. A list of railway stations on which it is desired posters shall be displayed should be forwarded to Head Office in September each year, together with a requisition for the number of posters required for display locally.

The work may be helped by posting notices on trees, logs, etc.

396.

Distribution of leaflets, etc.

Small pamphlets, giving information concerning the provisions of the Bush Fires Act and the fire provisions of the Forests Act, will be distributed among local residents and settlers.

Note.—Personal interviews, at the time of distribution of the above pamphlets, with persons living in the district, will greatly assist the work.

Recommendations for printing of new pamphlets and requisition for supplies should be submitted in September each year.

397.

Lectures to the general public.

Lectures, with lantern slides, will be arranged for in districts where fire control measures are instituted. Application for the services of a lecturer should be made to Head Office as desired.

(2) DIRECT.

(a) *Elimination of Fire Hazards.*

Controlled Burning.

398.

Controlled burning, together with popular education, should go far towards solving the fire problem.

Areas afforded complete fire protection.

All areas which do not require complete fire protection will be burned systematically by light, controlled fires. Complete fire protection will be afforded to—

(a) Areas treated and regenerated except that, where the crowns of the trees have reached a sufficient height to be beyond damage by a light surface fire, instructions may be given by the Conservator for controlled early burning under such stands.

(b) Areas partially treated and awaiting final treatment pending seed years.

(c) Areas to be worked over for trade purposes within three years need protection in order that they will carry a fire immediately before trade cutting commences. This fire is of importance as a means of modifying and controlling the final burn in order to protect groups of young poles.

399.

System of controlled burning.

The remainder of the forest will not be afforded complete fire protection, and will be burnt under control in regular cycles. In view of the fact that the bush will carry a fire only every three years, approximately one-third of the area will be dealt with each year, so that the whole area will be covered in a three-year cycle.

Within the boundaries of a Working Circle, this controlled burning will be carried out by compartments.

Special measures are necessary where large areas of country, not subdivided into compartments, adjoin a Working Circle. In the Jarrah belt the eastern boundary is the most critical from the fire control aspect, because the fiercest fires always come from that direction. In dealing with such country on the eastern boundary it is necessary to arrange systematic controlled burning in one-mile strips, running approximately north and south. It is necessary to have three such strips for burning in successive years.

400.

Preliminary inspection by officer in charge.

The officer in charge will make an inspection to determine—

(a) The nature of the country to be burnt.
(b) Its inflammability.
(c) Natural aids towards fire control, such as tracks and formations.

401.

Rough plan of area to be made.

A rough plan of the area to be burnt must be made, if only approximately. In most cases the area can be sketched in relation to compartment boundaries, features, or areas already treated and marked on the plan.

402.

Plan of burning to be laid down.

The officer in charge should then lay down a plan for burning each area, stating the order in which they are to be burnt, class of weather, direction of wind, time of day, labour required, etc. In the plan of burning, special attention must be paid to areas forming particularly dangerous hazards such as:—

Special hazards.

1. Areas on which trade cutting operations are to take place.
2. External boundaries.
3. Blackboy flats.
4. Other areas in the forest where work will take place, such as stone-quarrying operations.

A copy of this plan will be submitted to Head Office as part of the annual fire proposals scheme. (See page 106.)

During the actual burning he may find it advantageous to alter this plan, when weather conditions render an alteration in the order of burning expedient and possible with safety.

The Burning.

403

Responsible Officer to be in attendance during burning.

A responsible officer *must* be in attendance while burning operations are being carried out, and no burning should be undertaken without direct instructions from the Forester in Charge.

404.

General points to be noted in burning.

To obtain the best results, country which would burn fiercely should be burned against the wind on a cool day, or at night time, whereas country which it is difficult to burn will need to be fired in the heat of the day.

Particulars concerning any cases of fire escaping must be reported to Head Office without delay.

All fires should be patrolled until they are "dead out," special attention being given to fires in dead trunks and tops of standing trees.

Although one extensive burn is cheapest, it may be found necessary to burn by small sections for purposes of control.

When a fire is lit by a departmental employee, under instructions from the Forest Officer in charge of operations, the latter is to be held directly responsible for the fire being kept under

control. It is the duty of every forest officer, therefore, to see that there is *no possibility* of any such fire getting out of control.

Time of Burning. 405.

Prohibited period.

The Bush Fires Act of 1902 lays down that there shall be a closed season each year, during which the lighting of fires will be absolutely prohibited. This period will vary in different districts and is fixed each year by the local governing Road Board.

Care must be taken by the officer-in-charge to see that burning operations in his district are not carried out in contravention of the Act, and that any adjoining landholders are notified as required under the Act.

406.

Seasons for controlled burning.

Controlled burning will be carried out in early spring or late autumn.

At no time should any burning be undertaken which may possibly get out of control. The more inflammable the country, the earlier (or later) will it be burnt.

407.

Country carrying dense regrowth.

Country carrying dense young regrowth needs burning as lightly as possible, and when this regrowth occurs in patches, the desired result may be obtained by burning such patches in the cooler parts of the day.

408.

No burning in prohibited period.

In districts gazetted "fire protected areas" under Section 7A of the "Bush Fires Act, 1902," there is no prohibited period, but during the months of December to February no departmental burning may be carried out unless a permit is written out and issued to the officer responsible by the Forester in Charge.

409.

Special authority before burning.

In districts not gazetted "fire protected areas," the Conservator, on receipt of the forester's application to burn during the prohibited period, may, if he considers the reasons advanced in the application sufficiently strong, arrange for the approval of the Executive Council under Section 5 of the "Bush Fires Act, 1902." Such permission, however, will only be granted subject to the burning being carried out during the most favourable weather periods for control, and under the *strictest* precautions.

Summary. 410.

1. Local regulations and restrictions concerning close season must always be observed.
2. A fire must *never* be allowed to escape beyond control. All officers must realise that, quite apart from the actual damages for which the Department may become liable on this account, the consequences of letting a fire get out of control are serious.

Kerosene Pressure Torch. 411.

Purpose.

Difficulty will be experienced in starting a fire in certain types of country, although a satisfactory running fire will develop once sufficient heat is generated. To overcome this difficulty kerosene pressure torches are standard equipment in every district. The flames thrown by these torches generate sufficient heat to start a satisfactory burn, which might otherwise be difficult or even impossible.

412.

General description.

The torch consists primarily of a metal tank with the necessary fittings to enable it to be carried on the back knapsack fashion. To this tank are fitted a pump for maintaining pressure in the tank, a pressure gauge, and a filler cap which is also designed to form a pressure release. A length of rubber hose connects the flame projector to the tank. A stop valve is fitted at the tank end of the hose, and another at the projector end. The projector is so designed that the kerosene, before finally leaving the jet, passes through a coil of copper tubing surrounding the flame and is highly vaporised. A filter is built into the projector, and all sediment is thus prevented from reaching the jet. A conveniently placed handle is attached to the projector for carrying and directing purposes.

413.

Instructions for use.

1. Turn off the two stop cocks or valves.

2. Fill the tank from two-thirds to three-quarters full of kerosene and screw filler cap down tightly. Hand pressure is sufficient, as, if a wrench is used, the rubber washer under the cap is quickly ruined.

3. Pump the tank up to a 40lb. pressure.

4. Open the valve at the tank end of the hose.

5. Slightly open the valve on the projector and run about one-quarter of an inch of kerosene into the little tray under the burner and then turn off. Place a small piece of rag, bagging, binder twine, bark or other material in the tray to act as a wick and light. Allow to burn for four or five minutes, when the coil should be thoroughly heated, and then open the valve on the projector about one-eighth of an inch. Should kerosene run through, the coil is not yet hot enough to vaporise the kerosene. Allow the coil to heat until, when the valve is opened on the projector, the kerosene vapour spurts out in the form of a roaring blueish-white flame about 15 inches long. The torch is then ready for use.

6. It should only be necessary to open the valve on the projector very slightly to obtain the maximum intensity of flame, not more than one-eighth of an inch movement of the wheel forming the handle of the valve usually being found all that is required. To open further than this is merely to waste kerosene and, if the torch will not burn properly unless a much wider

opening is given, there is bound to be an obstruction in some part of the projector which should be cleaned out.

Two gallons of kerosene should last three hours.

7. The pressure in the tank should not be allowed to fall below 20lbs. per square inch. This, of course, may easily be checked from time to time by the gauge on the top of the tank. Some types of gauge fitted have a stop which it is necessary to release before the true pressure in the tank may be read. It is not advisable to pump above a 40lb. pressure.

8. When operating the projector should not be pointed into a strong wind.

9. To shut off the flame, tightly close the valve on the projector. If the torch is to be put away for a lengthy period, empty all kerosene out of the tank and thoroughly drain the hose.

414.

Adjustment of the projector.

Practically every failure of this torch to function properly can be traced to the projector.

The two most vulnerable points are the jet and the gauze strainer.

If the flame burns fitfully, either the jet is obstructed or the pressure in the tank is low. A small wire pricker is supplied for removing loose obstructions from the jet, and should always be carried when using the torch. The remedy for the latter is obvious.

When it is necessary to open the valve on the projector very considerably to obtain a good flame, and pricking the jet does not remedy the trouble, it may be taken for granted that either the gauze strainer is choked with dirt or rusty water, or a carbon deposit has formed behind the jet. The gauze is easily removed for cleaning. To remove the carbon deposit from behind the jet, this latter must be screwed out and the deposit chipped or scraped out with a piece of wire. This deposit usually adheres to the jet holder which connects the jet to the heating coil and is quite easily removed.

Top Disposal. 415.

Enormous damage has been done in the past by bush fires following in the wake of "falling" operations when the bush has been littered with "tops." Not only are saplings, poles and piles destroyed in this way, but where, as is often the case, the butts of mature trees are surrounded by a litter of tops, the resulting scorching, where not actually fatal, renders the trees of much less value, or in some cases even useless, from the timber point of view.

It is evident that money spent judiciously in clearing round trees and in top disposal operations generally will be repaid many times over in the saving of valuable timber.

416.

Sequence of operations.

The following procedure will be adopted in carrying out top disposal operations in typical Jarrah country. Sequence of operations:—

1. Advance burning.
2. Clearing Debris.
3. Top Burning.

417.

Advance burning.

The importance of burning country in advance of falling operations, as a means of modifying and controlling subsequent fires, cannot be over-emphasised.

The Forester, or assistant forester, in charge of Top Disposal Operations will be held guilty of neglect if such work is being carried out on country not previously burnt.

Exceptional cases will arise where burning is impossible, and in such cases the Forester should send prior information to Head Office, and not wait for the irregularities to be discovered by an inspecting officer.

418.

For the purpose of preparing this programme of work, the Forester shall obtain in July of each year a plan showing approximately the log lines to be constructed or location of cutting for the ensuing twelve months from mill managers concerned. In this connection, the attention of Foresters is drawn to Regulation 29, by virtue of which the Department is empowered to confine operations on a permit area to certain defined sections. Accordingly it is the duty of the local officer to see that operations are strictly confined to the sections agreed upon, and that no departure from this is allowed except by express permission in writing from the Conservator.

In the near future all permits will be brought on to a uniform basis and made subject to annual renewal.

Regulations have been drafted which will render it necessary for the permit holder, when applying for renewal, to submit each year an application, through the Forester in Charge setting out the area over which he desires to operate for the ensuing twelve months, and showing on a plan the tramlines it is proposed to maintain and construct.

This application will be forwarded to Head Office by the Forester in Charge with his recommendation, and before such papers are sent to Head Office, he will extract the information referred to above. When such Regulations are gazetted it may not be necessary to apply for the information in July as instructed above, but a map of the annual logging proposals for each permit area must be prepared by the Forester at the beginning of August each year, as a basis for controlled burning operations.

419.

The area to be cut over should be burned some weeks before the fallers come on to each landing, but should never be burned more than twelve months in advance. It will often be found necessary to burn several months in advance on account of the fire close season, weather conditions, etc.

Uncontrolled bush fires will at times forestall the forest officer in this work, burning the country more fiercely than is desirable.

A fire twelve or eighteen months prior to felling operations will leave the country in such a state that it will not burn again immediately in front of the fallers, but will yet run a fire when the crowns and bark lumber the ground, thus adding to the difficulty of disposing of this litter under favourable circumstances.

To avoid this, great care must be taken that advance fires do not escape and burn more than is necessary for the year's coupe. At present the staff is inadequate, generally speaking, to protect the following year's coupe from chance bush fires.

The area of country burnt in advance should not be more than will be operated over by timber workers during the following twelve months.

Burning will, in all cases, be carried out strictly in accordance with instructions set down for "Controlled Burning." (See page 30.)

420.

Clearing debris.

Workmen will follow the fallers and clear away debris for a distance of about three feet from around valuable trees and saplings.

Litter created by the trees recently felled, old limbs, etc., which have fallen against the butts of good trees and saplings, so forming a fire menace, should be removed in this way. Limbs which stick up from fallen trees, and are likely to carry fire into the tops of adjacent trees, should be lopped.

The amount of work to be done around any tree will depend on its value. Trees which already have valuable timber in them are worth many saplings. A valuable pile, for example, may justify the expenditure of a couple of hours' labour, while a short sapling (even though sound) requiring half an hour's work to clear round, would not be worth tackling.

In judging the value of a tree it should be borne in mind that many trees cut to-day would have been passed by a few years ago, and that many trees to-day considered worthless will be very valuable in years to come.

421.

Top burning.

The tops can safely be burnt at any time of the year, provided the advance burning has been satisfactorily carried out.

Top burning should, however, be left until at least a couple of months after falling. Many of the limbs will then burn away which, if fired soon after being felled, would remain to form a menace to future regrowth. The burning should usually be done in cool weather or at night, so as not to scorch individual trees too severely. The burning of tops must be suspended during the prohibited period for the district.

When, owing to fires having occurred during the previous twelve to eighteen months, an advance burn has not been obtained, the burning of the tops must only be carried out early in the

following spring when there is no possibility of the bush running a fire. This means that the Department is taking a risk of the area being swept in the interval by an uncontrolled fire, but it is better in such cases to accept that risk and clear the debris only, rather than undertake top burning under dangerous weather conditions when the Department carries the entire onus of letting a fire get out of control.

422.

Other work.

As opportunity offers, all disused bridges and culverts should be inspected and cleared round to protect them from fire, and with a view to having a system of cleared tracks available for transport, etc., when complete fire control is inaugurated. All disused wells are likely to prove of future value to forest working parties and should be covered with stout timber and marked on a plan.

Spark Nullifiers on Mill Locomotives.

423.

Mill locomotives must always be regarded as a very great source of bush fires. For this reason timber firms using mill locomotives should be required to co-operate with the Department in their efforts to minimise this danger by the use of effective spark nullifiers when and where found necessary. If live coals are dropped between the rails it is evident that the ash pan of the locomotive requires attention.

(b) *Firebreaks, Tracks, etc.*

Firebreaks and Subdivision.

424.

From the point of view of fire control, the method of subdivision and the firebreak system adopted for pine Working Circles differs from that adopted for hardwoods.

425.

Pine working circles.

In the case of pines, firebreaks are cultivated annually. The unit of subdivision (the compartment) is 25 acres, so that if a fire does get in, it may be confined to the smallest possible area. The system of subdivision is discussed under "Afforestation" (pages 71-74).

426.

Hardwood working circles.

In hardwood working circles the firebreaks are not cultivated strips, but belts of green timber burnt periodically by controlled fires, and the compartment is 500 acres in extent. No regeneration cleaning or ringbarking is carried out within five chains of a compartment boundary, or within ten chains of private property locations, where these form external boundaries. Compartments are, therefore, separated by belts of green timber ten chains in width. Controlled burning is carried out over one-half of the width of each firebreak belt on alternate years.

Such belts must be retained in addition to country which cannot be burnt early (*e.g.*, wet flats).

Tracks. 427.

In fire control, tracks serve as a means of access, as an aid to the control of burning on areas not treated or undergoing treatment, and also (in many cases) as compartment boundaries.

As an aid to the control of burning, however, tracks can be effectively used only when the burning is carried out frequently. If this is done, an early or late burn can readily be confined to a compartment, or to a portion of a compartment where such is surrounded by well-defined tracks.

428.

Firebreak scraper.

Where the tracks formed by bush haulage are not sufficient, or where these have become overgrown through disuse, a horse-drawn scraper is used to form new tracks and to link up existing ones. This implement will be extensively used where the formation of new tracks is necessary, as on private property boundaries, in country which has not been cut over for trade purposes (*e.g.*, Wandoo country in the Helena Reservoir Catchment Area), and on the boundaries of 10-chain strips of green timber separating compartments. If the standard type of triangular scraper constructed from a 6-foot length of 45-lb. rail with side plates does not prove effective on any particular type of country, full particulars must be forwarded to Head Office before undertaking extensive hand raking or mattocking or spading. Suggestions for other types of implements or improvements to overcome the particular difficulties should accompany the report. Standard pattern scrapers will be supplied on receipt of requisition by Head Office.

SECTION 3.

FIRE DETECTION AND SUPPRESSION.

429.

The successful combating of fires is mainly dependent on:—

1. Efficient organisation for their immediate detection (*e.g.*, look-out towers).
2. An effective system of communication between headquarters, look-out towers and field gangs.
3. Efficient fire fighting personnel and equipment.
4. Means of rapid transport to the site of the fire.

(1.) LOOK-OUT TOWERS.

(a) *Two Look-out Towers.*

430.

Where two look-out towers are in operation, the method of locating a fire is by means of cross bearings taken from the two towers, and plotted separately by each look-out man on his fire map.

N.B.—The instrument for taking bearings (obsolete theodolite, etc.) is set to give a reading of 0deg. on the true North meridian.

431.

Equipment consists of instrument for reading angles, telephone, heliograph, map of the area showing positions of the two look-out towers (each as the centre of a protractor), log book, etc. Equipment.

Note.—It is the duty of the Forester to see that at least two trained men are available for duty on each tower.

432.

A period of duty on a look-out tower lasts for one week. Period of duty.

433.

When a relief is detailed for look-out work, he should get together and take with him:— Supplies.

1. A week's tucker.
2. Blankets.

Everything else will be found at the Look-out Station.

434.

On arrival at the Look-out Station, the new man will have a general look round and, if he is satisfied that things are in order, he will sign the handing over register, which will be in the following form:— Taking over.

"In signing this register I accept full responsibility for all instruments, material, buildings and other property of the Forests Department at this Look-out Station, and undertake the duties and responsibilities of look-out man from the time stated on the day mentioned hereunder:—

Time	Date	Water in tank, Ring No.	Signature of man taking over.

435.

The look-out man will be constantly on the alert for fires within his range of vision. Location of fires

At 8 a.m. the look-out man will ring the nearest look-out station and synchronise clocks.

Every subsequent half-hour the look-out stations will exchange "All clear" and make an entry in the log. While there are only two stations in operation, they will take it in turn to exchange the half-hour signal.

On sighting suspicious smoke, the look-out man will:—

1. Take true bearing of the smoke.
2. Enter the bearings and time in his log.
3. Telephone or signal the other look-out giving the bearing observed.
4. Enter bearing received from the other look-out in log.

5. Plot the bearings and locate the fire.
6. Exchange messages with the other look-out, concerning the location of the fire, thus checking the location obtained by the bearings.
7. Send the information to the District Officer.
8. Prepare a message in code if a field gang is to be communicated with by heliograph. Enter this code message in the log book.

Note.—The look-out first spotting the smoke will notify headquarters of the location of the fire. Notifying Headquarters.

436.

Where field gangs are not connected by telephone to headquarters, it will be necessary for them to call up the look-out tower by heliograph. The look-out man will then send by heliograph any telephone message received by him from the district office for transmission to the field gang. Communication with field gangs.

437.

If a small fire occurs on private property some distance away from the forest, the look-out man must study wind direction and other factors, so as to decide whether the fire threatens to spread to the forest. He will notify district office whether, in his opinion, the fire is threatening the forest or otherwise. Fires on private property.

438.

The small tank at each station *must* last the whole summer. Every man must do his utmost to conserve water. Water at look-out stations.

Horses must not under any circumstances water at the look-out stations or be kept there over night. The information concerning water in the tank must be carefully booked each week in the handing over register.

(b) *One Look-out Tower.*

439.

Where only one look-out tower is in operation, the method of locating a fire is as follows:—

The position of the fire is obtained by means of a range-finder mounted on a graduated base by means of which the bearing is obtained at the same time. The bearing read from the graduated base is plotted on the fire map, and the range, as recorded on the instrument, scaled off along this bearing (see paras. 539-543).

440.

Equipment consists of:— Equipment.

Fortress range-finder mounted on a graduated base.

Telephone and heliograph.

Map of area under fire control showing position of tower as the centre of a protractor.

Telephone log book.

The taking over, hours, etc., will be given under (a).

441.

In locating fires the following practice will be adopted:—

Location of fires.

On sighting suspicious smoke the look-out man will—

1. Take true bearing and range of smoke.
2. Enter bearing and range in log.
3. Locate fire on plan and enter Section or Compartment number.
4. Send information to district office.
5. Prepare a message in code if a field gang is to be communicated with by heliograph.

(c) *Care and protection of Look-out Towers.*

442.

Towards the end of each summer, the Forester in charge of the district in which look-out towers are situated must have a careful inspection of each tower made with a view to determining:—

(a) Whether it is necessary to screw up any bolts.
(b) Whether it is necessary to place iron bands around uprights which may be splitting badly.
(c) The need for treating exposed ends of timber with petrolatum or some similar compound.
(d) The need for painting or otherwise treating any exposed wood or ironwork.
(e) Provision to be made for the care and storage of instruments during winter months.

At the beginning of the fire season, steps must be taken to clear all undergrowth for a radius of five chains around each tower. The question as to whether any big timber need be felled and burnt up is a local problem which must be dealt with separately for each tower.

The forest floor for a distance of five chains from the tower, however, must be cleaned up so that there is no possibility of its carrying fire on the hottest days.

During the fire season at least two buckets filled with water must be kept on the top of the tower, to be used in case of emergency.

(2) FIRE FIGHTING.

443.

Equipment.

All fire fighters must have on hand the following equipment:—

Plan mounted in sections.
Rake-head.
Full water bag.
Rations for self and horse.

444.

Surface fires.

Practically the only fires to be contended with in this country are "surface fires" (*i.e.*, fires burning through undergrowth and surface litter), and their intensity varies according to weather conditions.

445.

Nature of a fire.

On a calm day, when there is no wind, a small circular fire will be observed, burning slowly away from the starting point with equal intensity in all directions.

With a wind blowing, a fire rapidly assumes a long oval shape, and the fire has three distinct parts:—

(1) *Head Fire.*—This is the hottest portion; it travels the fastest, and must be controlled first.

(2) *The Side Fires.*—On either side of the rapidly spreading head fire are slowly spreading side fires. These become of great importance if the wind changes, when one will become the head fire. They must be left until the head fire is under control.

(3) *The Tail Fire* is burning against the wind, and is, therefore, not strong. It must not be neglected, but must be put out last.

446.

Principle of attack.

No time must be lost in travelling to the fire. The important thing is to stop a fire before it gains headway. To do this, fire fighters should tackle the head fire first, and then work sufficiently far round to either side to prevent the danger of wing fires developing into new head fires.

Preliminary reconnaissance is of the first importance, and makes for well directed effort. The lie of the country, the conditions of the bush, the strength and direction of the wind should all be studied and the best method of tackling a fire rapidly decided before actually commencing operations. Badly directed effort, however strenuous, gets nowhere and knocks up fire fighters for little or no result.

447.

Mode of attack.

With the exception of country about to be treated or recently closed for regeneration, practically all country within or surrounding a Working Circle should be kept in a reasonably safe condition by controlled fires. When an accidental outbreak of fire occurs on country subject to controlled burning, it will prove more effective and economical to allow the fire to burn out if the spread is not threatening any treated country. A very complete knowledge of surrounding country and hazards in the vicinity is necessary to justify permitting a fire to burn out in this way without any control. If he is in doubt the Forester should see that an overseer or other responsible officer investigates the outbreak in its early stages.

On areas subject to complete protection, the suppression of outbreaks is the principal responsibility of all employees during the summer months, and the following notes will prove a valuable guide in attacking the problem in an intelligent manner.

No two bush fires can be fought in exactly the same manner.

Two methods of actual attack are, however, employed. These are "direct beating" and "back firing."

448.

Direct beating.

Under special conditions, where a fire breaks out on an area burnt two years previously, or when weather conditions are favourable (*e.g.*, calm days in spring or late autumn), it will often be possible to suppress a fire by direct beating.

The actual operation needs scarcely any explanation. Marri boughs are best for beating and should always be used where available.

After beating, a strip on the edge of the burnt country must be swept clean. Sweeping should always be in towards the burnt country. At night this sweeping must be done with the beating, because the ground can then be seen in the light of the flames ahead.

449.

Back firing.

On protected country, and particularly on treated areas where the bush has been closed for, say, three to four years, it will be necessary to back fire from the five chain belts or other burnt country.

The distance ahead of the approaching fire at which the counter fire will be set is a matter of local judgment for each specific case.

450.

Back fire to be lit in sections.

The back fire must not be set in a long line at once, but gradually, in sections, so that each section can be made safe before another section is lit.

Although one man can do this by himself, a gang of three men is usually the best, two to take turns at raking and lighting, and the third to patrol the rear sections, beating out where necessary.

The greatest care should be taken always to rake around trees on the edge of a raked strip, so that back fires cannot run up the bark of these trees.

In some cases the head fire will be dealt with by "raking and counter-firing" and the wing and tail fires by "beating and sweeping."

In all cases, however, a strip averaging about a foot wide, either raked or swept, must be left all round the fire.

451.

Factors influencing mode of attack.

The method of attacking a fire in the jarrah bush will vary with—

(a) *Month of the year.*—Fires in November or December, depending on the season, might be beaten out, whereas fires in February and March generally need to be dealt with by "raking and counter-firing."

(b) *Period since last burnt.*—A fire occurring on an area burnt 18 months or two years before might easily be beaten out, whereas a fire on an area not burnt for, say, four years, would most easily be dealt with by "raking and counter-firing."

(c) *Type of country.*—Fires starting in scrub with Blackboys, or bracken country, are usually too hot for "direct beating," whereas, under identical weather conditions, a fire on more open country could be beaten out. Fires burning uphill are much fiercer than those on the level.

(d) *Wind.*—If strong gales are blowing, it is wisest to back-fire.

It should rarely be necessary to deal with a big fire in a fire-controlled area, but, if one does occur, it should be remembered that big fires can often be headed into an effective barrier such as an old burn, by choosing a certain portion of the head-fire to attack first.

452.

Extinguishing the fire.

Nothing is so troublesome as a fire which breaks out again. All fire fighters must remember that their job is to put fires out, not merely to stop them, and should aim to make it a record that no fire they have dealt with has ever broken out again.

453.

Points to note.

The following points should always be borne in mind:—

A fire which has been merely "beaten out" is not extinguished. It is only "stopped."

If a fire is stopped by "direct beating," care must be taken to sweep a narrow strip along the edge of the burnt country.

On the edge of a burnt area the following require special attention and must be burnt around:—

(a) Burning trees.
(b) Burning stumps.
(c) Burning logs.
(d) Burning debris, such as sleeper chips, bark.
(e) Burning blackboys.
(f) Any heap of thick litter.

Fire, or smouldering embers, in such places unnoticed in the haste of the attack on the live fire, can be made safe only by patrol.

It is always necessary to go back over the line to make sure the fire has not broken, or will not break out anywhere.

A patrol will be sent out to the site of the fire on the day following the outbreak, but if the fire has been put out properly there ought to be nothing for him to do.

(3) ORGANISATION.

(a) *The Forester-in-charge.*

454.

The controlling officer's part in fire-control is organisation.

Successful fire control cannot be based on a strenuous personal effort only. Careful attention must be paid to the instructions concerning methods and systems.

At any time, of course, old methods may appear to become obsolete and Foresters in charge may have ideas for betterment of the adopted methods.

455.

Scheme of fire control proposals submitted by Forester.

On or before the 1st November each year the Forester must draw up a scheme of fire-control for the district under his charge, and forward a copy to Head Office.

456.

The report must be accompanied by a map showing:—

Areas burnt by uncontrolled fires in previous season;

Areas burnt by controlled fires during the previous twelve months;

Areas on which controlled burning is to be carried out during the ensuing fire season (a) before the season begins, (b) after the close season ends.

Experience in the work should result in each succeeding scheme being more complete in detail, clearer in instruction, and more efficient than the preceding one.

These schemes of fire-control, together with the Forester's annual fire report, should greatly assist in the work in future years.

457.

Working circles will be divided into blocks, one or more of which will be in the charge of a working overseer, who will have direct control of any men who may be employed.

It is the Forester's duty to see that his assistants and overseers carry out their work efficiently. He is not there to do the actual fire-fighting, but should on occasions go out to a fire to see how the job is being carried out, and occasionally to the scene of a fire after it has been put out.

If a big fire occurs, the Forester or his assistant should go out to the fire to superintend operations, but, in the event of the Forester going out himself, he must leave an assistant forester at headquarters.

(b) *The Overseer.*

458.

A Forest Overseer is responsible to the Forester for the fire control of the block or Minor Working Circle allotted to him. He requires:—

(1) Fire map of the area under fire control (80 chain scale).

(2) Block Plans (20 chain scale). Two sets of each are required—one of each set mounted on linen for field use, and the other (paper copy) to be posted at the overseer's house or hut.

(3) List of names of settlers and local residents in his locality who are willing to assist at fires.

459.

Equipment issued to overseer.

Equipment on issue to an overseer may be either—

(a) for his personal use; or

(b) for use by his men.

In either case the overseer is responsible for the articles issued.

Where equipment is issued to each individual member of the gang by the Forester and signed for by the recipient, the individual himself is primarily responsible.

A list of all the equipment should be kept by the overseer at his camp, and it is the overseer's job to see that his own and every man's waterbag is kept full.

460.

Duties of overseer.

An overseer should make himself familiar with his block. He should find out the dangerous hazards, such as boundaries, areas where bush workers are operating, roads which are used by travellers, grass country, etc.

461.

Extra map to be posted at camp.

On the extra map posted in his camp, he should mark:—

(a) Areas dealt with by preliminary burning.

(b) Areas burnt during the season.

For the fire report he should mark in the fires as they occur.

462.

If a Departmental telephone line passes through his block, he must have the necessary tools and material in order to effect repairs in case of a break-down.

463.

Standing patrols may be retained in camp on Saturday afternoons and Sundays as the Forester may decide.

464.

Leave in lieu.

Instructions *re* leave in lieu will be found in Part I. of this Manual, paras. 224-225.

465.

Public co-operation.

Overseers should remember that sympathetic public co-operation is essential to efficient fire control, and with this end in view should take every opportunity to interest people in fire-control measures.

466.

It is the duty of every overseer to see that selected men are thoroughly conversant with the instructions given here in the use of the various F.P. forms.

467.

All report forms required by the overseer and men under him in connection with fire fighting have been prepared on a standard size sheet which fits into a loose-leaf notebook. The number and use of these forms is set out hereunder.

(1) *Form F.P.* 4 (*F.D.* 106)—*Payment for Services.*

468.

Fire control forms for use by overseer or deputy.

This form, duly filled in, will be handed to the fire fighter, at the scene of the fire, by the Forests Department employee immediately in charge, who is also responsible for completing forms F.P. 5 and F.P. 6 (F.D. 107 and F.D. 108 respectively).

Payment by the Forester will be made only on production of this form, and, if presented personally, a wages sheet will be prepared and immediate payment made by cash order. The person to whom the payment is made must sign the wages sheet.

If personal application for payment cannot be made, the fire fighter should send his form direct to the District Office. The Forester, after initialling the form (thereby certifying it correct) will re-address it, without delay, to the Conservator of Forests, Perth, when direct payment from Head Office will be arranged.

In such cases care must be taken to see that the fire fighter's address is clearly shown on the form.

The form is most important, as no claim for fire-fighting services can be recognised except from persons holding such forms.

The rate of pay, and name and address of the Forester, should be inserted by the Forester himself.

(2) *Form F.P.* 5 (*F.D.* 107) *Time Sheet for Fire-fighters.*

469.

The first Departmental employee at a fire is timekeeper, and is responsible for keeping form F.P. 5 (F.D. 107). This man usually remains timekeeper, unless definitely relieved by a superior officer, who must demand his time-sheet. If, however, the first man should have to leave a fire, he must then hand his time-sheet over to some other Departmental employee, who then becomes timekeeper.

The last man handling the time-sheet, and handing out the Orders for Payment (F.P. 4, F.D. 106) which must be given out on the job, is responsible for making out a Fire Report (F.P. 6, F.D. 108).

(3) *Form F.P.* 6 (*F.D.* 108) *Fire Report.*

470.

One of these forms must be filled in for every fire, no matter how small. These forms are handed to the overseer, who will hand them to the Forester in Charge.

As stated above (see No. 5, F.D. 107), the Departmental employee at the fire will be responsible for filling in one of these forms.

It may prove necessary for the Forester or his assistant to later visit the site of the fire and make a more complete investigation. In which case this officer would either write up a report, or fill in a further F.P. 6 (F.D. 108) for the same fire, which would be filed together with the original form.

(4) *Code Signal Forms* (*six in number*) *F.D.* 109.

471.

Each man using a heliograph will be issued with a set (in a cover).

(4.) COMMUNICATION.

(a) *Telephones.*

472.

A telephone system is employed to link up head-quarters with look-out towers and sub-stations. The Forester can thus communicate direct with overseers and assistant foresters at their stations by day or by night, and in all weathers. He can give detailed instructions and receive verbal reports. The telephone system is used extensively, not only in fire control, but also in the field of general administration.

473.

Grounded line the standard type.

A grounded line will be considered the standard type for use by the Department. This type is chosen in preference to a metallic line, because the construction and maintenance costs are very much lower, and because, except for interference, it is possible to talk and ring as far over a grounded line as over a metallic.

474.

Selection of route.

After the objective points of the line have been determined, a preliminary survey and selection of route should be made with a view to securing the following results:—

(1) The line wire and each tree insulator should be in plain view of a road or track. On slopes, if practicable, it should be on the downhill side of the track.

(2) It should not cross and recross a road or cross a railway track unless unavoidable.

(3) It should be located to minimise trouble from—

(a) high winds;

(b) falling timber;

(c) proximity of other grounded telephones or electric transmission lines. Proximity of electric transmission or telegraph lines should be avoided altogether, if practicable, by making detours.

(4) If it is possible to make a slight detour without materially increasing the difficulty and expense of maintenance, this should be done rather than cross rocky stretches which necessitates blasting for pole foundations, or the construction of tripods.

475.

Plan of route to be submitted to Head Office.

The proposed route of the telephone line should be indicated on a plan which should then be forwarded to Head Office for approval and also in order that the necessary permit from the Postmaster General for the erection of the line may be obtained. When the telephone line is completed the route should be distinctly shown on the district plans.

476.

Right-of-way.

Where any portion of the proposed line will traverse a public road, the Road Board concerned must be consulted, and permission obtained in writing. If it is necessary to cross private property, or land not under the control of this Department, including railway reserves and railway lines, the matter must be referred to Head Office, who will obtain the necessary authority and issue special instructions concerning the type of line required and other special conditions which may apply.

477.

Capacity of line.

From 10 to 20 standard telephone instruments ordinarily may be connected to a standard tree line not over 50 miles in length. On longer lines, it is not advisable to connect over 8 to 10 instruments. A pole line will carry about 25 per cent. more telephones than a tree line of the same size wire.

These figures do not represent the maximum carrying capacity of lines, but are given to allow a safe margin for unusual conditions.

Standard Bush Line.

478.

Main features of construction.

The essential features of the standard tree line type of construction are as follows:—

(1) The line wire is attached to trees instead of to poles, and held by "swinging insulators" through which it is free to slide in either direction if subjected to strain.

(2) The insulator is attached to the tree by a weak tie wire which will either break or pull loose from the tree should the line wire be subjected to a strain of not more than one-third of its breaking strength.

(3) Sufficient slack is left in the line to permit it to be carried to the ground if struck by falling timber, without breaking either the line or the tie wire.

479.

Location of wires—

(a) Along a track.

The line should be so located that both the wire and insulators are always in plain view from the track. A short cut may be made if the line wire is left in plain sight. Sharp angles should be avoided. On slopes the line should be built on the lower side of the track if practicable. Wherever cost of clearing, in order to keep off the track, will be excessive, the line wire may be hung up in the track right-of-way, but the wire should be kept to the side of the track as much as possible. Tree pins may be used where necessary, as at tie trees, where the line wire pulls towards the tree.

If a tree line is to extend along a road, the line wire should be kept on the road side of the trees and on one side of the road. Where the wire will pull against a tie tree, tree pins should be used. The line wire should *not* be hung over a roadway. (b) Along a road.

480.

All brush, limbs, etc., should be removed, so that they may not come to within three or four feet of the line wire. This must be thoroughly done, in order to prevent line leakage—loss of the ringing or talking current—which will result if the line wire is allowed to touch leaves, branches or tree trunks. Small trees in the way of wire and snags likely to fall on it should be cut down. Clearing.

481.

When, in clearing for a line, any accumulation of debris results, the officer responsible for the construction of the line must make immediate arrangements for its disposal by means of controlled fire. If there is the slightest danger of such fire spreading, the officer in charge of the district should be consulted, and the burning carried out under his direction. In certain cases, the small amount of lop and top resulting from falling will not burn until some months later. In such cases, the necessity for this debris being burnt at the first opportunity should be brought under the notice of the officer in charge of the district. Brush disposal.

482.

Sound trees of sufficient size to minimise the sway should be selected. Trees likely to be cut at an early date in milling operations should be avoided. Spans should be from 125 to 150 feet long and equalised as far as possible. The tie trees selected should not be directly in line but "staggered" enough to cause the line wire, when pulled up, to draw the insulator and wire away from the tree. Each tie tree should be lightly bark blazed to indicate upon which side the line wire is to be suspended. When the line wire is hung up in a track or road right-of-way, it is not always practicable to select tie trees sufficiently out of line, or to string the wire on the correct side of the tree. In this event, a tree pin (see paragraph 486) should be used in order to secure proper clearance between line wire and tree. The course of the line may be deviated to some extent to make use of any trees that will obviate the necessity of setting poles. Tie trees.

The tie trees on each side of any long span should be firm trees, having a minimum of sway, and the proper stay ties (see Fig. 3) should be used at each tree if necessary.

Standards and Specification of Material.

483.

The standard wire for all lines should be No. 8 B.W. gauge B.B galvanised iron wire (must be soft iron). No. 14 B.W. gauge hard drawn copper to be used in crossing Government railway lines. Line wire.

484. Insulators.

For construction of new telephone lines the solid or D6 type of insulator, or the split, or D1, type may be used. Care must be taken to see that the wire is twisted up tightly on the latter type. The swan-neck insulator should be used for terminating the line on any building, and in order that no undue strain will be placed on it a special stay tie (Fig. 3a) will be attached to the line wire at the last tree.

A special type of insulator is required for effecting a crossing over a Government railway line, and these are obtainable from the Railway Department.

485. Staples.

Wherever possible the standard 3-inch staple should be used (see Fig. 1).

486. Tree pins.

Except that, in the case of poles, dead or tough trees, or where the line wire pulls towards the tie tree, the standard tree pin must be used. (Fig. 1).

487. Tie wire.

No. 12, B.W.G. BB soft galvanised iron will be considered standard for ties.

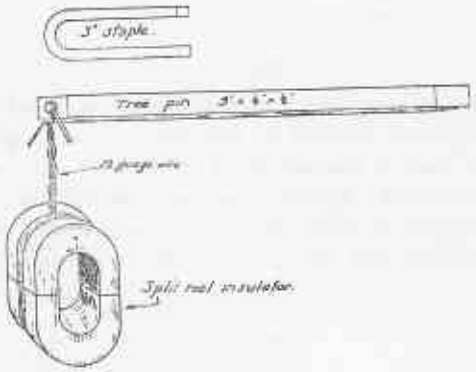


FIG. 1.

Erection Order and Methods.

488. Size of gang.

The construction gang shall consist of a working foreman and two men.

489.

Blazing line.

The foreman proceeds ahead, selecting tie trees and making a light blaze on the side of the tree to which the wire is to be attached. At the same time he clears the line of any scrub, growth, etc.

490.

Pulling out wire.

A simple reel to take a coil of No. 8 wire can be made from materials at hand (see Fig. 2 attached).

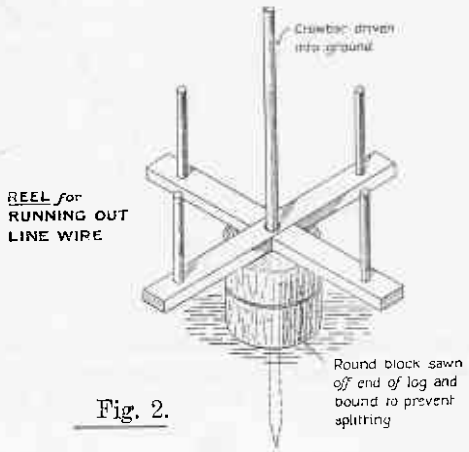


Fig. 2.

491.

Horse to pull out wire.

It has been found that the best results are obtained by attaching a horse to the end of the coil, to pull it out. It is necessary for one man to watch the coil in case a loop of wire should jump off and become entangled. In no case should the wire be drawn over sharp rocks likely to scrape off the galvanised covering, as this will cause the wire to rust and deteriorate very rapidly.

492.

Attaching the wire to insulator.

Tie wire is cut into 16in. lengths and is first twisted tightly round the insulator with pliers. The remaining portion of the twist can be most conveniently made with a wire key in which two holes are bored half an inch apart, and only of sufficient size to take No. 12 B.W.G. wire. A very neat and effective twist is made by inserting the two ends of the tie through these holes and twisting. Sufficient wire must be left free at the end of the twist to enable the attachment to be made to the staple or tree pin as the case may be. A supply of wired insulators may be prepared in camp in advance.

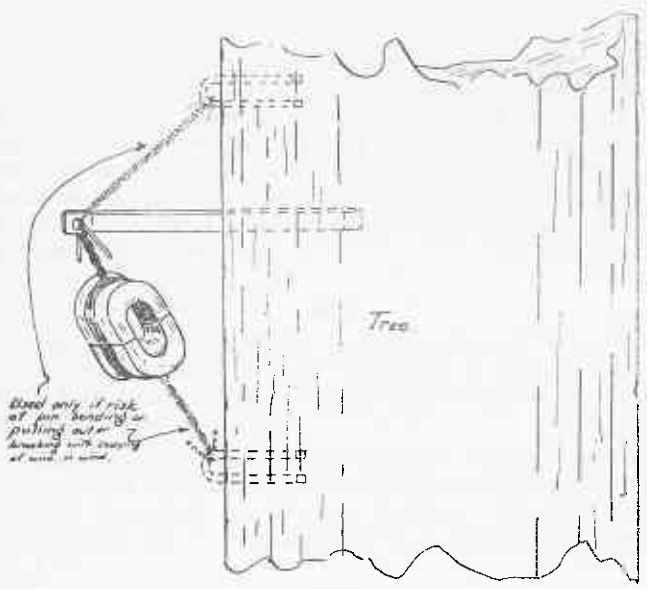


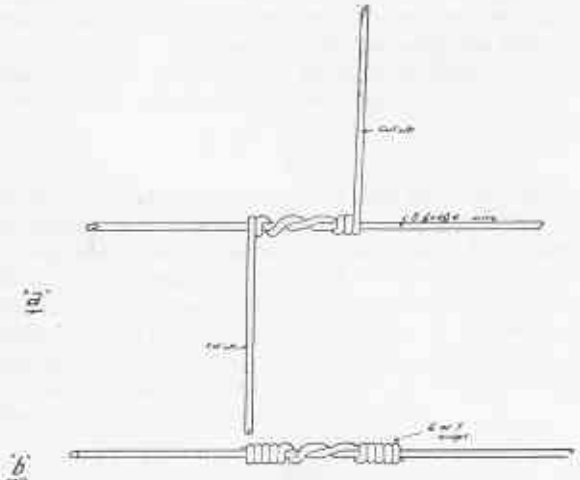
Fig. 3.

493.

Under ordinary circumstances 18 prepared insulators are threaded on to the rear end of the line, and carried forward from tree to tree as the work proceeds. Thread insulators on line wire.

494.

Having threaded the insulators on the freshly run coil of wire, its rear end is joined on to the preceding coil by means of a "Western Union" joint (Fig. 4), which supersedes the old type of "Britannia" joint. Joining the wire.



Standard "Western Union" Splice.

FIG. 4.

495.

"Western Union" joint.

This former joint is shown in Fig. 4 with a neck from 2in. to 3in. long, with 2 or 3 twists and 6 or seven close wraps on either side. A special recommendation of the joint is that no solder is required. Plenty of wire should be left for wrapping and to hold whilst making the joint. The ends should be cut off afterwards. To make the joint a wire key will be required, whilst a small vice is of great assistance to hold the wire whilst twisting.

496.

Attaching wire to tree.

The work of erecting the line is performed by two men. Before driving staples a light bark blaze to remove only the rough bark is made with a tomahawk, at a point about 15ft. from the ground.

The staple is driven in by means of the tomahawk, whilst in the case of the tree pin it is necessary to bore a hole with a ½in. auger bit into which the tree pin is driven. The wire is next lifted up and the tie wire attached in the manner as shown in Fig. I.

497.

Sharp angle.

In the case of very sharp angles, it is advisable to fasten two insulators on the one tree (Fig. 5c hereunder).

498.

Long swingers.

It is sometimes necessary to put on additional ties on long "swingers" to pull the wire clear of obstructions.

499.

Straining.

Once the line wire is erected it will be necessary to strain it. To do this a 25ft. length of rope, with wire grips attached, is required. It is fastened to the end of the wire, and with two men pulling the wire can be strained up to the desired degree of tension. This rope is left on until the following coil has been strained in a similar manner, so that two lengths of rope with grips attached are necessary.

500.

Sag or slack.

Sufficient slack should be left so that the wire can be pulled to the ground in any span without pulling out a tie. At least 2ft. of sag should be left in an ordinary span of average length, whilst in longer spans the sag will be greater. Spans across ravines should have an additional amount of slack, and if falling timber be likely to cause trouble, it may be advisable to allow enough slack for the line wire to hang within 12ft. or 15ft. of the bottom, and to fasten the line to an insulator attached to a stone or tree in the bottom of the ravine.

501.

Stay ties (solid).

Solid stay ties (Figs 5a and 5b) should not be used except where absolutely necessary, as at the end of the line on either side of crossings, at extra long spans, or where necessary to

prevent the wire from creeping down steep slopes. In the case of the stay tie (Fig. 5b) it would be advisable to solder the connection, as, in some cases, there would be no strain on the connections to hold the wires in close contact.

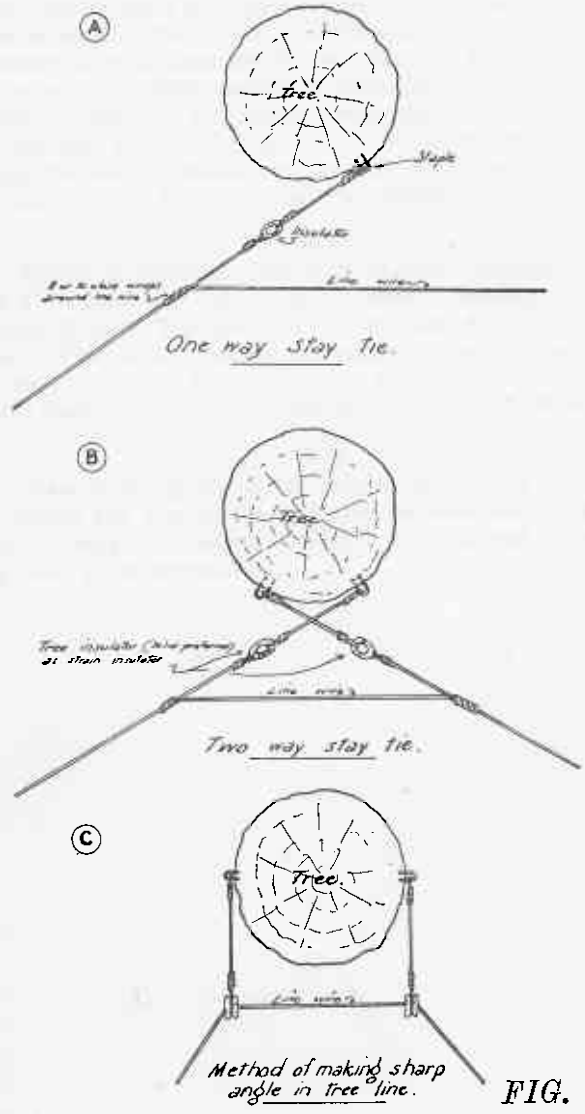


FIG. 5.

502.

Pole sections.

To cross existing clearings and areas to be cleared for pine planting or other purpose within five years, poles will be erected. The ordinary reel insulators will be used as for tree line and will be attached to the poles by tree pins driven into a bored hole.

Further experimental work is necessary to test the manner in which staples will hold in poles, and, until definite results are obtained, tree pins must be used.

It is not necessary to stagger the poles in crossing a clearing, as the tree pins should serve to keep the wire clear of the pole. Where there is a deviation or curve in the pole line, the wire should be fixed on the concave side (inside) of the curve to ensure a good clearance between the line wire and the pole. On a curve of short radius or sharp bend, it will be found necessary either to use strong swan-neck insulators or adopt the method shown in Fig. 5a. The short length of wire which attaches the insulator to the pole should be wound around the pole and not tied to a staple as indicated in the diagram.

503.

Specification for poles.

Jarrah or Wandoo poles shall be used, reasonable straight and free from dry rot or other defects affecting durability. Length 20 feet. Top diameter not less than 6in. including sapwood. Pole to be trimmed by removing sapwood up to 5ft. on large end. Care to be taken that no deep axe cuts are made in the heartwood. Tops of poles to be bound securely with wire.

504.

Erection of poles.

Poles to be set 4ft. in the ground at intervals of 4 chains. On curves and corners the pull shall be calculated as shown in Fig. 6. Rake as explained by Fig. 7 to be allowed according to the table given hereunder.

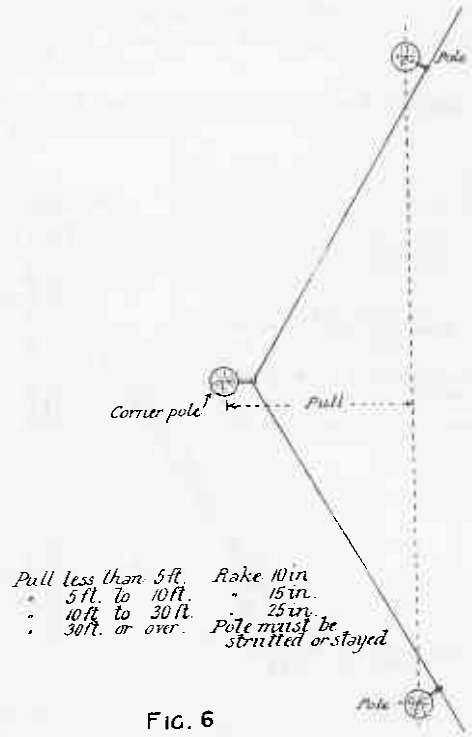


FIG. 6

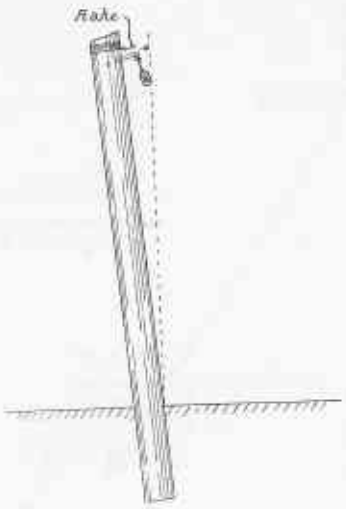


FIG. 7

505.

Stays and struts shall be used—(a) where the pull calculated in accordance with the diagram above exceeds 30ft.; (b) on poles on each side of a main road or crossing over railway line; (c) on excessively steep slopes; (d) where necessary to set poles up in swamps or loose ground; (e) on the first and last pole of any line. Stays and struts.

Particulars of method of strutting and staying are shown in Figs. 8 and 9 hereunder.

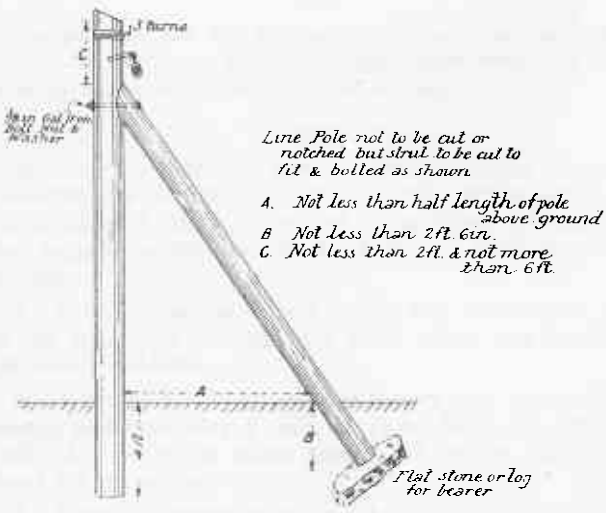
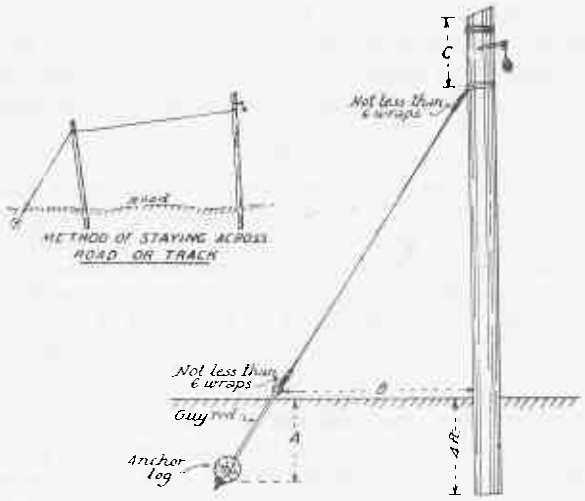


FIG. 8



A. Where 4½ ft use Anchor log 4ft long × 5in diameter
A. " 3½ ft " " 3ft long × 8in diameter
A. Must be not less than 3½ ft.
B. Not less than 8ft.
C. 3ft. or thereabouts.
Wire to be given two wraps around Post & fixed with G.I. Staples.
Guy Rod ½in gal iron rod fitted with eye & gal iron nut & square washer.

FIG. 9.

506.

Installing instruments.

The installation of instruments and telephone wiring will be carried out only by men experienced in this work. If such men are not available, application should be made to head office when the line is completed, and a mechanic will be sent to instal the instruments and give instructions in connection with their care and maintenance.

507.

Inside wiring.

For carrying the line and earth wire into the building and thence to the telephone 18 B.W. gauge copper wire with rubber insulation and braided covering will be used.

508.

Permanent grounds.

It is very necessary to have an efficient ground connection. By soldering the earth wire to a water supply service pipe, a good earth is obtained, but it is inclined to be noisy. If there is no water supply service, one of the following methods must be employed:—

1. Five feet of galvanised piping 1in. diameter is driven into the ground, if possible in a moist place, and to this the earth wire is soldered.

2. A coil of No. 10 gauge bare copper wire, about 12in. in diameter, and containing 8 coils, is placed flat in the bottom of a well. A sheet of 24 gauge copper, 2ft. square, may be substituted for the copper wire.

3. A coil of copper wire, or sheet of copper to which the earth wire is soldered, is placed at the bottom of a hole 6ft.

deep. Cover the coil or plate with 1ft. of pulverised charcoal mixed with salt, and over this earth should be placed. The charcoal will retain moisture whilst salt is slightly hygroscopic (*i.e.*, will absorb moisture from the atmosphere).

509.

Temporary ground.

Where a ground is required temporarily, as for a field telephone, a ground rod should be used. This consists of a 3ft. length of brass rod ½in. in diameter, pointed one end and with a terminal screw at the other end, which should be formed into a loop. This is driven into the soil, preferably moist, at the desired point. If the soil is at all dry it must be damped frequently with water.

510.

Lightning protectors.

To protect the wiring in the telephone instruments from damage by lightning, and other powerful currents, lightning arrestors and fuses must be fitted between the line wire and the telephone.

511.

Switchboard.

Where there are two or more lines connected, it will be advisable to instal a small switchboard so as to lessen the load on each line.

512.

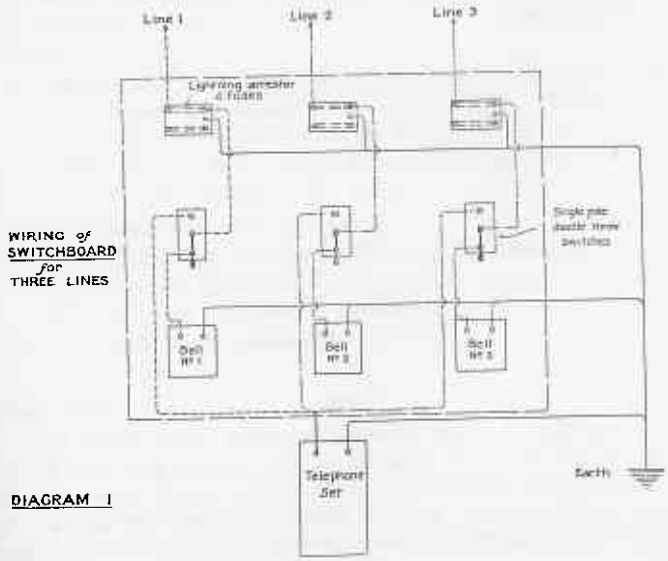
Knife switch.

The baby, single pole, double throw switch is most suitable for this purpose.

513.

Wiring board.

The system of wiring to be employed with the switch is shown on the diagram 1 attached. The chief advantage of the double throw switch over the single is that it is possible to eliminate one bell, and this means decreasing the load on the line, whereas with all lines connected three bells are eliminated.



WIRING of SWITCHBOARD for THREE LINES

DIAGRAM 1

514. Distinctive signal ring.

Each out-station must have a distinctive signal ring to use when ringing the district office. The operator of the board instantly knows which line to switch on to. This same signal ring would be used by the district office when calling the out-station.

515. Care of instruments.

Inexperienced men must not be allowed to experiment with the repair of the instruments. An extra set of instruments should be kept on the job for use in emergency. Application should be made periodically for a mechanic to overhaul installations, and faulty instruments should be sent to head office for repair when necessary.

516. Extra equipment necessary for erection.

The following is a complete list of equipment required for telephone line erection. All the articles listed are not essential, but such as are likely to be required should be requisitioned for as on loan from Head Office, and returned when the line construction is completed.

2 pairs grips (if not available, the grips from chain wire strainer will serve equally as well).
1 pair wire cutters.
1 pair safety belts.
1 pair stirrup climbers.
2 pairs large pliers.
1 brace and necessary auger bits.
1 small vice.

517. Ordering material.

When the route of the telephone line has been definitely fixed, its approximate length can be scaled on the plan, and from this figure the quantity of material required can be estimated. The material required for one mile of line is approximately as follows:—

3 coils of No. 8 B.W. gauge galvanised iron wire. (Add 5 per cent. to allow for slack in line.) When ordering specify that wire be of soft iron.
90ft. No. 12 B.W. gauge galvanised iron wire, for ties. (1 cwt. equals 1,170 yards.)
60 insulators—tree line type.
60 staples, 3in. standard (allowing for breakages).
12 standard tree pins. This number increases if passing through ringbarked country or open country where poles are necessary.

Fence Line.

518. Construction of fence line.

On areas where extensive fencing exists a satisfactory internal telephone system may be built up by using the top wire of an ordinary fence. It is necessary to improve the conductivity of the fencing wire by soldering a short length of wire across ties in the wire, and also across breaks existing at strainer posts.

Should any gates occur in the fence, it is necessary to lead a length of wire on poles at some height above the gate and solder the two ends to the fence wire. Instruments with good "earths" should be connected up as for a tree line.

Fence and Scantling Line.

519.

Fence and scantling line.

Where it is desired to connect to the main P.M.G. telephone system, a fence line using the top wire of a fence without insulation is frequently regarded as unsatisfactory. In such case, a fence and scantling line may be erected on which an insulated wire is run on scantlings attached to fence posts at intervals of 100 feet.

520.

Clearing

All small overhanging trees and any dangerous trees will be felled and cleared off the route of the line. Each post carrying a scantling will be cleared round to a radial distance of three feet as a precaution against fire.

521.

Scantling.

Details of Construction.—The scantling will be 3in. x 2in. jarrah, 8ft. long, and will be wired to posts in two places. The bottom tie will be about 1ft. from ground level (or depending on the position of the bottom fence wire), and the second tie about 9in. from the top of the post. No. 8 B.W.G. galvanised iron wire will be used and the standard department "wire twister" will be used to make the ties. The broad edge of the scantling will be at right angles to the direction of the fence.

522.

Bends.

Jarrah poles properly strutted will be used at any bend where the angle is 90deg. or more acute. In the case of obtuse angle bends, it will be sufficient to use scantlings bolted to the strainers. Such scantlings will be 3in. x 4in. and 8ft. long.

523.

Crossing of tracks and gates.

The line wire will be carried over gates and tracks on poles not less than 16ft. high and where a public road has to be crossed the line must have a road clearance of 18ft.

524.

Insulators.

Button type insulators will be used except where definitely advised by the P.M.G's. Department that a more efficient type is needed; for instance, swan neck insulators must be used when connecting to a Metropolitan exchange.

Button insulators will be 2½in. in diameter, and the standard fixing 2in. x 14in. Wood screws will be used to attach insulators to supports. These screws must be ordered in addition to the insulators.

525.

Gang and duties.

The gang will consist of three men. In constructing, the insulators should be fixed to the scantling before erection. The gang should be divided, one man going on ahead fixing the insulators to scantling and cutting and leaving two pieces of the

wire at each fence post where scantling is to be placed. The other men follow up erecting scantlings and tying them to fence posts.

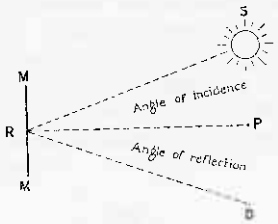
After all scantlings are in position with insulators attached, the wire is run out and tied on as for standard telephone practice.

(b) *Heliograph.*

526.

Use of heliograph.

The heliograph is used for communication between look-out towers and field gangs not connected to headquarters by telephone.



527.

Explanation of diagram.

In this diagram M M represents the heliograph mirror. By means of a heliograph the light of the sun is reflected from a mirror (or mirrors) to a distant station. The line S R represents a ray from the sun (the "incident ray") striking the mirror at R. R D represents the path by which the ray (now known as the "reflected ray") leaves the mirror. R P is an imaginary line drawn at right angles to the mirror from the point (R) at which the ray strikes.

528.

General principle.

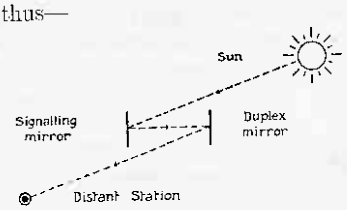
To reflect the light to a distant point D, the mirror M — M must be directed at right angles to an imaginary point (*e.g.*, as P) midway between the angle formed by the sun and the distant point D.

The source of light, the sun, appears gradually to move from East to West and the sun's altitude, or apparent height above the horizon, also varies, increasing until noon and then gradually decreasing. Therefore, if we wish to keep the reflected light in one direction, it is necesary to alter the direction of the mirror to counteract the apparent motion of the sun.

529.

Duplex mirror.

When the angles of incidence and reflection together are equal to, or greater than, 90deg., the "duplex mirror" must be used. This must be placed so that the light from the sun is reflected from the signalling mirror on to it, and thence to the distant station, thus—



530.

Method of signalling.

There are two positions of the signalling mirror, namely, the "position of rest" and "position of signalling." In the latter position, the light is directed full on to the distant station, and in the former position the light is "dropped." The mirror is brought up and down by means of the key, and left at the signalling position for short and long periods of time corresponding to "dots" and "dashes" in the Morse code.

531.

Length of dot and dash.

When signalling the actual length of the dot does not matter, but it must be of a consistent length during all the signalling. The dash must be three times the length of a dot. Great care must be taken to send each letter continuously, *i.e.*, without any interval between the elements composing it. In order to distinguish between the end of one letter and the commencement of the next, an interval equal in duration to one dash must be observed after each letter.

532.

(a) With the sighting rod.

Setting up the Heliograph.—1. Place the stand so that the mirror roughly faces the sun. Clamp the sight arm in the direction of the distant station. Elevate the mirror so that the distant station may be seen. The jointed sighting rod should be placed down as far as possible and clamped so that it moves stiffly. Turn the vane half-way down.

2. Stand clear of the stand with the back to the distant station. Looking into mirror, move the head until the reflection of the distant station is hidden by the unsilvered spot in the centre of the mirror.

3. Keeping the head still, move the jointed rod until the bi-section of the cross wires exactly coincides with the reflection of the distant station, *i.e.*, so that the centre of the unsilvered spot, the bi-section of the cross wires, and the reflection of the distant station are in line.

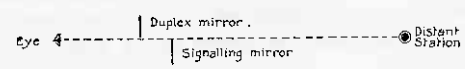
4. Turn up the vane gently, being careful not to displace the alignment in doing so.

533.

(b) With the duplex mirror.

Duplex Mirror.—1. Place the stand so that the signalling mirror roughly faces the sun. Turn the duplex mirror parallel to the signalling mirror.

2. Stand in front of the heliograph with the back to the sun, and ascertain whether the distant station lies on the right or left of the prolongation of an imaginary line passing through the sun and heliograph (*i.e.*, right or left of your own shadow). Move the sight arm to the right or left accordingly, keeping the mirrors parallel until the distant station can just be seen between the trunnions of the two mirrors thus—



Should the distant station appear just on the imaginary line, the sight arm should be moved in the direction in which the sun is apparently travelling. Clamp the sight arm and elevate the signalling mirror slightly.

3. Turn the duplex mirror in the sight arm roughly to face the distant station (it should move stiffly), and keep it parallel with signalling mirror.

4. Standing with the back to the sun, look into the signalling mirror; move the head until the reflection of the sighting mark on the duplex mirror is hidden by the unsilvered spot in the centre of the signalling mirror.

5. Keeping the head still, turn the duplex mirror horizontally, and vertically until the reflection of the distant station, as seen in the signalling mirror, is exactly covered by the reflection of the sighting mark. In this position the unsilvered spot on the signalling mirror, the reflection of the distant station, and the sighting mark on the duplex mirror are in one straight line.

The alignment may also be made from the rear by elevating the mirror to the fullest extent and looking down over it and proceeding as above.

The alignment should be verified by again seeing whether the three points are in line.

534.

Directing the light.

When the heliograph has been aligned the light is thrown on the distant station by turning the signalling mirror so that the reflected light covers the sighting vane, and the shadow spot just covers the sighting mark. The necessary adjustment of the signalling mirror is made by the slow motion screw, *i.e.*, the tangent screw and the collar. The light is properly directed when the shadow spot covers the sighting mark with the key depressed. The shadow spot will, therefore, be below the sighting mark when the key is released. The spot should fall ¼in. to ⅜in. below the mark on the vane.

535.

Calls for light.

Directly the distant station calls for light, the key should be depressed, and, if necessary, the shadow spot should be readjusted. When answering a call for light, care should be taken to depress the key to the same extent as when signalling.

The adjustment of the heliograph must be performed with the greatest accuracy.

536.

Searching for an unknown station.

Align the heliograph roughly in the direction required, then slowly traverse the body of the heliograph, at the same time turning the collar and making a succession of dots. The country should be freely swept until the flash is seen and answered. The duplex mirror held in the hands by itself may also be used for this purpose.

537.

Care of the instrument.

1. When riding or cycling, the heliograph should be slung across the shoulders and not attached to the saddle or cycle.

2. Never leave the heliograph on its stand when finished with it. Replace the cap on the stand when it is not in use.

3. Avoid holding the instrument by the "U" arms or mirror frame, and never touch the mirror surface with the hands.

4. If the heliograph gets wet, wipe the mirror dry and rub the metal portions over with an oily rag before putting it away, or at the first opportunity.

5. Always keep the heliograph clean and free from rust and dust. Grit and dust in the tangent box, or on the vertical rod and German silver ball, will soon destroy the best instrument.

6. The main working parts occasionally require oiling and adjustment, but this will be done by an officer specially detailed. Never leave superfluous oil on any part, as it collects dust. Never allow oil to drop on the mirror.

7. On no account must the heliograph be taken to pieces.

Morse Code.

538.

The beginner will find it much easier to learn the Morse Code by the system of groups and opposites given below rather than by learning the Morse alphabet straight through.

It is of the utmost importance in signalling to make a proper distinction between the lengths of the "dot" and the "dash."

THE MORSE CODE.

(System of learning by groups and opposites.)

E .	T —	
I . .	M — —	
S . . .	O — — —	
H		
A . —	N — .	C — . — .
U . . —	D — . .	
V . . . —	B — . . .	J . — — —
F . . — .	L . — . .	
G — — .	W . — —	
P . — — .	X — . . —	
R . — .	K — . —	
Q — — . —	Y — . — —	
Z — — . .		

539.

General principle.

Range Finders.—The range finder used by the Department is of the Single Observer type (*i.e.*, one in which a single observation alone is required for determining the range of an object).

The range of an object is virtually obtained by measuring the angle α subtended by the base of the instrument (A B) at the object (C). See Fig. 1.

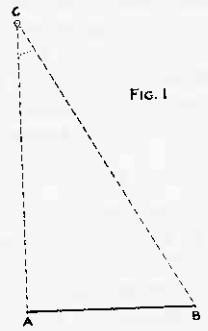


FIG. 1

Other things being equal, accuracy is directly proportional to the base length, and also to the magnifying power of the telescope employed. The base length of the standard instrument used by the Department is approximately six feet.

540.

Essential parts (see Fig. 2).

A Single Observer range finder may be regarded as consisting of two telescopes mounted in a common frame, and so arranged that the combined telescopes may be simultaneously directed on the target. Two object glasses (F.F.) are situated one at each end of the frame, and two eye pieces at the centre. The object to be ranged on is viewed through the right eye piece (the left eye piece being provided for reading the range scale only). For receiving and transmitting the rays of light from the two end windows to the eye-piece, reflecting prisms are provided at each end of the instrument (A and B), a deflecting prism D (with range scale attached), and a central combination of prisms (P).

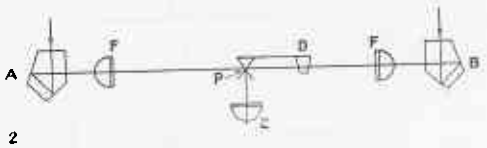


FIG. 2

541.

Upper and lower images.

Each object glass forms a separate image of the distant object in the focal plane of the eye-piece so that the observer sees in the field of view two images (see Fig. 3). In the type of range finder used by the Department, these two images are separated by a fine dividing line. The image seen below the dividing line is formed by rays of light which enter at the right-hand window, and is erect. The image seen above the dividing line is formed by rays of light which enter at the left-hand window and is inverted.

542.

Coincidence or alignment.

In order to measure the range of an object, the "working head" near the right handle must be turned until one image is vertically above the other (see Fig. 4). This act of bringing the

upper image vertically above the lower is called "making coincidence."

By turning the "working head" the observer moves the "deflecting prism" D (and the range scale attached to it) along the right-hand half of the range finder. This deflecting prism bends (or deflects) the rays coming from the right-hand window, and so moves the lower image across the field of view. When the lower image is vertically below the upper image (see Fig. 4), the image scale shows the correct range of the object.

543.

Accuracy of coincidence.

The accuracy with which the range is measured depends on the accuracy of the coincidence, and it is important that observers should realise that a very small cross of coincidence may mean a very large error in the range obtained. For this reason a well defined object should be ranged on where at all possible. Smoke, apart from the fact that it drifts, and for that reason is liable to give both a wrong range and direction, is altogether too indefinite for a satisfactory coincidence. If the point with which coincidence is to be made does not touch the dividing line the instrument must be rotated downwards till the images nearly merge as in Fig 5.

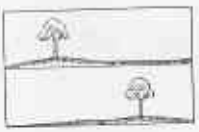


FIG. 3

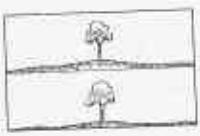


FIG. 4

FIG. 5

(5) FIRE REPORT.

544.

Fire report to be submitted annually.

A "Fire Report" on the form given below will be drawn up at the end of each fire season. It is most important that officers compiling these reports should adhere strictly to the headings laid down and so facilitate the compilation of the "Annual Report." This report must be submitted to Head Office not later than 1st June each year.

FORM OF FIRE REPORT.

(To be drawn up at the end of the fire season.)

1. Introduction. Stating protected area concerned, season, etc.

2. Date of commencement of season. That is, time when bush would carry a running fire. Notes *re*, and of rains, etc.

3. Date of manning look-out stations.

4. Preliminary precautions—
   (a) Extent of general controlled burning and costs.
   (b) Top disposal operations, extent and costs.
   (c) Burning of fire belts around treated compartments.
   (d) Spark nullifiers on engines.
   (e) Posters. Fire Notices, etc.
   (f) Help received from local settlers.

5. Communication—Systems in use and efficiency.

6. Fires on areas listed for complete protection—
   Total number reported.
   Date of first fire.
   Date of last fire.

Area burnt.	Number of Fires.						
	Nov.	Dec.	Jan.	Feb.	Mar.	Apl.	Total.
Acres.							
0 to 1 ...							
2 ,, 10 ...							
11 ,, 20 ...							
21 ,, 50 ...							
51 ,, 100 ...							
101 ,, 200 ...							
201 ,, 300 ...							
Over 300							

Full particulars concerning any fire occurring on treated or planted country to be given.

Causes of Fires.	Nov.	Dec.	Jan.	Feb.	Mar.	Apl.	Total.
1. Travellers ...							
2. Hunters and Bee Robbers							
3. Bush Workers ...							
4. Settlers burning off							
5. Stock Owners burning for grazing							
6. Campers ...							
7. Govt. Locos. ...							
8. Bush Locos. ...							
9. Any other ...							

7. Expenditure and Costs— £ s. d.

(a) Publicity ... ...
(b) Manning Lookout Tower ... ...
(c) Maintenance of plant ... ...
(d) Controlled burning ... ...
(e) Fire fighting patrol, etc. ... ...
(f) ... ...
(g) ... ...
(h) ... ...

Total ... ... £

Area listed for complete protection
Area of above burnt
Percentage burnt

Total cost

8. Map showing fires—
(a) Outside adjacent to boundaries.
(b) Inside on private property.
(c) On areas listed for complete protection
(d) Areas burnt by controlled fires during—(1) spring, (2) autumn.
(e) Unintentional fires on country set aside for controlled burning.

9. Methods employed to beat or stop fires. Any improvements in methods.

10. Prosecutions, warnings, etc.

11. (a) Date of ending of fire season with first winter rains.
(b) Date of last fire.
(c) Amount of rain during fire season.

12. Any other.

545.

NOTE :

1. Officers in Charge of Fire Control Schemes should prepare monthly report showing fires and causes. To be available for Head Office when called for.

These monthly statements would be made up from the fire reports. (Form F.D. 108.)

2. ANY SERIOUS FIRE LOSSES OR FIRES FROM WHICH COMPENSATION CLAIMS ARE LIKELY TO ARISE SHOULD BE REPORTED TO HEAD OFFICE IMMEDIATELY BY TELEGRAM OR TELEPHONE.

THE FORESTERS' MANUAL.

PART IV.

AFFORESTATION.

TABLE OF CONTENTS.

SECTION 1.

INTRODUCTORY.

546.

Owing to an absence of softwood species in indigenous forests of Western Australia, the State is forced to import large quantities of softwood annually. With the object of providing a local supply to meet this demand, pine plantations are being established. If these plantations are to prove sound business undertakings, it is necessary that the most valuable species of pine be determined for each district and class of soil.

Early settlers have introduced four or five species only, and pending the results of experimental work now in hand the planting rate must be limited and the bulk of planting stock confined to one or other of these proven species. Certain particulars are given on pages 87-96 concerning many species now on trial, but this information is of general interest only and has no value as a basis for the determination of the suitability or otherwise of any species for any given set of climatic and soil conditions.

SECTION 2.

SURVEY AND SUBDIVISION.

547.

The preliminary survey and subdivision of pine plantation areas is carried out by means of prismatic compass and 5-chain band. The general lay-out, or scheme of subdivision, will be influenced by the topography of the area. Firebreaks should be suitable for ploughing and grades satisfactory for future lines of transport.

The plan on page 73 represents a diagrammatic scheme of subdivision, but modifications will always be necessary in practice. The major internal firebreaks should run more or less at right angles to the direction of the dangerous winds. For example, if easterly or westerly winds are the most dangerous, the two-chain internal firebreaks should run mainly North and South.

548.

Design to be approved.

The officer responsible for subdivision work on any plantation shall first make a preliminary reconnaissance and submit a proposed design to Head Office. No plans may be prepared by the Drafting Office or detailed lay-out marked on the ground until this design is approved. The preparation of plans and subdivision work shall be maintained at least three years in advance of clearing on each plantation.

549.

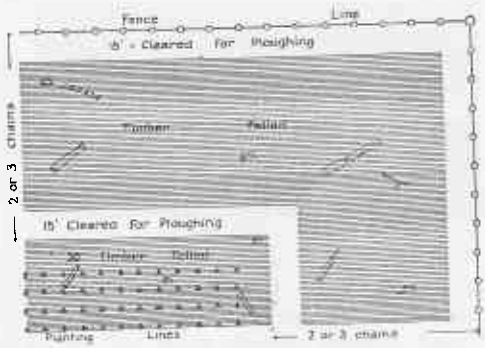
Compartment pegs.

At the North-West corner of each compartment a peg is erected, and on this peg the number of the compartment is cut. The standard size for corner pegs is 4in. square in section and 3ft. long (2ft. in the ground and 1ft. above ground). Trenches are cut on either side of each corner showing the direction of the compartment boundaries. In Fig. 1 these "direction" trenches would be at right angles to one another. The standards set out hereunder are to be accepted as a general guide in the design of breaks in and around pine plantations. At the same time, full consideration needs to be given to local conditions, and no rules should be considered to be hard and fast.

Firebreak clearing.

550.

External breaks shall be 2 to 3 chains in width, with two cleared strips of 15 feet on either side, as shown in the following diagram:— External breaks.



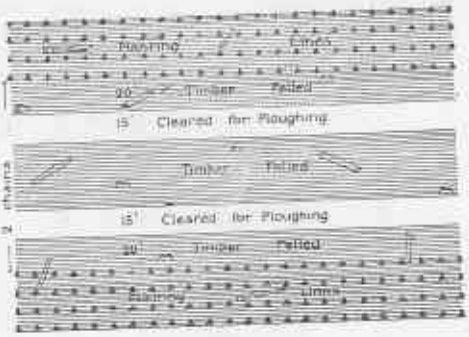
These 15ft. strips should be in all cases 20ft. from the outside row of pines.

In considering the establishment of external breaks consideration should be given to the fire hazards existing, and extra precautions taken on the side from which the greatest danger may be anticipated. If the extent of unoccupied Crown land is sufficient, it may be advisable to leave a further strip of up to 10 chains outside the plantation, which can be burnt by controlled fires.

On the other hand, where a plantation adjoins pasture without ringbarked trees, the external break may be reduced, but such case should be submitted for Head Office approval with a special covering report giving full particulars.

551.

(a) A 2-chain break of the same design as an external break should be continued around every 300-400 acres approximately. The area enclosed should not be less than 300 acres, but if the topography of the ground renders it advisable, it may be increased. Internal breaks.

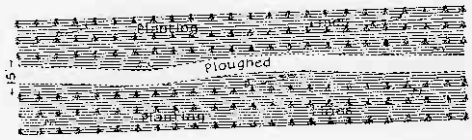


(b) Each section of 300-400 acres will be divided by 1-chain breaks into areas of approximately 100 acres each. The 1-chain break will have a strip 15ft. in width down the centre cleared

of all stumps and logs, so that it can be ploughed. The planting lines will start from either edge of the break, as shown in the design hereunder:—

552.

(c) *Secondary Breaks.*—Each block of 100 acres will be divided by secondary breaks into four compartments of approximately 25 acres. The width between planting lines will be 15ft. and clearing will be carried out in such a manner that a strip 10 feet wide may be ploughed. It is intended that, after the risk of grass or scrub fires has been largely eliminated by the trees on adjoining compartments forming canopy, the ploughing of these secondary breaks shall be discontinued. In later years, however, they will have considerable value as lines of access to each compartment, and their value for this purpose should be borne in mind when clearing logs and stumps.



Twenty-five acres shall be regarded as the minimum area of any compartment.

553.

Diagrammatic scheme of subdivision

The resultant lay-out of a plantation on reasonably level sandplain country, where there is no necessity to run breaks along contours, should be more or less on the lines shown in the diagram hereunder:—

Area of plantation = 400 acres. Area of firebreaks = 35 to 40 acres, or approximately 10 per cent. of the total area.

554.

Advance breaks.

It is frequently necessary, in order to provide for a good burn, that compartments shall be protected from a surface fire for a period of three to five years before clearing takes place. For this purpose strips 6 feet in width are cleared of undergrowth and ploughed. These advance breaks should, as far as possible, follow the lines pegged out for permanent breaks which will be fully cleared at a later date.

SECTION 3.

CLEARING FOR PLANTING.

555.

There are many types of country on which planting will be carried out and, in consequence, only general guiding principles having reference to the clearing of main types are set out hereunder.

It should be remembered that—

Initial expenditure such as cost of clearing will mount up at compound interest for the full rotation.

A saving in initial costs which introduces or leaves a serious fire hazard for the full rotation is false economy.

In a country with a long dry summer young pines have great difficulty in competing with woody undergrowth in the first summer, and, in consequence, a complete and intense burn is of great importance.

Always see that the subdivision work is carried out well in advance of clearing and that the approved design is pegged out on the ground at least three years ahead of clearing.

556.

Clearing methods.

The most satisfactory and economical method of clearing in any locality is a local problem, and instructions regarding the procedure to be followed will be issued for each plantation. When, in clearing a compartment, it is found that the width of break between the edge of the compartment and standing timber is less than two chains, an extra strip one chain in width must be felled on adjoining country and included in the burn. By this means, when the adjoining area is cleared, the fire will not damage the growing pines.

As the practice is to fell more than twelve months in advance of planting, there will be, at certain times of the summer, two sections of planting country awaiting burning. It will be found that in the burning it is difficult to prevent the fire escaping into the most recently felled compartments. In order to simplify control of the burn no clearing will be done within five (5) chains of the area felled during the previous twelve months. This belt of green timber must be burnt by a light sur-

face fire before the commencement of the felling of the section to which it belongs. The subsequent felling of this belt will be found a useful work upon which to engage men during a dry spell in the planting season, or otherwise will be carried out immediately planting is completed. As examples of the manner in which clearing operations should be mapped out, two of the types are set out in some detail hereunder:—

TYPE A. Heavy soil in main timber belt carrying large Blackbutt and Marri, when ploughing is not possible except at prohibitive cost.

To be planted June, 1929.

1. Cut down Blackboys and other minor species of the underwood first, starting in the spring of 1927.

2. Clear-fell and lop all green trees remaining on area. Work to be completed by April, 1928.

3. Heap debris round stumps of any standing dead trees which should be burnt down in the fire.

4. Burn during latter part of February, 1929, after burning season opens in district, by as fierce a fire as possible. Care must be taken to keep the fire under control and particular attention paid to wind and air humidity conditions. Easterly winds are usually dangerous, but, if the fire can be confined, will give the most satisfactory burn.

TYPE B. Sand plain Jarrah country where the ploughing will be carried out before the felling of the big timber.

To be planted June, 1929.

1. Blackboys, Banksia and other small trees to be felled level with ground between November, 1926, and May, 1927.

2. These trees and shrubs of lower storey to be burnt up late in February, 1928, after burning season for the district opens.

3. Plough during March and April, 1928.

4. After ploughing fell all big trees remaining and lop during the months August to October, 1928.

5. Burn the tops of these trees in late February, 1929.

Where necessary, five-chain safety belts of green timber should be held until after the burn, as for type A.

Note.—In connection with type A and type B, it is important to ensure that the branches of the big timber projecting in the air after falling be lopped immediately so that the branches may burn away and leave a clear field for the planters in the position occupied by the head of the tree after falling.

557. Firebreak clearing.

In all types of country, except where the timber is so light that practically all logs will burn up in the general burn, attention must be paid to the clearing of firebreaks as an essential part of

clearing operations. Standard layout of firebreaks has already been given and provision made that the subdivision work shall be carried out in advance of clearing.

Before starting clearing operations the strips on the firebreaks which are to be completely cleared of all logs and debris for ploughing should be clearly pegged out. When falling commences every effort should be made to drop as many trees as possible clear of this strip. Time spent in wedging and jacking a tree over to fall clear is time well spent. Where it is not possible to fall a tree clear of the strip, it should be dropped across the strip at right angles, so that there will only be one log to be sawn and jacked off.

Equipment necessary, which should be provided before clearing for planting starts, is a heavy bar, a cant hook with two big rings and a jack, also a supply of gelignite for shattering stumps. Stumps occurring on the strip, if too large for grubbing or cutting level with the ground, should be shattered with gelignite and debris heaped on them so that they will burn out when a fire is put through the cleared compartment.

SECTION 4.

CULTIVATION OF PLANTING AREA.

558.

On most types of country available for planting, the ground cover occurs as a dense growth of woody shrubs which have a more or less matted root development causing intense root competition with the young pines in the first summer after planting. As a consequence, a high percentage of failures may be expected in some years when dry summer conditions are unusually severe.

Experience appears to indicate the necessity for cultivation to eliminate this root competition. This cultivation is required particularly on the coastal sandplain, and on many types in the Darling Range, but a notable exception apparently is the ironstone gravel.

Experimental work to determine the amount of cultivation necessary on the various types of planting country is still proceeding, but in the meanwhile the instructions hereunder concerning ploughing and hand-cultivation shall be closely followed.

559.

Ploughing.

Ploughing is the cheapest and most satisfactory form of cultivation, but is not practicable on many types, owing to the prohibitive cost of the additional clearing required. In this additional clearing, which is carried out after the general burn, only the limbs and small logs will be stacked and burnt. The presence of the larger logs and stumps, singly or in groups, thereby preventing the ploughing of a small percentage of the ground, shall not be regarded as detracting from the value of this method of cultivation. Intensive clearing as for other classes of agriculture can never be justified. Ploughing shall be regarded as the standard practice, except where the stand of indigenous Eucalypts is so dense that the cost of heaping and burning the debris in preparation for ploughing would be higher than the cost of hand cultivation in spots. Burning operations must be completed during February and the ploughing commenced early in March.

560.

Spot hoeing without ploughing.

On sandplain country and other types carrying a heavy growth of woody shrubs, where ploughing is not practicable, as soon as possible after burning, the position in which each tree is to be placed shall be thoroughly cultivated two feet by two feet, by the use of spade or grub hoe. All roots and other debris should be removed, leaving free soil for planting.

The surface of the "spot," 2ft. x 2ft., should be left as a shallow depression, so that the rain may collect and soak in, but care must be taken to see that planting holes are not dug. These holes should not on any account be opened out more than an hour before planting. On ash beds, where the intense heat from the burn destroys the roots, no spot cultivation is necessary, and costs of the operation may be greatly reduced by avoiding unnecessary work in such positions.

561.

Spot hoeing following ploughing.

When an area has been ploughed, spot hoeing, if necessary, is a much cheaper operation than on unploughed country. The object is to remove all root debris from the position in which the tree is to be planted, and to work and compact the soil so that the winter rains shall soak in thoroughly before planting. The "spot" may be left as a slight depression, but the planting hole is not to be opened out until within an hour of planting.

SECTION 5.

PLANTING OPERATIONS.

562.

Planting season.

The time for the commencement of the planting season will be decided each year by the Divisional Forest Officer.

Although definitely depending on the particular season, the planting period may be said to begin in the middle of June in each year. The actual date will vary with the rains, and, although it may be later, it is a very exceptional year when it is safe to start earlier.

563.

Conditions for planting.

The optimum conditions for planting are a soil and subsoil thoroughly soaked by the rains, and a humid atmosphere.

Should a particularly dry spell occur after the planting commences, the officer in charge should not hesitate to take the men off planting and put them on some other work. To continue planting under such conditions would mean exposing the roots of the plants to a drying air, and thus robbing them of all chance of success even before they were put in the ground. Failing other work the gang must be paid off.

564.

Transport of plants.

For transport from the nursery to the planting site, pines will be bundled in heavy wheat sacking which has been thoroughly soaked with water. Light hessian is not satisfactory for this purpose.

565.

Shelter.

On arrival at the planting site plants will be heeled in under low shelters and watered with a watering can.

566.

Number of plants required daily.

The overseer will estimate the number of plants necessary each day, and only that number (approx.) will be lifted from the nursery.

In estimating the number of plants required daily, factors such as type of planting country, conditions of ground, size of plants, number and experience of men in gang, should be taken into consideration.

567.

Shelters to be moved as planting proceeds.

The planting carrier will be filled directly from the dumps in the shelters, and, as the planting proceeds, these shelters must be moved, or new ones erected close behind the planters.

It is an economic waste for men to have to leave the gang and walk long distances to replenish plant carriers. The most satisfactory results will be obtained by having dumps on the base-lines, with each planter carrying sufficient plants in his carrier for a trip up and back from the base-line.

568.

Type of plant carrier.

The standard type of plant carrier is a kerosene tin cut diagonally, lengthwise, and fitted with wire handles. Kerosene tins in the form of buckets are not satisfactory.

Plant carriers are to be provided with heavy wheat sacking for covering the roots.

A supply of water in buckets is to be kept at all dumps, so that, when the carrier is refilled, the sacking may be soaked with water.

569.

Roots to be protected from drying out.

Great care must be taken to see that at no time between the lifting in the nursery and the setting of the plant in the field are the roots of the plants allowed to become even partially dry. The practice of washing or puddling roots must, however, be suppressed.

570.

Lay-out of planting site.

The site must be laid out and pegs sufficient to provide for two days' planting erected before the gang moves on to the job. If this very necessary operation be delayed until the morning when planting is due to commence, the gang on the job will be kept idle until the area is laid out. Holding up work in this way is a sure indication of faulty organisation, and results in a totally unnecessary waste of time and money.

571.

Instruments.

The instruments required are a compass and a 66ft. tape.

572.

Firebreaks.

The firebreaks must first be marked out.

573.

Base line.

If a compartment boundary will not serve, a special base line must run as far as possible through the centre of the area, and should follow the longest axis. In cases where the shape of the planting site is very irregular, or where the surface of the ground is very undulating, two or more base lines may be necessary on a single compartment.

574

Interval pegs.

Starting at one end, pegs will be erected along the base line at intervals equal to the spacing distance multiplied by twenty-five.

For example, with 8ft. x 8ft. spacing it would be 200 feet. With 7ft. x 7ft. spacing it would be 175 feet.

575

Sighting sticks.

From these "interval pegs" sighting sticks will be set at right angles to the base line. There will thus be a sighting stick along each twenty-fifth planting line. The erection of sight sticks on firebreaks, base line, and planting lines can be left to the overseer after he has gained the necessary experience.

576.

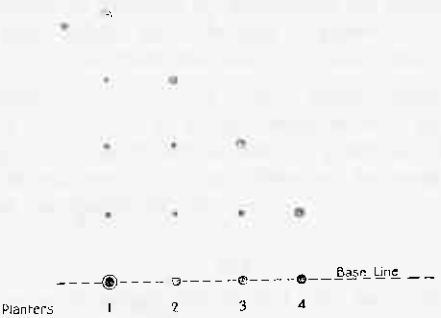
Alignment.

While accuracy of alignment (*i.e.* straightness of planting lines) is not important in pine planting, as in orchard planting for example, some sort of alignment is necessary to ensure that no patches of planting country are missed by the planters. On broken country, or with inexperienced planting gangs, this is very liable to happen.

577.

Eschelon formation.

The method of securing alignment will be by "eschelon formation," alignment being corrected on each twenty-fifth line.



With a planting gang of four men working in eschelon formation, the relative positions of the planters (when No. 1 has put in his fifth plant) would be as shown in diagram.

The inner flank man (No. 1) will be guided by sighting sticks or by the last row of pines, as the case may be. These sighting sticks (already referred to in paragraph 575) are aligned from the interval pegs at right angles to the base line.

Unless formation is maintained more or less in eschelon, the spacing, and consequently the alignment, will soon become too irregular. The inner flank man (No. 1) is largely responsible for the spacing and direction, and should, therefore, be the most experienced man in the gang.

At the beginning of the planting season, the use of eschelon formation may not secure satisfactory alignment, but this is due to inexperience on the part of the men. With a little further training, satisfactory results can be obtained from the average man under this method, and overseers must be made to persevere with it. The use of sighting sticks to guide each man is unnecessary and means a waste of time.

578.

Spacing.

Spacing is the distance between plants, and between lines of plants.

579.

Spacing of plants.

The spacing for species to be used will be found in the Working Plan, or, if not, as specified by the Conservator, *e.g.* for *Pinus pinaster* on sandplain country it is usually 7ft. x 7ft.;

for *Pinus insignis* 8ft. x 8ft. The number of plants required per acre for the different distances is set out hereunder:—

4ft. x 4ft. ..	2,722	8ft. x 8ft. ..	681
5ft. x 5ft. ..	1,744	9ft. x 9ft. ..	538
6ft. x 6ft. ..	1,210	10ft. x 10ft. ..	436
7ft. x 7ft. ..	889		

After very little practice no measuring stick of any description will be required, as the position for digging a hole, or setting a plant, can then be estimated with the requisite degree of accuracy.

This position is obtained by estimating the particular spacing distance at right angles from the line of plants (or holes) on the inner flank, and also from the plant, or hole, just completed.

With totally inexperienced men, a check measurement made with a spade or mattock as a measuring stick is advisable. For this purpose it is most convenient to mark on the spade or mattock a length equal to the difference between the spacing distance and the length of the spade.

580.

Arrangement of gang.

The gang will usually be divided into two sections—diggers and planters. Planters will, of course, follow the diggers.

Overseers, if they study their men closely, will find that some men are naturally better adapted for digging than for planting, and *vice versa*. The efficiency of a gang, therefore, will be greatly increased if each man is put to the job for which he is most fitted. On the other hand, some men will show better results if given a change of work.

During the first few days of the planting season it is advisable that the overseer be relieved of actual planting or digging in order that he can devote his time to the training of the men and securing the best arrangement of the gang.

581.

Dumps.

The placing of the dumps must be arranged each day by the overseer as the plants are brought from the nursery, and no man must be kept solely on the job of carrying pines from the dumps to the planters.

582.

Tools and equipment.

The tools and equipment required will be as follows:—

Grub hoes or mattocks for "spot hoeing" (where necessary).

Spades or mattocks (for diggers).

Planting tray (for planters).

Watering can for watering plants at the dumps.

Note.—If spades are used by the diggers, the overseer should carry a mattock, and two or three mattocks should be kept at the plant dump.

583.

The planting method will be pit planting. This may be varied only on written instructions from the Conservator. The planting method. Pit planting.

Pit planting means that the plants are inserted in a hole, or pit, excavated for the purpose.

584.

Where spot hoeing is not carried out, a certain amount of cultivation is necessary with the actual "holeing." For example, if a spade be used in digging the hole (or pit), three spits must be turned over before the hole is opened; if a mattock be used, an area 15 inches square must be mattocked before the hole is opened. Excavation of planting hole.

The Divisional Forest Officer will decide in each case what cultivation is necessary, and what tools are required.

585.

The size of the hole will depend on the size of the planting stock. Size of pit.

As a rough guide, a plant 8 to 12 inches in height will require a hole 8in. x 8in. by 10 to 12 inches deep. In all cases the hole must be of sufficient depth to accommodate the plant's root system in its natural position.

586.

The correct method of holding a plant is first to invert it, and then grasp it over the roots with the left hand, so that the branch roots lie all along the stem, pointing towards the needles or leaves. Details of planting.

The plant is then held upright in the centre of the hole, with the tap root pointing straight down.

The correct depth for the plant to be set is as indicated by the soil mark at the root collar (*i.e.* nursery depth).

As the soil is drawn into the hole the roots are allowed to fall gradually, so that they spread out, and, as far as possible, assume their natural positions.

587.

The soil should be compacted at intervals as the pit is filled in. Care must be taken to avoid filling the hole loosely with soil and then compacting as a single operation. Only good damp soil should be used, and no debris dragged in. Filling in pit.

588.

Common faults in planting are— Faults in planting.

(1) Drying of the roots by holding the plant too long in the hand after it is taken from the planting tray. A certain amount of exposure is in this case unavoidable, but the time of exposure must be reduced to the absolute minimum. Planters must be made to realise that with pines, which are evergreens, exposure of the root system is much more dangerous than with fruit-trees for example.

(2) Bunching, twisting or bending back of the root system, so that the roots are given an unnatural position in the ground.

The first essential is that the tap-root should be straight down and well packed with soil.

(3) Too deep planting. The correct depth is the "nursery depth." One cause of deep planting is filling the hole loosely and then trampling with the feet.

(4) Shallow and narrow holes.

The hole must be properly excavated, not opened by merely working a spade backwards and forwards to form a notch.

(5) Leaving the plants in the carrier uncovered by the sacking or allowing the sacking to become dry.

SECTION 6.

TENDING OF PLANTATIONS.

589.

Sucker bashing.

The destruction of indigenous scrub by slashing should not be necessary with the exception of the bashing of strong growing eucalypt suckers. Suckers should be allowed to grow until they are of sufficient size to be knocked off with the back of an axe rather than cut. Care should be taken that the pines are not damaged during this operation.

590.

Refilling.

Refilling will be carried out in the year following the original planting only.

The count to determine whether refilling is required shall be made in April of the year following planting, and each compartment shall be dealt with as a separate unit.

(a) Where the spacing is 7ft. x 7ft. or under (*P. pinaster*) a survival of 85 per cent. or over of the original planting shall be regarded as a full stocking unless the failures occur in very definite large patches, in which cases such patches only may be refilled.

(b) Where the spacing is 8ft. x 8ft. or over, a stocking of 90 per cent. or over shall be regarded as complete.

591.

Upkeep of firebreaks.

The most important work during the early years of the life of a plantation is the effective maintenance of fire breaks. During the first or second year after planting, ploughing will be necessary in all cases to suppress the natural woody shrubs. Following the second ploughing, lighter cultivation may prove effec-

tive for several years, when ploughing will again become necessary. Attention to fire breaks around planted areas prior to the beginning of the summer months is the most important duty of an officer in charge of a plantation, and if, for any reason, it is not possible to complete the cultivation of fire breaks well before the surrounding country will carry a running fire, the position must be reported to Head Office, when steps will be taken to further examine the position with a view to making extra implements, power or labour available as found necessary. Should inspection at the beginning of summer disclose fire breaks on any plantation in a condition to carry a running fire, the matter will be regarded as a serious dereliction of duty on the part of all concerned and action taken accordingly.

592.

Thinning.

All large plantation areas under the control of the Department are still too young for the problem of thinning practice to arise. Where necessary, special instructions will be issued and any general rules for guidance in thinning will be held over until a later edition of this Manual.

SECTION 7.

NURSERY PRACTICE.

Establishment of Nursery.

593

Clearing.

The nursery site will be cleared and grubbed to depth of 12in. All timber to a distance of two (2) chains round the boundary of the nursery will be clear-felled.

594.

Stacking and burning.

Logs felled on the actual site of the nursery can usually be rolled clear, but some heaping of logs and burning on the site may be found necessary.

All small debris, including roots, etc., will be gathered into heaps and burnt. The small debris and rubbish must be disposed of in this way to prevent it being ploughed in, and so remaining an obstacle to the proper cultivation of the seed beds later.

595.

Ploughing and harrowing.

The area will next be thoroughly ploughed and harrowed. Harrowing is necessary in a new nursery in order to get rid of as many roots as possible.

596.

Fencing with a rabbit-proof fence will be carried out after the ploughing and harrowing is completed. Fencing.

Note.—If the nursery is established on a slope, a deep trench must be dug on the top side of the nursery to carry off drainage water, and so prevent seed beds getting flooded or water-logged in winter.

597.

After being harrowed the ground will be dug over with a fork in order to thoroughly loosen and break up the soil. All the smaller roots dug up in the process should be raked together and stacked in heaps for burning. Preparation of ground. Digging.

598.

Raking will be carried out in order to reduce the soil to a fine tilth. Raking.

599.

If the nursery be established on sloping ground, narrow beds about 5 feet wide will be formed. The length of such beds will be about 1 chain, and they will be separated by paths 1ft. wide. If the nursery site be level or gently sloping the beds will be as long and as wide as possible, up to 1 chain square, so that the amount of space taken up by paths may be reduced to a minimum. Laying out seed beds.

600.

Sowing will be carried out by means of the Planet Junior Seed Sower, which is the standard machine in use by the Department. Sowing by hand will normally be carried out only in the case of small quantities of seed of new species. Sowing.

Before starting, the Planet Junior should be adjusted to sow approximately 20 seeds to the foot, depending on the germinating capacity which will be given when the seed is sent out from the central store. This adjustment will need to be varied for each species and for any one species from year to year, owing to differences in size of seeds.

The distance between rows should be from 12 to 15 inches. Care must be taken to make rows reasonably straight and evenly spaced, as this will greatly facilitate subsequent cultivation. The area of nursery beds required for the sowing of a definite quantity of seed for any particular species may be calculated from the above particulars, and a knowledge of the number of seeds to the pound. For the latter information, see notes on species, pages 87 to 96.

As a general guide where the annual planting rate is 100 acres, the area of nursery required to raise the plants as 1-year seedlings is about one-quarter of an acre.

In determining both area of beds and seed required such factors as spacing in the plantation, germinating capacity of seed, quality and age of nursery site, must all be taken into account.

The following figures are given only as a general guide of the seed required annually with a planting rate of 100 acres—

Pinus insignis—12 lbs.

Pinus pinaster—22 lbs.

601.

Manures. No manures will be used in nurseries unless special approval is obtained from Head Office.

602.

Weeding. In the rows (*i.e.*, among the seedlings) hand picking will be the method employed, and should commence as soon as the plants are strong enough to permit weeding.

Where seedlings occur in thick patches, thinning out may be necessary, and will be carried out at the same time as weeding.

Weeding between the rows will be done by Planet Junior fitted with special skim hoe attachments.

603.

Hoeing. The Planet Junior with harrow attachment will be run through between the rows after every rain in summer, or whenever the surface becomes caked.

604.

Lifting. In lifting seedlings, a trench is first dug in front of the outside row of the bed. This trench should be completed for the entire length of the row and should not be cut so close as to risk damaging the lateral roots of the plants, the distance being half that between the rows.

Starting from one end, the spade is next driven in behind the row (in such a way as to shoot soil and seedlings bodily forward into the trench). When the outside row of seedlings has been dealt with in this way, a trench will have been formed in front of the next row, which is then dealt with in a similar fashion. Two men are usually required for this operation, one lifting and the other digging. Badly grown "culls" should be thrown aside and the stock fit for planting roughly counted and placed in small heaps, the roots being immediately covered with moist soil.

The practice of lifting by driving a spade in on either side of a row, prizing the soil up slightly, and then dragging seedlings from partly slackened soil, is contrary to instructions and most unsatisfactory.

The plants, when lifted, should be root-pruned and packed straight away for transport to the planting site, the exposure of root systems being limited to the shortest time possible.

605.

Grading. In the course of lifting all badly rooted, poorly formed, damaged or weak plants must be thrown away. Plants with double leaders should also be discarded.

606.

Root pruning.

When stock is lifted in the nursery it will be found that the root systems are by no means uniform in size, especially in the length of the tap root. It is, therefore, necessary, whether the stock is to be planted out or merely lined out in the nursery, to trim the root system to a size which can be conveniently handled.

This operation is known as "root pruning," and a wooden block and an axe are used for the purpose. Care must be taken to see that only small bunches of plants are dealt with at the one time and that at least 10in. of tap root remain.

607.

Transplanting and raising plants in trays.

Instructions regarding the practice to be adopted in transplanting (lining out), and in raising plants in trays, will be given in the form of circulars when required.

608.

New nurseries.

Careful investigations have shown that there is some soil organism associated with the roots of pines which is essential for the successful development of young pines when planted out. It is found that this soil organism, probably a fungus, does not exist in sufficient quantities on land where pines have not been grown previously. In consequence, planting stock from new nurseries is not satisfactory and methods of soil infection are being tested at the present time. Care will be taken by responsible officers to see that stock from new nurseries is not planted out, but the problem affects old nurseries in that seed may be planted on areas which have not previously carried pine planting stock, and which are not properly infected. If portion of a nursery has not been previously planted under pines before it is sown, this fact should be brought under the notice of the Divisional Forest Officer, who will give such instructions as are considered necessary to provide for thorough soil infection before the seedlings from such new beds are used for planting stock.

SECTION 8.

NOTES ON EXOTIC CONIFERS.

Pinus Canariensis.

Geographical Distribution.

609.

P. Canariensis forms forests over considerable area of Canary Islands at altitudes ranging from 3,000-7,500 feet.

Temperature.—Stands high temperature, but not a temperature below freezing point, for any considerable period.

Rainfall.—Drought-resistant, grows in places where the annual rainfall is less than 23½ inches. Rainy season, October to May (winter), the other months being dry (except for dew).

Best growth on volcanic soils, grows in clay soils but not on chalk. High altitudes and rough ground favour growth.

Descriptive Notes.

Branches in regular whorls. Symmetrical conical crown.

Bark thick and deeply fissured.

Needles in bundles of three. 8in-11½in. long, blue-green.

Buds large, non-resinous, scales streaked with brown and turned back at tips.

Cones 4in.-6½in. long, on short stalks, shiny nut-brown colour.

Seeds to pound, 3,800, large, winged.

Difficult to handle in nursery, owing to long tap root. Usually raised in trays or sown *in situ.*

Pinus Caribaea.

Geographical Distribution.

610.

The range of *P. Caribaea* extends from the South-East coast of Carolina westward through Southern Georgia, Alabama, Mississippi, and South-East Louisiana to the Mississippi River, and southward nearly to the southern extremity of Florida. Commercially important over its whole range.

Wide variety of situations and soil types, at home on semi-swampy "seepy" bottoms, locally called "slashes," which are inundated in winter. A calcareous substratum does not appear to be unfavourable to its growth; does not usually thrive on dry, deep, sandy ridges.

Descriptive Notes.

Although narrow, pyramidal shape as a young tree, spreads later to a fairly dense rounded or umbrella-shaped crown. Stem cleans itself well.

Bark thin, red brown scales. Bark on young trees inclined to be thicker than on mature tree.

Needles in bundles of two or three, stout, 8in.-12in. long and dark green in colour.

Buds reddish brown in colour, elongating in spring into stout, straight, light grey "candle" about ½in. thick.

Cones 3in.-5in., and 2in. wide, rather egg-shaped.

Seeds to pound, 17,000.

Pinus Coulteri.

Geographical Distribution.

611.

The home of *Pinus Coulteri* is the coastal countries of Southern California—generally between 3,000 and 6,000 feet elevation.

Rainfall—20 to 30 inches. Humidity high near coast (fogs frequent), low towards eastern (inland) limits. In inland mountains endures almost arid conditions with summer droughts and rapid evaporation in summer.

Is found growing on dry, gravelly loam soils, on dry warm slopes and ridges as well as (sometimes) on more moist, sheltered, northern slopes.

Descriptive Notes.

When mature has an irregularly open crown, heavily branched, lower branches long and bending downwards.

Bark very dark in colour and deeply fissured.

Needles in bundles of three, usually about 9in. long; deep bluish green in colour and very stout.

Buds very large, sharply pointed and resinous.

Cones very large, 9in.-14in. long, 6in. broad (smooth polished surface), yellowish clay brown in colour.

Seeds to pound, 1,400. Large, winged, deep chocolate brown in colour.

Pinus echinata.

Geographical Distribution.

612

A very wide range, extending along the Atlantic seaboard from Pennsylvania to North Carolina and westward to the Mississippi River into the Indian Territory and Texas, where it reaches its best development and forms pure forests.

In importance to the lumber industry and in the value of its timber, *Pinus echinata* stands second to *P. palustris* among the coniferous trees of eastern North America.

Prefers a well-drained light or gravelly clay soil or warm loam, but a purely sandy and highly porous soil is not favourable to its development.

P. echinata does not occur in districts where the average annual rainfall falls below 40 inches.

Descriptive Notes.

Crown dense, with the outline of a truncated pyramid. Height 90 to 100 feet.

Bark light reddish brown colour, thick, deeply furrowed and flaky.

Needles short, three to five inches long, mostly two (sometimes three) in a sheath, deep green in colour.

Cones light brown in colour, 1½in. to 2in. long; oval or somewhat conical.

Seeds small; 45,000 to lb. (av.).

Pinus halepensis.

Geographical Range. 613.

The range of *Pinus halepensis* is mainly associated with the countries bordering the Mediterranean. Its western limit is Portugal, while towards the east it goes as far as Afghanistan.

Dry summers and winter rains are usual in its habitat.

The species grows well on poor soils and in hot and dry situations. Does well on dry limestone ridges.

Descriptive Notes.

Pinus halepensis is a comparatively small tree. The crown is fairly dense and very limby. Older trees are often recognisable on account of the large number of persistent old empty cones. The timber is resinous and in its home country mainly used for firewood.

Bark thin, with reddish-grey scales. Bark on young shoots grey, smooth.

Needles, 2 in sheath. Length 3in.-6in. Colour light green.

Cones, with stem, 3in.-5in. long, 1in.-2in. wide, brown. Scales smooth. Persistent after opening.

Seed small, 25,000 to pound.

Pinus insignis (syn. *P. radiata*).

Geographical Distribution.

614.

The natural distribution of *P. insignis* is very restricted; it is found only at three points on the coast of central California, and on the islands off the coast. The largest natural forest (5,000 to 6,000 acres in extent) occurs on the Monterey Peninsula. The climate of Monterey is characterised by winter rainfall and daily fogs during summer; the temperature is extremely mild and equable. Average annual rainfall, 18 inches, summer fogs compensating greatly for low winter rainfall.

This species under Western Australian conditions requires a fairly good loamy well-drained soil.

Descriptive Notes.

Habit and form of crown varies considerably from open conical with weak laterals and distinctive leader to dense with massive laterals. The branches are very persistent, even after dying off.

The timber is cream coloured to light brown, soft.

Needles usually 3 to bundle, deep grass green in colour, rather slender, 4in.-6in. in length, sharp pointed and ribbed on inner side.

Buds cylindrical, obtuse, ¼in.-½in. long, slightly resinous.

Cones 3in.-4in. long and asymmetrical. Scales strongly developed on upper side. Smooth, shiny and dark russet brown.

Seeds, No. to pound, 15,400.

Pinus laricio.

Geographical Range.

615.

The home of this species is the mountain ranges of Central and Southern Europe and Asia Minor. It is also found at high altitudes on some of the islands of the Mediterranean. Two varieties are recognised by foresters, the Austrian or Black Pine, often quoted as *Pinus nigra*, and the Mediterranean or Corsican variety. It is the Corsican variety which may possibly be found of value, under certain conditions, in this State.

Descriptive Notes.

The crown is conical, heavy and dark green. The timber is light-coloured and resinous, being among the heavier pine timbers.

Bark, scales dark brown.

Needles in bundles of two, length 4in.-6in., dark green.

Cones 2in.-3in. long, 1in.-2in. wide. Tawny-yellow cone-scales, purple on lower side.

Seed small, dark coloured, 30,000 to pound.

General.

This species is slow to develop in the nursery, and planting stock can seldom be grown to satisfactory size for planting out in less than two or even three years.

Pinus muricata.

Geographical Distribution.

616.

P. muricata occurs in widely separated localities on the coast of California, ranging from near sea level to 1,000 feet elevation, and extending about a mile inland.

Its range is within the fog belt.

Grows in swamps, sandy plains or steep sand hills near the sea, reaching best development in the "peat bogs" (water-soaked sandy plains covered with heath) in the northern part of its range.

Descriptive Notes.

Height, dense crown rounded at top when mature.

Bark deeply furrowed, dark brown.

Needles usually in bundles of two, 3in.-4in. long, stiff, same deep green as *P. insignis.*

Buds pointed, non-resinous.

Cones 3in. long, 1½in. broad, tapering to a blunt point, shiny russet brown in colour when mature. Prickly scales.

Seeds to pound, 45,000. Small, dark, with roughish surface.

Pinus palustris.

Geographical Distribution.

617.

P. palustris is the tree of widest distribution and of greatest commercial importance in the Southern Atlantic forest region of eastern North America. Its range is principally confined to a belt about 125 miles in width, bordering on the Atlantic Ocean and Gulf of Mexico, and extending South-Westwards from Southern Virginia to the Mississippi Valley.

Not exacting as to soil, thrives best on a light siliceous soil, loamy sand or pebbles, or light sandy loam with slightly clayey subsoil sufficiently porous to ensure at least a partial underground drainage and to permit unimpeded development of the long tap-root. It does not do well on swampy bottoms.

Descriptive Notes.

When mature has open crown, irregularly shaped.

Bark reddish-brown in colour and furrowed with deep, horizontal fissures; scales off in thin plates.

Needles in bundles of three, 9in.-13in. long, bright green colour, set closely in brush-like clusters.

Buds peculiarly large, white, fringed with long free cilia of bud scales.

Cones large, dark tan in colour, 6in.-8in. long and 2in.-2½in. wide.

Seeds to pound, 6,300; light-coloured, with wing, somewhat triangular in shape.

This species has a peculiar habit of remaining like a tuft of grass for three to five years after germinating, and then sending up a very vigorous leading shoot. One of the distinctive features of this pine is the long thick tap root developed in the seedling stage. Is valuable for resin as well as timber (Pitch pine).

The species is fire-resistant in the early stages of its growth.

Pinus pinaster (syn. *P. maritima*).

Geographical Distribution.

618.

Pinus pinaster is indigenous to the South of Europe and to both sides of the Mediterranean, extending eastwards from Greece into Western Asia. Its natural distribution, from Portugal to Eastern Greece, and from Dalmatia to Algiers, extends over more than 30° of longitude and 10° of latitude. The species is chiefly found at low altitudes on islands and upon stretches of country within the influence of a purely seaboard or insular climate, where it frequently forms almost pure forests. Artificially established on a very large scale in the Landes District of Gascony, *P. pinaster* is thriving very well and yielding a great revenue. Is usually found on a deep sandy soil; does not do well on soils containing an excess of lime.

Descriptive Notes.

Dense crown.

Bark deeply furrowed, coarse.

Needles in bundles of two, dark green, 6in.-8in. long, and rigid.

Buds ¾in. long, white, streaked with brown, woolly, non-resinous; scales turned back at tips.

Cones 4in.-6in. long, 2½in. wide at broadest axis; light shining brown in colour. Often in clusters.

Seeds, number to pound 8,500, oblong in shape, and winged. Dull to black on upper surface, shining on under surface.

Pinus ponderosa.

Geographical Distribution.

619.

The range of *P. ponderosa* extends from Southern British Columbia to Lower California and Northern Mexico. Altitude, 1,000ft. British Columbia, 6-7,000ft. Arizona.

Rainfall below 20in. probably limits its commercial occurrence.

Not exacting as to soil (found on all soils, from glacial drift and volcanic ash to deep loose sands and stiff clays). Dry, well-drained, gravelly or sandy soils most characteristic. Not exacting as regards surface moisture; can thrive on dry soils because of deep root system.

Descriptive Notes.

Broad, conical crown with heavy foliage.

Bark dark grey, fissured. On mature trees the bark is broken into large orange-coloured plates.

Needles in bundles of three, 5in.-11in. long, twisted, sharp-pointed, occurring in heavy brush-like clusters at ends of branches.

Buds with prominent point, resinous.

Cones vary in size and colour, 2¾in.-5¾in.

Seeds to pound, 9,900. Dull, yellowish colour with purplish spots or blotches.

In the nursery it is rarely fit for planting out until second year.

Pinus taeda.

Geographical Distribution.

620.

The range of *P. taeda* extends from Delaware and the Maryland Peninsula through Lower Virginia to Cape Malaber in Florida, and all over the Gulf States and Southern Arkansas to the Colorado River, in Texas.

Prefers moist sandy or light loamy soil with considerable retentive power for moisture, but not water-logged land.

Descriptive Notes.

P. taeda is one of the important trade pines of the Southern States of U.S.A.

Bark orange-yellow in younger plants; in mature tree thick, rough, grayish in colour, becoming reddish-brown, smoother, and flaky with age.

Needles in bundles of three, 7in.-9in. long, pale green, with sharp points.

Buds non-resinous, streaked with brown scales.

Cones over 3in. long, 1½in. wide; light brown in colour, and have very sharp spike on umbo.

Seeds to pound, 19,000; ridged with narrow border of delicate wing.

Pinus Torreyana.

Geographical Range.

621.

The range of this species is limited to San Diego county and Santa Rosa Island, Southern California.

The rainy season occurs during winter months, and total precipitation is low. This is, however, to some extent supplemented by numerous fogs.

The species thrives on well-drained soils of various compositions.

Descriptive Notes.

The tree reaches a height of 50-60 feet, and is fairly well formed in sheltered locations. The crown is sparse and very open.

The wood is pale reddish-brown and light, brittle, and coarse grained.

Bark, scales pale reddish-brown. On young trees it is dull grey, thick and spongy.

Needles, five in sheath, 7-13 inches long; colour dark grey-green.

Cones 4-6 inches in length and 3-5 inches wide; attached to branch by stout stem.

Seed, per pound = 500.

Pseudotsuga taxifolia (Douglas Fir, Oregon).

Geographical Range.

622.

The distribution of this species is very wide. It stretches from the coast districts of British Columbia and through Washington and Oregon, Northern and Eastern California, and follows the Rocky Mountains through Colorado down into Arizona and New Mexico. From being a coastal and low altitude tree in the north, it becomes a high mountain type in its southern limits.

It thrives in a variety of climates and grows well on many types of soil, but does best on moist deep well-drained slopes in mountain gullies.

Descriptive Notes.

This species is one of the most important in Western America from a timber point of view. It attains a height of 150-200 feet, with a diameter of 3-8 feet B.H. It is found in large pure forests or associated with other species. The species is tolerant in the early stages and forms fairly dense canopy. Tolerance decreases with age. Laterals are very persistent during first 30 to 50 years.

The timber is moderately heavy, colour yellow to light reddish brown. Autumn wood in annual rings, dark and dense.

Bark thick, dark and deeply furrowed.

Foliage usually deep green, leaves narrow, from ¾in. to 1½in. in length.

Buds brown, pointed, close-fitting scales.

Cones 2-3½in. long, bracts protrude from between scales, colour light brown.

Seed small, black—43,000 per lb.

Sequoia sempervirens (Redwood).

Geographical Range.

623.

The home of this species is a coastal strip of the United States from Oregon to Monterey, south of San Francisco. It penetrates 10-30 miles inland and is usually found on the seaward side of the coastal range from sea level to 2,500ft. elevation.

Winter rains prevail, but the whole area is within the so-called fog belt, which contributes considerably to the humidity.

The best development occurs on well-drained rich alluvial along creeks and rivers, but first-class growth is also met with away from watercourses on well drained sandy loams.

Descriptive Notes.

The tree is one of the finest timber species in America. Heights of 200-300ft. and diameters of 8-15ft. B.H. are of common occurrence. Crown is fairly open. Laterals not persistent. Coppices well. Occurs in pure and mixed stands.

Wood reddish-brown, brittle, durable, soft and light in weight.

Bark is brown, furrowed, stringy and thick, on old trees it frequently is 8-12in. thick at the butt.

Leaves arranged on both sides of the twigs, flat, pointed, stiff and of unequal length from ⅓ to 1in.; colour bright green with yellowish tinge.

Cones small, ½-1in. long, and ½-¾in. wide, light brown colour.

Seed small, 104,000 per lb.

Taxodium distichum.

Geographical Range.

624.

It is a native of the Southern States of North America, reaching its optimum development in the delta of the Mississippi in Louisiana. It grows in swamps, but only develops well when the bottom is deep and rich.

Descriptive Notes.

The tree reaches a height of 80-100ft., form is usually good and canopy of medium density.

The stem is often heavily buttressed.

The wood is light brown to reddish-yellow in colour; it is soft and durable when exposed to weather, owing to contents of aromatic oils.

Bark thin, dark brown.

Leaves deciduous, narrow, ½-¾in. long. The foliage in spring is soft and light green in colour, darkening later in the season.

Roots: a series of taproots developing from the primary laterals; from the laterals numerous vertical roots connected with respiration on a similar principle to those associated with certain mangroves.

Cones almost spherical, light brown in colour, about 1in. x 1in.

Seed small, winged (it can float)—4,600 per lb.

THE FORESTERS' MANUAL.

PART V.

EXPENDITURE CONTROL AND PERIODIC REPORTS.

TABLE OF CONTENTS.

SECTION 1.

INTRODUCTORY.

625.

The unit of organisation in the Forest Service is a Block or Minor Working Circle, which is under the control of a resident officer, usually an overseer.

Blocks—Definition of.

In its simplest terms a Block is a group of compartments which will ultimately carry a regular series of age classes and provide a sustained output indefinitely. For better control and management a number of Blocks are grouped together to form a Major Working Circle.

626.

Working Circle—Definition of.

The term "Working Circle" is used to refer to the area controlled by a single Working Plan. As during the early stages of development work is being started more or less independently on adjoining "Blocks," the term "Minor Working Circle" has been adopted to refer to Blocks managed under separate Working Plans until such time as they reach a stage of development and the necessary staff is available to group them into "Major" Working Circles. The actual forest operations to be carried out on any Block or Minor Working Circle is clearly set out in the Working Plan. The Working Plan is a document prepared in its simpler forms under the following standard headings:—

Standard headings for Working Plan.

Introduction.

Part I.—*Summary of Facts.*

1. Name, Location and Size.
2. Existing Rights and Privileges.
3. Physiography.
4. General Description of Forest Growth.
5. Past Management.

Part II.—*Future Management.*

6. Objects of Management.
7. Subdivision.
8. Silvicultural System.
9. Method and Order of Operations.
10. Fire Control.
11. Grazing Control.
12. Control of Work.
13. Determination of Cut.
14. Prescription.

627.

Working Plan not to be altered or departed from.

Before being put into operation, a Working Plan is submitted to the Executive Council for approval, and, when approved, may not be altered except with Executive Council approval.

Special attention of officers is drawn to this explicit provision of the Forests Act, and it must be clearly understood that no departure may be made from the provisions of a Working Plan without *written* authority from the Conservator.

SECTION 2.

GENERAL PRACTICE.

(1) *Time Sheets, F.D.* 204.

628. Time sheets to be prepared daily.

The overseer, or other officer immediately in charge of casuals, will each day enter on a time sheet the number of hours worked by each man.

629. Overseer's time not to be included on time sheets.

Where the overseer receives his own wages payment direct from Head Office, his own time should not be shown on the time sheet.

630. Method of filling in time sheets.

In the second column of the time sheet headed "Nature of Work," the status of the employee will be given.

In the column marked "Hours," hours for which the employee is entitled to pay must be entered. If absent, "A" to be inserted. If on leave in lieu of emergency fire-fighting, "L.L." to be inserted. If away on recreation leave, "R.L." to be inserted.

No attempt may be made on the time sheets to divide up the costs of work on which a man is engaged. The Daily Diary is kept for this purpose.

(2) *Daily Diaries, F.D.* 173.

631. Overseer's time to be included in Daily Diary.

Entries must be made each day in the daily diary dealing with the costs of all works carried out, including the overseer's own time.

632. Method of filling in Daily Diary.

In the left-hand column will be given the day and date. Under "Ledger reference" will be entered the key number of the standard heading authorised for the work. In the wide column each man's name and time and particulars of the work he is engaged upon and compartment number will be written.

In the first money column the wages due for each man for the time worked on the particular job will be set out.

In the second money column the total costs for the day under each heading will be summarised. These entries must be made at the end of each day, and at the end of the pay period no difficulty will be experienced in preparing the expenditure statement on the standard Form F.D. 167.

633.

List of standard heading to be affixed to Diary.

Particular attention should be paid to the points enumerated hereunder:—

(a) A list of the standard headings authorised for the particular Working Circle or Block, for the purpose of properly controlling expenditure, will be forwarded to the overseer in charge at the beginning of each financial year. This list should be pasted on the inside of the cover of the Daily Diary for handy reference.

Expenditure not to be charged against other than standard headings.

(b) No expenditure shall be shown against other than a standard heading without written approval.

Action to be taken when standard headings not applicable.

(c) Should an Overseer consider that no authorised heading is applicable to a particular work he may be engaged upon, he should ask or write immediately for advice.

3. *Wages Sheets, F.D. 52.*

634.

Preparation of wages sheets.

Wages Sheets, in the form F.D. 52, must be prepared at the close of each pay period from the information appearing on the time sheets. Care must be exercised to see that the names and initials of the employees are correctly shown, and that the signatures obtained when making payment agree in every respect with the names appearing on the sheet.

The total amount of wages paid during each period must agree with the total as per the time sheets.

635.

Computation of wages.

Tables for the computation of wages will be forwarded from Head Office upon receipt of a requisition, and each paying officer should be in possession of a copy.

The method of calculating the amount of wages due is to multiply the hours worked by the weekly rate and divide by 44.

636.

Cash Order numbers to be quoted.

For every payment made a Cash Order number must be shown in the column provided opposite the respective entry.

637.

Alterations in wages sheets.

No erasures may be made on wages sheets. Any mistake must be rectified by crossing out the wrong entry and entering the correct amount immediately above. All alterations must be initialled.

638.

Instructions *re* payment of wages.

Paragraphs 212-220, "Foresters' Manual," Part I., contain complete instructions in regard to the payment of wages, and each paying officer should make himself acquainted with the procedure laid down.

4. *Cash Order Books.*

639.

Preparation of Cash Orders.

Books containing Cash Order forms in triplicate will be issued to each authorised paying officer. After the Wages Sheets have been prepared, Cash Orders will be drawn in the names of the respective payees for the amounts shown on the Wages Sheet. Three copies should be prepared at the one writing by the use of carbon paper, and the signatures of the payees must be obtained at the foot of their respective orders before the carbon paper or any orders are removed from the book.

640.

Method of issuing Cash Orders.

The original order will then be handed to the employee, the duplicate will be forwarded to Head Office securely attached to the supporting voucher (*i.e.*, either a Wages Sheet or a Treasury Form No. 10), and the triplicate copy will remain in the book for the information of the issuing officer.

When issuing orders, care should be taken to see that the condition of the carbon paper is such as to ensure the duplicate and triplicate copies being perfectly legible.

641.

Payments not to exceed authority.

Cash Orders shall be drawn to order, and no single order nor the aggregate amount for which orders are drawn monthly shall exceed the authorised amounts.

All vouchers paid by Cash Orders must be prepared in ink or indelible pencil and stamped on face "Paid by Cash Order No. —," the number of the Cash Order being inserted in each case.

642.

Revenue stamps to be attached to vouchers by payee.

Under the Stamp Act all receipts for amounts of £1 and over (except those for salary or wages not exceeding £5) must bear duty (Revenue Stamp) in accordance with the following scale:—

£1 and over and under £25	1d.
£25 and over, and under £50	2d.
£50 and over, and under £100	3d.
£100 (for every £100 or part of £100)	3d.

643.

Cash Order books not transferable.

Cash Order books must not be loaned to other officers, or handed over when transferring from District to District. Orders can only be drawn by an officer from the book issued to him from Head Office.

Orders not to be drawn in favour of issuing officer.

Under no circumstances whatever must an order be drawn by an officer for payment of any amount due to himself.

5. *Half-monthly Expenditure Statement.*

644.

Half-monthly Expenditure Statements.

A separate book of half-monthly Expenditure statements will be kept for each Block (Form F.D. 167a) or Minor Working Circle (Form F.D. 167b).

A report in the above form, which is self-explanatory, must be submitted at the close of each pay period, and should be forwarded securely attached to the wages and time sheets covering the same period.

The wages to be entered in the Wages column against the approved standard headings, will be obtained from the Daily Diaries.

645

Expenditure statements to agree with Cash Order payments.

Care must be taken to see that the total of the Wages column of the report form agrees with the wages paid by Cash Orders during the period. Other cash order payments which are supported by a Treasury Form 10 must agree with the total of the second column, and in the third column should be shown all wages paid direct from Head Office (*e.g.*, overseer's own wages).

646.

Reference numbers to be quoted on requisitions.

The reference number or standard heading against which the expenditure is to be charged must be shown on all requisitions other than those for stamps or stationery. This is essential in order to enable Head Office to debit the expenditure correctly to the respective works.

Key numbers or standard headings must be quoted on all Treasury Forms 10 supporting Cash Order payments.

6. *Requisitions.*

647.

Proper requisition forms only to be used.

Books of requisition forms will be supplied upon application and all requisitions must be submitted on these forms. Separate forms are provided for the purpose of ordering (a) "Stationery and Stores" (F.D. 201), and (b) "Equipment, Plant and Machinery" (F.D. 197), and these forms are to be used only for the purpose for which they are issued.

When ordering equipment, plant, etc., it is essential that the numbers of the standard headings against which the cost is to be charged should be shown against the respective items.

648.

Full details to be shown when ordering.

When ordering, full details must be shown on the requisition form, *i.e.*, quantities required, nature of goods, etc., and if ordering departmental forms, receipt books, license books, etc., the departmental number also must be quoted, *e.g.*, F.D. 10.

649.

Urgent requisitions to be reduced to a minimum.

When requisitions are forwarded to replenish stock, care should be taken to see that the orders are placed before the stocks are exhausted, in order to reduce to a minimum the number of urgent requisitions received.

7. *Treasury Form* 10.

650.

A Treasury Form 10 must be submitted in support of each Cash Order payment, with the exception of wages payments, which must be supported by Wages Sheets. When Treasury Form No. 10 to be used.

651.

The form must be made out in the name of the person to whom payment is due, and, under no circumstances, shall it be prepared in the name of any other party. Form 10 to be prepared in creditor's name.

652.

In the event of the payee desiring another person to collect the amount due to him, the paying officer shall first obtain a procuration order duly signed by the payee in favour of the person authorised to collect and bearing a penny revenue stamp. The voucher will still be made out in favour of the party who has rendered the service or supplied the goods, but the person authorised to collect will sign his own name at the foot of the form, and the procuration order must be pasted to the back of the voucher. Procuration order necessary if another person collect for payee.

653.

In all other cases, the signature at the foot of the form must agree in every respect with the name of the person in whose favour the voucher has been prepared. Signature to agree with name of creditor.

No payment shall be made before a receipt has been obtained in the space provided.

The date of service must always be shown in the extreme left-hand column, and full particulars of the goods supplied or of the services rendered must be shown in the space headed "Particulars."

654.

The method of preparing Treasury Forms 10 in regard to contract payments is clearly defined in parargraph 207 of the Foresters' Manual, Part I. Contract payments.

655.

Paying officer shall sign the voucher as "Officer incurring the expense," but not as certifying officers, who are always Head Office officials. Field officers not to sign as certifying officers.

SECTION 3.

MAJOR WORKING CIRCLE

(AND GROUPS OF MINOR WORKING CIRCLES UNDER A.D.F.O.).

(1) *Annual Scheme of Expenditure.*

656.

Estimates to be submitted annually.

Annual Scheme of Expenditure will be prepared, in accordance with the provisions of the Working Plan, under standard headings and ledger reference numbers shown on Forms, 93, 94, 94a. The Officer in Charge of each Major Working Circle or Division shall submit estimates with explanatory notes not later than 15th June in each year. Before 15th July, a scheme of expenditure will be returned showing the amounts finally approved. The scheme of expenditure shall not be accepted as authority for work provided for on the estimates to be carried out.

Scheme of expenditure.

657

If necessary, excesses to be obtained.

If approval is given during the year to carry out work which is not provided for on the estimates, or for which the amount provided is insufficient, the Officer in Charge of the Major Working Circle or Division must apply for the excesses required before the work is put in hand.

Each application for an excess must indicate whether a credit is likely to result against any item at the end of the year, so that any excess approved may be provided by transfer where possible.

(2.) *Financial Statements.*

658.

Returns to be forwarded to Forester.

Overseers in Charge of Blocks will forward time sheets, wages sheet, expenditure statement, etc., to the Forester in Charge of the Working Circle.

659.

Financial statements to be submitted half-monthly.

From the Expenditure Statement submitted by the overseers, Officers in Charge of Major Working Circles must compile and submit half-monthly to Head Office Financial Statements under standard headings, in the Forms 91, 92, and 92a, covering the periods 1st to 15th and 16th to the last day of each month.

660.

How to prepare financial statements.

Although the forms are self-explanatory, the following information will more clearly define the purpose for which the various columns should be used:—

(a) *Wages Column.*

All wages and allowances paid locally by Cash Order should be shown in this column, the total of which must agree with the total payments within the period as disclosed by the wages and time sheets, which must be forwarded with the financial statements.

(b) *Salaries Column.*

This column should only be used for the purpose of allocating the salaries of officers paid from Head Office where it is possible to definitely allocate such salary against the respective items.

(c) *Allowance Column.*

Only allowances paid from Head Office should be shown in this column when it is possible definitely to allocate such payments.

(d) *Other payments by Cash Order.*

All cash order payments other than wages and allowances must be shown in this column.

Immediately after the close of each month Forms 93, 94 and 94a will be despatched from Head Office showing the expenditure for the month, and also the position for the expired portion of the year.

661

Application for authority to exceed allocation.

It is the responsibility of the officers directly controlling expenditure to see that the expenditure does not exceed the allocation for the year. If, through any circumstances unforeseen at the time the estimates are prepared, any of the amounts allocated should prove insufficient to meet the estimated expenditure on the respective items within the year, application for authority to exceed the allocation should be immediately forwarded to head office.

Such application should not on any account be delayed until the financial statements disclose debit balances.

662.

No expenditure to be incurred in anticipation of authority.

No expenditure shall be incurred in anticipation of the necessary authority being forthcoming.

In order to ascertain the balances available on the respective items, the value of any outstanding payments or contracts known to the local officer should be deducted from the amounts shown in the last column of the statement.

(3.) *Quarterly Reports.*

663.

Quarterly reports to be submitted.

Quarterly reports will be submitted by officers in charge of Major Working Circles within 30 days of the close of each quarter.

A separate report will be submitted for each Block.

The report will deal with each item for which expenditure has been incurred or work carried out, and will be drawn up from the Half-monthly Expenditure Statement.

664.

From the progress plan the units of work completed will be obtained, so that unit costs can be given each quarter. Unit cost to be stated

The items will be dealt with in their correct numerical order as given on the financial statement.

665.

Definite information is required, *e.g.*, location, areas and unit costs. A sub-heading need not be shown when no work has been carried out against an item. Definite information required in quarterly reports.

An account of the works is required, not a mere statement of expenditure.

(4.) *Annual Planting Report.*

666.

Planting—as distinct from preliminary operations such as spot cultivation—shall not be included in the April, May, June quarterly report, but full particulars and costs for the season's planting shall be given in July, August, September report, together with a summary of other costs chargeable against the area planted, such as nursery stock, clearing, fencing, establishing firebreaks, cultivation, etc. This report should summarise all information concerning plantations for the previous twelve months (October 1st to September 30th). Counts of deaths in previous year's planting should be made in April (see para. 590) and particulars of refilling given. Planting reports.

(5.) *Fire Control Reports.*

667.

Not later than 1st November in each year the officer in charge shall submit to Head Office proposals for control of the district during the coming fire season. Scheme of fire control proposals.

The report must be accompanied by a map showing:—

Areas burnt by uncontrolled fires in previous season;

Areas burnt by controlled fires during the previous twelve months;

Areas on which controlled burning is to be carried out during the ensuing fire season (a) before the season begins, (b) after the close season ends.

668.

Not later than 31st May in each year the officer in charge shall submit to head office a report on the fire control during the past season. Fire report (covering fire season).

The costs should close on 15th May.

The form of report is given in Part III., Section 3 (5).

(6.) *Progress Plans.*

669.

Progress plans shall be brought up to date by the last day of each quarter. Progress plans.

Until a divisional office is established, progress plans for each Working Circle will be forwarded to Head Office for recording purposes and calculations of areas at the beginning of every quarter.

670.

Where divisional offices are established, the Divisional Forest Officer will be responsible for keeping progress plans up to date and also for the computation of areas for quarterly reports and unit costs. Progress plans will be forwarded from divisional offices to Head Office in July each year and will be returned within one month. Responsibility for keeping the progress plans up to date.

APPENDIX.

LIST OF FORMS.

Nature of Form.	No. of Form.	Purpose.
Time Sheets	F.D. 204	Recording daily the number of hours worked by each man.
Daily Diaries	F.D. 173	Recording costs of all works carried out.
Wages Sheets	F.D. 52	Recording amount of wages payable to each employee.
Requisition for Stationery, etc.	F.D. 201	For ordering supplies of stationery, etc.
Requisition for Plant, Machinery, etc.	F.D. 197	For ordering supplies other than stationery.
Expenditure Statement	F.D. 167A	For summarising the costs shown in daily diaries. (Blocks.)
Do. do. ...	F.D. 167B	For summarising the costs shown in daily diaries (Minor Working Circles).
Financial Statement ...	F.D. 91	For allocation of expenditure (General District Items).
Do. do. ...	F.D. 92	For allocation of expenditure (Hardwood and Fire Control Items).
Do. do. ...	F.D. 92A	For allocation of expenditure (Pine Planting Items).
Statement of Account ...	Treasury Form 10	To furnish particulars of amounts paid or due to creditors (not to be used for wages payments).

FENCING DIAGRAMS AND DATA.

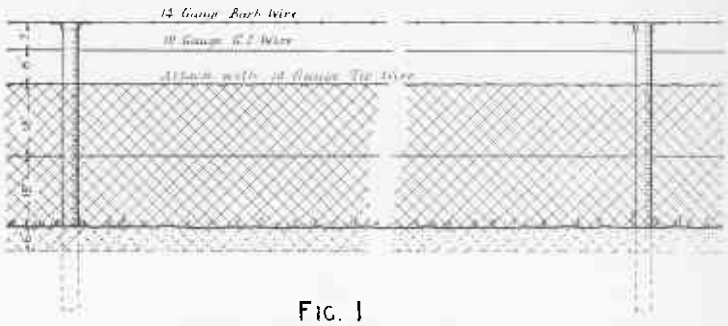


FIG. 1

RABBIT PROOF FENCE.

(For Nurseries, and house Gardens.)

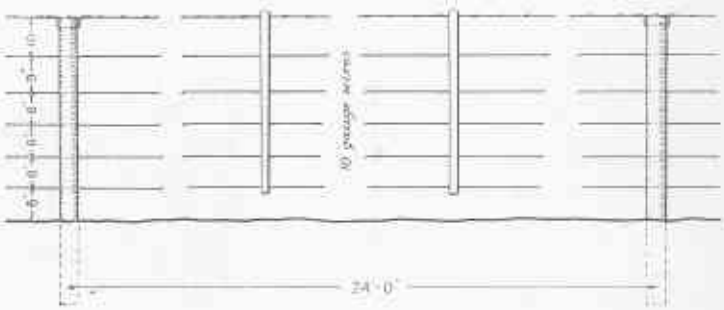


FIG. 3.

STOCK PROOF FENCE

(For Small Stock.)

Note:- The use of droppers in Types 3 and 4 will depend on cost of posts and nature of ground affecting sinking.

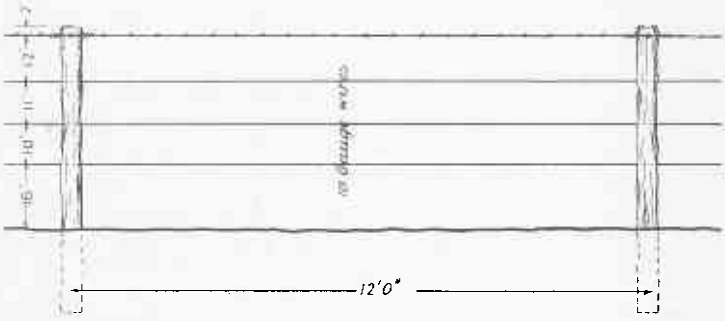


FIG. 4.

STOCK PROOF FENCE.

(For Large Stock.)

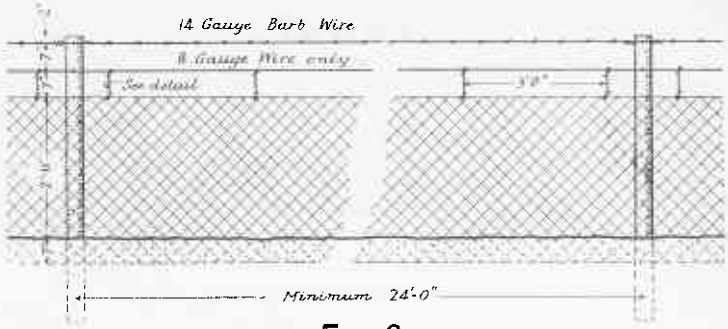
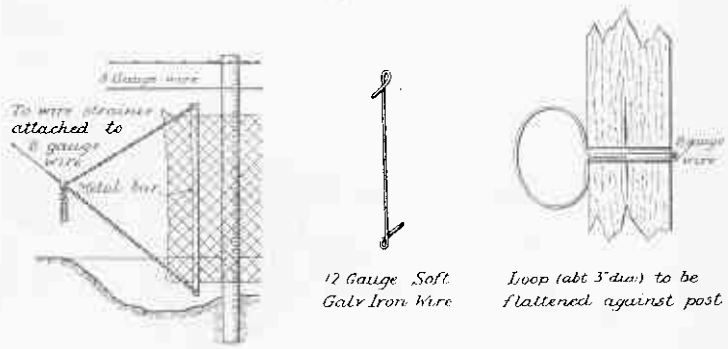


FIG. 2

RABBIT PROOF FENCE. WAITE TYPE

(For Plantations)



CONSTRUCTION DETAILS.

(For Waite Type only)

GENERAL INFORMATION.

POSTS.—6′ 0″ long. 1′ 9″ in ground under average conditions.

RABBIT NETTING.—42″ wide x 1½″ mesh x 17 gauge, in 100 yard rolls.

WIRE.—

No. 8 gauge Galv. Iron Wire, in coils approx. 1 cwt. x 520 yards.

No. 10 gauge G.I. Wire, in coils approx. 1 cwt. x 820 yards.

No. 12 gauge G.I. Wire, in coils approx. 1 cwt. x 1,200 yards. (For Waite Type suspenders and telephone insulator ties.)

Tie Wire—No. 14 gauge G.I. Wire, approx. 54′ 0″ to 1 lb.

Barb Wire—No. 14 gauge 4 point Galv. Iron Wire, in coils approx. 1 cwt. x 900 yards length.

Note.—The above lengths are approximate, depending to some extent on brand of wire used.

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By Authority: FRED. WM. SIMPSON, Government Printer, Perth.