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A TOPPING MACHINE FOR FLORIDA CITRUS GROVES

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Pruning of Florida citrus trees has gained in popularity since the advent of the hedging machine about 10 years ago (7). Most hedging is currently being done with either custom-built or commercially built hedging machines, while hand tools are being used for small hedging operations and selective pruning (3).

Rather severe pruning to maintain tree size has been extensively practiced in Spain for many years, and results have shown that the smaller, more compact trees suffer less fruit and limb damage from high winds and the trees are easier to harvest (8). Favorable results have been obtained from topping lemon and orange trees in California (1, 4, 5, 6), and lemon topping is considered a standard practice. Investigations in Florida have also demonstrated the advantages of topping for rejuvenating crowded and canopied citrus groves and for easing grove operations (2).

Mechanical topping of lemon trees began about 1952 in California (5). Toppers were used to eliminate the hand pruning of vigorous shoots in the top of the trees. The machines consisted of modified sickle-bar mower blades mounted on towers which were adjustable for height. Shoots up to one inch in diameter could be cut by this type of equipment. Later, topping machines were constructed which had a series of circular saws mounted on a horizontal boom (6). These machines were capable of removing limbs up to about six inches in diameter and were used for topping orange, lemon, peach and plum trees.

A later innovation in California was the top trimmer nicknamed the "Whirlybird."[1] It made use of a cutter consisting of electric motor-driven circular saws mounted on a rotor. Power was supplied by an enginer-drive generator. The main advantage claimed for this principle of topping was that the rotating wheel threw the resulting brush out of the trees.

Topping of citrus trees other than lemons or limes is being practiced in Florida only in experimental trials or in limited grower trials using hand saws or small power saws. However, with the possible future importance of topping

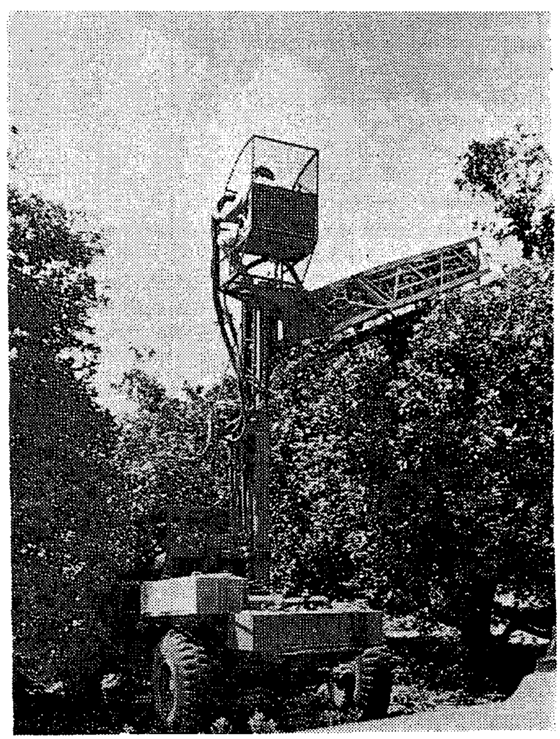

Figure 1.—Single-boom type topper.

[1]Developed by E. C. Kimball and Son, Ventura, California.

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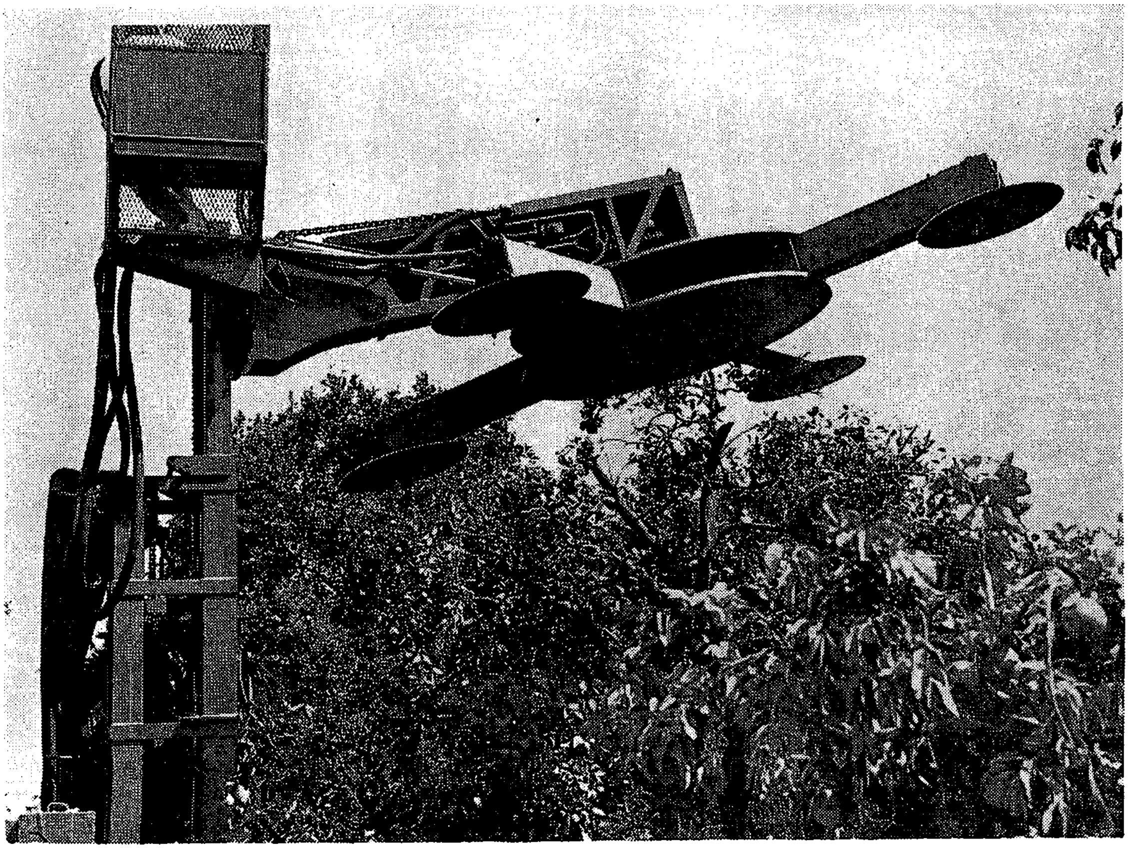

Figure 2.—Rotating-boom topper set for horizontaltopping.

for tree rejuvenation and for tree size and shape maintenance for future mechanical harvesting, and with the desire of growers to reduce hand labor requirements in production practices, the development of a topping machine for Florida conditions was desirable. This paper presents the description and results obtained from the use of two types of experimental topping machines.

Description of Equipment and Results

Single-Boom Type.—A machine based on the Leydig[2] design was constructed and tested during the 1960-61 season (Fig. 1). Seven overlapping 32-inch circular saw blades were mounted on the boom on 23-inch centers. Each saw blade was directly connected to a hydraulic motor. The blades were inclined at a 3° angle to allow the trailing edge of the blades to clear the cut surfaces. The blades revolved at 1,500 rpm in a direction such that the cutting edge moved from the tip toward the base of the boom.

The base of the boom was attached to the carriage of a hydraulic hoist by means of a pin and hydraulic cylinders. This feature enabled the placement of the boom at any angle from a near vertical position for hedging to horizontal for topping.

The maximum height of cutting with the boom is a horizontal position was 14 feet; but by increasing the angle of cut with respect to the ground, it was possible to obtain a resulting tree height corresponding with the angle of cut.

The hydraulic power available was five H.P. per saw or a total of 35 H.P. Power available at the engine was 40 B.H.P. at operating speed.

The transport unit was a four-wheel-drive, four-wheel steering vehicle with a turning radius of 12 feet for easy maneuvering. The rear wheels

[2]Clyde O. Leydig, Exeter, California.

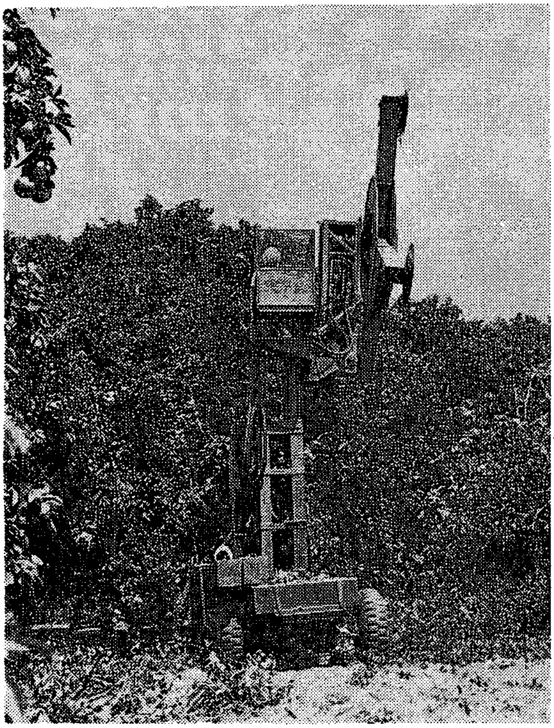

Figure 3.—Machine in hedging position.

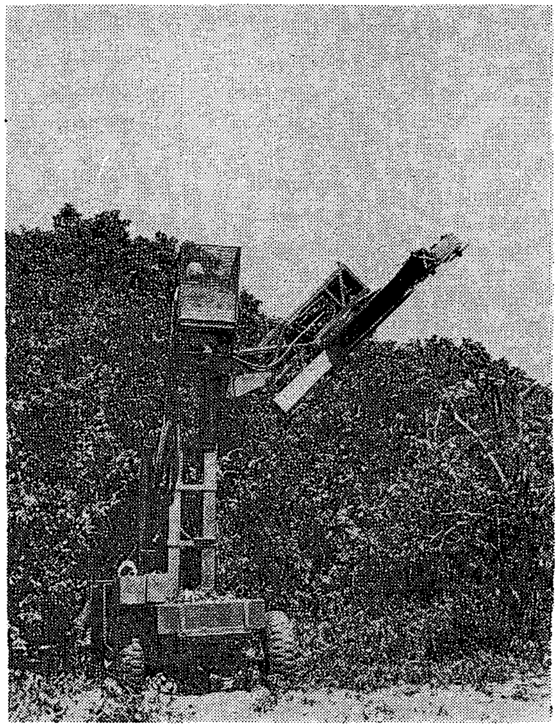

Figure 4.—Topper set for topping obliquely.

could be locked for highway travel. The power transmission was designed to provide a minimum ground speed of one mph.

The driver's compartment and the operator's cage were enclosed to provide protection against flying brush. Helmets and face guards were also worn as added protection. The operator's cage contained all the necessary hydraulic controls for the operation of the boom and saws.

The machine was tested on large tangerine and orange trees in the spring of 1961. It performed satisfactorily where the amount of top removed was less than three feet in length. As the quantity of prunings increased, the brush which was being directed toward the basal end of the boom often choked down the saws, and frequent stalling resulted. An additional problem encountered when limbs became wedged between the boom and the blades also resulted in stalling.

Rotating-Boom Type.—Because of the numerous problems encountered with the single-boom topper, the rotor principle (based on Kimball's "Whirleybird") was investigated in the spring of 1962. The rotor assembly consisted of four arms, each with a 32-inch circular saw located on the end (Fig. 2). The rotor revolved at approximately 11 to 13 rpm, and the blades revolved at approximately 1,600 rpm (peripheral speed of 13,400 fpm), being patterned after those used on one of the commercial hedgers manufactured in Florida (John Bean Hedgeall).

The rotor was supported by a boom which contained the hydraulic drive components. The base of the boom was attached to the carriage of the hydraulic hoist in a manner similar to that of the straight boom design. This feature again enabled positioning for either hedging or topping (Figs. 2 - 4).

The rotor was mounted at an angle of approximately 3° with respect to the rotor support. This allowed the trailing edge of the rotor to clear the cut branches and decreased ragging.

The final drive to the saws was obtained through the use of belts because of their quietness at high speed, shock absorption properties and overload protection by slipping. The rotor was chain-driven because of its slow speed. A relief valve in the hydraulic system afforded overload protection to both the rotor drive and the saw drive.

The power transmission system was redesigned to offer ground speeds as low as ¼ mph. This was found to be important for satisfactory performance of the cutting mechanism under adverse cutting conditions such as large and dense tangerine growth.

Power requirements were found to be a function of variety, size and density of growth, forward speed and condition and size of saw teeth. Saw teeth were kept sharp longer with the rotor-type topper than with the straight boom. Saws at the basal end of the straight boom had relatively small wood to cut compared to the large, dense wood encountered by the remaining saws. They, therefore, maintained their sharpness much longer. With the rotor-type cutter, every saw was worked equally and all saws wore at the same rate. Only four saws were used instead of seven. Since only two saws were actually doing the cutting at any one time and because of the nature of the rotor and its fly wheel effect, power requirements were in the range of only 30 B.H.P. at the engine, which was rated at 40 B.H.P. at operating speed. Power available was sufficient for this type design under most conditions. Under certain circumstances, as in heavy tangerine work, it was necessary to drive forward until the rotor stalled and then back up and try again.

Two different tooth sizes were tried: one set of 32-inch saws had 320 teeth, the other 80. In hedging and topping all varieties, the 320-tooth saws produced a smoother cut than the 80-tooth saws. However, in topping large diameter tangerine wood, it was found that the 80-tooth saws did not bind as much as the finer tooth saws and, therefore, reduced rotor stalling appreciably.

The rotor-type topper proved to be very effective in removing the cut brush from the top of the trees.

SUMMARY

Two tree topping principles were investigated for use in Florida citrus groves, the straight boom design and the rotor design. Although both can be used to remove the tops of citrus trees, the rotor-type topper was found to have lower power requirements, lower saw blade maintenance and greater ability to remove resultant brush from the tree tops. An added feature was gained by pivoting the boom at its basal end so that the equipment could be used for either hedging or topping. This feature may be attractive to growers whose size of operation does not warrant the ownership of two separate units.

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THE INFLUENCE OF PRUNING ON SIZE AND QUALITY OF FLORIDA GRAPEFRUIT

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The proportion of bearing citrus groves which are being hedged has been increasing since the development of the hedging machine by Prosser in 1953 (9). The greatest increase has occurred very recently, because many growers are concerned over increased production costs and lower net returns in severely crowded and canopied older groves, and because the response of hedged trees has generally been very favorable. Norris (6, 7) reported that hedging in several groves in Lake County substantially increased pack-out of tangerines, and to a lesser extent, increased the pack-out of grapefruit and oranges.

Grierson (1) studying the influence of pack-out on grower profits stated, "With Duncan grapefruit the pack-out achieved could determine whether the crop was handled at a profit or a loss." He also concluded that to increase net returns of grapefruit (and tangerines), it

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