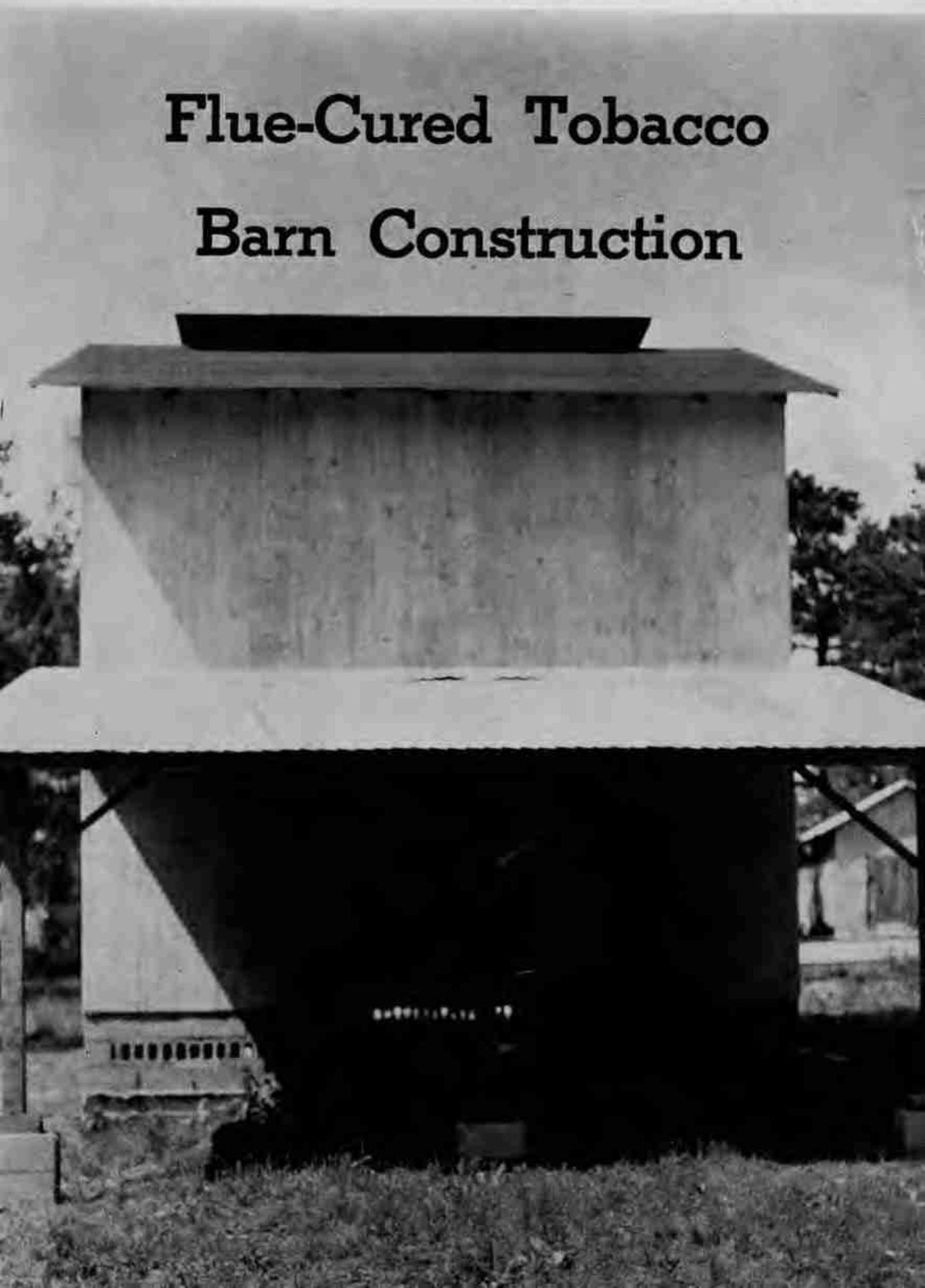
January, 1949 (Revised) Extension Circular No. 316

Flue-Cured Tobacco Barn Construction



Eliminate Fire Hazards in Barn Construction

1. Flues should be at least 12 to 15 inches from combustible sills or walls. Heating units should be at least 28 inches from combustible material.

2. Lay 15 or more inches of masonry between the furnace and any combustible part of the frame structure. Leave ½ inch air space between the masonry above the furnace and the framework. This crack can be stuffed with rockwool or other fire-proof insulation.

3. Locate the bottom tier poles high enough so that the tobacco will hang three feet above the flues or other heating equipment. (Use sticks of sufficient length.)

4. Suspend poultry wire over the furnaces and flues to catch falling sticks and leaves. (Loop tobacco securely with four-ply twine.)

5. Electric wiring of a barn should be installed by a competent electrician whose work should conform to the safety regulations of the National Electrical Code.

6. Each joint of flue pipe should be securely wired or riveted on two sides.

7. The stack elbow coming from the barn should be supported on a masonry footing or by wire.

8. The stack should be anchored at least 12 inches from the barn at four points on the stack with wire or metal bands. Allow for a clearance of 12 inches from inflammable material where the stack passes through the shed roof.

9. Better draft and less fire hazard may be expected if the stack extends about two feet above the ridge of the barn roof.

10. With the stoker "clean out" door inside the barn, remove clinkers from the barn as the "clean out" is completed.

11. Locate the barn a safe distance from other buildings.

Flue-Cured Tobacco Barn Construction

R. R. Bennett, S. N. Hawks, Jr., and R. M. Ritchie, Jr.

The high fuel and insurance cost involved in curing tobacco emphasizes the importance of proper barn construction. In many cases tobacco barns are being operated with holes in the gable ends, openings under the eaves between the rafters, and ridge ventilators that cannot be closed. In practice and under experimental conditions, it has been found that this open condition of the barn is both expensive and unnecessary.

Building Materials

Walls:

From the standpoint of efficiency and low heat loss, the old log barn is still one of the best, if properly constructed, although wasteful of timber.

Another good construction material and type of structure is the frame barn with a layer of boards or insulating board, a layer of building paper or roll roofing and a layer of boards on the outside. (Actually a layer of building paper nailed to the inside and outside of the upright studs and a layer of boards nailed to the inside and outside with a dead air space between the two layers of building paper gives a better heat retaining wall than one layer of paper between two close layers of lumber.) However, most people do not like to sacrifice the space taken up by the sealed walls on the inside of the barn. A layer of boards against the studs, a layer of building paper covered with the insulation board to which asphalt covered gravel is applied makes a good wall. (Mastic should be used in the joints.)

Roof:

From the standpoint of heat loss and to reduce the extreme changes in the temperature, solid sheathing is to be preferred. In case a metal roof is used, it should be supported with solid sheathing or insulated or both. Two-inch by six-inch rafters must be used if they are to help support the tier poles.

Insulation:

It has been found that proper insulation of the side walls and ceiling on the inside of tobacco barns gives a considerable saving in

fuel, especially if the side walls are subject to considerable air leakage and the barn has a tin roof. Tobacco barns with tight double walls with heavy building paper between and solid sheathing, to prevent air leakage, may not require insulation.

Reflective coated Kraft paper, fire resistant cotton, fiber glass, rock wool, insulation board and other efficient insulation materials may be used for insulating tobacco barns. Actually fiber board and insulation board are easier to install and with less danger of sagging as an insulation material for the ceiling.

It is not practical or economical to insulate a barn unless the insulation materials are installed securely and protected so as to insure long life. Fireproof cotton and rock wool, which are stuck to paper on one side, can be held in place by stapling poultry wire over the insulation or by strip nailing Kraft paper over the insulation. Long staples or nails should be used to hold the poultry wire and insulation in place so as not to pack the insulation tightly against the wall. Packing reduces the efficiency of the material.

Such materials as fiber glass should be protected by covering with tough Kraft paper held in place with strips of wood.

The reflective coated Kraft paper is easy to install and is probably the most economical material that has been tried to date. It shrinks some as a result of the changing temperature and moisture; therefore, care should be exercised to see that the edges of Kraft paper overlap two inches or more. Strips should be nailed along the overlap (seams) and every two feet apart where spans of Kraft paper, 3 or 4 feet wide, are used in addition to the strips to hold the paper in place. Install long rolls of insulation material vertically (up and down the walls) between the upright studs rather than horizontally with the ground.

New barns should be built with upright studs 4 feet and 4 inches on center or 24 inches on center to provide for easy installation of insulation material.

Foundation:

Fasten 2 x 6 sills to foundation by embedding bolts in the concrete foundation or in fresh concrete poured into the holes of the top layer of concrete blocks.

The high foundation is very important in that the sills and other building materials are further removed from the hot furnaces, flues and heating units.

If bottom ventilation is needed, the openings should be well distributed around the barn and small enough to prevent drafty air

currents. This can be obtained by turning one layer of four-inch concrete blocks so that the holes are open to the outside. The holes in the blocks should narrow to a quarter or half inch slit on the inside. The outer holes can then be stuffed with such material as rockwool to regulate the amount of air admitted. For detail of this block, see Fig. 2. It is important to place this layer of concrete blocks low enough so that the holes open beneath the flue level in the barn.

Tier Poles:

Tier poles should be about 22 to 26 inches, one above the other, depending on the size of tobacco being grown. Round tier poles from small trees are preferred by most growers and are highly recommended. A 2 x 6 tier pole or two 1 x 6 spaced apart with blocks of 2 x 4 between may be used.

If 2 x 6 or two 1 x 6 are used for tier poles, horizontal braces and vertical braces will be needed to make the poles rigid enough to support the weight of tobacco and the people who hang the tobacco. Notice how the horizontal braces are located and how the vertical braces are supported by the rafters at the top. If the tier poles are tied to the rafter it is essential that the rafters be 2 x 6 to carry the load. Round tier poles of sufficient size needs no bracing.

Door:

The barn door located on the opposite end from the furnace has some advantages, especially with the flue arrangement as shown in Figure 1. The foundation at the bottom of the door should **not** be high enough to interfere with handling the tobacco across since high door sills will cause breaking and bruising of tobacco.

Ridge Ventilator:

Probably the most important immediate change needed in the present barns and additions to new barns is to construct a ridge ventilator like that shown the diagram on pages 12 and 13. The reason for specifying this type of ventilator, which was developed at the Oxford Test Farm, is that the ventilator is designed to reduce the interference from outside winds with the inside conditions in the barn. For example, the flat covering over the ridge ventilator tends to allow strong winds to blow straight through between the ridge and ventilator roof. On the other hand, the usual type of ridge covering, built on the same pitch as the barn roof, tends to encourage winds to strike the curved underside of the ridge covering and be deflected down through the ventilator opening. This tends to upset

the air movements in the barn. Also the ventilator doors inside the barn are built in such a way as to further reduce the tendency for direct streams of air entering the barn. The ventilator doors are built in at least four sections (2 or more to a side) to reduce the influence of gusty winds that might be blowing against one side of the barn.

As the ventilators stand open, a sort of partition is formed to encourage the air to be expelled from each section of the barn more uniformly. (If a grower has hit upon an idea for a ridge ventilator that will prevent outside influence or cold spots and down drafts in the barn and the ventilator is satisfactory, a change would not be necessary.)

The control poles for opening and closing the ventilators may be braced against the outside of the barn as shown in Figure 8, or the ventilators may be operated by control poles braced to the tier poles and extending within about two feet of the ground on the inside of the barn as shown in the alternate plan. The ventilators may be controlled by using springs to hold the vents open and a wire or cord running under the eave to the outside of the barn to pull the vents closed. Most any convenient system that will insure positive control will be all right. A makeshift system that is apt to break down during the cure should not be tolerated.

Flue Arrangement:

The flue should be located high in the back of the furnace and should be about 10 inches above ground level where it emerges from the furnace. Give just enough elevation to insure good draft. Usually six inches of rise from the furnace to the end of the barn where the flue goes out to the stack is sufficient. If the flues draw too freely there will be excess heat loss from the stack.

If there are areas in the barn where the tobacco does not cure out easily, try additional flues or check the ventilation control.

Automatic draft controls may be installed in the flues as they emerge from the barn to control the draft and reduce heat loss from the stack. These controls will also aid in drawing more heat to the cold side of the barn. Small fans have been used successfully at Oxford to circulate the gasses in the flues. These fans in the flues serve to circulate the gasses to get most of the heat out and to reduce stack loss.

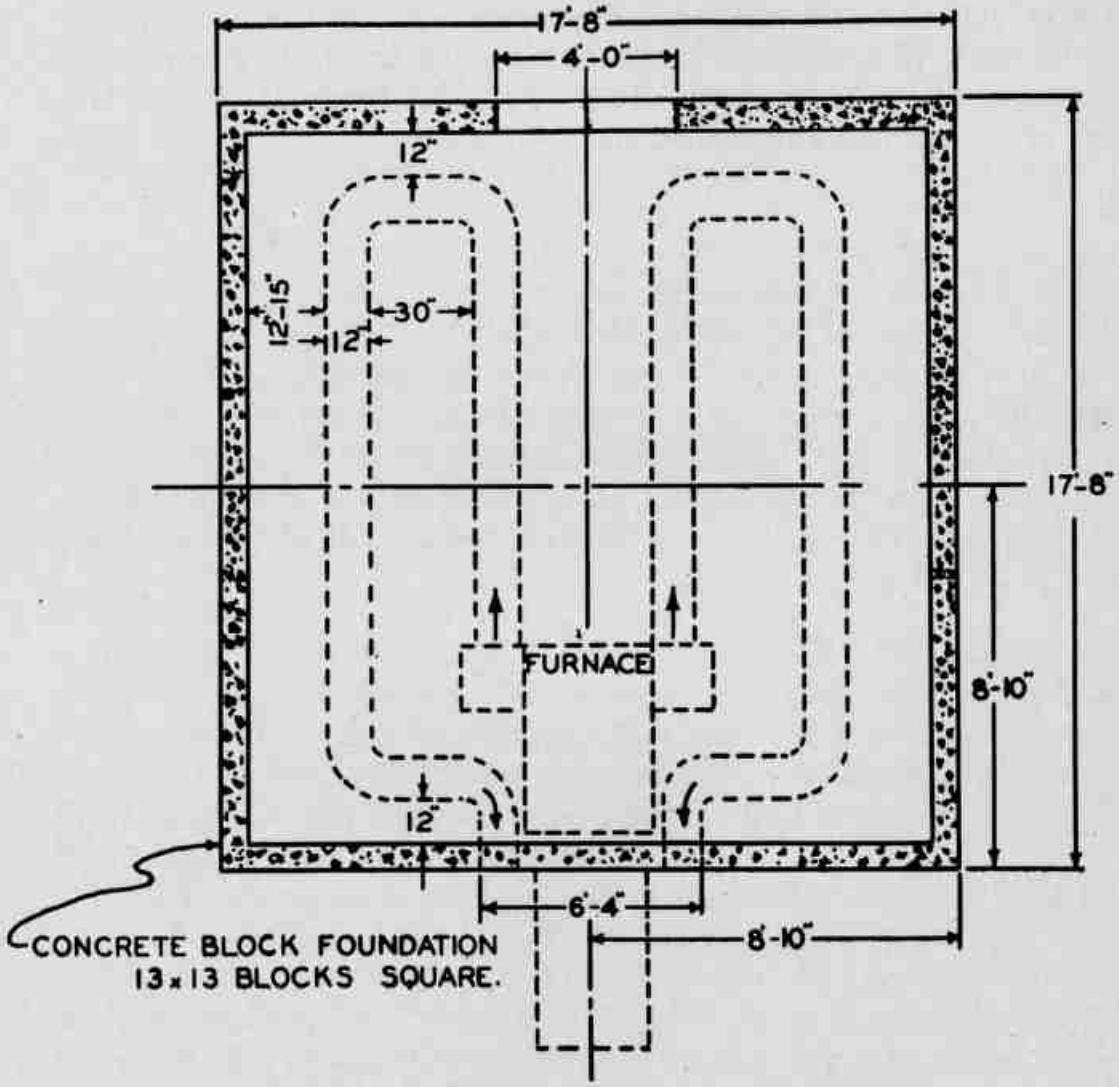
Stoker Furnace:

In building a stoker furnace, it is highly important to use a very thin smear of cement between bricks (dip the edges to be smeared

into a thin mixture of high temperature cement). Thick layers of cement tend to crumble and fall out. Use high temperature cement mortar between the brick layers.

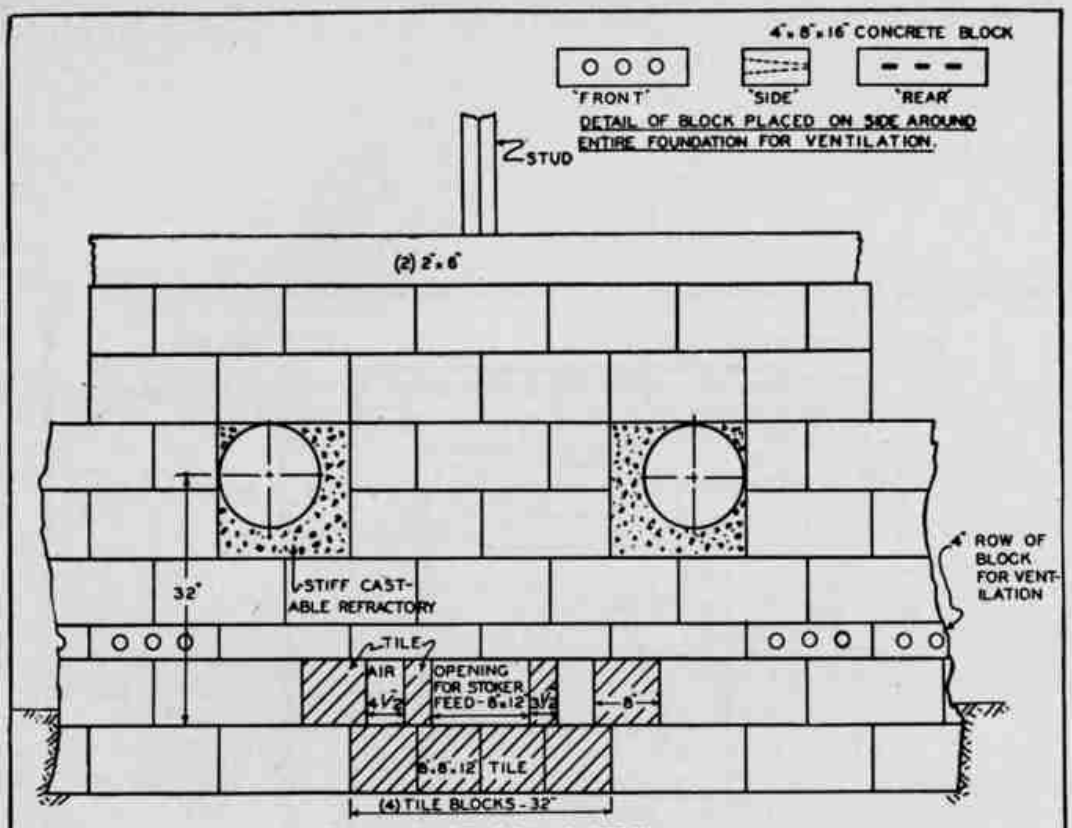
The shape of furnace shown in the top view (Figure 9) has the advantage of avoiding direct radiation or glare from the heat which causes red fire joints. This system reduces the difficulty from red-hot fire joints.

Stoker furnaces should have a large sheet of metal, 16 gauge or heavier, lying on top and extending about one foot over the end of the furnace. This sheet of metal will spread the heat and protect the top of the furnace from careless feet. Set brick up around the edge of the furnace to support the sheet metal.



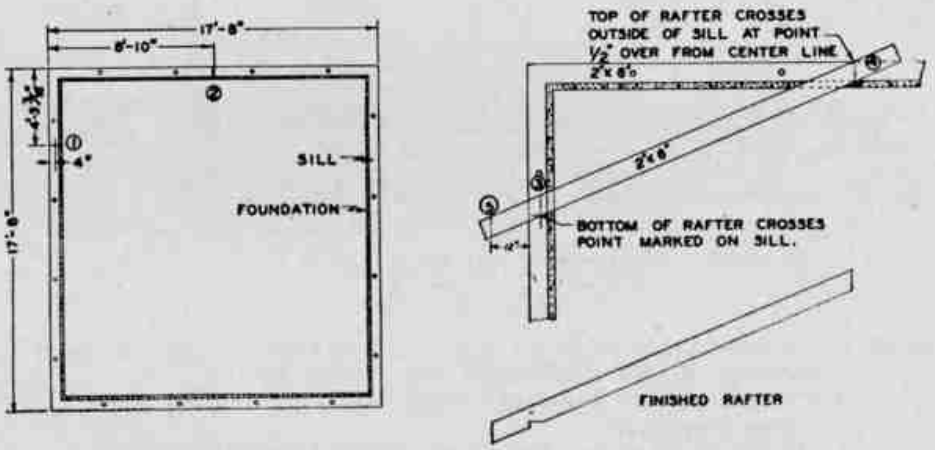
PLAN VIEW OF FOUNDATION AND FLUE ARRANGEMENT

FIG. 1



FOUNDATION VIEW

FIG. 2



PATTERN RAFTER MUST BE CUT BEFORE STUDS ARE ERECTED

STEP 1

① MARK THE SILL AND FOUNDATION $4'-3\frac{3}{16}"$ DOWN FROM CORNER THEN MARK 4" FROM OUTSIDE OF SILL.

② MARK THE SILL AND FOUNDATION AT THE CENTER THEN MAKE A MARK 1/2" OVER FROM CENTER LINE TO ALLOW FOR RIDGE BOARD.

STEP 2

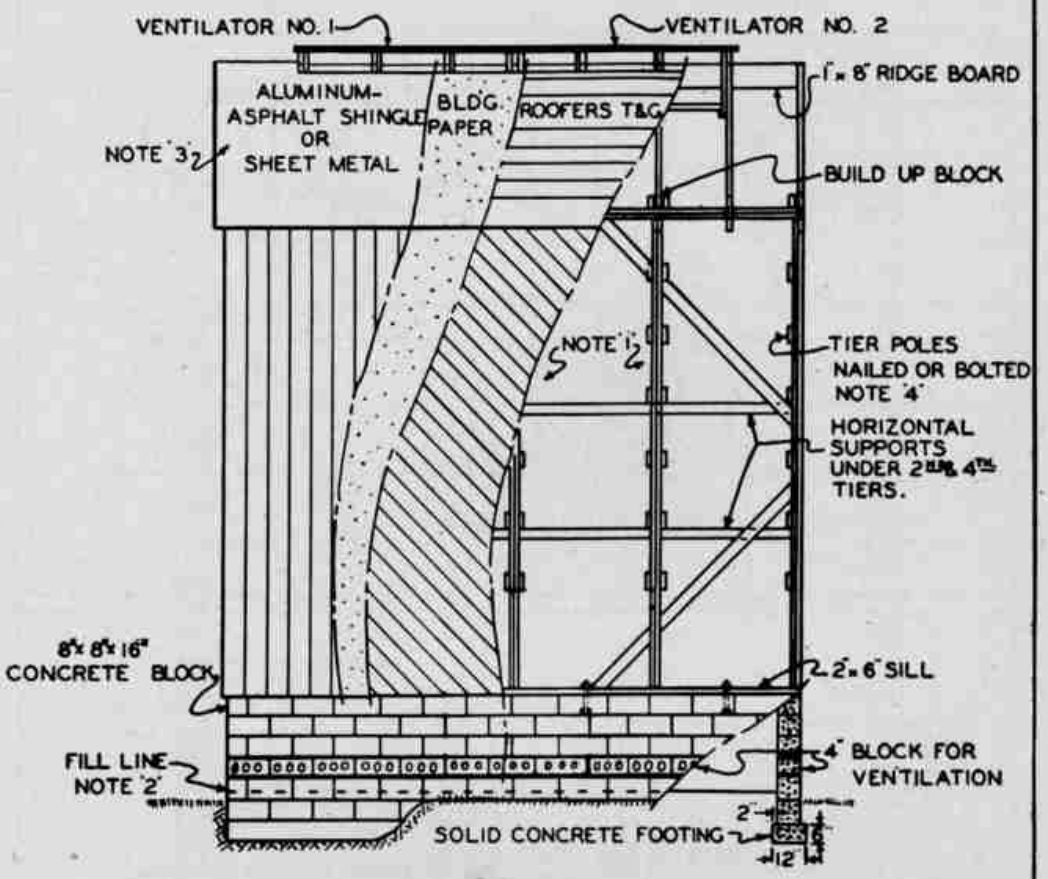
③ PLACE SQUARE ON RAFTER — ALIGN WITH OUTSIDE OF SILL AND LINE ON SILL AND FOUNDATION. MARK RAFTER NOTCH.

④ PLACE SQUARE ON RAFTER — ALIGN WITH OUTSIDE OF SILL AND LINE ON FOUNDATION WHICH IS 1/2" OVER FROM CENTER LINE. MARK RAFTER.

⑤ MARK RAFTER PARALLEL TO AND 12" AWAY FROM OUTSIDE OF SILL.

FIG. 3

RAFTER CUTTING PROCEDURE

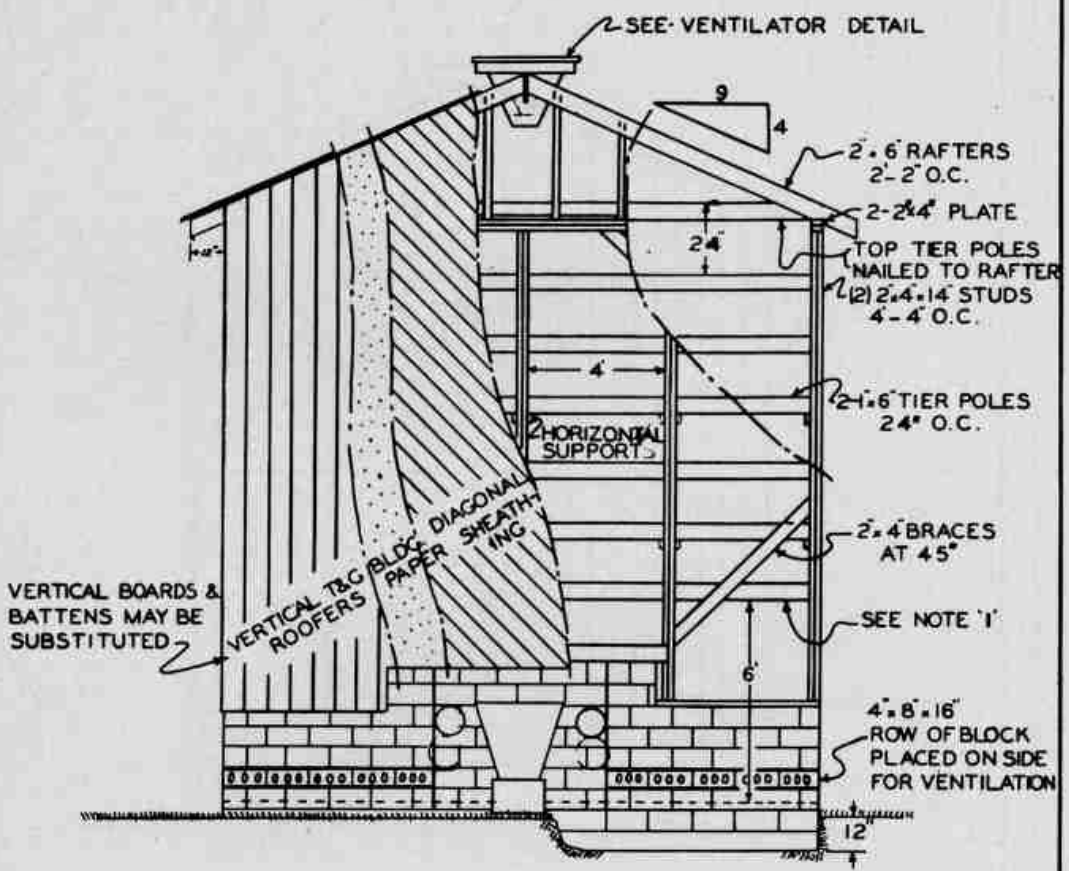


SIDE VIEW

FIGURE 3

NOTE: 1. 4" WIDTHS OF INSULATION INSTALLED BETWEEN STUDS WITHOUT CUTTING - BEFORE TIER POLES ARE INSTALLED.
2. 6" FILL INSIDE OF BARN NECESSARY IN EASTERN PART OF N. C. FOR DRAINAGE.
3. USE SOLID SHEATHING EVEN WITH SHEET STEEL ROOFING.
4. SHORT 2"x4" BLOCKS MAY BE USED TO SUPPORT TIERS ON STUDS.

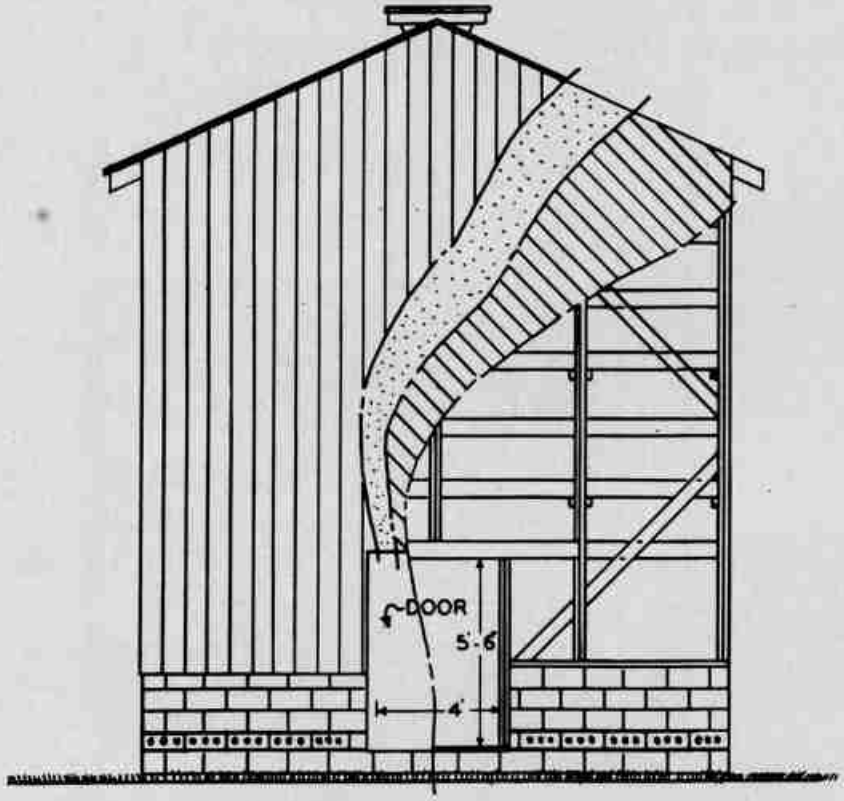
FIG. 4



END VIEW

NOTE: 1 - ROUND TIER POLES ARE GENERALLY PREFERRED TO 1×6 POLES IF AVAILABLE.

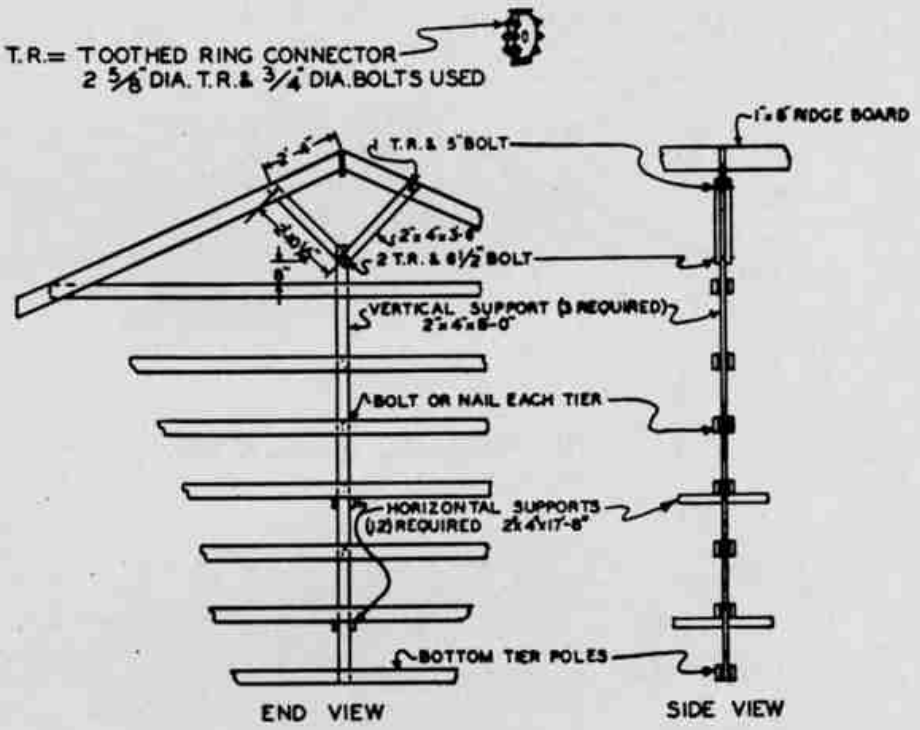
FIG. 5



END VIEW

OPPOSITE END FROM FURNACE - SHOWING DOOR

FIG. 6



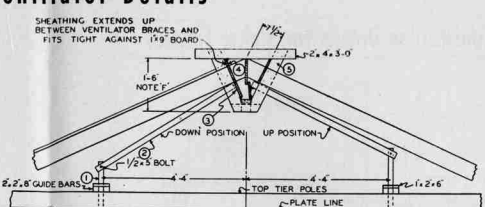
HORIZONTAL & "VERTICAL SWINGING" SUPPORTS

FOR TIER POLES AND BRACES

TOBACCO BARN - FLUE CURED

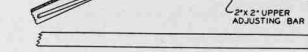
FIG. 7

Ridge Ventilator Details

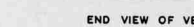


VIEW SHOWING ALTERNATE METHOD OF OPERATING VENTILATOR

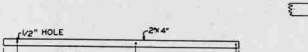
END VIEW OF VENTILATOR



① VERTICAL ADJUSTING BAR (2 PER VENTILATOR)



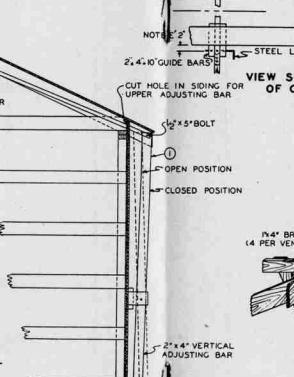
② UPPER ADJUSTING BAR (2 PER VENTILATOR)

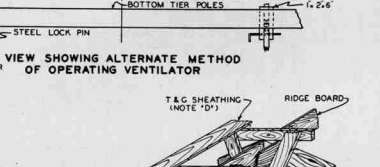


③ VENTILATOR DOOR (2 PER VENTILATOR)

④ 1"x8" x 2'-2" BOARD (2 PER VENTILATOR) (CLOSE DOOR BEFORE NAILING TO INSURE GOOD FIT)

⑤ BRACE (4 PER VENTILATOR)





VIEW OF VENTILATOR FRAMING

NOTE: A - 2 VENTILATORS REQUIRED FOR THE INCLUDED BARN DESIGN
B - THE VENT, MAY BE SHORTENED TO INSTALL BETWEEN EACH ROOM OF A CONVENTIONAL BARN.
C - ALL LUMBER SHOULD BE WELL SEASONED TO AVOID WARPAGE AND SHRINKAGE. THE EFFICIENCY OF THE VENTILATOR DEPENDS UPON TIGHTNESS OF FIT.
D - 1 PIECE OF HEAVY ROLL ROOFING 3'x14' MAY BE USED OVER SOLID SHEATHING TO COVER BOTH VENTILATORS.
E - TO INSURE FULL MOVEMENT, DRILL HOLES FOR ADJUSTING VENTILATOR OPENING AFTER VENTILATOR IS ASSEMBLED.
F - LOCATE BOTTOM OF VENTILATOR FRAME 1'-6" BELOW TOP OF RIDGE ACCURATELY.
G - USE OF ANGLE BRACE WILL HELP PREVENT WARPING OF THE DOOR
H - TWO METHODS OF OPERATING THE VENTILATORS ARE SHOWN. THEY MAY ALSO BE OPERATED BY USING SPRINGS TO HOLD THEM OPEN AND PULL CHAINS OR WIRES TO CLOSE THEM.

VENTILATOR DETAILS

FIGURE 8

Construction Details For Stoker Furnace

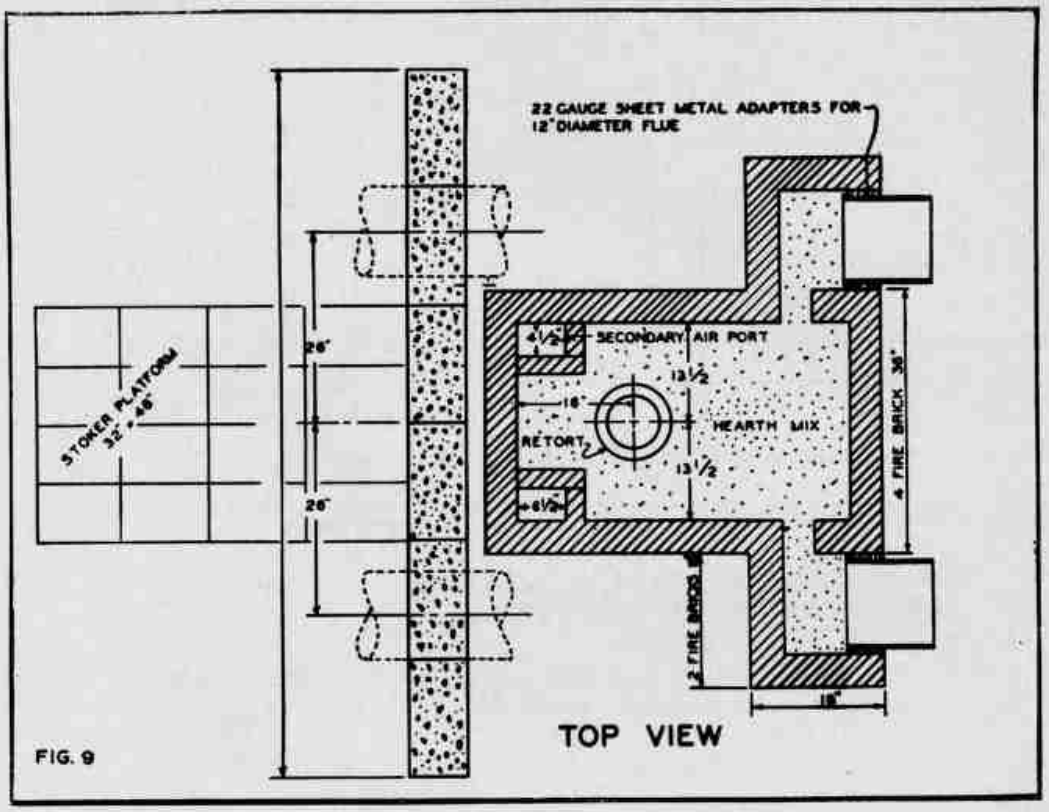


FIG. 9

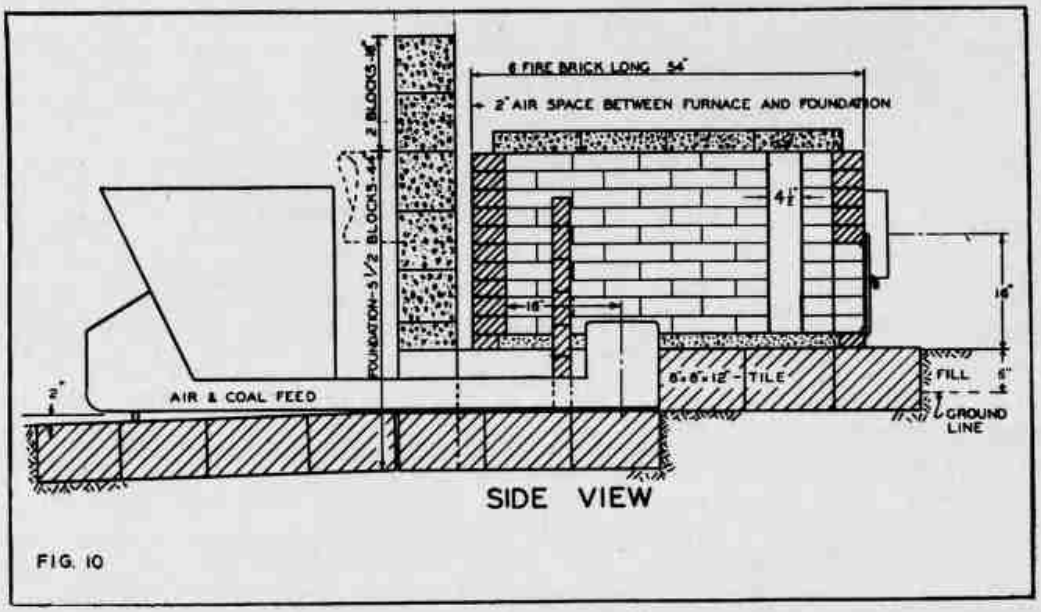
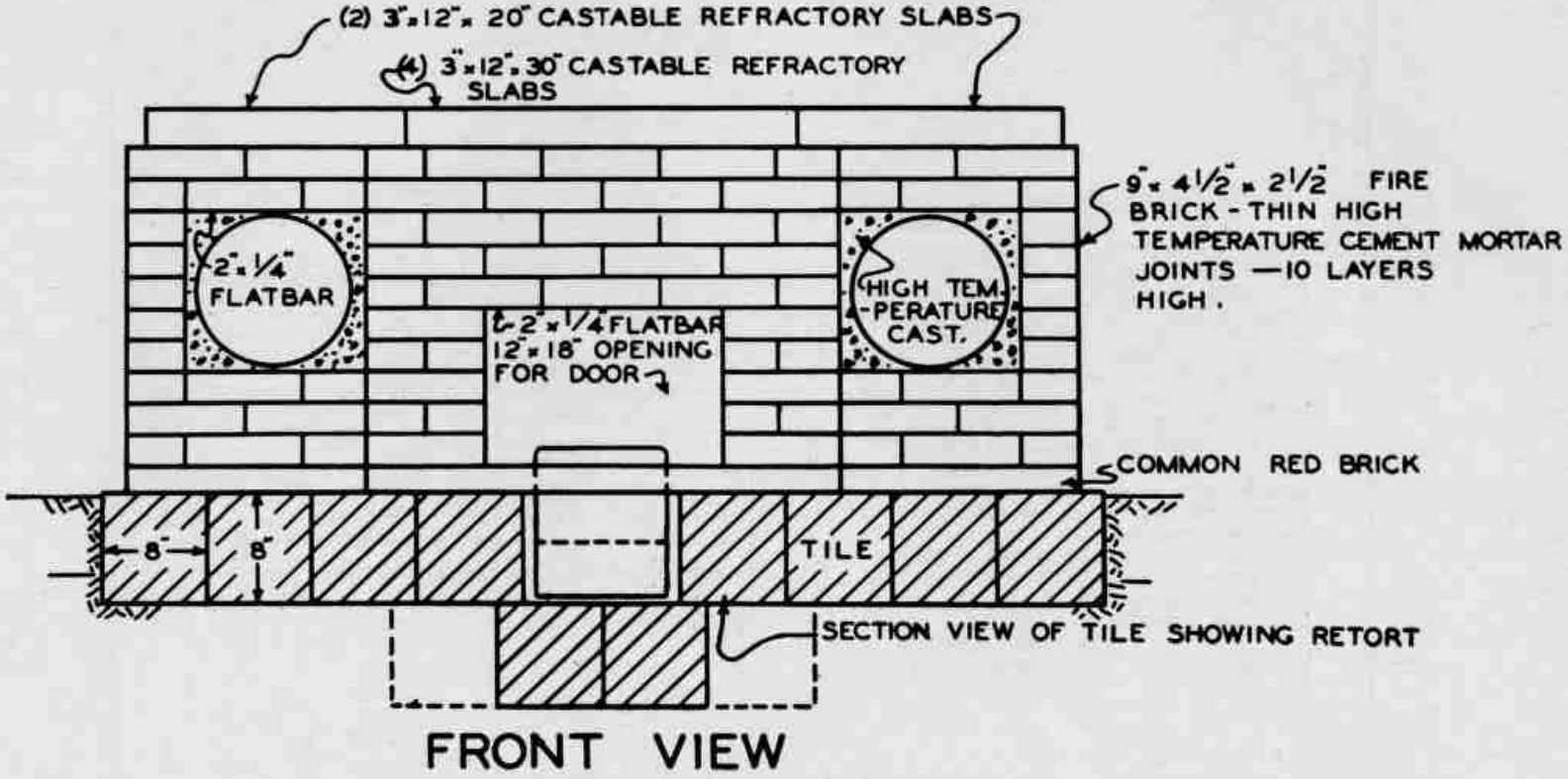


FIG. 10



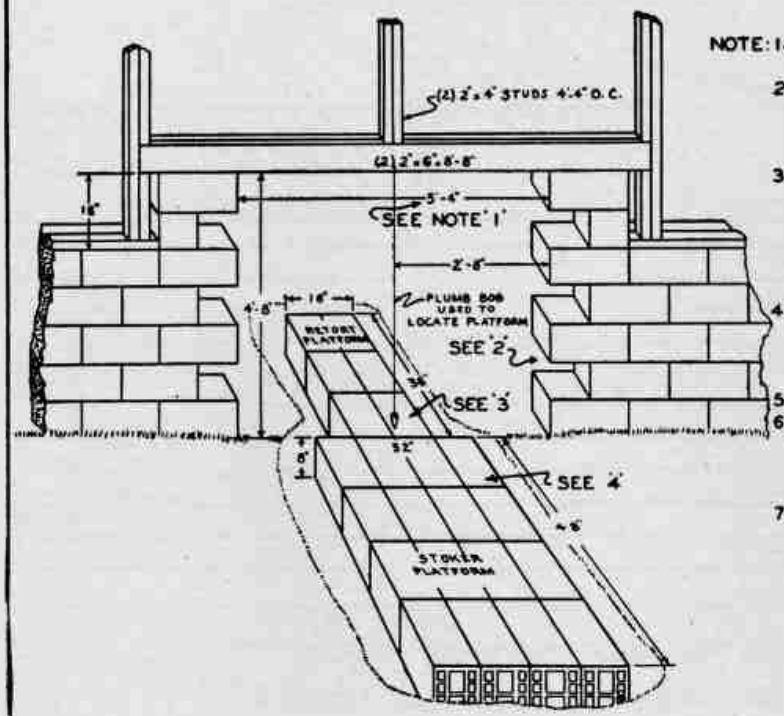
FRONT VIEW

TOBACCO BARN FURNACE - AUTOMATIC COAL FEED

FIG. 11

STEP 1

RETORT & STOKER PLATFORMS



NOTE: 1- LEAVE AN OPENING OF 5'-4" IN THE BARN FOUNDATION.

2- HALF-BLOCK MAY BE USED TO FILL IN THE 8"x8" SPACE OR FULL SIZE BLOCK MAY BE FITTED IN WHEN THE WALL IS COMPLETED.

3- DIG A TRENCH 8" DEEP FROM OUTER EDGE OF THE WALL LINE INTO BARN TO RECEIVE THE 16"x36" TILE RETORT PLATFORM. USE THE CENTER OF THE FOUNDATION OPENING TO LOCATE THE TRENCH - LEVEL THE BOTTOM.

4- DIG A TRENCH 8"x32"x48" FOR THE STOKER PLATFORM - ALLOW A SLOPE OF 1" IN 2' AWAY FROM FOUNDATION FOR DRAINAGE.

5- LAY THE 8"x8"x12" TILE AS SHOWN.

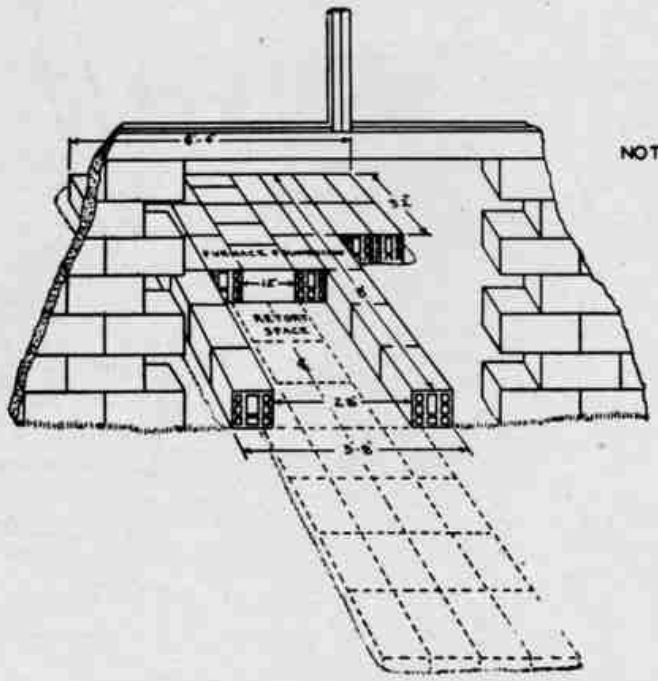
6- OTHER SIZED TILE MAY BE SUBSTITUTED IF THE PLATFORMS ARE AT LEAST THE MINIMUM SIZE SHOWN WHEN COMPLETED.

7- BACK FILL AROUND THE PLATFORMS.

FIG. 12

STEP 2

FURNACE FOUNDATION CONSTRUCTION



NOTE: 1 LEVEL AN AREA EVEN TO THE TOP OF THE RETORT PLATFORM TO RECEIVE THE TILE FOR THE FURNACE FOUNDATION.
2 NOTICE THAT THE TILE IS LAID IN THE CENTER OF THE FOUNDATION WITH ITS 12" SIDE FORWARD.
3 THE 8" FACE OF ALL OTHER ROWS IS FORWARD.
4 THE FURNACE FOUNDATION MUST BE LEVEL & 8" ABOVE THE RETORT SPACE.

FIG. 13

STEP 3

PLACING RETORT & SECONDARY AIR PORT OPENING

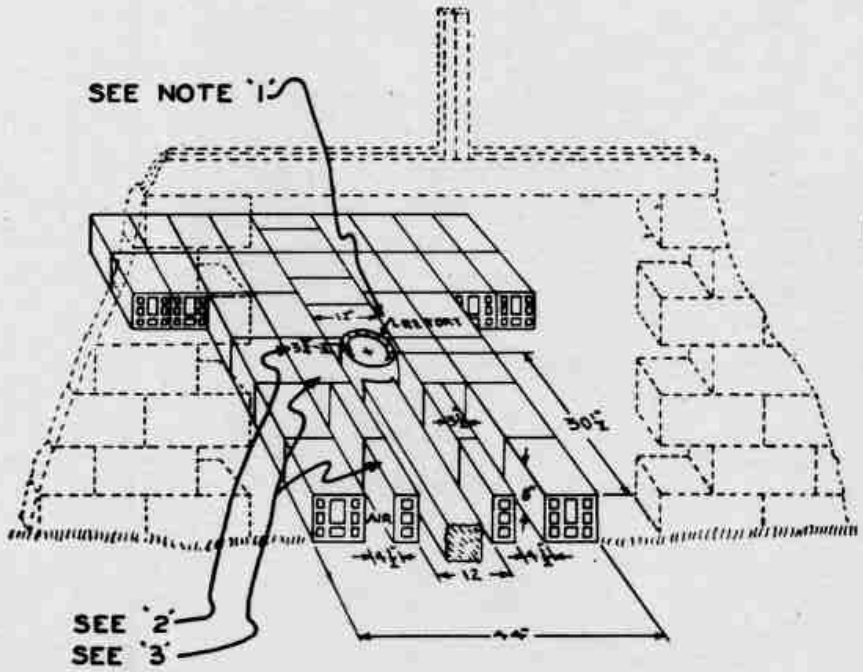


FIG. 14

NOTE: 1- PLACE THE RETORT IN THE CENTER OF THE PLATFORM 30½" FROM THE OUTSIDE OF THE FOUNDATION.
2- RAISE THE RETORT UNTIL ITS TOP IS 3¾" ABOVE THE TILE.
3- PLACE A TILE BLOCK ON EACH SIDE OF RETORT & FORM SECONDARY AIR PORTS BY SETTING 3½" TILE AS SHOWN.
4- THE STOKER - FEED - & RETORT SHOULD BE LEVELED AT THIS TIME ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS.

STEP 4

LAYING COMMON RED BRICK ON THE TILE & PLACING THE HEARTH MIX

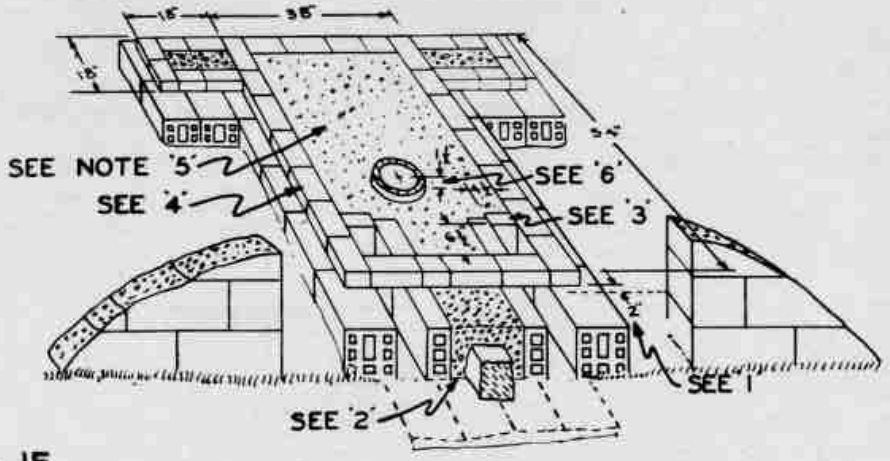


FIG. 15

NOTE: 1. CLEARANCE OF 2" BETWEEN THE FURNACE & FOUNDATION.
2. PACK STIFF HEARTH MIX OVER COAL-AIR FEED TO TOP & FRONT OF TILE OR FILL WITH SAND.
3. FRAME SECONDARY AIR PORTS BY STANDING FIRE BRICK ON END - FILL IN SPACE BETWEEN BRICK & TILE WITH HEARTH MIX.
4. LAY COMMON RED BRICK TO FORM THE FURNACE BASE.
5. FILL IN WITH HEARTH MIX TO FORM THE FURNACE FLOOR - FLOOR SHOULD BE LEVEL TO TOP OF BRICK.
6. TOP OF RETORT IS NOW 1½" ABOVE FURNACE FLOOR.

STEP 5

FURNACE CONSTRUCTION

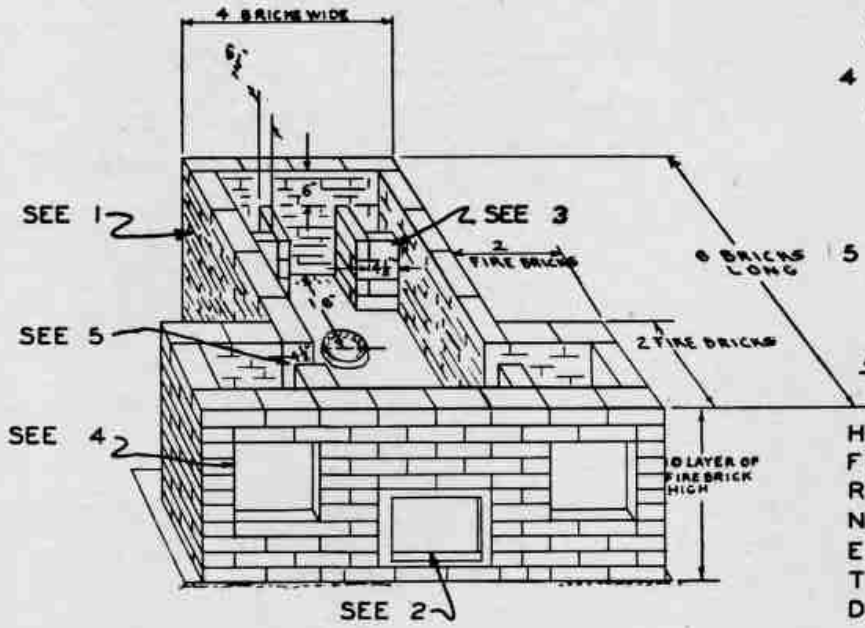


FIG. 16

NOTE: 1. HIGH TEMPERATURE CEMENT MORTAR JOINTS MADE BY DIPPING FIRE BRICK IN A THIN MIXTURE OF HIGH TEMPERATURE MORTAR & PLACING. THICK JOINTS ARE UNDESIRABLE.

2. FURNACE DOOR IN PLACE BEFORE FIRST COURSE IS BEGUN. MOUNT DOOR WITH MASONRY FASTENERS.

3. SECONDARY AIR PORT SIDE FORMED BY PLACING FIRE BRICK ON 2 1/2" SIDE- CUT BRICK TO FORM 6 1/2" x 4 1/2" OPEN. PORT IS 6" FROM TOP OF THE FURNACE.

4 FLUE OPENING BEGINS AFTER THIRD LAYER OF FIRE BRICK IS PLACED. THE OPENING IS 1 1/2 BRICKS WIDE & 5 LAYER HIGH. 2" x 1/4" x 16" STEEL FLATBAR IS LAID OVER TOP OF OPENING TO SUPPORT THE REMAIN--ING 2 LAYER OF BRICK.

5 THE 4 1/2" OPENING IS IN ALL TEN LAYER OF FIRE BRICK.

ADVANTAGES OF THE 'T' FURNACE

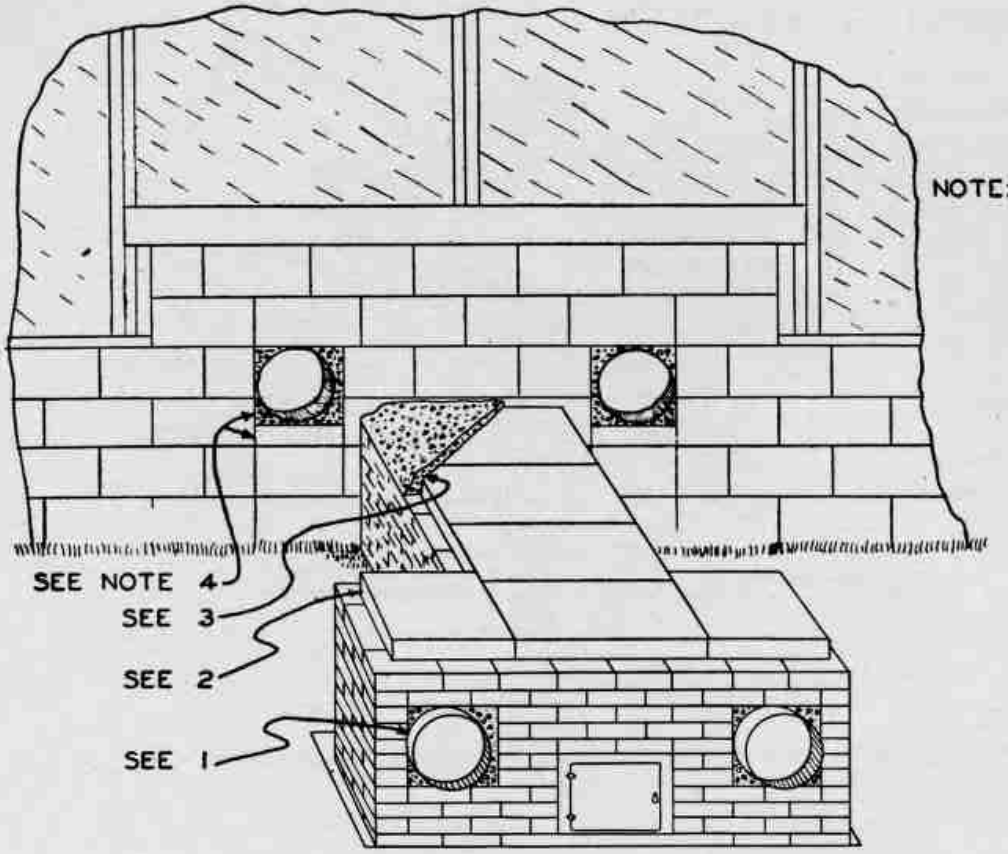
THE 4 1/2" SLOT THROUGH WHICH THE HEATED AIR MUST PASS BEFORE ENTERING THE FLUE CHAMBER & FLUE PREVENTS DIRECT RADIATION ON THE FLUE. THE FURNACE WALL NEAR THE FLUE & THE FLUE DO NOT HEAT EXCESSIVELY. IN CONVENTIONAL FURNACES THE FLUE WALL & FLUE INLET IS OVERHEATED DUE TO DIRECT RADIATION.

SECONDARY AIR ENTERS THE FURNACE 6" FROM THE TOP TO CIRCULATE THE HOT AIR AT THE TOP THROUGH THE FLUE.

THESE ADVANTAGES GIVE THE T FURNACE A MORE CONSTANT MOVEMENT OF AIR WHICH PREVENTS OVERHEATING.

STEP 6

COMPLETING FURNACE & FOUNDATION



NOTE: 1. METAL ADAPTER FOR 12" DIA. FLUE IS 12" LONG - PLACE IN OPENING & FILL SPACE BETWEEN BRICK & ADAPTER BY PACK--ING IN A HIGH TEMPERATURE CAST--ABLE.

2. CASTABLE REFRACTORY SLABS - (4) (3" x 12" x 30" & (2) 3" x 12" x 20"

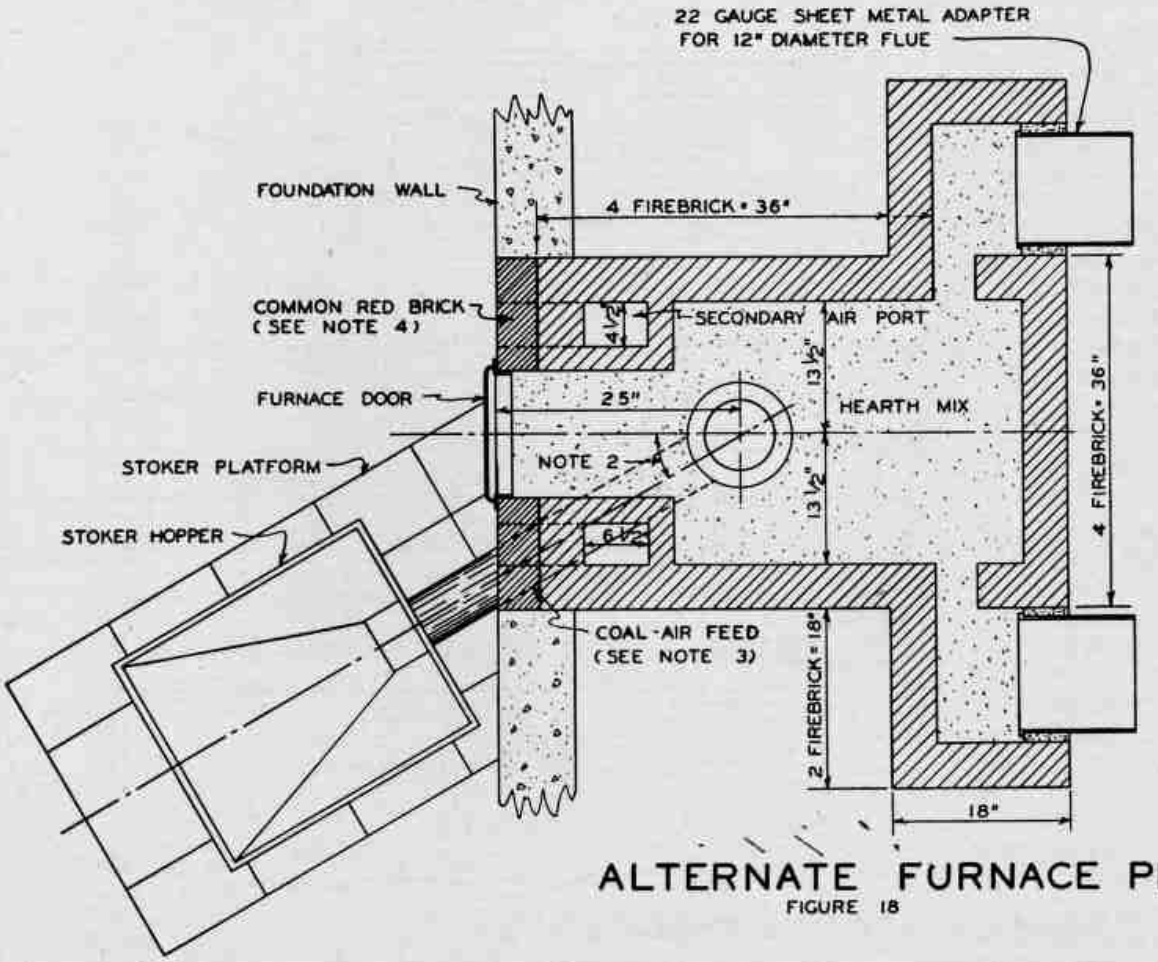
3. 1" OF CEMENT ASBESTOS OVER THE ENTIRE FURNACE TOP, NOT LESS THAN A '16 GAUGE' METAL COVERING SUPPORTED BY BRICK IS LAID OVER THE ASBESTOS TOP TO PERMIT STANDING ON THE FURNACE (METAL COVERING NOT SHOWN)

4. FOUNDATION IS COMPLETED. THE FLUES ARE INSTALLED SIMILAR TO NOTE '1' & THE TILE ENDS EXPOSED ON OUTSIDE OF BARN ARE CLOSED WITH A STIFF CASTABLE.

- REFER TO DRAWING 1 FOR FOUNDATION WALL DETAIL & COMPLETE FURNACE LAYOUT.-

NOTE: 5. FLUE ADAPTER IN FOUNDATION IS 8" HIGHER THAN THE FURNACE ADAPTER.

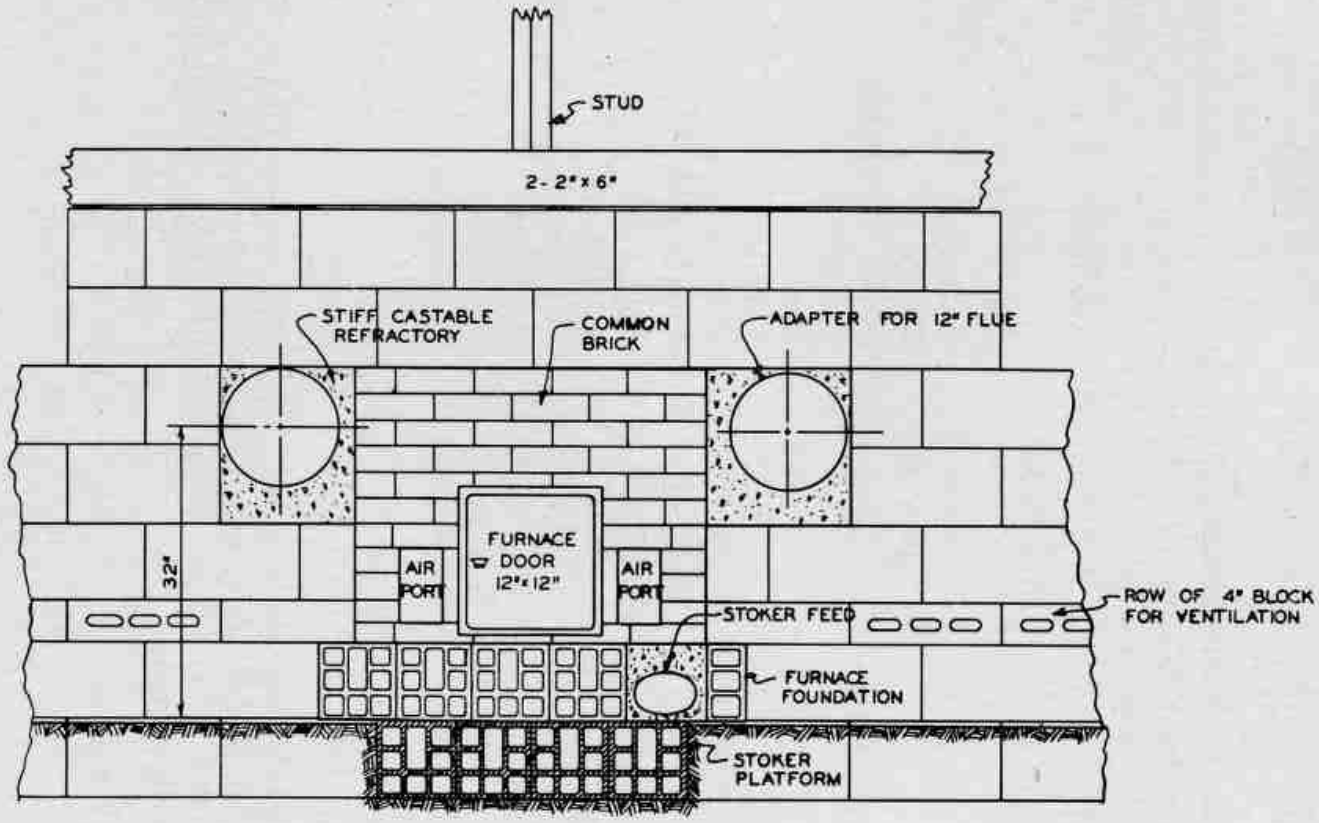
FIG. 17



NOTE: 1 - THIS FURNACE ARRANGEMENT PUTS FURNACE DOOR ON OUTSIDE OF BARN FOR EASIER CLEANING.
2 - OFFSET ANGLE VARIES FROM 30° TO 45°, DEPENDING ON THE INSTALLATION.
3 - AFTER THE RETORT AND STOKER PLATFORMS ARE BUILT, SET RETORT AND COAL-AIR FEED IN PLACE, THEN FILL IN AROUND THEM WITH TILE AND HEARTH MIX OR SAND.
4 - RED BRICK FACING ON FRONT OF FURNACE MAY BE LAID AFTER FURNACE IS BUILT. BE SURE TO GET A TIGHT JOINT BETWEEN RED BRICK AND FIREBRICK.

ALTERNATE FURNACE PLAN

FIGURE 18



OUTSIDE VIEW OF FURNACE
USING ALTERNATE FURNACE PLAN

FIGURE 19

FLUE-CURED TOBACCO BARN — BILL OF MATERIALS

Concrete:

1.25 cu. yds. 1:3:5 mix
6 bags cement
0.8 cu. yds. sand
1.3 cu. yds. gravel

Concrete Block:

250—8x8x16″
20—8x8x16″ corner blocks
50—4x8x16″

Mortar for Concrete Blocks: 1:3 mix
7 bags mortar mix
0.8 cu. yds. brick sand

Lumber:

No. pcs.	Dimensions	Use
4	2x6″x18′	Sills
18	2x6″x12′	Rafters
8	2x4″x18′	Plate
45	2x4″x14′	Studs, Ventilator
3	2x4″x12′	Ventilator
16	2x4″x10′	Braces
4	2x2″x12′	Ventilator
2	1x9″x14′	Ventilator
2	1x8″x10′	Ridgeboard
56	1x6″x18′	Tier Poles
2	1x6″x14′	Ventilator
2	1x4″x18′	Tier Pole Supports
2	1x4″x12′	Ventilator
1700	bd. ft.	Sheathing
1400	bd. ft. T&G	Roofers—Siding

Building Paper: 1200 sq. ft.

Roofing:

20—10′ sheets galvanized or aluminum roofing (for roof only) plus 3′x14′ piece heavyweight roll roofing (for ventilator cover), OR: 4.5 sqs. composition roofing (for roof and ventilator cover).

Paint: 7 gallons

Hardware:

1 pr. 8"strap hinges—(door)
8 prs. 3" strap hinges (ventilator)
12—2⅝" diam. Toothed rings (tier pole supports)
14—½ x 5" bolts (ventilator) (tier pole supports)
3—½" x 6" bolts (tier pole supports)
16—½" x 12" bolts (anchor bolts)
4—pcs. 1 x 1 x ⅛" angle iron (ventilator)
Nails, screws, etc.

Stoker Furnace Material:

60—8 x 8 x 12" hollow tile blocks
4—3½ x 8 x 12" hollow tile blocks
270—9 x 4¼ x 2½" firebrick
40—common red brick
200—lbs. hearth mix
100—lbs. high temp. cement mortar
4—3x x12 x 30" castable refractory slabs
2—3 x 12 x 20" castable refractory slabs
100—lbs. cement asbestos mortar
4—sheet metal adapters for flues
1—furnace door and frame

For alternate furnace plan, with furnace door on outside of barn, add 40 common red brick.

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