ly 37,000 acres, thus something like 12,000 acres or a total of about 1½ million trees have a shadow hanging over them. If this dire prediction comes about, it will be the obligation of the nursery industry to make available a comparable number of nursery grafted trees, upon which to rebuild this industry.

It is obvious from these examples, as well as from many others which could be cited, that the nurseries of California hold a key position in the fruit industries of this state. The nursery business will continue to play a major role in helping solve the problems that come to face California horticulture, and as well will be instrumental in insuring its future progress.

In order to insure the success of the nurseries in fulfilling their obligations to these fruit industries, they must be capable of providing a continuing supply of strong and healthy grafted replanting stock. In order to do this, the use of modern techniques of propagation and the adopting of new ideas of mechanized grafting as they are brought to light are obviously important.

The expansion of new plantings of horticultural crops is going on continually. Many old areas in California are going out, and new areas are being developed to take their place. Research has pointed the way to an understanding of the old and some new disease and pest problems and in some cases, has offered new types of graft combinations as their solution. Many of these new types will be tested and adopted by the industries. On the other hand labor costs are continually climbing The production of hand-whipped bench grafts is slow and expensive. It requires great skill in the hands of the individual. We all know that the finding and training of new grafters is increasingly difficult.

For these reasons, and many others, the progress in the development and use of mechanized grafting tools is of great interest to nurserymen today. A panel of three speakers has been brought together here to discuss for you several types of mechanical grafting tools and how they have been adapted to specific situations in commercial operations.

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Chairman Lider introduced Dr. Curtis Alley of the Department of Viticulture and Enology, University of California, Davis.

MACHINE GRAFTING AND PREPLANTING TECHNIQUES FOR GRAPE BENCHGRAFTS

CURTIS J. ALLEY
University of California, Davis

Before the introduction of phylloxera into France around 1868, and into California about the same time, there was little need for grafted or budded grapevines. Most grapevines were developed on their own roots, generally by rooted cuttings grown in the nursery the previous year.

Phylloxera, however, made it imperative to grow desired fruiting varieties on phylloxera-resistant stocks. The same was true of sandy areas where nematodes were a troublesome pest. When resistant rootstocks were first used, hand labor was the chief method of making the benchgrafted vines. Where labor costs are low, such is the common practice even today.

Present economic conditions in the U.S. prohibit such an operation. It wasn't long after benchgrafting became a reality that enterprising nurserymen and growers began to develop machines to do the job for them. Not only could the workers be semi-skilled, but the machines could work faster and without tiring.

There are three methods of producing nursery grafted grapevines: (1) the scion may be grafted on the resistant cutting, rooted in the nursery, and planted in the vineyard a year later; (2) the resistant cutting may be rooted in the nursery, dug the following spring, benchgrafted, returned to the nursery for a year, and planted in the vineyard the third year; (3) the resistant cutting may be rooted in the nursery for one year, grafted or budded in place without removal the following fall (budding) or spring (grafting) and planted in the vineyard the third spring. The first method is fastest and cheapest, and therefore preferred. The second method is recommended for rootstocks that root with difficulty or for cuttings of resistant stocks that are too small to graft as cuttings. The third method eliminates digging and replanting, but produces very large vines, difficult to dig and handle.

BENCH GRAFTING MACHINES — The machines to be discussed are used either commercially or experimentally in making benchgrafts of grapevines.

TONGUE and GROOVE MACHINE — The tongue and groove type, a very successful machine, uses the basic ideas of a tongue and groove type cut contained in an Austrian patent, issued about 1928 to

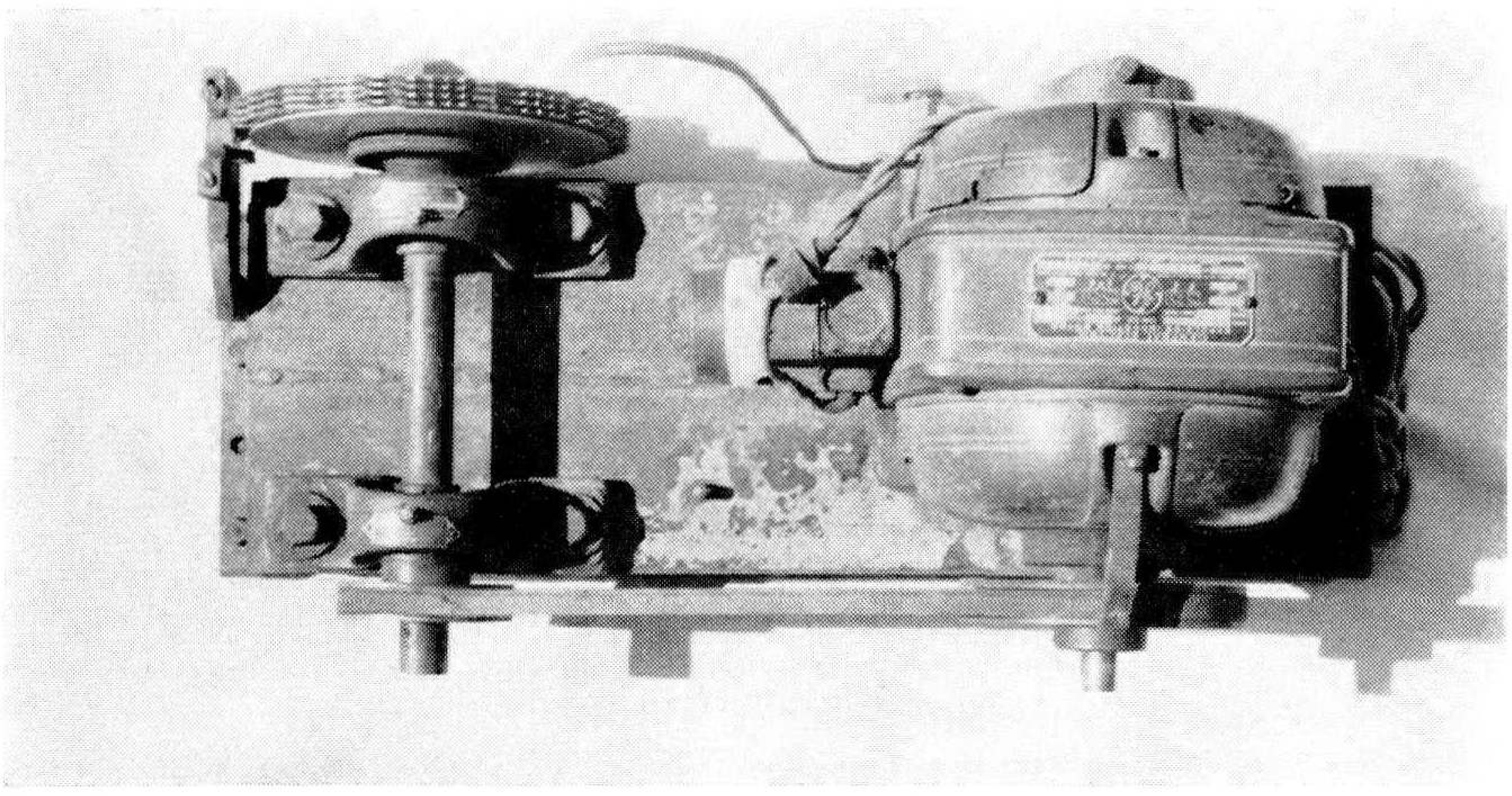

Fig. 1 Tongue and Groove type benchgrafting machine with covers removed.

Albert Hengel, Limberg, Austria A modified version, built by H. E. Jacob, University of California, (Fig. 1) consists of a ½-HP 110 V. electric motor with a 5¼″ pulley that runs at 3,500 RPM.

The motor drives a saw mandrel by V belt at 5,250 RPM. The saw mandrel consists of a 3¼″ pulley, a 1″ shaft supported by two bal-bearing supports, and a series of saw blades (separated by aluminum discs or spacers), all purpose blades 1/16″ thick 8″ in diameter, with very little set to the teeth — 1/32″. Water is sprayed on the saw blades through the top of the saw guard by a ⅛″ copper tube flared on the end to give a fine spray. This prevents burning or drying out of grape tissue in cutting the series of grooves

For benchgrafting, the saw head is four blades, separated by aluminum spacers, ⅛″ thick and 7″ in diameter. The combination of blades and spacers is such that it cuts a series of grooves, each 3/32″ thick and ½″ deep The entire saw unit is covered with a sheet metal guard, except the cutting guide opening for insertion of the scions and stocks, and the bottom, which permits the water and sawdust to drain into a barrel. The cutting guides are so adjusted that the fit between rootstock and scion is even along the sides when the rootstock cutting or rooting is cut against one guide and the scion against the other guide, providing both are of the same diameter and the ends of both are cut squarely across before the grooves are cut When scion and stocks are ½″ thick or more, tying at the union with a rubber budding strip or raffia is unnecessary

Good, straight, well-matured wood, accurately size graded, is necessary for fastest work. In careful tests, a number of grafts made with the machine were comparable to short whip grafts made by hand by a skilled grafter. Three reasonably fast men can make 2,000 to 3,000 grafts per day with the machine. The completed benchgrafts are generally tied with a rubber budding strip or with raffia. With a similar machine, the pulley that drives the saw mandrel is located in the center of the shaft. One end of the shaft turns the saw blades for cutting the grooves, and the other end turns a wire brush, for disbudding, or turns another set of saw blades. With one head for cutting the scion and the other head for cutting the stock, two men working at the same machine can obtain a high output.

A large version of this type of machine is used commercially. A seven-man crew, making 5,000 to 6,000 benchgrafts in an 8-hour day, consists of one man cutting rootstocks, one cutting scions, three joining stocks and scions, and two tying the benchgrafts Excluded, of course, are the time and labor required to make the cuttings and scions, disbud the rootstock cuttings, and grade. Raffia is the preferred tying material. Rubber budding strips have been used in the past, but this requires their cutting in mid-summer. This machine cuts a single groove, ⅛″ thick. The advantage of this machine is the speed and ease of operation. Output is high, and it works very well with large and medium size material. The finished grafts can be handled roughly without disturbing the union (especially when tied with rubber budding strips). A disadvantage is a tendency to give a rougher cut than machines that use knife blades

Another machine of this type cuts a single groove, 1/8″ thick and 3/4″ deep instead of 1/2″. A very long staple inserted at right angles through the entire graft union is very satisfactory, though the grafts cannot be handled quite as roughly as grafts tied with a rubber budding strip.

FRENCH-TYPE MACHINES — Modified Long Whip Graft: This machine can be hand or foot operated (see Fig. 2). The operating lever moves two knife blades, fastened to a V-shaped bracket at an angle, on machined runners through a base, slotted to permit just the blades

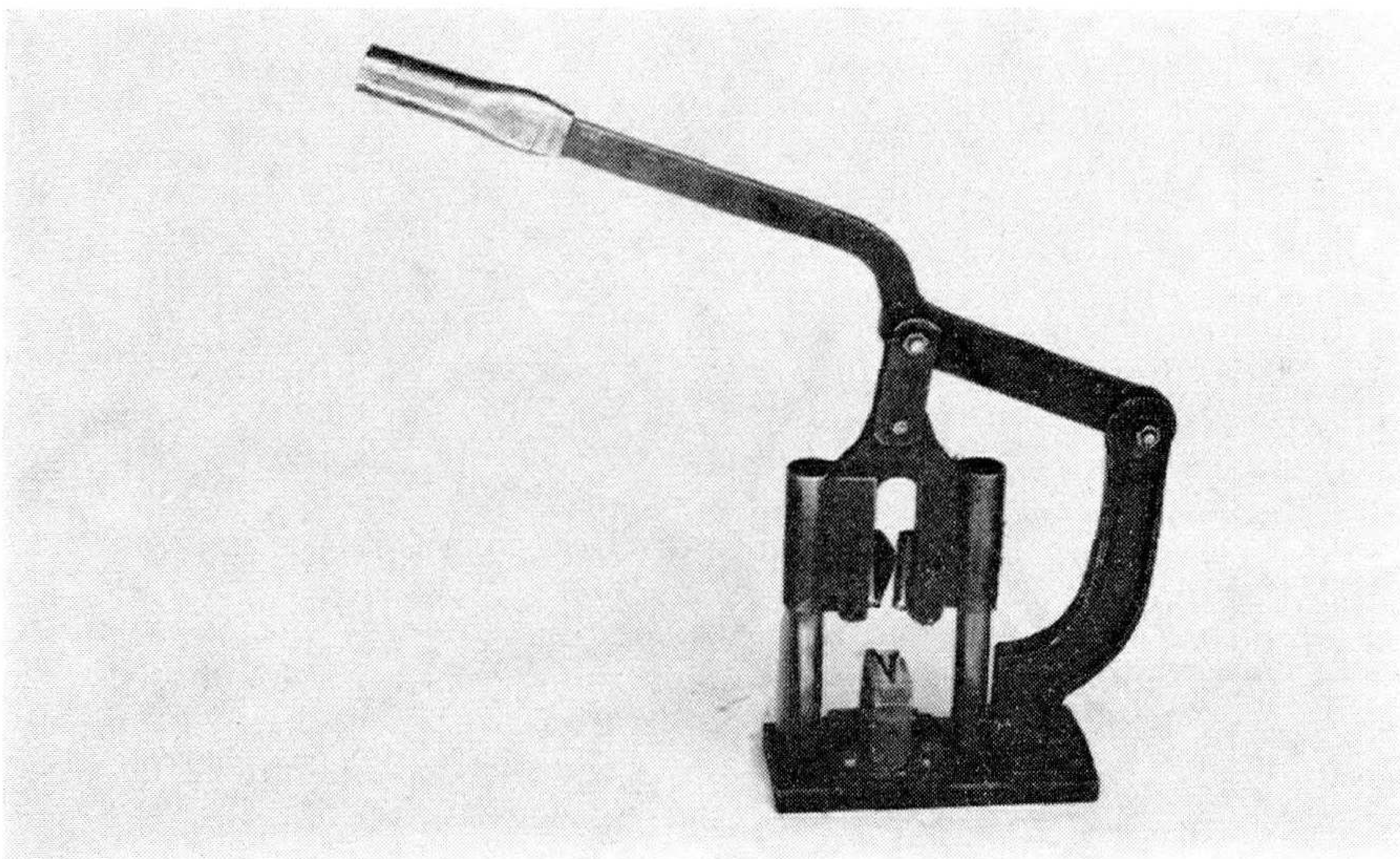

Fig. 2 Modified long whip graft French machine.

to pass through. This machine cuts a long V-shaped notch in the top *of the rootstock cuttings and a corresponding tapered point on the scion.* The taper is equivalent to two to four times the diameter of the stock (long whip). A five-man operating crew can make about 4,000 benchgrafts in an eight-hour day — one man cutting stocks and scions, two men matching stocks and scions, and two men tying with rubber budding strips. This is exclusive of preparation of cuttings, grading, and sizing. The completed graft after tying is very strong and can be handled rather roughly without breaking. The machine does a very good job on large and medium-size stocks. Since the machine uses knife-type blades, the cut is much smoother than that obtained with the tongue and groove machine. A disadvantage is the difficulty of obtaining cutting blades that have a good steel and can hold their edge. There is one report that when the scion and stock grow together, there is a tendency for the scion to cause a splitting of the stock down the center. The machine retails for about $45.

Modified Short Whip — A. Lozevis, Agen, France, sells grafting machines that make short whip type of benchgrafts. Several types of such machines are available. All the machines use three knife-type cutting blades. The machines are operated electrically or by hand or foot. The types demonstrated here are the hand and foot operated models.

The Nova Rapide is reported by the manufacturer to be portable, permitting grafting in the field. Consequently, it is not a production machine. It can also be mounted on a table and used for benchgrafting. Although not tested commercially, what use has been made of this machine indicates that it will be slower than the modified long whip machine. This machine is hand-operated, but could be easily altered to foot operation. It costs about $25 delivered.

The Ultra Rapide is a foot-operated production machine (Fig. 3), costs about $40 delivered. The carriage, holding the three cutting blades, slides forward horizontally on machined guides. The scion is cut with the left hand, and the stock with the right hand, the two parts are joined together, and passed to the next person for tying or dipping in wax. The manufacturer claims 5,000 to 6,000 benchgrafts per day.

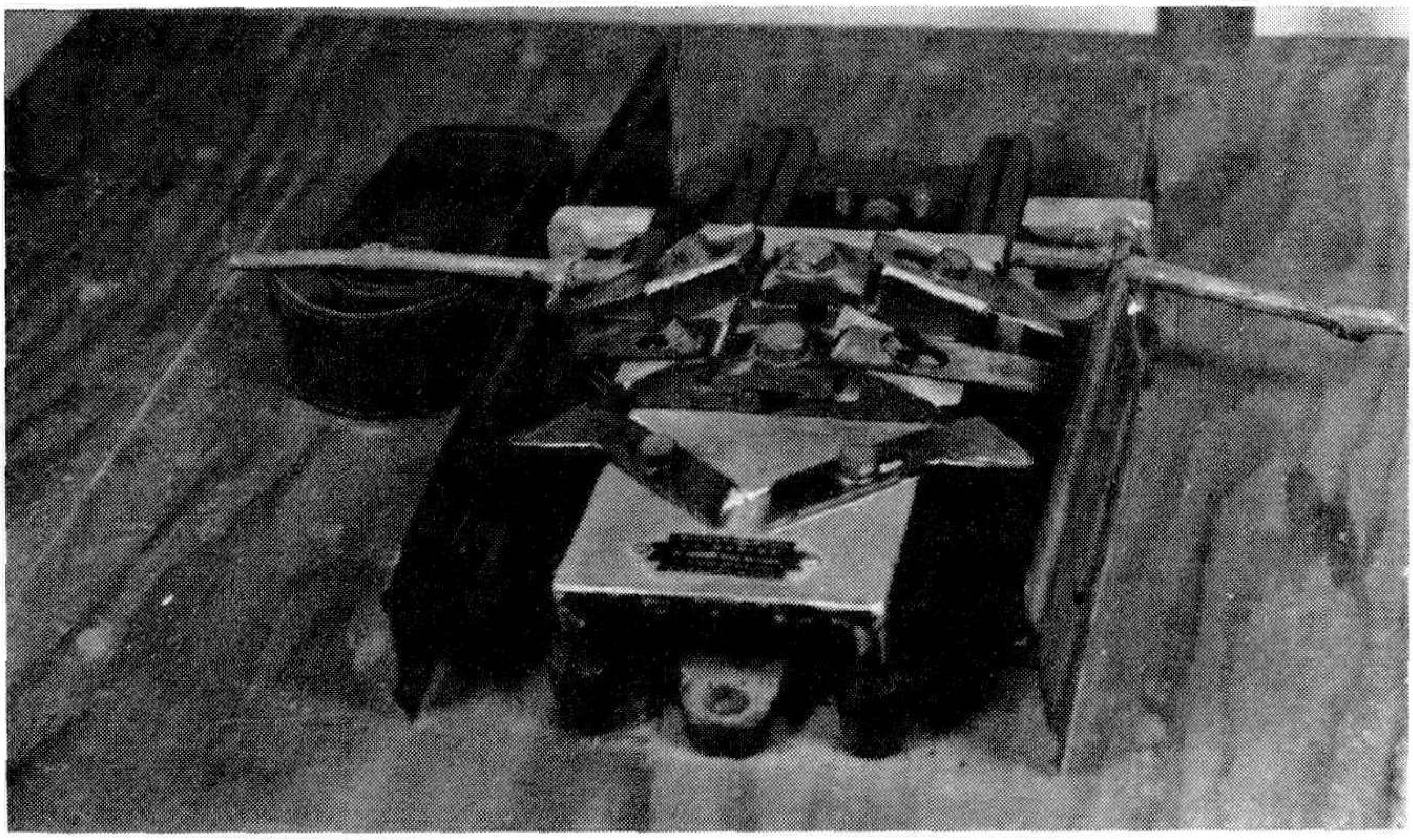

Fig. 3 Ultra Rapide benchgrafting machine

The two types of machines made by A. Lozevis that we have used make a much finer cut than does the tongue and groove type machine. *However, the short-whip type of graft does not lend itself to a union* that can be handled roughly in the nursery. The cut is so short that it cannot be easily tied.

If the benchgrafts are completely dipped to about ¾″ below the graft union with a very hard type of grafting wax, a fairly strong joint can be obtained. It is not necessary to tie waxed grafts, but they must be handled more carefully than a tied graft made by the tongue and groove type machine or the modified long-whip machine. Waxing is a faster operation than tying with raffia or budding strips.

All the machines of A. Lozevis make a type of short-whip graft that must be handled carefully. These types of machines do excellent work on medium and small diameter wood. On large diameter wood or wood that is rather hard, the cut may tend to be wavy, since types of wood cause the somewhat flexible blades to bend when passing through the material. The advantage of the machine is that the cut on small or medium size wood is very clean. Also, the machines are more readily available and some are cheaper than the tongue and groove type or modified long-whip type.

LILIPUT BUD-GRAFTING TOOL — This type of benchgrafting machine (Fig. 4) is in reality a Yema grafting tool manufactured by Leon Brendel of St. Helena. It is an improvement of the original machine, developed by Ulysse Fabre, Vaison (Vaucluse) France. This machine uses three knife-like blades and cuts out a dovetail bud (Yema) that fits snuggly into a corresponding notch cut out of the rootstock cutting or rooting. The machine can be used in the field or on the bench . With sharp blades and correct adjustment, the machine gives a very clean, smooth cut. Tying is not necessary, but nevertheless is recommended, using raffia, staple or budding rubber. The machine is not as fast as a skilled budder, but does a satisfactory job in semi-skilled hands. On the bench the machine would be about equal in output to the Nova Rapide. The main advantage to this machine is that the

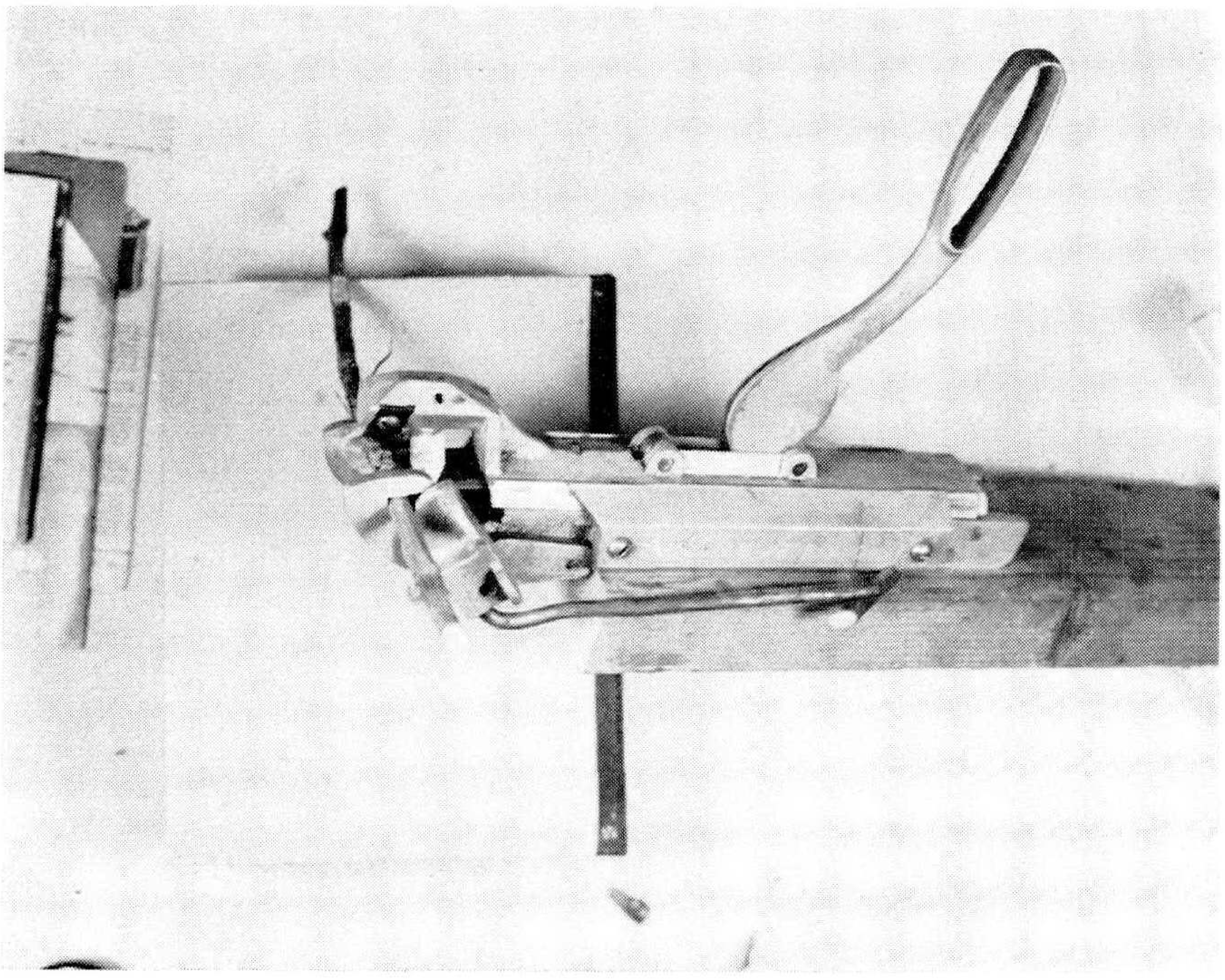

Fig. 4 Liliput bud-grafting tool.

stock is not lost should the bud fail to grow. The top bud of the rootstock cutting or rooting is not removed The Yema graft is made below this bud. Should this Yema bud fail to grow, a nurseryman or grower can make another attempt on the same stock.

The machines discussed above have been used chiefly for grapevines.

In addition, A Lozevis manufactures a machine for benchgrafting roses It seems very possible that such machines could be adapted for woody ornamentals as well as trees. One should remember that these machines work only on hard wood, such as would be found with woody plants in a dormant condition.

PREPLANTING TECHNIQUES FOR GRAPE BENCHGRAFTS

Rootstock cuttings and scionwood cuttings are collected in the winter when the vines are pruned. The cuttings may be made in lengths of 30″ or more. Just before grafting these long cuttings are made into the desired lengths. Benchgrafting can start as early as January and continue until the middle of April The rootstock cuttings should be as straight as possible. The length of the rootstock cutting depends on the locality where grown For coastal regions, a 10 to 11″ cutting is best, for loamy or sandy regions of the interior valleys, a 12 to 14″ cutting is preferred. After cuttings are made, they should be completely disbudded with a sharp knife, pruning shears, or disbudding machine. The stock cuttings are cut off at the base just below the basal bud, and not less than one inch above the top bud.

GRADING — For greater ease and speed in making benchgrafts by machine, the stock and scions should be graded. The best location for grading is where the cut on the stock or scion will be made by the machine. Grading is easy with a slot grader. This consists of a "V" slot, marked across with 5 or 6 horizontal guide lines, cut in the head of the lug box or a brass plate 7″ long with a width of ¾″ at the top, tapering down to ¼″ at the bottom. The ends of the slot are widened into circles, 1¼″ and ½″ respectively at top and bottom. Five or six grades are generally sufficient.

PREPARATION — Scion cuttings generally consist of one bud, cut 1¼″ above each bud and with 1½″ to 2½″ of internode below. Stocks and scions soaked in water for 12 to 24 hours just before cutting are, thereby softened, permitting a smoother cut.

One-year-old rootings to be benchgrafted must first be washed clean. The rootings are shortened to a uniform length of about 12″ and completely disbudded; the roots are cut back to very short stubs no more than 1″ long.

BENCHGRAFTING — After the scions and stocks are graded, they are cut, using one of the machines described earlier. Then they are put together and tied or fastened by staples

CALLUSING — The stocks and scions are nearly or completely dormant. Under favorable conditions, they begin growth processes that bring about the rooting of the stock, the sprouting of the scion bud and the union of one with the other. However, conditions in the nursery are not usually favorable at the time of benchgrafting, so many will dry or be injured by cold or excess moisture if planted then. For this reason, the newly-made grafts should always be placed where moisture, temperature, and aeration can be controlled. Benchgrafts made late in the spring (end of April), when conditions for growth are favorable, may be planted out directly in the nursery. They will callus in the nursery row.

Benchgrafts made with a long hand whip or long machine-type graft are suitable for sand-callusing. For the short or modified short whip graft, the hot-room callus method is recommended as more gentle handling is necessary.

SAND-CALLUSING — First, benchgrafts are tied in bundles for convenient handling

Fine sand, free of pebbles, clay, and organic matter is best; fine, clean building sand is ideal. It must be moist enough to support plant growth, but not too wet to work easily between the bundles of grafts.

The callusing bed may be a pile of sand in an open shed or on the south side of a building. The shed, if used, should be in a warm location. A callusing bed in the open must have a cover of glass, canvas, board, etc., for protection during rainy or cold weather, and open during dry, warm weather The bundles of grafts are placed in the sand in a nearly vertical position, one row at a time, scions up, and sand worked in between the bundles. A layer of sand 2 or 3″ deep is laid on the bottom of the bed before the grafts are placed in position, and the tops of the grafts are covered with a uniform layer of sand 3 or 4″ deep. All the unions should be at the same level. The top of the sand must be slightly moistened every day or two to replace the water lost by surface evaporation. Care must be used to wet only the sand that has dried out and to cover the bed during rainy weather and cold nights.

If the temperature of the sand is about 75° F, the union will callus over and the buds and roots begin to grow in 3 to 4 weeks This period will be shorter with higher temperatures Temperatures above 85° F. cause a profuse, soft callus tissue that may die or be severely injured by unfavorable conditions during or after planting in the nursery. Below 70°, callus formation is very slow, and below 60° it practically ceases. The grafts should be planted in the nursery as soon as the unions are well-callused and before the shoots and roots have made excessive growth.

Sand-callusing or a modification is used by some nurseries that benchgraft grapevines in California The completed benchgrafts are placed either indoors in moist or semi-moist sand or outdoors in an open sand bed. Temperature is more variable outdoors than indoors. Benchgrafts are stored for 4 to 8 weeks and then are planted in the nursery row about the middle or end of April in the coastal areas and around the middle to end of March in the San Joaquin Valley

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Chairman Lider introduced Dr. Thomas D Terry, S. J., Novitiate of Los Gatos, Los Gatos, Califonia.