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# University of Arizona

College of Agriculture  
Agricultural Extension Service

## TOP-WORKING FRUIT AND NUT TREES

BY THE

## BIEDERMAN BARK GRAFT METHOD

By A. F. KINNISON

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### INTRODUCTION

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Many fruit growers, after developing an orchard to the bearing age, discover they have used unsatisfactory varieties or find a few trees which do not fulfil their expectations as to type or the amount of fruit produced. Instead of replacing these trees with new ones of a more suitable variety or strain, the grower may save considerable time by top-working them to the desired kind.

In other cases seedling trees are found which are producing a very poor quality of fruit. These may have developed from the planting of fruit and nut seeds or may be native species as in the case of the Arizona black walnut, *Juglans major*. These may be top-worked to desirable varieties and brought into profitable production.

Many methods of grafting have been developed and are in use, it has been said that there are as many ways to graft trees as there are to whittle. However, the particular method of grafting here-in described comes more nearly to meeting all the requirements and conditions encountered in the top-working of fruit and nut trees than any other one method known to the author.

### HISTORY OF THE METHOD

The Biederman bark graft was developed by Mr C R Biederman of Hereford, Arizona while experimenting with the top-working of the Arizona black walnut to varieties of the Persian walnut. Formerly Mr. Biederman was engaged in the production of walnuts in Oregon for commercial purposes and was familiar with the propagation of walnut trees. He found, however, that the usual methods were unsatisfactory for top-working the native walnut, and his experiments led to the development of the improved bark graft which now bears his name. He has been using the method with complete success for years, and now has nearly a thousand native walnut trees on his place grafted to the finer varieties of Persian walnuts.

The Arizona Agricultural Experiment Station published in 1915, Bulletin 76, "Walnut Growing in Arizona". This bulletin contains a careful description of Mr Biederman's method of grafting walnuts.

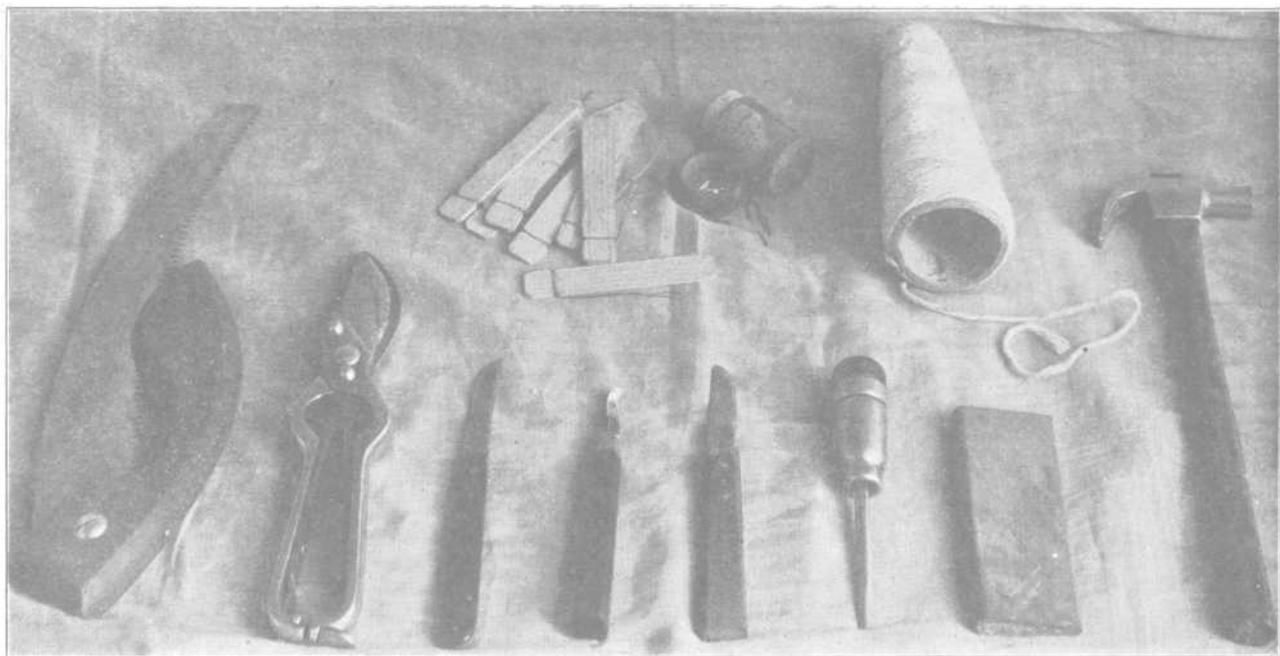


Fig. 1.—Necessary equipment for the Biederman bark graft.

The Horticultural Section of the College of Agriculture has used this method successfully since 1920 for grafting walnuts, pecans, apples, pears, stone fruits, citrus fruits, olives, and figs.



Fig. 2.—The Biederman paraffin melting-pot.

### SEASON FOR GRAFTING

Since this method of grafting involves the insertion of a cion between the bark and the wood of the stock, it follows that the grafting must be done at a time when the bark loosens readily. The writer has found the best season to be within 2 or 3 weeks after the appearance of the first leaves on the tree. For evergreen trees, such as citrus trees and olives, the corresponding period would be shortly after the first new growth appears in the early spring. Sap movement at this time is not so strong as to induce bleeding and yet is sufficient to insure the bark's slipping easily and a quick union.

The work may be extended well into the season provided dormant cion wood is obtainable. However, the month of June is generally to be avoided for grafting in the lower valleys of Arizona due to the extreme high temperatures and low humidity at that time. It may be undertaken again successfully after the rainy season begins in early July and continued well into August. For this later work it will be necessary to secure cion wood carrying reserve buds or wood of the current season's growth, as it is difficult to keep winter-cut wood dormant so late, even in cold storage.

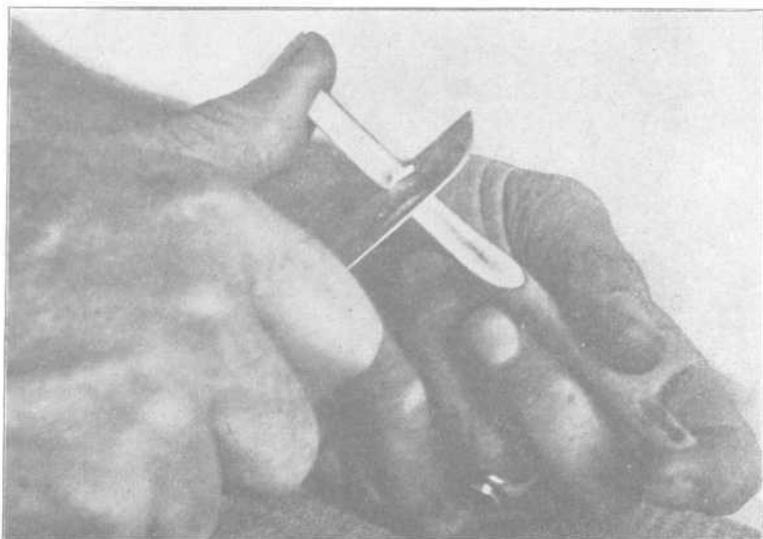


Fig. 3.—Making the scarf; the first step in the preparation of the cion.

### PRINCIPLES INVOLVED

Before discussing the details of this method of grafting it may be well to state briefly some of the principles involved in any grafting or budding operation:

Grafting can be done only between plants which are somewhat closely related botanically, such as different varieties of a species or different species of a genus, but as a horticultural practice, seldom between plants more distantly related than this.

The growing part of a stem or branch of a tree consists of a few layers of cells called the cambium layer located between the bark and the wood. Practically speaking, when the bark is peeled away from the

wood of a stem, the cambium layer is divided or split, exposing growing cells on the surfaces of both the bark and the wood. It is obvious then that when we want to cause a branch or bud of one tree to grow on the roots, trunk, or branches of another, it is necessary to bring these growing cells or cambium layers into close contact with one another. The bringing into contact of relatively small areas of the cambiums of two plants will result in satisfactory unions under favorable conditions. However, where low humidity and high temperatures prevail, the greater the area of cambiums that can be brought into contact, the better will be the results.



Fig. 4.—Hollowing the surface of the scarf, the second step in the preparation of the cion.

In order to prevent loss of moisture and the consequent death of the united cambiums, grafts are protected from the air, usually with some sort of wax.

#### CION WOOD

Cion wood should be secured from trees whose bearing characteristics are known. It is desirable to see the tree in fruit one or more seasons before securing wood from it for top-working purposes. Such characteristics as high productivity, fine quality of fruit, and freedom from disease and physiological defects are to be desired. If cions of

the particular variety desired are not procurable in a given locality, they may be secured from a reliable nurseryman.

Cion wood 1 to 3 years of age is used and is generally cut during the dormant season and stored until needed. It is essential that the cions carry dormant buds when the grafting is done. Where there is no danger of winter injury to wood desired for cion wood, it may be left on the tree until within a few weeks of the swelling of the buds. When cut it may be kept in good condition if packed in slightly moist sphagnum moss or sawdust in a cool cellar or buried in moist sand or



Fig. 5.—Shaving the bark off the back opposite the scarf; the third step in the preparation of the cion.

soil a foot or more in depth in a shaded location. When it is desired for work later than a few weeks after the trees to be grafted come into leaf, it should be placed in cold storage as soon as cut and held at approximately 40 degrees F.

Sometimes it is desired to graft after the supply of stored cion wood has been exhausted or become unfit for use, and after the trees from which it was secured are in leaf.

For this work, wood of two sorts may be cut directly from the tree and used immediately. The first is found at the base of 1 to 3-year-old

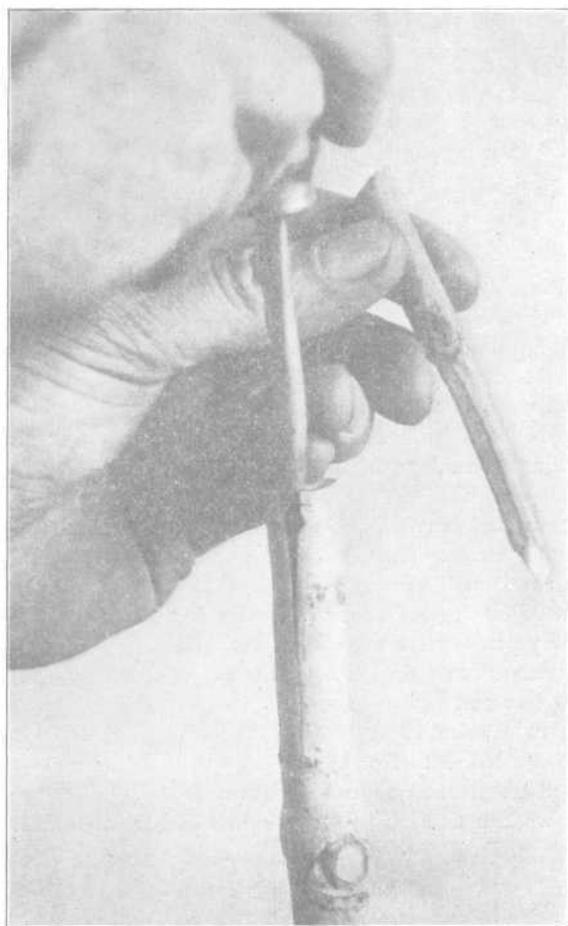


Fig. 6.—Use of the bark opener preparatory to the insertion of the cion.

branches and carries reserve buds. These buds have failed to come into leaf because of the greater demand for sap at the growing tip of the branch. Often from one to three cions may be obtained from the base of a given branch.

The second sort consists of practically mature wood from the base of shoots of the current year's growth. The leaves should be removed from that portion of the branch to be used a week or 10 days before

it is needed. This results in the development of the axillary buds. When the stubs of the leaf petioles have dried and fallen off, it is considered safe to use the wood for grafting.

Since the practice of covering the entire surface of the cion with a coating of paraffin has been developed, mid-summer grafting, using either of the types of cion wood described above, should result in success for the careful workman.

#### EQUIPMENT NECESSARY

- 1 good pruning saw set for green wood.
- 1 large knife or draw knife for removing the old bark of the stub.
- 1 pair of pruning shears, preferably double-bladed.
- 1 straight-edged grafting knife with blade comparatively narrow and thin and made of the best of steel.
- 1 curved-bladed knife for hollowing the face of the scarf.
- 1 budding knife kept slightly dull for making an incision on the stock.
- 1 gouge or bark opener made of steel or hard wood.
- 1 paraffin melter, similar to the one illustrated, with 4-ounce alcohol lamp and small varnish brush.
- Paraffin of 60 degrees C. melting-point for the lower valleys of the State; ordinary parawax for the cooler portions.
- Small wire nails ranging in length from  $\frac{3}{8}$ -inch to  $\frac{3}{4}$ -inch.
- 1 small hammer.
- Cotton twine, size 12 or 16.
- Paper bags, No. 3 to No. 12.
- 1 curved-edged fine carborundum stone.
- 4-inch wooden tree labels, copper-wired and white-leaded.

#### SIZE OF STOCK

Trees should be top-worked just as soon as it is fully determined that they are unsatisfactory. While they may be worked over after reaching maturity, it is a simpler task if they are worked comparatively young, and years of unprofitable production are avoided.

In general, it is not advisable to work branches over 5 or 6 inches in diameter. Stocks larger than this make large wounds when cut, which require years for healing.

Trees having trunks under 5 or 6 inches in diameter may be worked by trunk grafting at the height it is desired the new branches to form. This is the usual procedure with walnut and pecan trees, and a desirable height for these is from 4 to 5 feet from the ground.



Fig. 7.—Waxing the grafts.

With lower headed and more spreading types of trees, three or four well selected side branches may be grafted.

For larger trees, it is necessary to go into the primary and secondary scaffolds to find branches small enough to graft. These should be in sufficient number and carefully selected so as to insure the new growth's forming a symmetrical top.

This practice may vary in the case of old native walnut trees which are prone to sprout from the trunk when cut down. These may be sawed close to the ground and the new sprouts thinned to two or three, one of which may be grafted in 1 or 2 years.

### PREPARATION OF STOCK

On medium sized and large stocks, it is a good plan to leave a few side branches as nurse limbs to utilize the excess sap supplied by the roots and to elaborate food for the plant during the period when its top is so greatly reduced. Where possible, these should be in a position to shade the grafts at least a part of the day.

Some advantage will result from the removal of scaffold branches not to be worked (excepting one or two wanted for nurse limbs) and even the stubbing of some which are to be grafted a few days to a few weeks before the grafting is to be done. This is for the purpose of concentrating the sap flow into those branches to be grafted.

It has been noticed that the sap flow in the stub of a branch is practically at a standstill for a period of a few days to a few weeks

following the removal of the branch. This condition is very marked in the case of citrus trees but much less so with the walnut or pecan.

It is evident that cions placed on the stub during this period of comparative inactivity will unite very slowly. However, if grafting is delayed until new shoots are forced out on the stubbed branch, indicating increased sap activity, cions will be found to unite more quickly. It is, of course, necessary to make a fresh cut on the stub for grafting.



Fig. 8.—Completed grafts, wrapped and waxed, showing different number of cions used on different sized stubs.

A straight place free of knots is selected on the trunk or branch to be grafted, and the cut made at right angles to the branch. To prevent a branch's splitting down from its weight while sawing, saw about one-third through the stock on the side the branch will fall, then saw from the opposite side and slightly below until the branch snaps off. Complete the lower cut in order to have an even surface.

The ragged surface of the stock is next smoothed with a sharp knife to facilitate the adherence of the wax. This is applied immediately to prevent the wood's checking by excess evaporation.

The heavy, corky, outer bark found particularly on older nut trees is removed from the upper 3 inches of the stub with a heavy knife or draw knife. The exposure of any considerable area of live bark should be avoided, however.

Occasionally a tree is found which bleeds badly when cut. The excess sap pressure may be relieved in a few hours by boring several holes with a  $\frac{1}{2}$ -inch bit just into the sapwood near the base of the tree. When the work is continued, a short section of the top of the stub should be sawed off to provide a fresh place to work.



Fig. 9.—A paper bag is inverted over the stub and tied securely to shade the grafts.

## WAX

Paraffin has replaced resin and beeswax grafting waxes to a considerable extent in top-working fruit and nut trees. It requires no preparation for use other than melting, hardens immediately, is cheap and easily obtained, and is suitable for covering the entire cion as well as all exposed surfaces of the stub.

In the cooler parts of the State, the ordinary form known as "parawax" used by housewives for sealing jellies and jams is suitable. However, in lower valleys where summer temperatures are high, paraffin of at least 60 degrees C. melting point is necessary.

## PREPARATION OF THE CION

A cion carrying two to three buds is ordinarily used. Where the wood is scarce, one bud will suffice if in good condition. The cion may be cut from the cion stick, either before or after shaping, as suits the convenience of the operator. The cut on the upper end should be within  $\frac{1}{4}$ -inch of a bud. Two to three inches of the lower portion of the cion are used for the scarf or cut even though this necessitates the wasting of one or two buds.

Beginning at a point opposite and slightly below the lower bud to be retained, a cut, or scarf as it is called, is made with a rather abruptly sloping shoulder at its beginning. (Fig. 3) It may taper slightly from the shoulder but flatten over the lower half of its length, leaving the wood about  $\frac{1}{8}$ -inch in thickness at the tip.

A grafting knife with a straight, rather narrow blade is most suitable for this operation and must be kept sharpened to a razor edge, if a true, smooth cut is to be secured.

With a curved-bladed knife especially designed for the purpose, the wood surface of the scarf is slightly hollowed. (Fig. 4) In doing this the wood is cut away from the bark at each side of the scarf for a distance of about  $\frac{1}{16}$ -inch to expose a greater area of cambium. The hollowed surface of the scarf should have a slightly sharper curve than that of the stock to which the cion is fitted to insure complete contact of the cambiums.



Fig. 10.—Growth of citrus grafts, six weeks after their insertion.

The next step is to shave off the outer bark down each side of the back of the cion, opposite the scarf. (Fig. 5) This exposes the chlorophyll cells and even the outer cells of the cambium layer, thus providing more cambium surface for union. The strip of bark left down the middle of the back of the cion will fit under the vertical incision in the bark of the stock.

The final step is beveling the tip of the cion on the back and cutting off each corner slightly to facilitate its slipping into place between the bark and the wood of the stock.

### INSERTING THE CION

A vertical incision is made just through the bark from the top of the stock the approximate length of the scarf of the cion to be inserted. The bark is loosened slightly with the point of a knife in the top of the incision.

Next, a steel or hardwood bark opener is slipped between the bark and the wood at the top of the incision. (Fig. 6) If the bark loosens readily, it need be inserted only  $\frac{1}{2}$  to 1 inch, and by pushing it slightly away from the stub, the tip of the cion may be slipped in behind and

easily pushed into place. If the bark adheres to the wood, it should be loosened the full length of the incision with the gouge.

The bark is now tacked snugly at each side of the cion at the top of the incision, closing the small openings caused by the insertion of the cion. Small wire nails or brads  $\frac{3}{8}$  to  $\frac{3}{4}$ -inch in length are used for this.

#### WAXING

Apply melted paraffin to all exposed surfaces, using a small varnish brush. (Fig. 7.) It is desirable to fill with paraffin the vertical incision which has been forced slightly open by the entrance of the cion. It is important also, to cover the top of the stub with a thick coat of paraffin to insure a perfect seal about each cion. In addition the cion, including the buds, is completely covered. (Fig. 8)

This last precaution prevents evaporation from the cion and has a tendency to retard its development until a union may be effected with the stock. It also permits the use of cion wood carrying buds considerably swollen or even beginning to open and the use of herbaceous cion wood of the current season's growth in mid-summer.

The paraffin should be kept in a complete liquid state but not sufficiently hot to burn when brushed on the back of the hand.

#### NUMBER OF CIONS PER STUB

The larger the stub to be grafted, the more cions will be required. In general only one is used for stubs under 1 inch in diameter. For



Fig. 11.—A grafted pecan seedling, six weeks after the insertion of the cion, the growth supported by a substantial stake.

1-inch to 1½-inch stubs, it is desirable to use two cions; for 1½-inch



Fig. 12.—The first season's growth of the grafts on a trunk grafted pecan seedling about 5 inches in diameter at the point of working. The new growth is supported by the long poles tied to the trunk and extending into the top.

to 2-inch, three; for 2 to 3-inch, three to five; from 3 to 4-inch, five to seven; and for stubs 4 to 6 inches in diameter, eight to ten cions may be used to advantage. The greater number for the larger stubs is desirable to help heal over the larger wound. Those not needed for scaffold branches may be removed later, before crowding.

Each cion is inserted as soon as prepared to prevent injury to the exposed cambium cells by excessive evaporation, then tacked and waxed before another cion is shaped and placed.

### TYING

After all the cions are placed and waxed, they are bound firmly in place with 12 or 16-strand, soft, cotton twine. (Fig. 8) The estimated length of string required for the wrap is first cut. Then, beginning with

the middle of the string, the first wrap is made so as to catch the tips of the cions. The wraps are then continued upward, spaced about ½ to ¾-inch apart until the top of the stub is reached. Each time the hands are crossed in the operation, the string is drawn taut and the tension retained until a hard knot may be tied. For small stubs or those with thin bark, the wraps should be just tight enough to insure the cion's being drawn snugly against the stock the full length of the scarf. Large stubs with heavy bark, however, will require a tighter wrap.

It is advisable to go over all the waxed surfaces with melted paraffin again at this time to insure a perfect seal.

### SHADING

It is advisable to shade the grafts until new shoots are well started, particularly in the lower valleys or where the work is continued well into the summer. Paper bags, from No. 3 to No. 12 sizes are used for this and are inverted and tied over the stubs. (Fig. 9)

Ventilation is secured by cutting a hole several square inches in extent in the north side of the bag.

### LABELING

The name of the variety used and the date of grafting should be written on a wooden label previously dipped in white lead paint and attached to the tree by means of a copper wire. It may be fastened to a small side branch or to a nail driven into the stub. If an ordinary

lead pencil is used, the record will remain legible for 2 years or more. It is advisable, however, to replace the wooden label at the end of the first year with one of aluminum if a permanent tree record is desired.

Where all or the larger part of the top of a tree is cut away for grafting, the exposed trunk and larger branches on many stocks are often injured by sunburn. This may be prevented by the use of a heavy application of whitewash immediately after grafting, renewed as needed until the top is replaced sufficiently to shade the trunk.



Fig. 13.—Growth of a top-grafted pecan seedling 14 months after the insertion of the cions. About half of the cions originally placed were removed the first winter.

## AFTER CARE OF CIONS

Soon after shoot growth has started from the cions, it will be noticed that the string is cutting slightly into the bark due to the increase in the circumference of the stock after the cions have united.



Fig. 14.—The cion growth of the Persian walnut grafted on the Arizona black walnut, given a coating of wax for winter protection the first winter after grafting.

The string should be cut at this time to prevent the strangulation of the cions. A single cut severing each wrap is sufficient.

The cions are as yet insecurely united, so in order to hold them firmly to the stub until a stronger union is effected, each cion is tacked to the stub near the top of the union with a  $\frac{3}{4}$ -inch nail.

Rewaxing may be necessary at this time also as cracks may have developed in the paraffin.

The paper bags should be removed when the new shoots have developed so as to require more space. Further shading is usually unnecessary except when temperatures are extremely high at this period, in which case a larger bag may be used or a shade of burlap constructed.

It is very important that the new growth be given some support after it has reached a foot or so in length to prevent its being blown out by heavy winds and to insure an upright growth. (Fig. 11) Substantial strips or cleats may be nailed directly to the stub and allowed to extend 3 or 4 feet above it to which the new shoots may be tied. Raffia or soft cloth is best for this purpose, and the tie should be loose to allow for the growth of the branch.

For large stubs, three or four strips may be nailed at a slight angle to the stub which will form a vase about the shoots. Strings running around these strips spaced 6 to 8 inches apart will serve to confine the growth.

Usually vigorous water sprout growth will appear on the stock before the cions start growth. On large stocks of considerable vigor two or three of these may be allowed to develop to utilize the surplus sap of the stock until the grafts are able to take care of it. Where the grafts are inclined to make too vigorous growth, these watersprouts may be retained through the first growing season. All growth on small stock should be removed as soon as it develops.



Fig. 15.—The Biederman bark graft used as a side graft on a citrus tree.

Nurse limbs left on stocks at the time of grafting may be removed throughout the growing season as the cion growth develops. Where the cion growth is developing with sufficient vigor, however, the nurse limbs may be left until the following winter.

Extremely vigorous shoots may be headed during the growing season to start the development of secondary branches. In the case of nut trees, however, it is usually customary to allow these to grow unchecked through the first growing season and to head them to the desired height the following winter. At this time also, the shoots may be thinned to the actual number desired for the formation of the permanent top.

On small stubs, even though two or more cions have united and made a good growth, it is desirable to retain but one. The shoulder of the stub opposite the cion retained is cut sloping to facilitate its healing over more quickly.

It is a good plan wherever possible to reduce the amount of irrigation water supplied to grafted trees during the late summer and early fall months of their first growing season. This will allow the grafts to mature earlier, thereby reducing their susceptibility to winter injury.

Where this plan is followed, however, a heavy irrigation should be given in the early winter soon after the trees are fully dormant.



Fig. 16.—An Arizona black walnut top-worked to an early bearing Persian variety, bearing six nuts one year after grafting. C. R. Biederman's place, Carr Canyon.

Even where the foregoing precautions have been taken, citrus and walnut grafts in many localities will need some protection the first winter. The former may be wrapped with sorghum stalks or even paper and burlap, leaving the tips slightly exposed. The latter may be adequately protected by applying a coating of melted wax composed of two parts of paraffin and one part vaseline, to the entire new growth after the leaves have fallen.

#### THE BIEDERMAN GRAFT USED AS A SIDE GRAFT

Cions prepared by the Biederman method are well suited for use in the side of branches where it is not desired to saw off the branch to a stub at grafting time. (Fig. 15) This type of grafting may be used to advantage in top-working the south and west branches of old citrus trees which are needed to supply shade to grafted branches on other parts of the tree, and where buds often fail. A "T" cut similarly to that made for budding is used, with the vertical cut the approximate length of the scarf of the cion to be used. Beginning at a point three-quarters of an inch above the horizontal cut, a sloping cut is made to this line, removing a section of bark and forming a slight shoulder. Other steps in the operation are identical with those already described, with the exception that the cion may be held firmly against the stock with two or three small nails instead of with wraps of twine. The cions are inclined to remain dormant for a considerable period if the branch is

not girdled about 6 inches above the grafts. This should be done 2 to 3 weeks after the cions have been inserted. If the branch is not needed to shade other grafts, it may be removed at the point of girdling when the cion growth is 6 to 8 inches long. The remaining stub should be sawed off close to the cion the following winter.

This graft may also be used to start branches on the trunks of trees which have been headed too high.