Farm-scale winnower

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Appropriate Technology for Small and Subsistence Farms
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This electric winnower removes chaffs from small grains (barley, clover, quinoa, wheat), large grains (vetch, pea, bean) and dried roots. It uses a blower with a 1/3 horsepower 1025 rpm, AC motor and a 10-inch diameter wheel (Figure 1). The winnower chute is 14 inches wide because 30-gauge galvanized sheet metal flashing (roofing material) comes in 14-inch wide rolls (Figures 2 and 3).

The winnower separates grains from chaff by density difference; the greater the differences in density, the more complete the separation. Materials to be winnowed are placed in the grain tray, and then pushed into the chute through the grain entrance near the top of the chute (Figure 1). The blower forces air upwards from the bottom of the chute. The airflow causes the lighter chaff to follow the air up and out the top of the chute, while allowing the heavier grain to drop down the chute. The winnower cannot separate materials with similar densities (beans from dirt clods; beans from fresh nightshade berries; or wheat from vetch).

Air velocity in the chute is determined by the blower size and rpm, the size of the blower opening, the throat depth of the chute (Figures 2, 3 and 4), and the amount of material in the chute being winnowed. Adjust the air velocity to lift the grain up but not high enough for the majority of the grain to exit through the top of the chute. This design has a 5-inch hurdle (Figures 3 and 4); chaff must rise more than 5 inches above the grain entrance to exit the top of the chute. For initial settings, adjust the air velocity to lift the grain 6 inches or adjust the air velocity to float 1 percent of the grain out the top of chute while allowing 99 percent of the grain to drop down the chute. Re-winnow the 1 percent of grain that exited the top of the chute.

Air velocity in the chute is not constant. When materials enter the chute, they obstruct the airflow and decrease the air velocity. Varying the rate in which materials are pushed into the chute will affect the degree of obstruction, the air velocity, the proportion of grain lifted out the top of the chute and the proportion of chaff remaining in the winnowed grain.

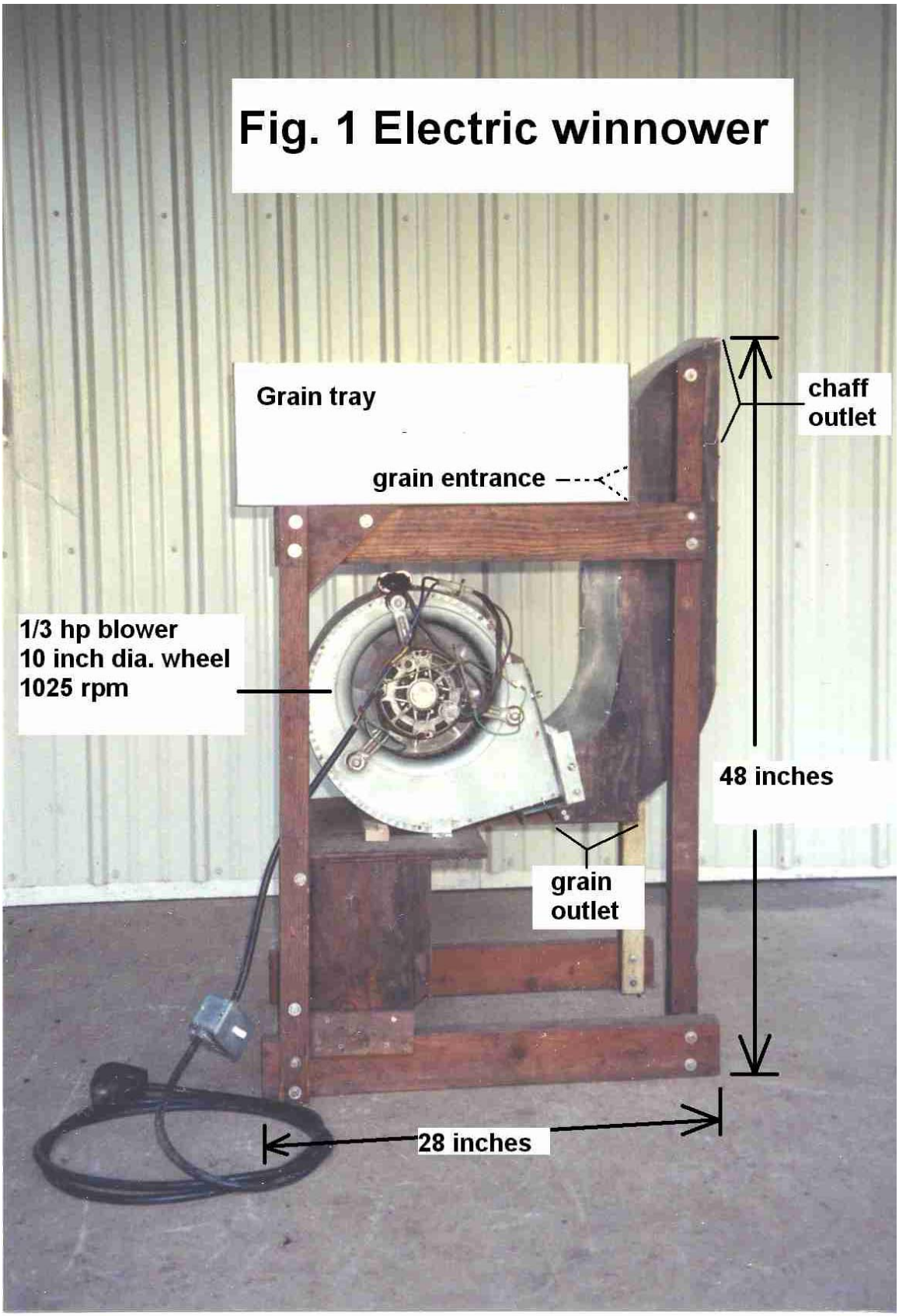
Fig. 1 Electric winnower
Grain tray
grain entrance
chaff outlet
1/3 hp blower
10 inch dia. wheel
1025 rpm
48 inches
grain outlet
28 inches

1. Design considerations: provide a uniform and well-regulated airflow across a large cross sectional area for winnowing.
    a. Using a blower with an AC motor complicates the design because it lacks continuously variable speed control. The reasons for using an AC motor are cost and availability. If cost were not a consideration then it would be simpler to regulate the airflow with a continuously variable speed DC blower.
    b. A typical 1/3 hp heating and ventilation blower with an AC motor provides excess airflow needed for winnowing, even at the lowest speed. The blower is baffled to reduce the airflow.
    c. The cross-sectional area for winnowing increases with increasing throat depth. However the uniformity of airflow begins to decrease significantly at a throat depth of 3 inches.
    d. Reducing the winnower throat depth with (removable) spacer boards may improve the uniformity of airflow across the cross-sectional area. The spacer board also causes the airflow in the chute to increase and requires corresponding baffle adjustment to reduce the airflow.
2. Airflow regulation is accomplished by blocking the blower opening with a baffle plate. Multiple boltholes are made to the baffle plate to allow adjusting the blower opening from ¼ inch to 3 inches. CAUTION, prolonged operation of an unloaded wide-open blower, without baffling, may cause the motor to 'over run' and burn the motor.
3. The throat depth of the winnower chute is 5 inches wide. Removable spacer boards are attached inside the chute using c-clamps to reduce the throat depth. A smaller throat depth (1 ¾ -2 ¼ inches) provides a more uniform airflow and more consistent winnowing of small grains. A larger throat depth (up to 3 inches) provides a larger cross-sectional area to winnow large grains. Larger materials such as dried roots may need a throat depth greater than 3 inches to pass through the chute efficiently. If the winnower will not to be used for large materials, then design the chute with a 3-inch throat depth and use spacer boards to decrease the throat depth as necessary.
4. The chute dimensions (height, radius of curvatures, angle for blower air inlet, grain entrance, chaff exit etc) are not critical as minor changes in dimensions are easily compensated using spacer boards and by varying the blower opening with a baffle.
5. Optional: to prevent grain and chaff from entering the blower, attach a screen with ¼ x ¼ inch wire spacing (wire cloth) in the blower opening or in the chute near the blower opening. The screen also helps diffuse the air inside the chute for a more uniform airflow.

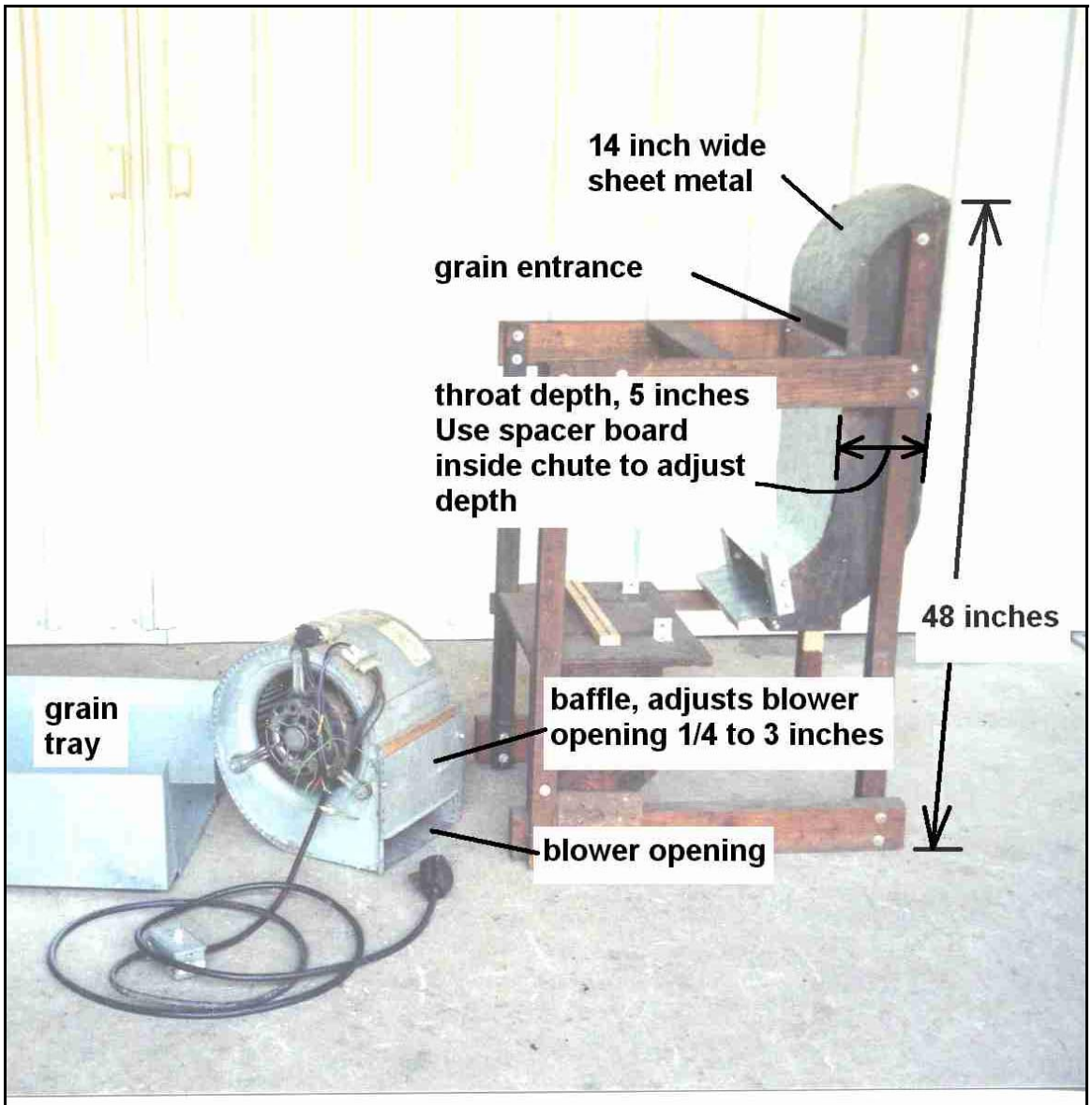

Fig. 2 Winnower, disassembled

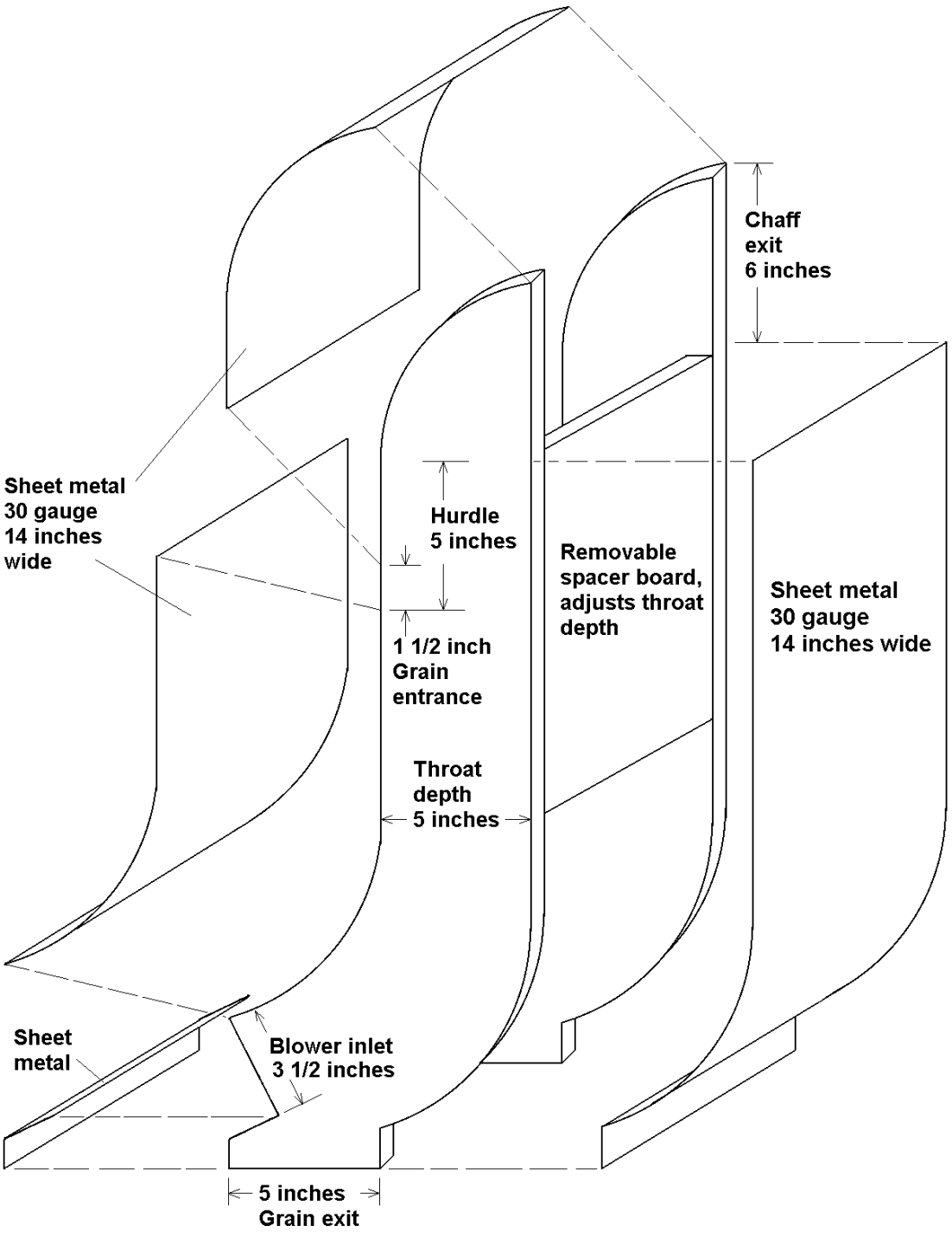

Figure 3. Exploded view of winnower chute

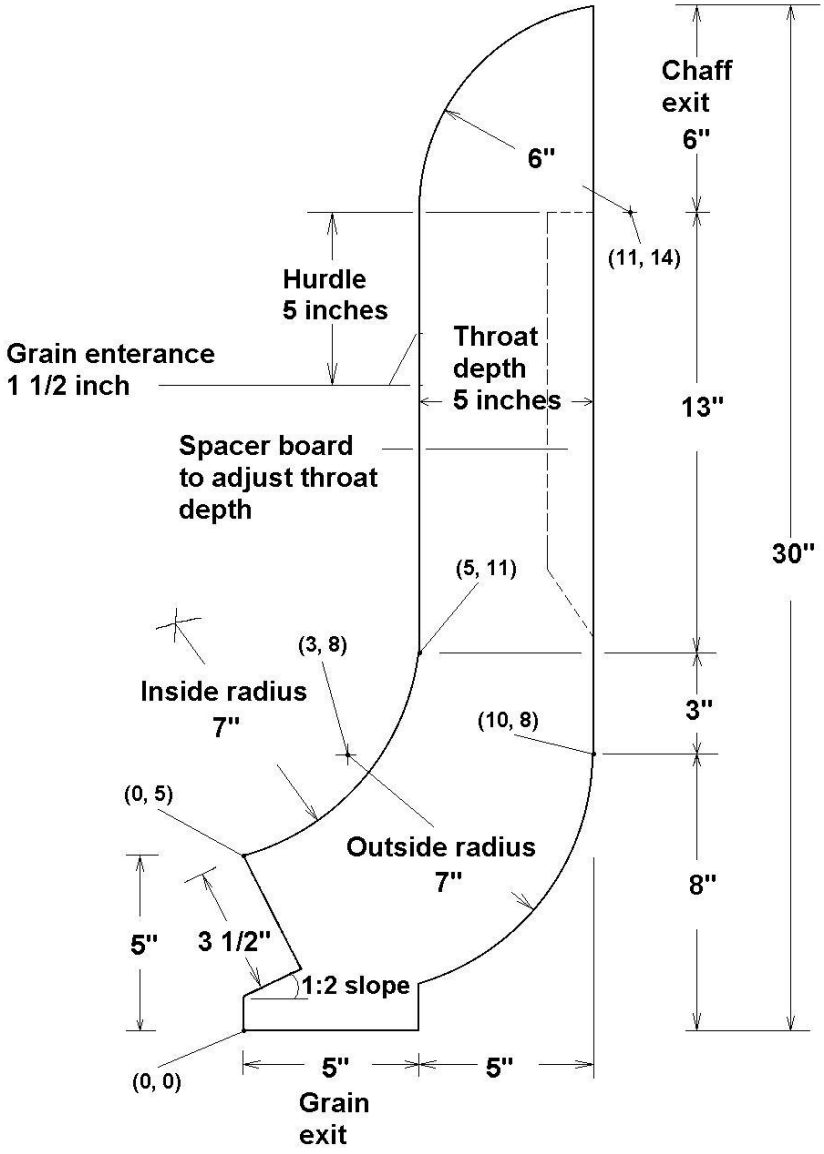

Figure 4. Winnower chute dimensions.

Technical assistance from Robert Rousseau and Larry Fisher, Davis, CA