Grafting Fruit Trees

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Grafting Fruit Trees

by

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Gardeners practiced grafting over 2,000 years ago but it didn't become the well-known practice of today until numerous fruit varieties needing propagation were developed.

Commercially, grafting is selecting a bud or twig from one plant and making it unite with and become part of another plant. But grafting also occurs naturally. Overlapping roots and crossing branches held firmly together for a long period also sometimes grow together.

DEFINITION OF TERMS

The stock and scion. In each graft there is a scion and a stock.

The scion is the top part of the graft, usually a bud or twig. The scion is the part taken from the plant you are propagating, and it becomes the top of the new plant.

The other part is the stock. It may be just the root, as in the case of the root graft, or, as with the top-worked tree, it may also include the tree framework.

The cambium. The cambium is a group of cells lying between the bark and the wood. This group of cells may be several layers deep, but cannot be seen with the naked eye. When the bark slips, some of the cambium cells stay with the bark and some stay with the wood. As a tree grows, some cambium cells become wood and some become bark.

Cell division and growth take place in the cambium region, and not in the wood or bark. So your only chance of getting the scion and stock to unite is to place the cambium cells of the stock in contact with those of the scion. Wood against wood or bark against bark does not work. The two cambiums must be in

* The authors wish to acknowledge the able assistance of the many who read the manuscript editorially.
contact and remain so until they develop new cells that become united.

*Bud sticks or budwood.* The bud stick is simply a twig of the current season's growth from which you take buds.

*Top-working.* Top-working is a term commonly given to putting a new top on a tree. As generally understood, the term applies to trees past the nursery stage. In commercial practice, top-working is used to change a tree from one variety to another.

*Double-working.* Double-working is a type of grafting in which you place an intermediate trunk between the scion and the stock. This intermediate stock may vary in length from an inch to several feet. In practice, double-working serves several functions. For example, you may use "P 18 pear" as an intermediate pear stock to make the trunk and framework resistant to fire blight; or you may use a short intermediate dwarf stock to dwarf the top of a standard apple variety.

**CONDITION AND SIZE OF SCION WOOD**

Grafting can be no better than the scion wood. First of all, you must use wood that will grow; it must not be diseased, unhealthy, or of the wrong variety.

![Fig. 1. Apple scion wood.](image)
In recent years there has been a lot of winter injury to fruit trees. Injured wood is not suitable for grafting. Unfortunately, it is hard to detect injury during the winter, but in early spring injured tissue turns brown.

It is customary to use scion wood 1 year old and about ½ inch in diameter. Ordinarily, wood of this size is firm enough to be cut into a well-shaped solid wedge. Smaller wood is hard to handle, and the pressure of the stock, particularly in the case of the cleft graft, may crush it.

Occasionally, water sprouts are the only wood that is big enough. You can use them, but select those that are well matured; many are soft and immature.

**COLLECTING SCION WOOD**

The best time to collect scion wood is in the late fall. As a rule, it is fully dormant and free of winter injury at this time. You can collect it any time during the dormant period. But collecting in late winter is hazardous in areas of occasional winter injury because there may be injury you cannot see; and in the spring the buds start growing even before they show outward signs of growth.

Buds for budding must be fully developed. Generally, those at the tip and at the butt of the current twig are not good; at the tip they are immature and at the butt they are poorly developed. You usually find the best budwood on trees in good average vigor.

The danger of spreading some virus diseases through the budwood is especially great. Be sure to collect from healthy trees only, and select twigs on which the buds are well developed. Generally, wood exposed to the sun is better than that in the shade. It is customary to collect the wood as you use it, but you can collect it several days beforehand if you keep it cool and moist until you use it. Budwood on trees with average orchard care is generally in good condition when most budding is done.

As you collect budwood, clip off the leaves, leaving part of the leaf stem or petiole attached to the bud stick (see Fig. 21, page 27). This helps to keep the twig from wilting, but the sooner you bud after cutting the twig from the tree, the better. The petiole serves as a handle for setting the bud. If you must hold the bud sticks several weeks, keep them moist and cool.
PREPARATION AND STORAGE OF SCION WOOD

A convenient way to handle the scion wood is to tie it in bundles of about twenty-five or fifty (see Fig. 1). These bundles are easy to store.

Keeping the wood fresh is easy; all you need to do is keep it dormant and from drying out. One satisfactory and convenient way is to wrap the bundles in burlap or something similar and bury them horizontally on the north side of a building where they are protected from mice. Bury them just deep enough to keep them from freezing and where there is good drainage. Scion wood stored in this way in central and eastern Washington has been known to keep until May.

In the spring when you do the grafting, the wood should be green and fresh without any sign of shriveling.

Another way is to pack the bundles in a large wooden mouse-proof box lined with moisture-proof paper. First put in a layer of wet moss and then a layer of bundles and continue until all bundles are packed. Store at about 34° F. or as near that as possible.

TIME OF GRAFTING AND BUDDING

There is a period of a month or two during which you can graft, but generally there is one best time. You can bridge graft, for example, whenever the bark slips, but the sooner you do it after the bark first slips, in the spring, the better. You can cleft graft almost any time you can get dormant scion wood. But with apples and grapes the ideal time is just as the buds start swelling, and with walnuts it is better to wait until the first leaves are well out.

All the bark on a tree doesn’t reach the slipping stage at one time. It starts on the south side. And the top is ahead of the roots. So the time for bark grafting varies with the position of the graft on the tree.

Most budding is done in July and August and is commonly referred to as fall budding. At this time you can get good buds, and, as a rule, the bark of the stock is loose.
JUNE BUDDING

June budding is not common. You do the budding in May or June and the bud develops into a tree that same season. The process is practically the same as for the fall budding. Use the shield or T bud and remove the wood from the bud before inserting the bud. There should be at least one leaf above and several below the bud. Three or four days after you do the budding, cut back the top 2 or 3 inches above the bud. Two weeks after the budding, cut the top back to the bud. Remove all stock leaves and shoots as soon as there are several leaves from the new bud.

TOOLS AND MATERIALS

You don't need a lot of tools for grafting, but there are special grafting tools. Even though you don't have these, you probably can get along unless you plan to do considerable grafting. The right tool, of course, speeds up the work and may increase the percentage of takes.

The Knife

There is no substitute for a sharp knife. The sharper it is, the better. A sharp cutting edge slices through the cells without disturbing them otherwise. Almost any pocket knife that takes and holds an edge will do. The cutting edge of a professional grafting knife, as shown in Figure 2, is straight, while that of a budding knife is curved.

The Grafting Tool

In an emergency you can use something such as a discarded butcher knife or a corn knife. The cutting edge should be sharp and the blade must be heavy enough to withstand pounding. Although you can get by with knives of this sort, a regular grafting tool, as shown in Figure 2, is best, especially if you have much grafting to do.

There are many types of grafting tools, the essential parts of which are: (1) a cutting edge, and (2) a chisel-like wedge somewhat blunter than a screw driver.
It is customary to make the cutting edge curved with the assumption that it cuts instead of splits the bark. Actually, the blade must be thinner than is commonly true of grafting tools if you want to avoid splitting the bark.

The wedge of the grafting tool is used to hold the two sides of the cleft or sawed-off stub apart after you split it. You can then insert the scion. The split cleft exerts considerable pressure, so the wedge should be at least 2 inches long and fairly wide. When it is too short it slips out, and when too narrow it buries itself in the wood without opening the crack.

The Hammer or Mallet

You need some kind of a hammer to pound the grafting tool. You can use a regular mallet or hammer, although a club of wood about 2 inches in diameter and a foot long works very well.
The Saw

The shoulder of the stub you leave as you cut off the branch being grafted should be square and without rough and torn edges. To make a smooth cut you need a fine-toothed saw. It should be sharp and with a good set so that when sawing you can give attention to keeping the stub from tearing rather than making the saw work.

The Brush

All you need is a 10-cent paintbrush about 1 or 1½ inches wide. A small brush works fast and uses less wax than a large one. With an inexpensive brush, you don’t feel that you must give it the care a better brush deserves.

The Nails

You need to nail bark graft scions such as used in bridge grafting. For this nailing, you want long, thin nails with flat heads so you can draw the scion up firmly. Finishing nails sink readily into the wood. The nail should be long enough to go into the sapwood of the stock at least $\frac{3}{4}$ inch. For bridge grafting bearing apple trees, you need nails about $\frac{3}{4}$ inch long. Where the bark is thin, as in young trees, shorter ones will do. Twenty-gauge or cigar-box nails are ideal.

Grafting Wax

Do not use unproved materials; some have caused considerable loss.

The grafting wax protects cut surfaces from drying and from rot organisms, but it must not injure plant tissue. To be satisfactory it must stick to the wood without peeling or sloughing off. And the easier it is to put on, the better. There are brush waxes and hand waxes.

Brush Wax

Cold brush waxes, of course, are easy to apply. You apply them cold with a brush. You can buy good commercial grafting compounds.

Hot brush waxes, because they must be heated, are not the easiest to use. When using them, heat only to good brushing consistency. Hot wax kills the bark tissue and leaves a thin coat of wax on the graft.
There are many formulae for making brush wax. Here are some if you don’t already have one you like:

**Number 1.**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin</td>
<td>5 pounds</td>
</tr>
<tr>
<td>Beeswax</td>
<td>1 pound</td>
</tr>
<tr>
<td>Pulverized charcoal</td>
<td>½ pound</td>
</tr>
<tr>
<td>Raw linseed oil</td>
<td>1 gill (¼ pint)</td>
</tr>
</tbody>
</table>

Melt resin and beeswax slowly. Stir in charcoal and oil. Cool so mixture is just thin enough to apply with a brush. When cold, it is hard and you have only to heat to brushing consistency to use after it’s been stored.

**Number 2.**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beeswax</td>
<td>2 pounds</td>
</tr>
<tr>
<td>Resin</td>
<td>4 pounds</td>
</tr>
<tr>
<td>Tallow</td>
<td>1 pound</td>
</tr>
<tr>
<td>or Raw linseed oil</td>
<td>1 pint</td>
</tr>
</tbody>
</table>

Melt beeswax and resin slowly. Stir in oil or tallow. It is ready to use at brushing consistency. It is hard when cold, and to use after storage you need only to heat it to brushing consistency.

**Number 3.**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin</td>
<td>6 pounds 10 ounces</td>
</tr>
<tr>
<td>Tallow</td>
<td>1 pound</td>
</tr>
<tr>
<td>Paraffin wax (low melting point)</td>
<td>1 pound 4 ounces</td>
</tr>
<tr>
<td>Venetian Red powder</td>
<td>1 pound 8 ounces</td>
</tr>
</tbody>
</table>

Melt resin and paraffin slowly. Remove from heat and add tallow. Then stir in Venetian Red powder, warmed beforehand. Heat removes air from the powder. Pour the mixture into cold water. Then pull like taffy candy. Mold into suitable blocks for storage. It is hard when cold. Heat to brushing consistency when ready to use.

**Number 4.**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin</td>
<td>5 parts</td>
</tr>
<tr>
<td>Beeswax</td>
<td>1 part</td>
</tr>
<tr>
<td>Linseed oil</td>
<td>¼ part</td>
</tr>
<tr>
<td>Lampblack or powdered charcoal</td>
<td>½ part</td>
</tr>
</tbody>
</table>

Melt resin slowly. Add beeswax and melt. Add linseed oil. Remove mixture from heat and stir in charcoal or lampblack.
slowly. It is hard when cold and requires heating to use after storage. Many growers have used tree heel successfully.

**Hand Wax**

There is no danger of burning the tissue when you use hand wax, and you can do a good job of protecting your graft with it. Some grafters prefer it to brush wax. Good hand wax is very adhesive and free of visible air bubbles. You develop adhesiveness by pulling it like you pull taffy candy. As with taffy, you must grease your hands when working with the wax. The pulling also takes out air and makes the wax soft and pliable. Good hand wax is hard when cold but not as hard as brush wax. Out of storage it becomes soft and pliable as you work it.

- Beeswax: 2 pounds
- Resin: 4 pounds
- Tallow: 1 pound
- Linseed oil: 1 pint

Melt beeswax and resin together slowly. Remove from heat and stir in tallow or linseed oil. Then with greased hands, pull the mixture like you pull taffy until it is amber-colored, soft, and pliable. Shape into small balls or sticks. Wrap these in oiled paper and store in a cool place. It is ready to use without heating. When you take it out of storage, you need only work it enough to soften it.

**Grafting Tape**

Some grafts require binding. In the whip graft, for example, there is not enough natural pressure of the wood to keep the cambiums together. You can use waxed string that holds its position without tying. For an occasional amateur graft you can use string of almost any sort, but with ordinary string you must use a binding loop or tie not needed with the grafting tape now in general use.

Grafting tape is similar to adhesive tape and comes in strips about ¾ inch wide. The adhesiveness on one side makes the tape hold its position so you can slit the tape, well before it shows any sign of girdling the graft.

11
Budding Strips

The bark of the stock, which holds the bud in place, is so light that wrapping is necessary to be sure of good contact.

Raffia was used at one time, but now rubber Budding strips are most common. Rubber maintains continual pressure and doesn’t usually girdle the stock. If you don’t have Budding strips (available from your nurseryman), you can use almost any kind of string.

WHAT YOU CAN GRAFT

In general, you can graft apple on apple, pear on pear, pear on quince, quince on quince, peach on peach, cherry on cherry, apricot on apricot, etc. But in some cases you can graft one kind of fruit onto a different kind and occasionally there is an advantage in doing so. For example, plums on peach stocks sprout.

Fig. 3. Graft in which the growth rates of the scion and stock are not equal. Delicious (above) was grafted onto Jonathan (below).
less than on plum stocks, and standard pear varieties grafted onto quince stocks produce dwarf trees.

You can graft most apple varieties interchangeably. That is, you can graft Delicious on Winesap, and vice versa. The same is also true of other tree fruit and tree nut varieties.

The different varieties of these crops are compatible enough so that when grafted together they grow into productive trees. But because some varieties grow faster than others, some combinations are not as desirable as others. For example, Delicious grafted onto Jonathan outgrows Jonathan, as shown in Figure 3. But for practical use, it is safe to combine varieties of about the same growth rate.

METHODS OF GRAFTING

There are many different methods of grafting. As a rule, they vary with what you want to accomplish. The name sometimes, but not always, suggests the nature of the graft. The bridge graft, for example, bridges across an injured place on the bark.

The Cleft Graft

The cleft graft is perhaps most common; it is reliable and easy to make. To cut the wedge of the scion, start about 2 inches from the butt end of the whip and make one straight smooth cut in a single sweeping slice, as shown in Figure 4.

Complete the cut so you come to the end of the whip as you reach the pith area, leaving a cut surface about 2 inches long. This surface should be smooth and even, much as it would be if you were to make it with a carpenter's plane.

Now turn the scion over and make a similar cut on the opposite side, leaving one edge of the wedge slightly thicker than the other (Fig. 5).

It is customary to cut the wedge so the bottom bud is on the thick side, as shown in Figure 5 on the right. You need not bring the wedge to a sharp point. In fact, when grafting large branches particularly, a blunt point is better; then the cut surfaces are more nearly parallel with the split surfaces in the stock.

Now, you are ready to shorten the scion. Authorities differ as to how long it should be, but most favor three or four buds;
Fig. 4. When shaping the scion, cut with a straight stroke that leaves a smooth level surface, such as you make with a carpenter's plane.

Fig. 5. Left: wedge of scion for bark grafting. Note that it is straight.
Right: wedge of cleft graft scion. Note that one side is thicker than the other.
others prefer seven or eight. Generally, the longer you leave the scion over three buds, the fewer *takes* you get, but the sooner the graft comes into bearing.

**Getting the Tree Ready**

Plan to graft only small branches; first cut these off just beyond where you expect to make the graft. Leave everything else. The less you prune the easier it is on the tree and the sooner the tree comes into bearing again. Branches 2 inches or less in diameter are ideal. Wounds then heal rapidly before decay can weaken the grafted branches.

The location of the graft is very important. Locate the grafts so they make a well-balanced top. You may first want to look the tree over and make a mental note of the branches to be grafted. Strong, wide-angled branches are better than those with weak angles; those exposed to the sun grow better than those in the shade. And as a rule, grafts on vertical branches grow more vig-

![Fig. 6. Branch of top-worked apple tree.](image)

A.—Before the grafts were pruned. Note the many stock branches. Some trees in this orchard produced 30 boxes the year they were grafted.
B.—After the grafts were pruned. Note the size of the branches that were grafted and that most of the stock branches were pruned off.

orously than those on horizontal branches. To avoid excessive vigor then, you may want to use slanting rather than vertical branches.

To prepare the branch for grafting, select a smooth, knot-free, and straight-grained section. First saw the branch off 10 or 12 inches above the straight-grained section to avoid tearing the bark where you want to put the graft. Then make the final cut in the upper part of this smooth section and make the cut perpendicular to the grain, without tearing or splitting the bark. Then split the stock so the crack extends through the center of the branch, as shown in Figure 7.

Ordinarily it is not necessary to drive the grafting tool more than about 2 inches into the branch. Driving it too far splits the branch farther than needed. Occasionally there are slivers in the crack which you must cut with your knife; otherwise, they interfere with inserting the scion.
If, when sawing off the branch, you do not make a smooth cut all the way across, trim off the rough edge.

With the wedge of the grafting tool, open the crack in the cleft wide enough to insert the scion without much force. Insert the scion so the thick side of the wedge is toward the outside, and its cambium is in contact with the cambium of the stock. Then the pressure of stock against scion takes place where their cambiums touch, as shown in Figure 8.

The more contact you get, the better; but it is better to be sure of getting some than to try to get more and fail completely. If you were to set the scion straight and place it so the cambiums were absolutely parallel, you would obtain the maximum contact but you might miss entirely. So it is better to slant the scion slightly, as shown in Figure 9.

Where the cambiums cross is important. They must cross where the stock is tight against the scion, and generally it is better for this contact to be near the top of the wedge. Be sure to push the scion down into the crack far enough so no cut surface is exposed (see Fig. 9). It is customary and advisable to insert two scions in each cleft.
Wax the graft so all cut surfaces are covered (see Fig. 10). Some grafters like to put a tape band around the graft at the cut surface as an extra precaution.

While waxing the graft, pay special attention to the cracks, both on top and on each side, as shown in Figure 10. Coat the side of the stub for about \( \frac{1}{2} \) inch below the shoulder to be sure that the stub is well covered. As you finish, coat the tip of the scion. It is well to check the wax after a week. Sometimes it fails to adhere correctly and the union dries out.

**Grafting Grapes**

If it is necessary to change grape varieties after the plants are established, you can do so by grafting. There are many methods of grafting grapes but the ordinary cleft method is about as satisfactory as any, especially for established plants an inch or more in diameter at the soil line.

With grapes you place the graft about an inch beneath the soil line. This means you must first remove several inches of soil from around the plant and then cut the plant off an inch below the soil line.
Select 1-year-old scion wood of good average vigor and of medium size. Collect it during the dormant season and keep it fresh and dormant until you use it, just as you do when grafting apple trees.

In preparing the scion, cut the wedge so the bottom bud, when the scion is in place, is level with the top of the stub. Cut the scion to two buds instead of three or more.

Split the stock with a grafting tool and insert two scions in each stub, using the usual care in getting contact between the cambiums of the scion and stock. It is not necessary to wax the graft. Nor is it necessary to wrap it except in the case of small stocks where the pressure is not strong enough to maintain contact. After inserting the scions, mound soil up over the graft, leaving the top bud exposed. The soil keeps the graft moist.

When the shoots are 6 to 8 inches long, tie them to protect them from the wind. If both grafts on the stub grow, cut off one the following spring when the plants are dormant.

The best time for grafting grapes is as the buds begin to swell in the spring. This timing is important. If you graft too early, the scion may dry out before the sap begins to flow.

The Stub Graft

The stub graft is somewhat like the cleft graft. You insert a two-sided wedge into an opening extending through the bark and into the wood, as shown in Figure 11. But with the stub graft you use stock branches up to about an inch in diameter. One advantage of this graft is that you can make it faster than you can make the cleft graft.

For the stub graft, prepare the opening in the stock by making a slanting cut at the base of the branch you are grafting. Extend the cut about half way through the stock. To make the cut, you need a strong, sharp knife.

The scion is essentially the same as the cleft graft scion. But you may want to make the wedge a little shorter because the stock is smaller.

To insert the scion, first spring open the crack by bending the branch in the direction away from the crack. With the crack open, insert the scion, thick side out, until no cut surface on the wedge is exposed.
Then let the branch spring back to its natural position and clip it off, leaving a stub of about an inch. The spring holds the scion in place, so no tacking or binding is necessary. Then wax the graft carefully so all cut surfaces of both scion and stock are covered.

**Veneer Grafts**

There are several types of bark grafts. You make contact by slipping a one-sided wedge beneath the bark (see Fig. 4). Do not cut into or disturb the wood of the stock as you do with the cleft and stub grafts. The union takes place by growing over the more or less flat surface to which the scion is tacked. This union is not as strong as that of a cleft graft in which the new tissue grows around and over a stub. For this reason, bark grafts are used mainly for bridge and inarch grafting.
The Bridge Graft

Select a smooth and accessible place for the graft. Rough surfaces and those hard to get at are not good, but sometimes there are no others. It is not necessary to trim the margins of the injured section when bridge grafting mice-girdled trees. Trimming takes time and usually exposes more cut surface.

To prepare your scion, first select a whip that you are sure is long enough. Fit it, right end up, in the exact position in which you later expect to nail it. While the whip is still in place, mark where you want to cut it off at the top and bottom. Then with the whip still in place, use it as a guide to cut strips of bark under which you slip the ends of the scion, as shown in Figure 12. Cut only through the bark and extend the cut to within about an inch of the end of the scion.

You then have at top and bottom a strip of bark as wide as your scion is thick. When you are ready to insert the scion, you slip each end of it under this strip of bark, as shown in Figure 12. You have only to lift the end of the strip and slide the scion into place.

To shape the scion, make a one-sided wedge with one straight smooth cut, starting about 2 inches from the butt of the whip and finishing on the opposite side of the whip near the butt end (see Fig. 4). Here again the wedge should have the smoothness and straightness of a planed surface.

After cutting one side, you may want to turn the whip over and clip off the tip bark. You then have a better point for slipping the wedge under the bark. Then shape the other end of the scion in the same way. But before you cut it, fit the scion into the exact place where it is to be nailed so that when the top wedge is cut, the scion fits snugly into place without having to be twisted.

Insert and tack the lower end of the scion (see Fig. 12); it is harder to insert, so it is good to have the top end free as you

Fig. 12. Inserting the lower end of a bridge graft scion. Note the strip of bark cut to the width of the scion.
work. Lift the end of the bark strip enough to start the tip of the wedge, but don't peel the bark all the way back. The wedge loosens it as you slide the scion into place. In this way, you keep the wood on which you must make contact clean and fresh. Insert the scion far enough so all cut surface of the one-sided wedge is in firm contact with freshly uncovered wood.

Then tack with two nails, first toward the tip of the scion, and through the bark as well as the scion. Then cut off the loose end of the bark and drive the second nail through the scion about an inch above the first nail. As soon as you have the bottom end of the scion tacked in place, insert the top end in like fashion. In young trees where the trunk is apt to bend considerably, it is well to set the scion with some bow to allow for bending.

It is rather difficult to get wax between the scion and stock, especially toward the end of the scion. So when waxing, pay special attention to this area. You need not cover the middle section of the scion, but covering the injured section of the stock protects it from weathering.

Spacing Bridge Grafts. Place the bridge grafts 3 inches or less apart (see Fig. 15). They restore the passage of food and cover the sapwood from which the bark has been destroyed. The passage of food must be restored as soon as possible if it is not to be damaged.
injury to the tree is to be held to a minimum. And the sooner the grafts cover the sapwood, the better. Eventually the grafts grow together and completely restore a smooth trunk surface (see Fig. 16).

When bridge grafting mice-girdled trees, you often see narrow strips of bark which the mice missed. Even though these are sometimes very small, they are very valuable. They are more effective than bridges and cut down the number of grafts that might first appear necessary on a girdled tree.

**The Inarch Graft**

You can repair root injury by using what is called the inarch graft (see Fig. 17). To make this graft you simply set young trees around the trunk of the injured tree and graft their tops into the trunk. You
may also use sprouts, and the sooner you do the grafting after the injury occurs, the better. Vary the number of trees with the severity of the injury. For a badly injured mature tree you may want to use as many as five or six.

The young trees, of course, must be healthy and it is customary to use 1-year-old trees. When setting the trees, slant them so their tops lie against the trunk on which they are to be grafted. Then keep branches from developing on the young trees by pinching off the new sprouts as they appear.

**The Whip, Tongue, or Bench Graft**

Nurserymen at one time propagated most apple and pear trees by the whip graft, but they now bud most of them. Besides propagating nursery trees you can whip graft small branches when top-working bearing trees.

When whip grafting, you use 1-year-old scion wood, preferably the same size as the stock. When the stock is larger, you get contact on one side only. Whether you get contact on one or both sides, the graft is so small it heals rapidly.

To prepare the stock, first select one that is smooth and of straight grain. Avoid side branches in the area where the graft is to be made; in the case of root grafts you may have to trim off side roots.

How you cut the stock is important. It should match the scion, and how well it matches depends upon how you cut it. Starting about 2 inches from the butt of the whip, make a smooth straight cut about 1 ½ inches long (see Fig. 18). With practice and with a
Fig. 19. A.—Starting one-third the distance from the tip of the wedge, cut parallel with the grain for about one-third the distance of the wedge. Note the wedge is supported by the pointing finger.

B.—Fitting scion and stock of unequal size together.
Fig. 20. Whip graft wrapped with grafting tape.

sharp knife you can make this cut with one good sweeping movement. It should not be necessary to do any extra whittling to make it even.

You are now ready to make the final cut. In your left hand hold the one-sided wedge up with the cut surface facing you (see Fig. 19A). Support the wedge with the pointing finger of the left hand and make a downward cut about \( \frac{1}{2} \) inch long, starting about one-third of the way down from the tip of the cut you have already made. This cut is more or less parallel with the grain of the wood and virtually splits the scion in this area. But it may actually slant toward the heel slightly, rather than be parallel with the grain.

With scion and stock cut, fit them together as shown in Figure 19B. Push them together far enough so the cut surfaces match. The toe of the scion then just comes to the heel of the stock. If the scion and stock are not of the same size, match one side only.

This graft must be wrapped to maintain contact (see Fig. 20). You can use string of almost any kind, but waxed string and grafting tape are better than just string. When using string,
you must use a binding loop at the beginning and at the end of the wrap to keep the string from unwinding. This loop is not necessary when you use grafting tape. When wrapping, see that the scion does not move out of position, and wrap so the tips of both wedges are bound tightly against matching cut surfaces. No waxing is necessary, but the string must be cut sometime to prevent girdling. The grafting tape may be cut soon but the string must remain until the union is made.

**Budding**

Each budder has his own technique for cutting the buds off the *budding stick* (see Figs. 21 and 22). You can cut slightly into the wood and take a sliver of wood with the bud. This practice is commonly used by commercial fruit tree budders. You then have what is sometimes called a *bark* bud. Or you can cut deeper into the wood (see Fig. 23) and peel the wood out of the bud (see Fig. 25). This latter method is somewhat slower, but possibly surer than the other, especially for amateur budders. It is also used in budding roses and some other ornamentals.

To cut the bud, be sure your knife is very sharp. Start about \( \frac{1}{2} \) inch below the bud (see Fig. 22) and make a smooth slicing
cut upward to about $\frac{1}{2}$ inch above it (see Fig. 23). To cut the bark bud, cut into the wood about twice the thickness of the bark and hold this depth until you reach the end of the cut (see Fig. 23). Then remove the knife and make a cross-cut about $\frac{1}{2}$ inch above the bud (see Fig. 24), going only through the bark.

To remove the bud, just lift it off, leaving the sliver of wood with the bud stick (see Fig. 25).

To cut the bud from the stick, the commercial fruit-tree budder frees the bud in one stroke. No cross cut at the top is necessary for this method. As you finish the stroke, hold the bud by pressing the thumb against the knife blade. Then with the bud in this position, start the bud in the previously made opening of the stock (see Fig. 27). Always make the cut sur-
face of the bud shield straight, from one end to the other. You then get good contact all the way as you slip the bud into place. But if there is a big bulge in the middle of the shield, good contact is unlikely. Rocking chair buds, as those with a large bulge are commonly called, are very objectionable.

Nursery stock to be budded must first be prepared. In early summer, strip off the lateral shoots on the lower 6 inches of the trunk. When you get ready to bud you then have a smooth surface in which to work.

When budding older trees, you must first develop some good new growth on which to bud. You can force it by heavy pruning or dehorning. But your trees usually produce plenty of good wood without heavy pruning.

To make the opening in which you set the bud, first select a smooth place. On nursery trees this usually is 2 or 3 inches above the ground line. In this smooth area make a vertical cut parallel with the grain of the wood, as shown in Figure 26. Start it about \( \frac{3}{4} \) inch below the place where you want to set the bud, and draw the knife upward for about \( 1\frac{1}{2} \) inches. This and the next cut need extend only through the bark. You are now ready to make the next

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Fig. 26. Making the vertical cut on the stock. Note that where the cut is being made, the trunk surface is smooth.
or cross-cut which forms a T with the vertical cut (see Fig. 27).

To make the cross-cut, start to the left of the vertical cut, but level with the top, as shown in Figure 27. Holding the knife blade at an acute angle with the trunk opens the bark as the cutting edge passes the vertical cut. This opening makes it easy to start the bud when inserting it.

To insert the bud, place the tip of the bud shield into the opening at the top of the T cut. With the opening properly made, you have no difficulty in starting the bud. Slide it down so the top of the shield is even with or beyond the cross-cut (see Fig. 28).

When the bud is in place, as shown in Figure 28, you are ready to wrap it. Rubber budding strips are commonly used, although you can use raffia or string of almost any sort. To make the wrap, start with a self-binding loop slightly below the bottom end of the vertical cut (see Fig. 29).

Continue wrapping to slightly above the cross-cut and use a self-binding loop at the top to keep the string from unwinding (see Fig. 30).
Fig. 28. Bud slid into place. Note that top of the bud shield is slightly below top of the T.

Fig. 29. Starting to wrap the bud with budding tape. Note that you start below the bud and make a self-binding loop that takes the place of a knot.
Fig. 30. Finishing the bud wrap. Note that the wrap extends to the top of the T and that you make a self-binding loop at the end of the wrap.

CARE OF THE GRAFT

Making the graft properly doesn’t finish the job. You must give the graft some attention as it grows. You need to train grafts on top-worked trees. Also keep them from bearing too heavily, and protect young grafts from wind.

The Bridge Graft

All that is necessary is to keep the graft from producing shoots. As buds on the scions swell, rub them off and force the food to pass through the scion. The scion then increases in diameter very rapidly for its entire length. Otherwise the bottom grows much faster than the top. In fact, numerous branches on the scion may virtually dwarf out the top union.
The Cleft Graft

You want new tissue to completely cover the wound as soon as possible (Fig. 31D), and you want the graft to start bearing as soon as possible. Light pruning, rather than heavy pruning, favors both.

Fig. 31. Apple grafts.
Top left, top right, and lower left are 1-year grafts. Lower right is 4 years from grafting. All grafts were on branches about 2 inches in diameter. Upper left and upper right are the same branch; Top left—before pruning. Top right—after pruning. Note that the top branch has been selected as the permanent branch; the lower one has been pruned enough to keep it from interfering with the upper one.
Lower left—Note that the wound is already partially covered at the end of the first growing season.
Lower right—At 4 years, the scion has completely covered the wound.
As a rule, it is neither necessary nor advisable to prune the graft during the summer. Only on very vigorous and fast-growing shoots resulting from grafting big branches should you consider even pinching out the tips of these shoots when they are about 18 inches long. This pinching gives some protection from wind. You can also protect them by nailing a 1 x 2 strip on the stub so it extends in the direction of the grafts.

As pointed out earlier, it is customary to set two scions per stub. One is enough on stubs up to an inch in diameter, and you may need more than two on those over about 3 inches in diameter. As these grow together on the stub, thinning out the surplus, maintaining all of them until the wound is covered, gives earlier protection.

In the spring while the tree is still dormant, select the branch that promises to make the best renewal of the branch being replaced by the graft. Generally the upper one is better than the lower (see Fig. 31 A and B). Remove weak crotches from it and do any other structural pruning that may be necessary. Prune the other branch as much as necessary to keep it from interfering with the chosen one (see Fig. 31B).

You must also remove stock branches—that is, those of the variety you are replacing by the grafts. When grafting only small wood, you can remove virtually all of these during the first dormant pruning after grafting. Otherwise, it may require 2 or 3 years to get rid of them. It is well to check the wax as you prune. It may be necessary to re-cover some exposed areas, particularly in the cracks.

The Bud Graft

The bud starts getting nourishment from the stock soon after you set the bud. In 10 days or 2 weeks it looks like any other good, healthy bud; examine it then. If it has not taken, you may be able to set another bud.

Non-elastic bands must be cut before they girdle the stock. Adhesive bands can be cut almost immediately after setting the bud, but raffia string and material of that sort should remain for a week or so.

In the spring as soon as the buds start swelling, cut off the stock just at the cross of the T cut, except in the coastal region. Here it is best to make an initial cut 4 inches above the T and the final cut 4 or 6 weeks later. The scion then soon grows over this stub. While the bud is starting, numerous other buds usually arise below it. Remove these as they appear. Generally, it is not advisable to prune the new branch during the summer.