Ice skating rink permits studies on

Orchard Heater Plume Heights

under controlled laboratory conditions

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Previous tests have shown that 75% to 90% of the heat of combustion of the fuel oil burned in an orchard heater goes into producing the hot gases which rise as a plume vertically above the heater. As these hot gases rise, they cool by mixing with the surrounding air. Cooling is rapid until a height is reached where the temperature of the plume is near the temperature of the adjacent air. If the temperature of the air over the crop increases with height at this point—if a temperature inversion exists—continued upward movement of the gases soon brings them to a height where the surrounding air has the same temperature as that of the plume. Above this point, the plume's gases are actually colder than the adjacent air. Thus the gases in the plume are heavier than the surrounding air and their momentum is dissipated. This soon brings the upward motion to a halt. Then the gases fall part way back to the height at which they had the same temperature as the surrounding air and spread out at that level. This height at which the gases spread out and the height at which the upward motion ceases are measures of the depth of the air over the crop being heated.

In the development of frost protection systems, more information on the behavior of these plumes is needed.

Two different investigators have proposed theoretical descriptions of the behavior of a buoyant plume under temperature inversion conditions and for the case of no wind. In both treatments, the strength of the temperature inversion—temperature change per foot—is taken as a constant with height to well above the top of the plume. In nature, the strength of the temperature inversion usually decreases with height under frost conditions. The temperature inversion decreases to zero at some height above the crop land which then defines the top of the inversion layer. If the temperature of the hot gases in the plume does not become equivalent to that of the surrounding air within the inversion layer, then the foregoing description does not hold and the plume continues to rise almost indefinitely. The strength of the temperature inversion has its greatest effect on the vertical motion of the gases in the upper part of the plume; in the lower part, the buoyancy of the gases is so great that the strength of the temperature inversion has little effect on their upward motion.

Although the two theoretical formulations are somewhat different, they do result in almost identical formulae for the maximum height of the plume—the height at which the vertical velocity equals zero. A preliminary objective of current research was to check experimentally the validity of the theoretical approaches.

The instrumentation problem of lo-

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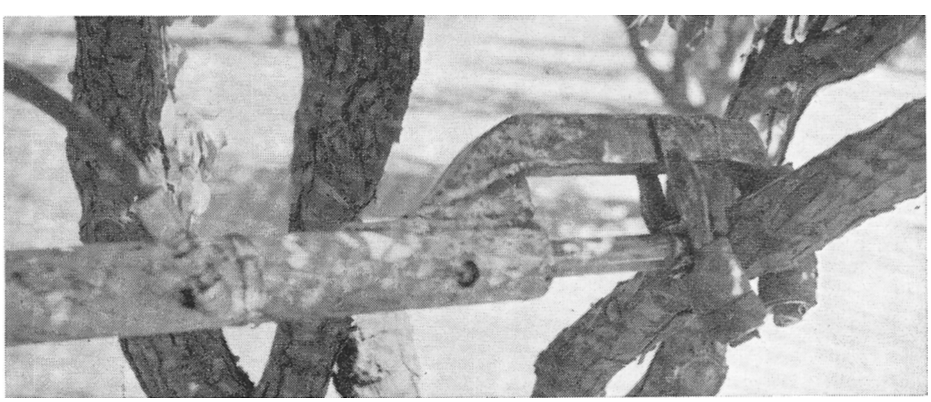
damage to the tree at the point of attachment. Minimum damage results from the linear motion for clamping. Regardless of limb size, the force applied to the limb is nearly in line with the direction of force application. Thus, the total force, and also any shear forces on the limb, are minimized. In addition, the hydraulic circuit used for clamping is also designed to yield a minimum force on the limb. This is accomplished by closing the clamp with a low pressure, then blocking the oil flow so as to be able to develop the higher pressures and forces required.

Field tests indicated that the unit is comparable to boom shakers with respect to harvest rate and fruit removal but pointed out the advantages:

Close-up of C-type clamp engaged on limb.



1. A separate propelling vehicle is not required, thus reducing the cost.

2. Provided the incline of the shaker is not great, the mounting effectively isolates the vibration from the catching frame, reducing maintenance.

3. The C-type clamp, together with the flexible mounting, reduces bark damage.

Further work is needed toward optimizing shaker design, considering both power consumption and reactive loads. For example, the rotating-mass design that was used requires less power than the piston-crankshaft design that was used. Also, the reactive load is a function of the weights and the electricity.

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