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A 500-Pound Capacity

ELECTRIC NUT DRIER

R. N. Lunde



AGRICULTURAL EXPERIMENT STATION OREGON STATE COLLEGE
CORVALLIS

Circular of Information 501

October 1951

A 500-Pound Capacity **ELECTRIC NUT DRIER**

R. N. Lunde

Agricultural Engineer

Oregon Agricultural Experiment Station

The nut drier shown on the accompanying plan has a capacity of approximately 500 pounds of dried walnuts or filberts when loaded two feet deep. Electric heat is used, thermostatically controlled in part, so that a uniform temperature can be maintained with the minimum of attention. If the unit is completely insulated as shown on the drawing, the consumption of electric current will be held to an economical minimum.

On a carefully checked test, 660 pounds of filberts were dried to 493 pounds in 35 hours, using a total of 163 K.W.H. of electricity. If the cost of power were 2 cents per K.W.H., which is about average if one uses an electric range, this would represent an operation cost of \$3.26, or .66 cents per pound of dry nuts. Since most commercial driers charge 1 cent per pound for custom drying, it can be seen that the operating cost of this drier is quite competitive, leaving some margin below the custom-drying cost.

This drier can be constructed by anyone reasonably handy with tools. Ordinary hand tools are all that are needed for the construction of the cabinet, although a power table saw or a portable hand electric saw would speed up the work in cutting the plywood and insulating panels.

The drier was designed long and narrow so that it can be readily moved through a 2' 6" door, and if fitted with casters it moves very easily.

The casters need be only heavy enough to carry the weight of the empty drier, about 300 pounds. When in use it should be blocked up so that the weight is not on the casters.

Operation

The bottom should be built, first, by mitering and fastening the 2 x 4 frame together at the corners and fitting in one crosspiece in the center, as shown on the drawing. Cover this frame with $\frac{1}{4}$ " plywood, best side up. Then turn it over and fit in pieces of the insulating board under the plywood and inside the frame. Hold the insulation in place with $\frac{1}{2}$ " wide strips sawed from $\frac{1}{4}$ " plywood scraps, tacked to the edges of the 2 x 4 frame with shingle nails. If casters are to be used, these should be put on at this time. Install about a foot in from the ends and close to the outer edge of the bottom frame. Use plate style casters with at least 2" diameter wheels.

The two sides should be constructed next, using four 2 x 4 and one 2 x 2 studding on each side, between 2 x 2 plates top and bottom. The 2 x 4 studs must be notched for the bin support crosspieces, and the 2 x 2 top plates notched $\frac{1}{2}$ " deep on the inside face to receive the 2 x 2 top crosspieces. This part requires the greatest care to be sure all dimensions are correct and the notches cut accurately. The two sides must be exact right- and left-hand pairs. Line the inside surface with plywood, best side in, cutting holes for the crosspieces where the notches are in the studs.

Fasten each side to the bottom with four $\frac{1}{4}$ " x 3" lag screws through the bottom plate. Figure 1 shows one side fastened to the bottom, with three crosspieces in place, ready for putting on the other side. It is desirable to use waterproof glue on the joints of the crosspieces to aid in making the cabinet more rigid.

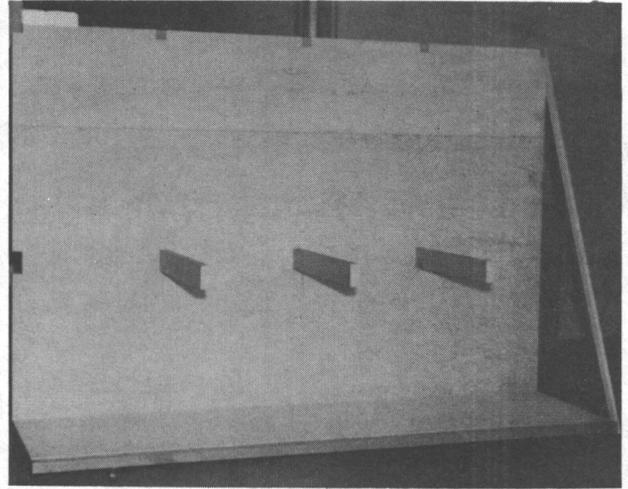


Figure 1. Sides fastened to bottom.

When the second side is in place, add the top and end crosspieces. Figure 2 shows it at this stage.



Figure 2. Second side in place.

The top cover and underside insulation and the bin-bottom slats are installed next as shown in Figure 3. Use small blocks of $\frac{1}{2}$ " plywood as spacers when nailing down the 1 x 2 slats.

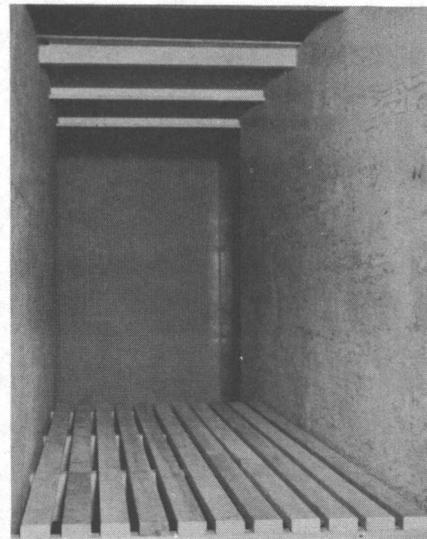


Figure 3. Bin slats installed.

Figure 4 shows the appearance from one side at this stage. The lower plywood panel is a full 4' x 8' sheet. The upper part is one piece about 16 $\frac{1}{2}$ " wide, ripped from another sheet. The joint between the two should be carefully fitted by planning the edges to get them to butt tightly together. This joint should be at the top and not the bottom, since the pressure below the bin is enough to cause considerable air leakage even with a well fitted joint.

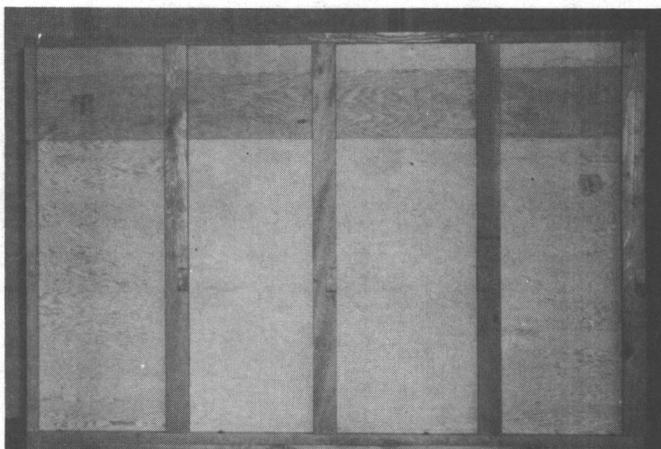


Figure 4. Full side view.

The insulating panels can next be fitted to the sides, setting them in between the studs. It was found that the insulating panels could be used more economically by cutting these across the 4 x 8 sheet. This necessitates a horizontal joint in these panels, which should be near the bottom to prevent it being in line with the joint in the plywood. Fasten these panels in with strips the same as for the bottom. The finished appearance is shown in Figures 8 and 9.

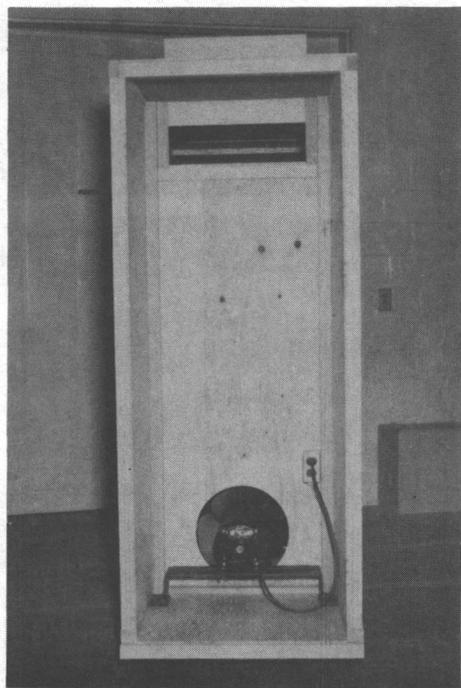


Figure 5. Motor and fan in place.

The next step is to install the dividing panel at the rear of the bin. This must first have the hole cut for the fan, just enough larger so the blades can turn without interfering. Excess clearance here will reduce fan efficiency. Also the recirculating opening, regulating slide, and slide frame at the top should be finished before the panel is installed. The panel is held in place by 2 x 2 pieces in the corners and a 1 x 2 piece across the bottom behind it. The 2 x 2 pieces are nailed through to the 2 x 4 studs on the outside and the panel nailed to them from the bin side. The regulating slide comes out through a slit in the top cover of the rear cover panel. Figure 5 shows this stage of construction with motor and fan in place.

Figure 6 shows the rear again, with the upper outside back panel in place (install the insulation to the inside before putting it on), and the lower removable panel with its metal fresh-air duct ready for installation. It is held in place with two wooden turn-buttons at the top corners. The lower edge rests in a grooved 1-inch crosspiece at the bottom as shown on the drawing.

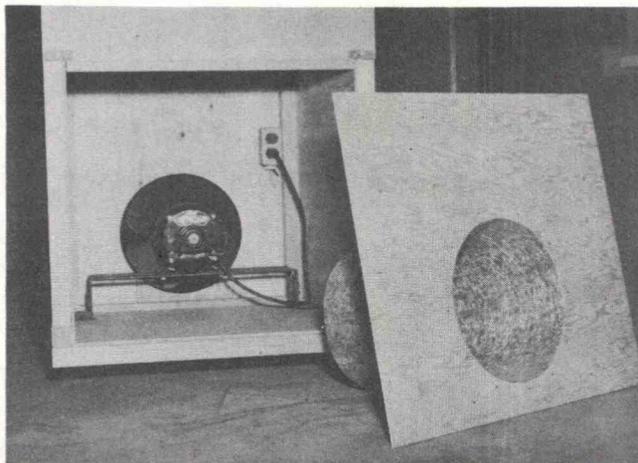


Figure 6. Fresh air duct.

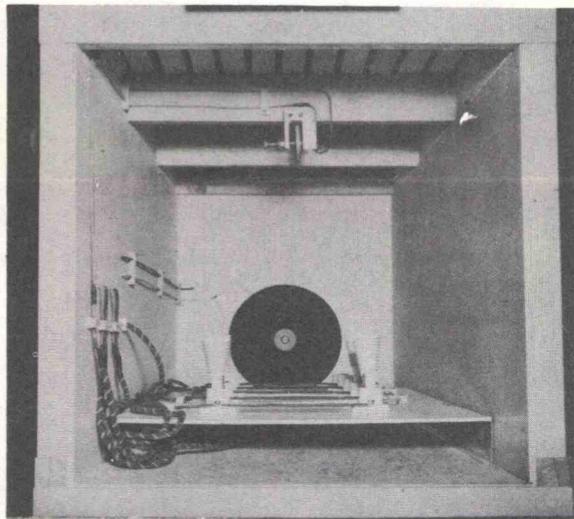


Figure 7. Heating chamber.

Figure 8 shows the wiring and switches on the outside. The switches are mounted to the plywood and the insulation fitted around them afterward. The input lead is an electric range "pig-tail" which goes into the junction box, with the fan switch directly above. The five heater control switches are next in order, and the socket under the fifth switch is for the pilot lamp which tells when the last pair of elements from the fan is on. This pair is connected through the thermostat. Solder

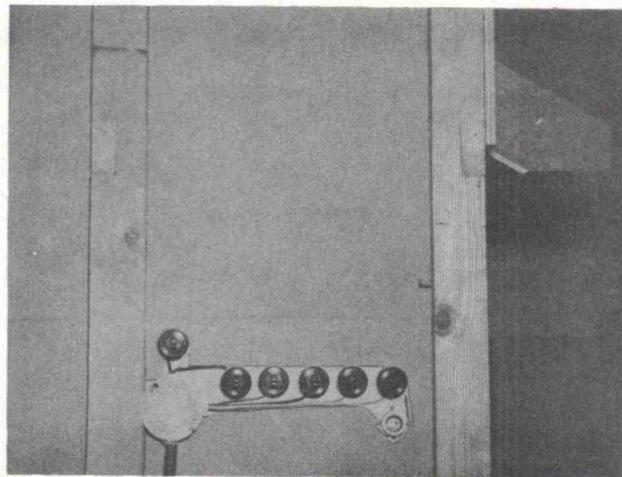


Figure 8. Control switches.

all connections and tape with vinyl-plastic electrician's tape, which withstands heat better than rubber or friction tape. The power source is 220-volt 3-wire and should terminate in a standard range outlet, into which the "pig-tail" of the drier is plugged.

Figure 9 is a view of the completed drier, with the upper and lower front panels in place, held by the sash locks. The sacking chute is in place with safety corks pushed over the sharp sack-holding hooks. The unloading gate slides in a $\frac{1}{4}$ " deep groove in each side of the chute and is shown in the open position.

The cover photo shows the drier with sack in place and ready to start unloading nuts at the end of the drying period. The upper front or unloading door, is removed after the nuts have stopped running out on their own accord.

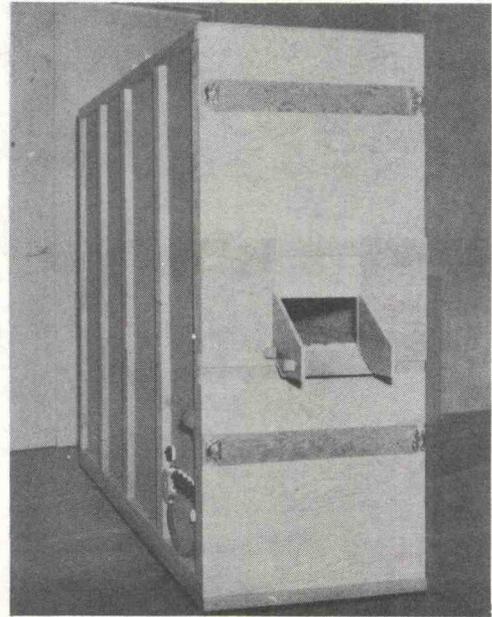


Figure 9. Completed drier.

Figure 10 shows how the remainder of the nuts are pulled forward and out the chute by using a hoe or rake. The unloading operation is very easy and fast.

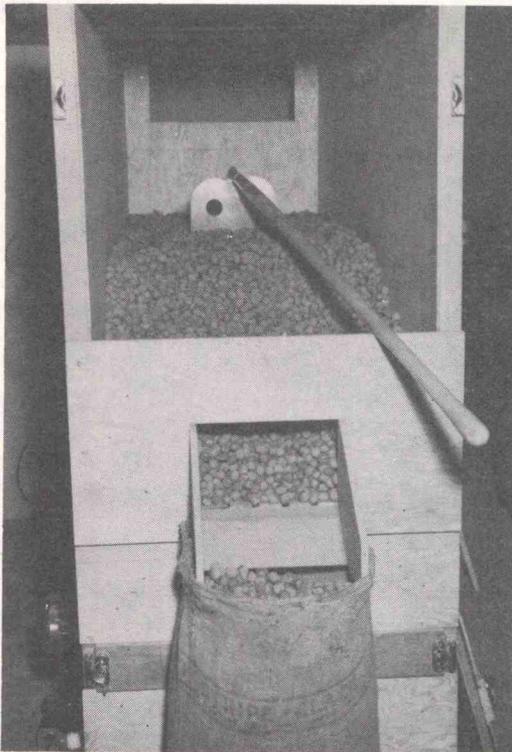


Figure 10. Unloading operation.

Loading is not difficult, as the nuts can be dumped in through the top center opening after that panel has been lifted out. Some sort of platform about 2 feet high is needed to stand on so the operator can lift the sack of nuts to the top easily. A platform about 2 feet square, and 2 feet high could readily be constructed, having steps on one side (2 or 3 risers) for easily mounting the platform with a sack of nuts.

A line should be drawn around the inside bin wall 24 inches above the top of the bin bottom slats. This level indicates the proper depth of load for normal operation, and is a help in getting the load properly leveled on top. This is important, as uneven depth will result in uneven drying. The nuts will dry faster where the depth is less, since more air will be pushed through the thinner layer of nuts.

Construction

After the drier has been filled with a load of wet nuts, the recirculation opening should be closed by pushing the slide clear down, and the opening in the loading door panel opened fully by pulling the slides out at each side. Start the fan, and then turn on all the heaters.

The thermostat should be adjusted to cut off at 100° F. This can be checked by hanging a well-shielded, accurate mercury thermometer under the bin at the front, where it can be read quickly after the lower door is removed. Be sure the bulb of the thermometer is shielded from the radiant heat of the heater elements. This can be done by having an open tin-can-metal shield fastened loosely around it. Leave enough space for free air circulation. The pilot lamp will tell you when the thermostat cuts off, as the lamp will go out. When it stays off most of the time, as it will after the load warms up in about 3 or 4 hours, switch off one pair of heaters (the second pair from the front). As soon as the free moisture is all gone from the nuts on top of the load (about 4 or 5 hours) open the recirculation duct slide 1 inch and close the exhaust slides, 1 inch on each side. The air being discharged is now less than saturated, and by recirculating some of this air, heat is conserved. This warm air will be drawn through the recirculation opening, down the back, and forward through the fan, where it mixes with the fresh cold air coming in through the fresh air duct. This duct is installed this way so that the cool incoming air flows directly over the motor and prevents it from overheating.

After recirculation is started, the temperature will start to rise as evidenced by the pilot lamp staying off more of the time. Soon it may be necessary to switch off another pair of heaters (the third pair from the front).

The number of heaters left on steadily is governed by the amount of time the thermostatically controlled heaters are on. If they stay on steadily, switch on another pair; if they stay off almost altogether, switch off another pair. Best control is attained when the thermostat is cutting off and on regularly every few minutes.

An easy way to check on this is to connect a self-starting electric clock in the pilot lamp socket by using a side-outlet auxiliary socket. The clock will run only when the thermostat and the pilot lamp are on. The number of minutes the clock runs in an hour elapsed time indicates the relative amount of time the thermostat is on. If it runs less than 10 minutes per hour, the safe thing to do is switch off one pair of heaters. Otherwise the temperature may go too high.

As most people who have experimented with walnut or filbert drying know, high temperatures are very detrimental to nut quality. The only time it is safe to go above 100° F. is during the first part of the drying period when the rapid evaporation of the free moisture on the outside and in the shell outer portion produces a cooling effect. This prevents the nut meats from becoming too hot, although the air temperature may be somewhat over 100° F. The highest safe temperature for the first 4 hours is 108° F. in any case.

As the nuts become drier, the air being discharged carries less and less moisture, so more of it can be recirculated, thus saving heat. After about 6 hours open the slide to 2 inches, and close the exhaust opening a corresponding amount. Each 4- to 6-hour period thereafter, open the recirculation slide another inch and close the discharge-opening slides a corresponding amount. After 24 hours the recirculation slide will be pulled up to the 7 inches, or wide-open, position and the exhaust closed until there is only a 3-inch opening between the slides. This opening must never be closed completely. By this time the heat requirements will be reduced to the point that only the first pair of heaters next to the fan, plus the last pair on the thermostat, will be needed to maintain temperature, unless the fresh air is quite cold.

About 30 to 36 hours' operation should be sufficient to dry either walnuts or filberts. In general, the filberts tend to be a little slower in drying. Walnuts are dried sufficiently when the thin membrane between the two halves of the meat becomes brittle so that it will break readily.

It is more difficult to tell when a filbert is dried sufficiently. The usual test is to sample, and when the meat seems crunchy instead of rubbery between the teeth, it is dried enough. Overdrying of filberts will cause unnecessary shrinkage of the nut meats.

Bill of Material
500-pound capacity electric nut drier

Lumber: Grade B or better. Must be thoroughly dry.

2 pieces 2" x 4" x 8'
 2 pieces 2" x 4" x 10'
 4 pieces 2" x 4" x 12'
 8 pieces 2" x 2" x 8'
 1 piece 2" x 2" x 12'
 6 pieces 1" x 2" x 12'
 1 piece 1" x 2" x 8'

Plywood: Exterior type, Grade BC.

6 sheets 1/4" x 4' x 8'
 1 piece 1/2" x 1' x 2'
 1 piece 3/4" x 16" x 28"

Insulating board: 1/2" Fir-Tex or similar.

4 sheets 1/2" x 4' x 8'

Asbestos flex board:

1 sheet 1/8" x 4' x 8'

Galvanized sheet steel:

1 piece 22 gauge, 30" x 48"
 1 piece 24 gauge, 20" x 48"
 1 piece 24 gauge, 14" x 38 $\frac{1}{4}$ "

Casters: 4 - 2" or 2 $\frac{1}{2}$ " diameter x 1 1/16" wide, iron wheels, plate style.

Sash locks: 4 - pressed steel type, for double-hung windows.

Nails: 2 pounds 3d galvanized shingle
 1 pound 8d finish
 1 pound 10d finish
 1 pound 16d finish

Screw hooks: 4 - 3/16" x 3" straight right-angle style.

Saw off at bend and weld on 1/8" rod to make 9" long hook
 (less threads), for shield supports.

Wiring materials:

- 10 - Porcelain-center screw-in type heater units.
500 watt - 120 volt.
- 11 - Porcelain cleat ("Pony") receptacles.
- 6 - Surface type tumbler switches; porcelain base, bakelite covers; single pole, 10 amp.
- 1 - Wafer type thermostat for 100° F. temp. adjustable, with 10 ampere snap-action switch.
- 1 - 7½ watt, 120 volt, lamp bulb.
- 1 - Range pig-tail (cap and cord set) 3 wire.
- 1 - Range outlet, surface type.
- 1 - 4" octagon outlet box, 1½" deep, with cover.
- 5 - Federal porcelain clamp bushings, for 1/2" knock-outs.
- 20 feet - 2 cond., 14 gauge asbestos insulated heater cord.
- 45 feet - 1 cond., 14 gauge plastic insulated wire.
- 2 feet - 2 cond., 16 gauge Tyrex cord.
- 1 - Utility outlet box, 2 1/8" x 4".
- 1 Duplex convenience outlet.
- 1 - Cover for 2 1/8" x 4" outlet box with duplex outlet.
- 1 - 2-prong attachment plug.
- 24 - Porcelain cleats.
- 1 - Small roll vinyl plastic electrician's tape.

Stove bolts:

- 20 - 3/16" x 3/4" round head.
- 12 - 3/16" x 1 3/4" round head.

Wood screws:

- 12 - #8 x 1 3/4" round head.
- 12 - #6 x 3/4" round head.
- 8 - #8 x 1 1/2" flat head.
- 4 - #12 x 1 3/4" flat head.
- 4 - #6 x 1/2" round head.
- 2 - #8 x 1 1/4" flat head.
- 6 - #6 x 1/2" flat head.

Lag screws: 8 - 1/4" x 3".

Strap iron: 2 pieces 3/16" x 1 1/2" x 30", for motor base.
2 pieces 1/8" x 3/4" x 6", for sacking hooks.

Machine bolts: 4 - 1/4" x 1", motor to base.

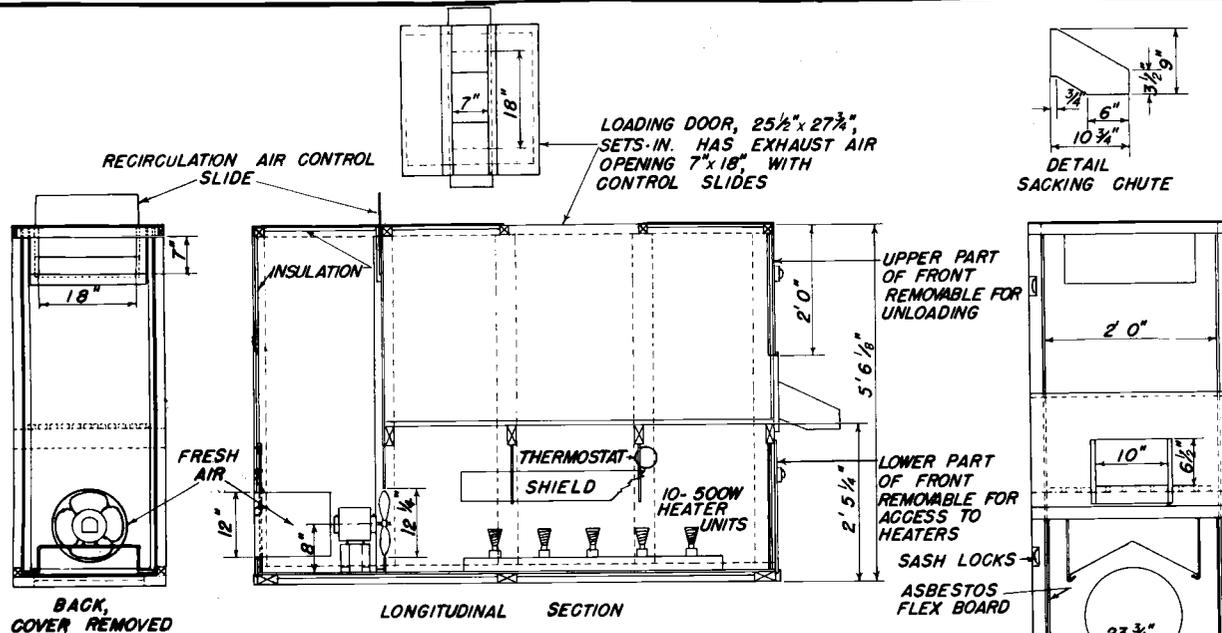
Welding rod: 4 pieces 3/16" x 3/4", sacking hooks, ground sharp.

Rubber pads: 2 - 1/4" x 1 1/2" x 4", soft rubber to silence motor,
cement under ends of base.

Fan: 12" diameter, silent propeller type, 1/2" bore hub. (Torrington #P1218)

Glue: 1 - small can waterproof resin-base glue. (Weldwood or Cascamite)

Thermometer: Mercury type, etched stem style recommended, range 0 to 120° F.



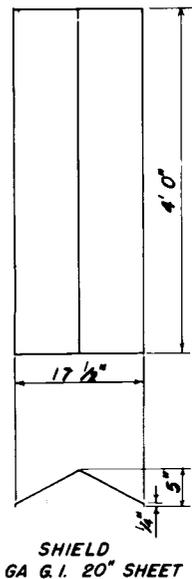
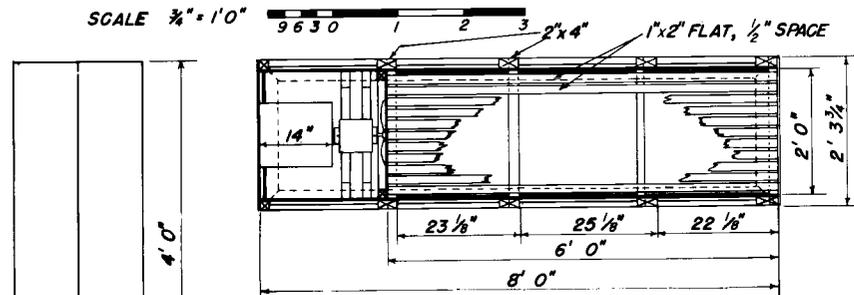
CAPACITY
500 LBS. DRY NUTS, LOADED 2' DEEP

HEAT
10-500 WATT PORCELAIN CONE TYPE HEATER UNITS. CONNECT EACH PAIR IN PARALLEL TO 110 VOLTS WITH SEPARATE SWITCH (5 TOTAL); THERMOSTAT CONTROLS PAIR NEAREST FRONT.

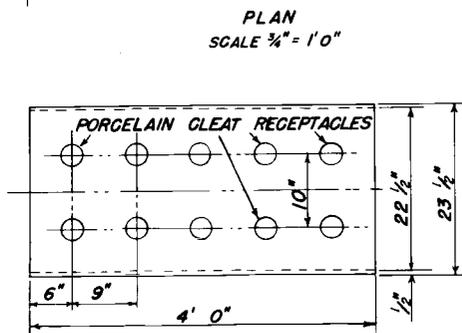
MOTOR
1/2 TO 3/4 H.P. 1725 RPM

FAN
12" 4 BLADE SILENT PROPELLOR TYPE, ON MOTOR SHAFT. AIR REQUIREMENTS - 600 CU. FT. PER MIN. AGAINST STATIC PRESSURE OF 0.15 IN. WATER.

CONSTRUCTION
PLYWOOD - 1/4" EXTERIOR TYPE GRADE B.C., BEST SIDE IN EXCEPT FOR TOP AND ENDS. INSULATION - 1/2" FIR-TEX OR SIMILAR INSULATING BOARD, SET IN BETWEEN STUDDING ON OUTSIDE OF SIDES, UNDERNEATH ON BOTTOM AND TOP, AND INSIDE INSIDE OF INSULATION. HEATING COMPARTMENT HAS 1/4" ASBESTOS BOARD LINING ON SIDES AND FRONT. SHIELD RESTS ON HOOKED ROD SUPPORTS AND MUST BE POSITIONED OVER HEATING ELEMENTS.



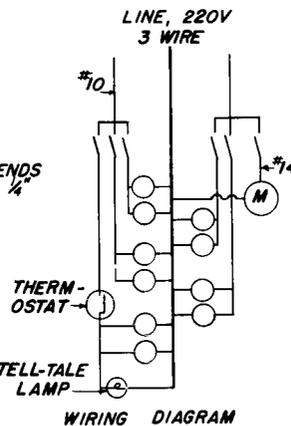
SHIELD
24 GA G.I. 20" SHEET



HEATING UNIT BASE
22 GA G.I. 30" SHEET

SCALE 1" = 1'0"

9 6 3 0 1 2 3



WIRING DIAGRAM



DETAIL REMOVABLE OPENING CONSTRUCTION

COOPERATIVE RESEARCH & EXTENSION WORK IN
AGRICULTURE & HOME ECONOMICS
OREGON STATE COLLEGE
CORVALLIS, OREGON
DEPT. OF AGRICULTURAL ENGINEERING
U.S. DEPT. OF AGRICULTURE COOPERATING

500 LB. NUT DRIER

OREGON PLAN NO. 5.36 SHEET (OF 1)

DESIGNED BY
R. N. LUNDE