

HOW TO ERECT A POLE-TYPE CLEAR-SPAN BUILDING



MICHIGAN STATE UNIVERSITY

COOPERATIVE EXTENSION SERVICE — EAST LANSING

DEPARTMENT OF AGRICULTURAL ENGINEERING

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How to Erect a Pole-Type, Clear-Span Building

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Introduction

Clear-span construction is quite new in farm buildings, although this principle has been recognized and used in industry for some time. Rural contractors and farmers generally do not know how to use this construction, which is easier than conventional construction and which can be done with unskilled labor.

If you plan to construct this type of building, you can save time by doing the operations in a certain order, as outlined here. You can get information on building the clear-span trusses in Michigan State University's Farm Building Series Circular 732, "Clear-Span Roof Construction."

Preliminary Planning

Choose the site carefully—this will determine how useful and efficient the building will be.

- Decide on the finish floor grade when laying out the building. Make the floor high enough to drain water away from the building and not allow it to stand in driveways or doorways. An 8- to 12-inch rise in the floor above the ground level is enough. This may require filling.
- Consider fire safety in locating buildings. If the building is 15 feet or higher, leave 75 feet between buildings to fight fire. Smaller buildings need less space between them.
- Locate all buildings for working ease. Cut down on as much walking and hand labor as possible. Plan the chore routes of both men and machinery as you plan the building.
- Plan for the future. Plan for possible expansion without loss of time and materials. Don't block the ends of storage and livestock buildings with permanent buildings such as milk houses, silos, or feeding facilities. If you leave room, you can easily remove end walls and add sections to the building.
- If you want an open building, leave it open on the south or east. This will be best for keeping

snow and rain from blowing in. Also, the building will block the cold north and west winds from blowing across the lots. If possible, run the ridge at right angles to the nearest side of the paved lot, so the roof water will not run across the paved lot. Where there is an unequal slope on the roof, place the short side of the roof toward the lots. Install eave troughs and suitable down spouts.

- In structural design, estimates must be made of the probable loads expected. Loads affect the size and spacing of members, the design of the joints and the foundation. Michigan State University plans are designed for a roof load of 25 psf (pounds per square foot) plus a dead load of 5 psf. This makes a total roof load of 30 psf. In some sections of the United States, where snow and ice are less important, lower values are used.

Choosing Poles

Choose poles which have been commercially pressure-treated with a permanent type preservative in accordance with TTW 571 or REA regulations. Ask for poles that are branded on the side. These brands identify the amount and quality of treatment. Poles marked or tagged on the ends are not well branded because one end of a pole is put in the ground and the other end is cut off when the building is put up—you lose the brand.

Using Native Lumber

Pole buildings and trusses are designed for a number two Douglas fir or its equivalent. You can use good native lumber if it is properly cut and dried. Where strength is important, do not use boards with large knots or other defects, or those which are warped and twisted. Select the best lumber for joists, rafters, girders, and trusses. You can use the poorer material for roof girts and bracing.

For glued construction, use planed lumber. The ends of the boards at a glued joint must be the same thickness. Do not use warped or twisted lumber.

Joint Design

The joints are usually the weak points in farm building construction. Make the joints as strong as the wooden members. If you use poor or too few fasteners, you reduce the strength of the whole building. Use nails, bolts, or other fasteners as shown in the plan.

Pole construction has just a few joints, so each joint must be strong. The common nail or spike is not strong enough for pole buildings. Nails used in pressure-treated material are even weaker because of the lubricating effect of the preservative. Deformed nails (ring shank or screw shank) are recommended. Oil-hardened nails are harder than regular steel nails, so you can use a thinner shank to reduce the chance of splitting. Oil-hardened nails cost more per pound, but there are more nails in a pound, so the cost per nail is about the same. Use two nail sizes: 40d for purlins, braces etc.; and 60d for rafter plates, scabs, etc.

Bolts

Use machine bolts with a 2-inch steel washer on both ends. When fastening rafter supports, keep the head of the bolt to the outside so it will not interfere with putting on the siding. With full-dimension native lumber, use longer bolts so you won't have to countersink the head. The lists of materials assumes that you will use dressed lumber.

Special Connectors

Split-ring connectors provide top strength truss construction. With them, you can use minimum-sized members. One split-ring connector with a ½-inch bolt is as strong as six ½-inch bolts or 30 16d common nails.

Glue

Many Michigan Farmers are using glue-nail trusses successfully. Use exterior-type plywood and a water-resistant or water-proof glue for the

gusset plates. Type I aircraft casein glue is water resistant and suitable for buildings with low-moisture conditions, such as a machinery storage.

Truss members are connected by 5/8-inch plywood gusset plates. Put glue on both the truss members and on the plywood. Then nail the gusset plates in place with 6d box nails 3 to 4 inches apart on all members. This provides pressure for the initial glue set. Nail one gusset plate to each joint. Then remove the truss from the jig and glue and nail the gusset plates to the other side. Let the glue set for 24 hours before placing the truss on the building.

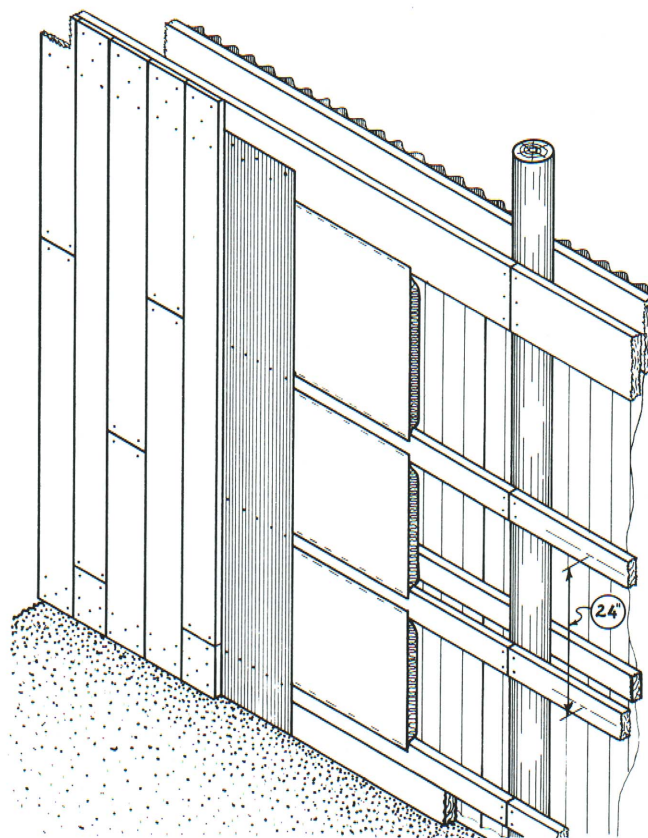


Fig. 1.

Using Concrete Under Poles

In regular frame construction, continuous concrete footings 12 to 18 inches wide and 8 inches thick are used to provide enough contact area on the ground. In pole construction, this size of contact area between each pole and the ground is too small. To carry the heavy pole loads, always use concrete pads 18 to 24 inches in diameter and 8 to 12 inches deep. Clean the bottom of the hole of all loose soil and make it flat, not

ball shaped. Use a good dry mixture of concrete (1 part cement to 5 parts pit-run gravel and 6 gallons of water per sack of cement). Place it in the hole at least 12 hours before setting the poles. Use about 1 cubic foot for a hole of the size mentioned above. Dip or pump out all water in the holes before pouring the concrete. If water seeps into the bottom of the holes during the drilling operation, consider relocating the building.

Insulating Sidewalls

Insulated walls are necessary for some types of farm buildings, such as poultry houses, stanchion barns, and fruit and vegetable storages. In such cases, you must put wall girts and sheathing on the inside as well as on the outside of the poles. Run the nailing girts horizontally, as is common in pole construction. Space the girts 24 inches on center so you can place blanket insulation horizontally between the interior wall girts. Exterior siding can be metal, vertical wood siding, or exterior plywood. The interior can be common boards or plywood (see Fig. 1.)

Choosing Eave Heights

The distance from the floor to the plate will vary, depending on how you plan to use the building. For poultry houses and hog houses, 7-foot clearance under the plate is enough (leaving an 8-foot ceiling). For this you need 14-foot poles. Machinery storages are usually made 12 feet to the plates; in some cases they run 14 feet, where certain large machines will be stored. This may require an 18-foot or 21-foot pole. For dairy and beef barns, a minimum plate height of 10 feet is recommended. This requires 16-foot poles. For hay storage, use a plate height of 16 to 20 feet with poles 22 to 27 feet long.

Poles must be at least 6 inches across at the top for all of the larger and higher buildings. Where you use plate heights of only 8 or 10 feet, 5 inches is a large enough top diameter. Follow the pole spacing as called for on the plans.

Roofing

Space the nailing girts for metal roofing 24 inches on center. Plan to have a nailing girt where the ends of two sheets butt together; this provides a nailing surface under the end lap. Steel

roofing should be 28-gauge, 2½-inch corrugated, and galvanized steel with a 2-ounce "seal of quality" coating. When sheets are delivered, stack them on end right away so water will not collect in the corrugations.

With aluminum, use 2½-inch corrugated sheets, 0.024 inch thick, whenever you can. Metal sheets normally come in 26-inch widths which cover 24 inches on the roof with 1½ corrugation edge lap. In some places you can get 48-inch wide sheets. Lengths of 6 feet to 12 feet are available; however, each material supplier does not stock the complete range of sizes. Check before you build to see what lengths are available so you can plan the nailing girts right.

When laying the roofing, provide an 8-inch end lap and a 1½-inch corrugations side lap. There is a "right side up" for the sheets to make this side lap possible. Use 2½-inch spiral-shank galvanized nails with a lead head or neoprene washer. Put one nail on every other corrugation. Use aluminum nails with aluminum roofing. Locate all roofing nails on the ridge and drive them in at a slight angle for best holding power.

Asphalt

Use solid 1-inch dressed tongue-and-grooved boards with asphalt strip shingles or roll asphalt roofing. You can put this 1-inch deck on rafters 4 feet apart. Follow the instructions that come with the roofing.

Wood Shingles

Use solid 1-inch dressed tongue-and-grooved boards with wood shingles. No. 1 grade red cedar shingles are best. Place them according to manufacturers' instructions. When you apply the shingles dry, be sure to leave enough space (¼ inch) between shingles in the row to prevent buckling when they get wet. Use galvanized shingle nails.

Size of Building

For each farm enterprise, there is one width (the shorter of the two over-all dimensions) of building that works out best for each use. For cattle sheds, use the 40-foot building—it gives the most usable area for the animals. Narrow buildings must be made longer for the same floor area. When the south side of such a building

is left open, more snow and rain can blow in. You can make lean-to additions to the 40-foot wide building to increase the dimension up to 70 feet. These additions are especially good for the lounging shed of loose-housing barns.

You can plan machinery storages for both 30-foot and 40-foot widths. In the 30-foot building use a crosswise system for parking the machines so that they will not be in each other's way. Because farm machines differ so much in size, it is best to space the poles to fit the machines you will store. Tillage machines are all used at about the same time of year and can be stored in one bay, the seeding equipment in another bay, and the hay-harvesting equipment in still another bay. You can use doors on the north and west sides of the building; the south or east is usually left open. In a 40-foot building, put doors on the ends, and park machinery on either side of a central drive. You can use this central drive only

for overnight storage of trucks, combines, balers, etc. Do not let the drive become a permanent storage, blocking machinery on either side.

For poultry, the 36- and 40-foot widths are best, especially where you keep many birds in relatively small areas. In these wide houses, the space heated by the birds is high compared to the area of the cold outside walls, and the housing conditions are better for the birds. Mechanical feeding, watering, ventilation, and manure removal are used to lower the labor needs and to improve the conditions in the poultry house.

For fruit storage buildings, use the 36- and 40-foot width. The clear-span can increase the storage area 5 to 10 percent. Side walls 12 to 14 feet high permit the use of mechanical handling equipment.

Clear-span, pole-type buildings are good for such commercial buildings as lumber sheds, warehouse storage, and terminal buildings.

Laying out the Building

1. Locate and set corner stake A. Drive a nail in the top of the stake to locate the exact corner (see Fig. 2).

2. Stake out a line in relation to roads, buildings, fence lines, etc. Measure the length of the building with a steel tape along this line. This becomes the base line for the building.

3. Set second corner stake B with a nail in the top at the exact distance from A.

4. Measure back exactly 30 feet along line BA, set a stake, drive a nail in the top, and hook one steel tape to the nail.

5. Hook a second steel tape on the nail at stake B, cross tapes at 40 and 50 feet, and establish line BC. Locate third corner stake C on line BC at the desired width of the building. (A right angle is formed with sides of a triangle in the ratio 3-4-5.)

6. From corner stake A, measure the width of the building; from corner stake C measure the length of the building; and set fourth corner stake D.

7. Recheck all four sides for correct length, then check diagonals. The distance from A to C must equal B to D and they should cross each other at the middle (see Fig. 3.)

8. Place batter boards at all four corners. Locate batter boards far enough away from the corner stakes to operate hole-digging equipment. This distance may vary 5 to 10 feet. All four sets of batter boards should be level.

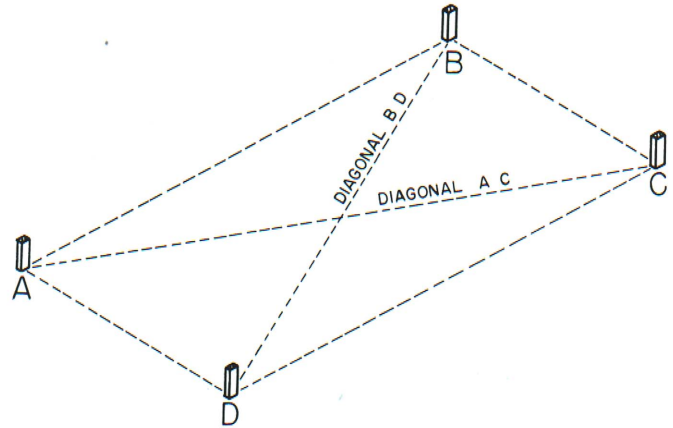


Fig. 3.

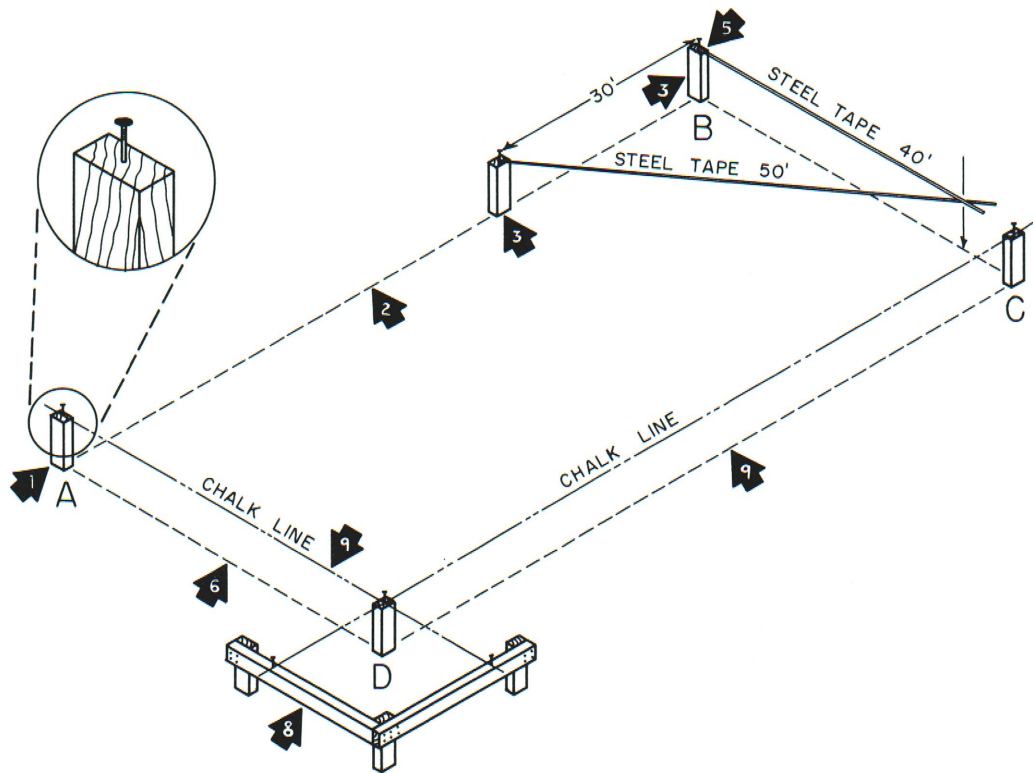


Fig. 2.

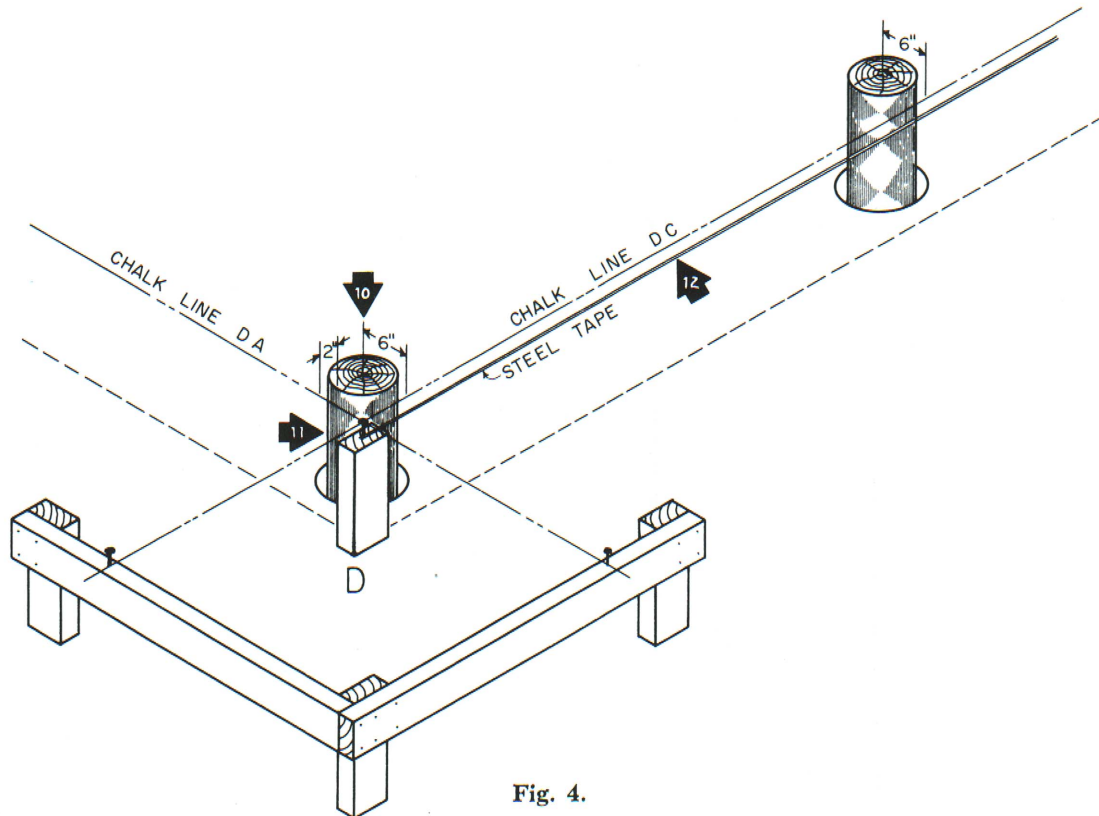


Fig. 4.

9. Stretch a chalk line from the batter board at D to the batter at A exactly over the nails in stakes D and A. Put a nail on each batter board to locate permanent reference points. Repeat this procedure for the other three sides.

Locating Poles

10. Determine the four corner-pole locations first (see Fig. 4).

11. Locate the center of the corner pole by measuring in from the chalk line one-half the diameter of the pole plus 2 inches for nailing girts.

12. Hook a steel tape over the nail at D and measure along chalk line DC, the distance to the first pole. Locate pole center 6 inches in from chalk line.

13. Leave the tape hooked to the nail at A and measure to the second pole. Repeat for all poles.

14. Take down the chalk line, and remove corner stakes.

Preparing Holes

15. Drill holes 8 inches deeper than the set of the pole about 5 to 6 feet deep and 18 to 24 inches in diameter (see Fig. 5).

16. Place 8 inches of concrete in the bottom of each hole. (An 18-inch hole takes about 1 cubic foot of concrete.)

17. Do not place concrete in water-filled holes. Pump or bail water out of the holes first.

18. Allow the concrete to set for 12 hours before placing poles in the holes. Do not set poles in fresh concrete.

19. Reset the chalk lines.

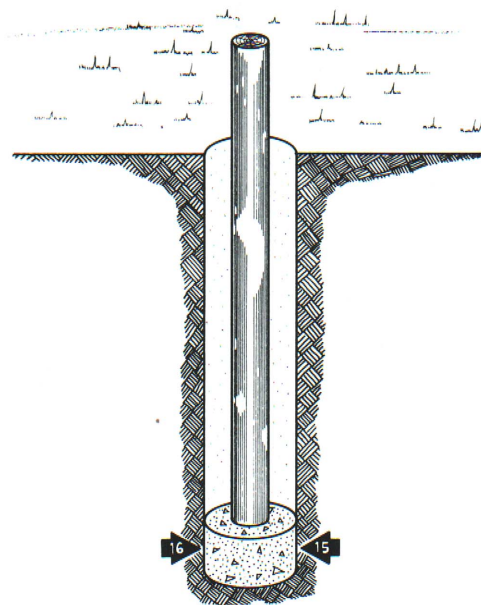


Fig. 5.

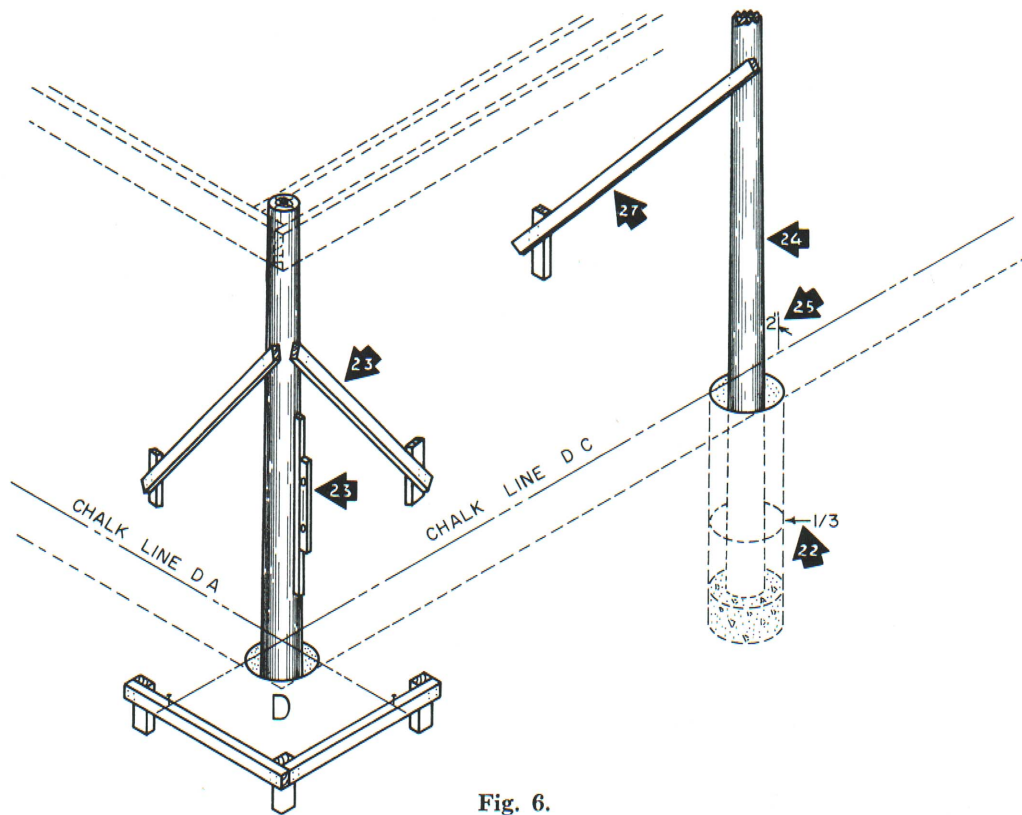


Fig. 6.

Pole Setting

20. Select four straight poles for the corners (see Fig. 6).

21. Set the poles in the corner holes the thickness of a nailing girt (2 inches) from the chalk line. At the same time, plumb the pole on two sides by placing a straight board with a carpenter's level on the outward side of the pole.

22. Fill and tamp to only one-third depth.

23. Brace corner poles from two directions by putting the braces on the inside of the building. Put the top of the braces below the bottom of the plate location, and so they will not be in the way of nailing girts.

24. Place the rest of the poles in the holes with the straightest side outward. Small bumps and curves, on the **inside** will not alter the shape of the building.

25. Set the pole plumb 2 inches (the thickness of a nailing girt) from the chalk line. Be sure the pole spacing agrees with the plan.

26. See that the side poles are in line by sighting from corner pole to corner pole.

27. Brace the poles from the inside—every third or fourth pole along the side.



Batter boards are placed at corners. Corner poles set, plumbed and braced in place and chalk lines placed in position.

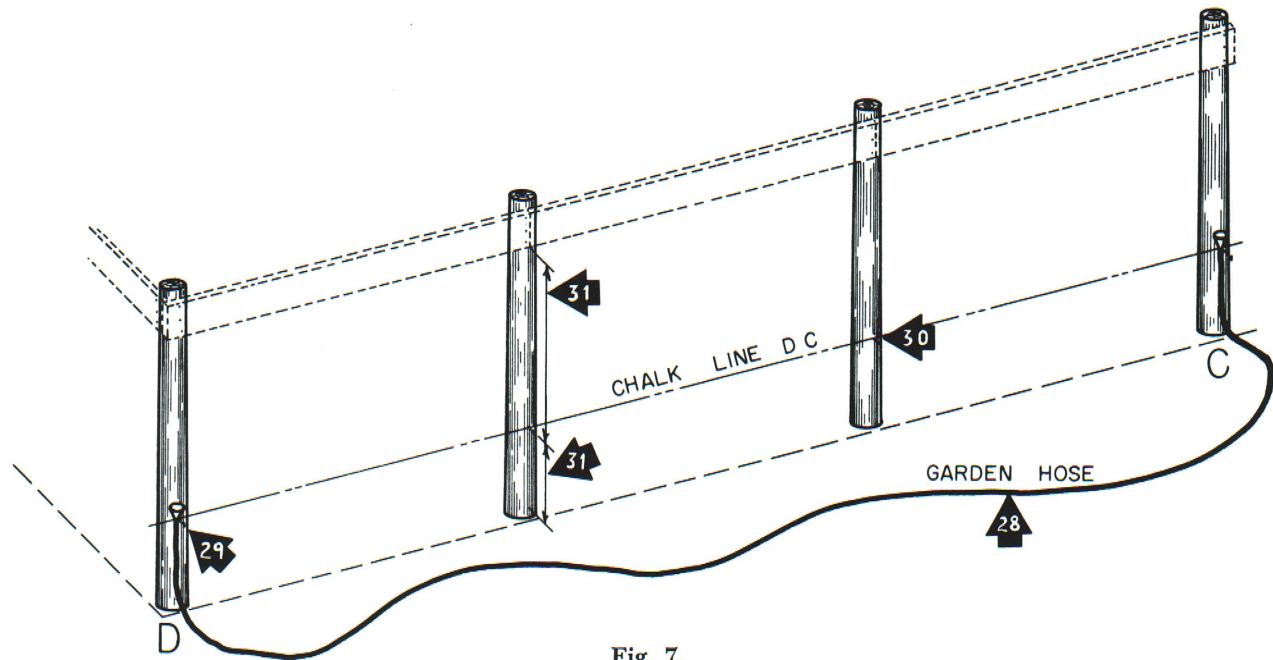


Fig. 7.

Determining Plate and Floor Level

28. Find a level point on all four corner poles; also on other poles if distance between corner poles is more than 50 or 60 feet. Use an engineer's level for this. If you don't have an engineer's level, use a water-filled hose to find the level points. A transparent hose is good for this (See Fig. 7).

29. Drive a nail half-way into the poles to mark the level points on corner poles and on each fourth pole between.

30. Set the level point on other poles with taut chalk line from corner pole to corner pole. Mark level points on intermediate poles with a nail. Be sure the chalk line is taut and the wind is not blowing it out of line.

31. Measure up or down from level points to establish plate and/or floor lines.

Corner poles are set and plumbed. Line poles are being positioned. This pole building was erected around an old concrete slab.



Setting line poles in position after corner poles have been set and plumbed. Chalk line is in position. Tractor loader is used to carry and erect poles.



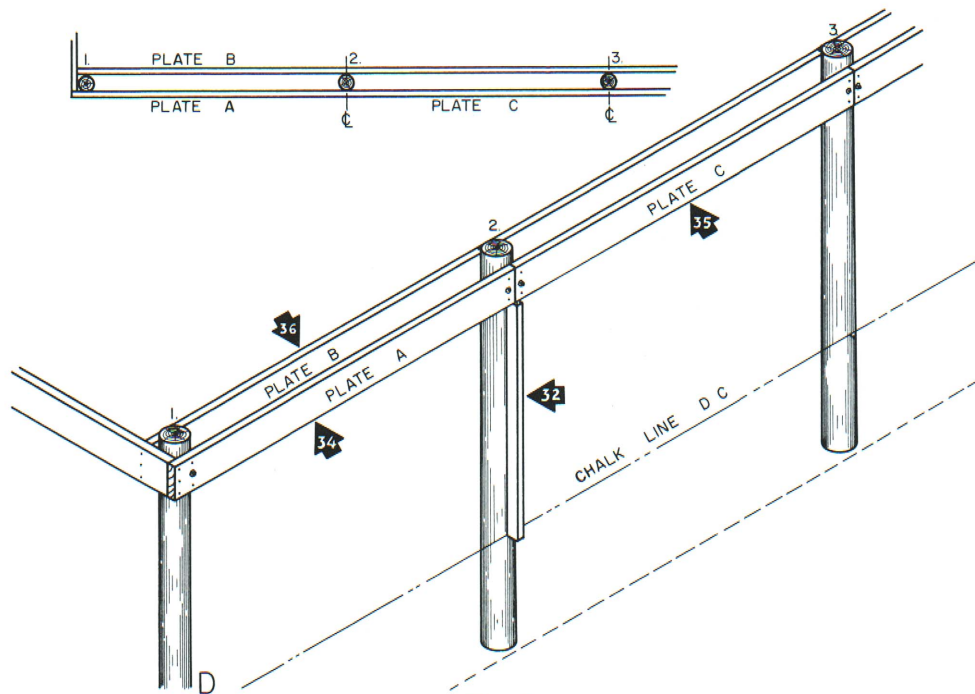


Fig. 8.

Putting Up Plates

32. From the plan, determine the distance from level points on poles to the bottom of plates. Cut a 2 by 4 to this dimension to use as a measuring stick. Use it to measure exact plate height (see Fig. 8).

33. Cut plates squarely and to the exact length.

34. Plate A length is from the center line of pole 2 to the outside of pole 1, plus the thickness of a 2-inch nailing girt.

35. Plate C length is from the center line of pole 2 to center line of pole 3.

36. Plate B length is plate A length minus the thickness of a 2-inch nailing girt or a 2-inch plate.

37. The length of plate A equals the length of plate C.

Start one 60d ring-shank nail in the center of the plate, 1½ inches from the end (except for end bent plate). Set the plate on the 2 by 4 measuring stick held against the pole, and rest it on the nail driven near the bottom of the poles. Center the end of the plate on the pole. Drive a 60d nail into the pole. Drive the nail in the other end of the plate. Put up the inside plate, the top level with the top of the outside plate. Continue installing plates on one side of the building.

Check plan for the correct number of nails and bolts to connect the plates and proceed to attach all plates to poles.

If bolts are needed, use a 16-inch tree surgeon bit for drilling through plates and poles.

Repeat for plates on the opposite side of the building.

Intermediate Posts

38. If plan calls for short posts between framing poles, drill holes about 2 feet deep. Intermediate posts are used to provide support for the nailing girts when the poles are more than 8 feet apart (see Fig. 9).

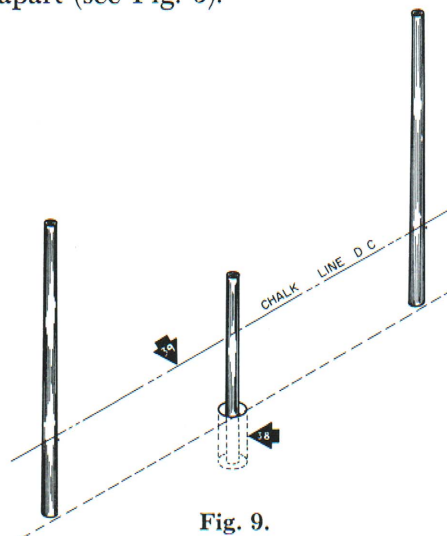
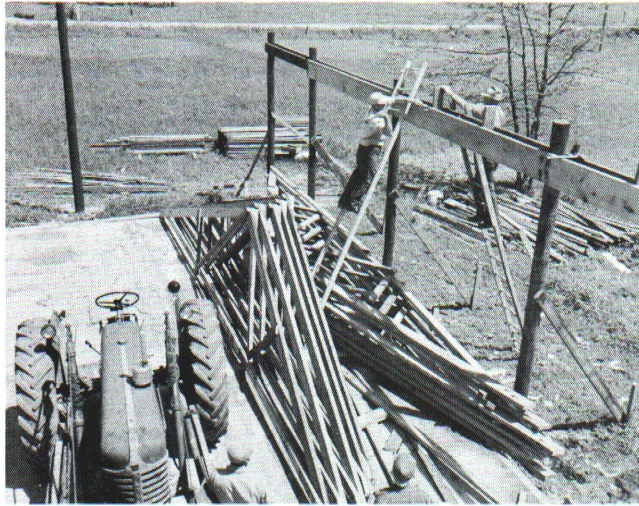


Fig. 9.



All poles have been positioned and rafter supports bolted to the poles. Vertical bridging is being placed between rafter supports.

Install Siding Girts

39. Place post in the hole, sight along the outside of the framing poles, or use a chalk line stretched along the outside of the poles to make sure they are even.

40. Backfill one third and tamp all intermediate poles.

41. Apply siding girts by using (A) butt joints or (B) lap joints, depending on the length of the siding girt (see Fig. 10).

42. You can use both butt and lap joints on the same building. Using both may save some time in putting on the girts.

43. Use two 60d ring shank nails in each end of the girt.

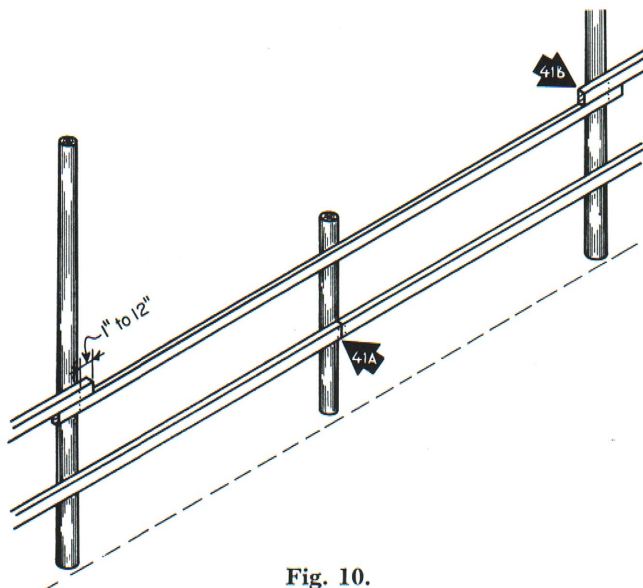


Fig. 10.

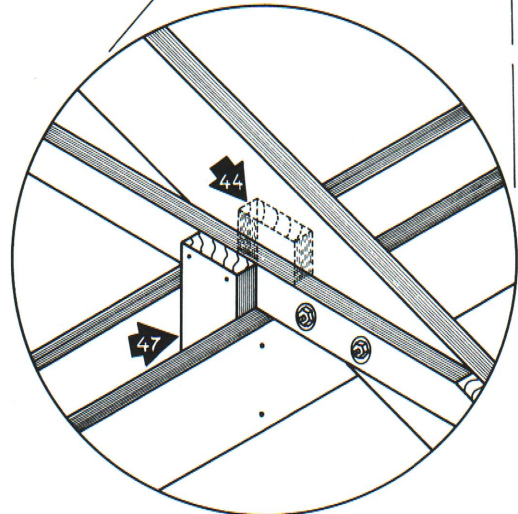
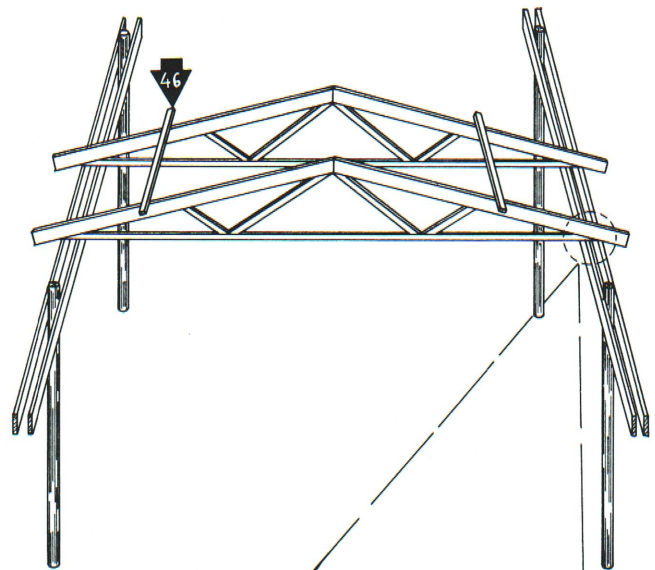
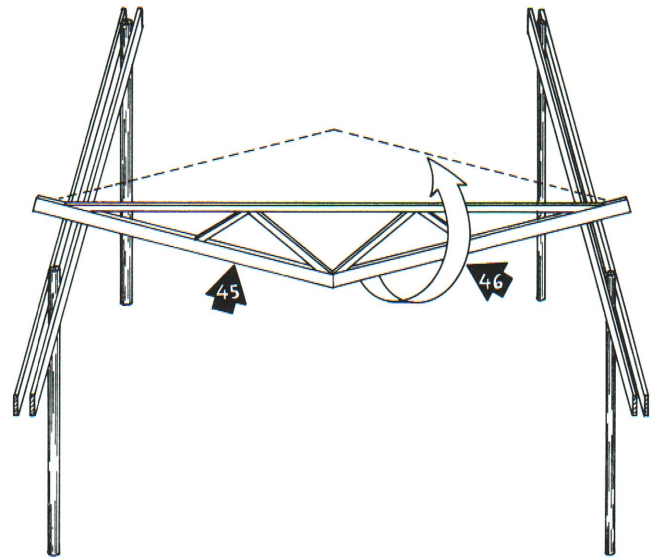


Fig. 11.

Putting up Trusses

44. Install vertical bridging before the truss is set on the plate (see Fig. 11).

45. With truss upside down, place one end over the plate. Next, set the opposite end of truss over the opposite plate.

46. The truss is now supported upside down over the plates. Pivot the truss into an upright position and hold it steady with a roof girt extending from the last truss; also nail the heel to the vertical bridging. Before nailing, be sure the truss is in the correct position on the plate, and that the width from outside of the rafter plate to outside the rafter plate is the width called for on the plan.

47. Install second piece of vertical bridging after all trusses are nailed or bolted in place.

Recheck Alignments

48. Recheck building for plumb. Sight along plates on the front of the building to be sure they are straight. It is possible that the plate on the back side of the building can be slightly out of line. There are two choices (1) leave as is, or (2) split the difference on the two sides.

49. Fill all holes and tamp.

50. Install bracing as shown on the plan (Fig. 12).

Planning Roofing

51. Measure the distance from the ridge to the eave along the rafter and add 2 inches for metal overhang. This is the length to use when figuring the length of the sheets (see Figs. 13-14).

52. Choose roofing sheet lengths that overlap at least 8 inches at each joint. Consult your dealer to find out the available lengths.

53. You can sometimes get the right overlap using a different width ridge roll, which allows the top sheet to start farther down from the ridge. Extend lower sheet 2-inches below the first nailing girt.

54. Measure the distance along the ridge from the outer edge of the end rafters and add 1 foot (6 inches on each end for finishing).

55. Since most sheets normally cover 2 feet wide, divide the total (from step 54) by 2 feet for the number of rows you need. Roofing is sold by the square (10 feet by 10 feet), or 100 square feet.

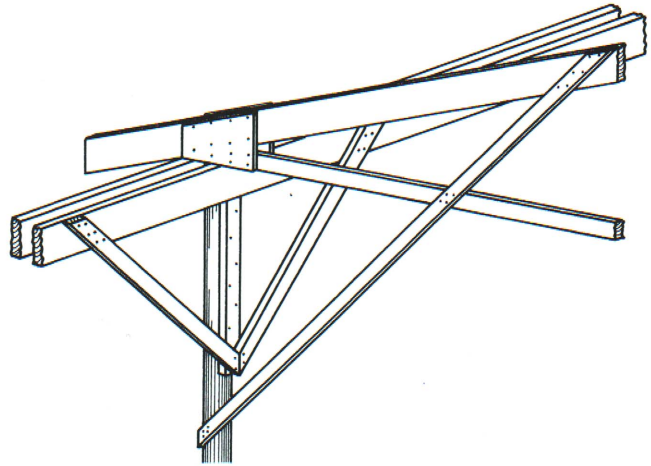


Fig. 12.

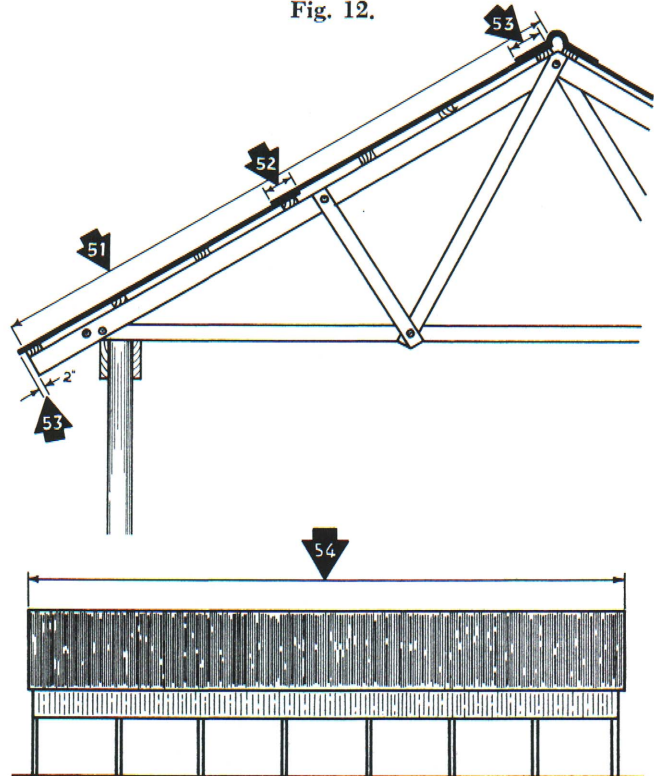


Fig. 13-14.

A square will **not** cover 100 square feet, because it does not allow for overlaps. Ask your local dealer about roof coverages other than the 2 feet.

Putting on Roofing Girts

56. Measure the plate-to-eave distance of the end rafters on one side of the building (see Fig. 15).

57. If the distance varies, mark a point (measuring from the ridge down) that is equal to the shorter of the two. Mark each rafter.

58. Place a taut chalk line between these two points.

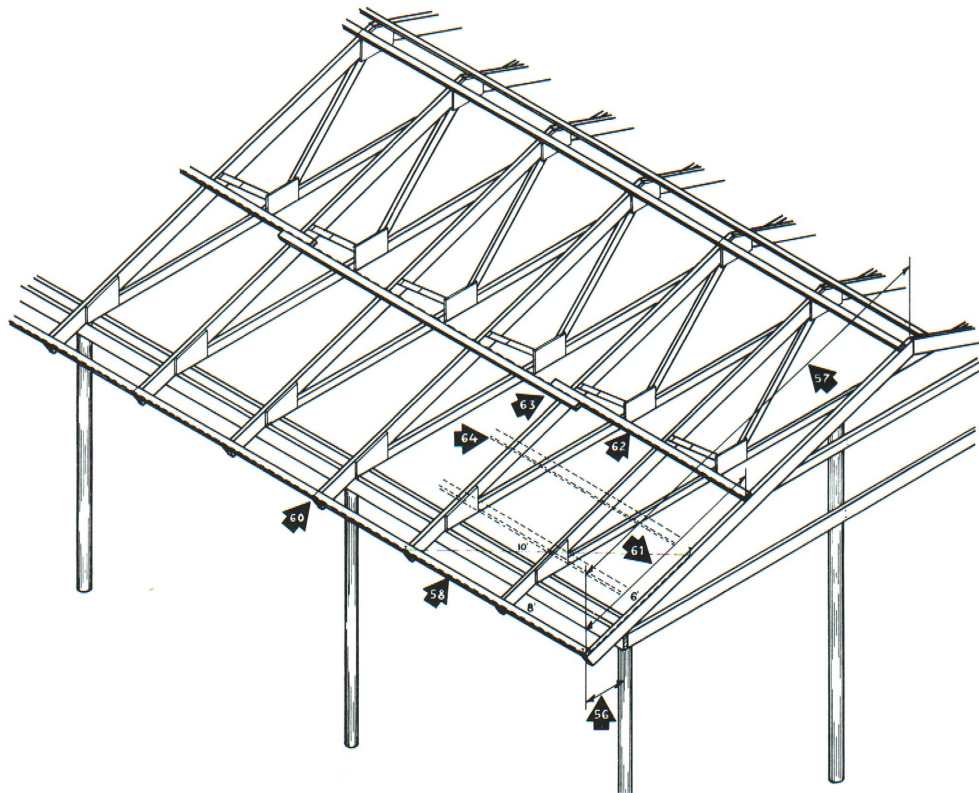


Fig. 15.



Vertical bridging is spiked secure between rafter supports at truss locations.

59. If the rafters between vary less than 1 inch, you can correct the differences when putting on the first eave roofing girt. (Let the roof girt overhang the short rafters.) If there is a difference of more than 1 inch, remake the chalk line to the length of the shortest rafter and cut the others off to match.

60. Choose a straight 2 by 4 for the first (eave) roof girt. Use the taut chalk line or corrected rafter overhang as a guide. Use butt joints on the first roof girt.

61. Measure up from the eave along the end rafters. Measure the length of the first sheet less the 2 inch metal overhang, and half of the end lap. Mark this point.

62. Again, place a taut chalk line between these two new points on the end rafters.

63. Place 2 by 4 roof girts above and below this chalk line using a lap joint. Nail each 2 by 4 roof girt with two 40d ring shank nails.

64. Locate the other roof girts, spacing them 24 to 30 inches on center between the roof girts already placed.

Putting on Roofing

65. Start putting the roofing on at the east end of an east-west building, or at the north end of a north-south building. The side laps then will be away from the prevailing winds (see Figs. 16-17).

66. Make a line on the nailing girt at the eave, parallel to the edge of the eave girt. With a 6 by 8 by 10 triangle, make a line at right angles

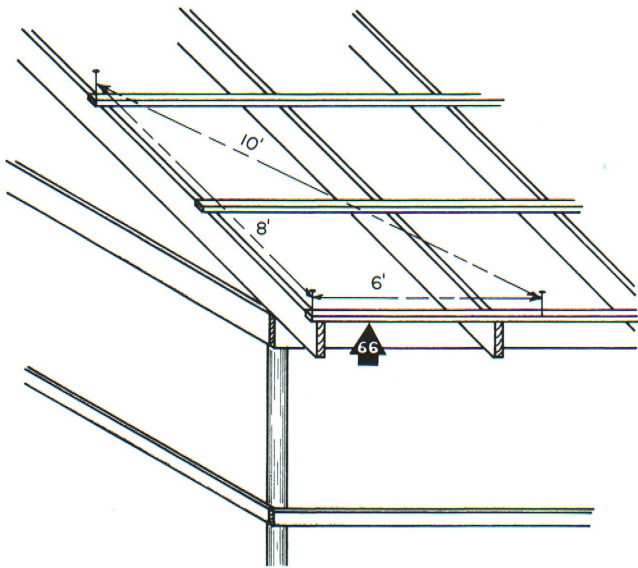


Fig. 16.

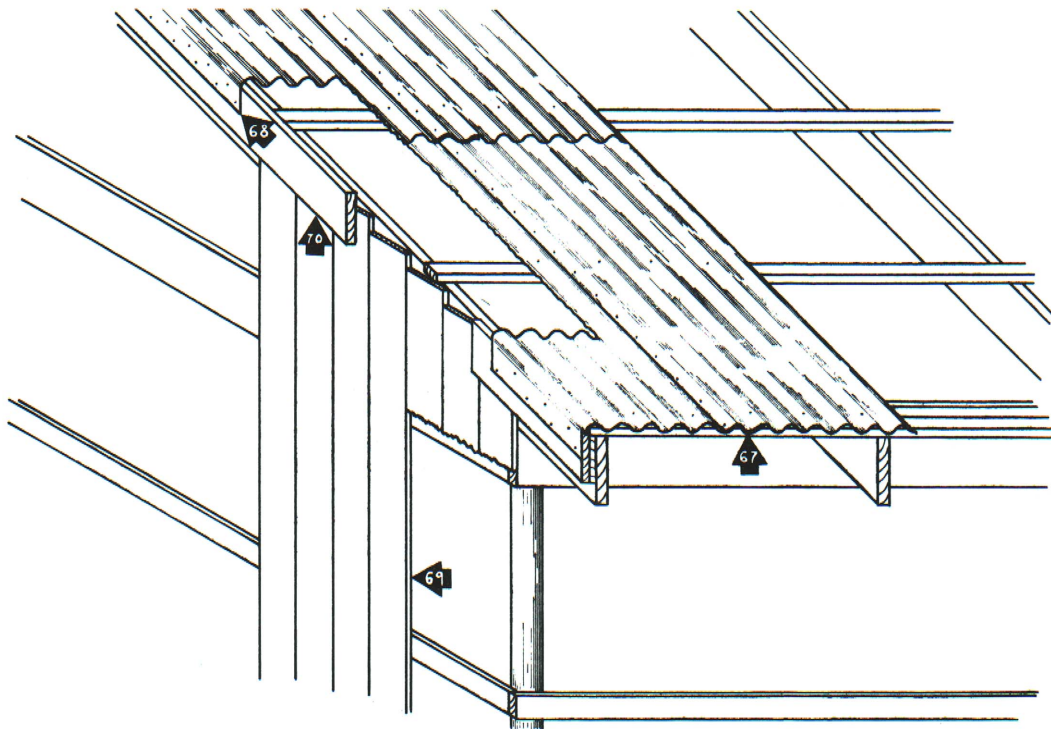
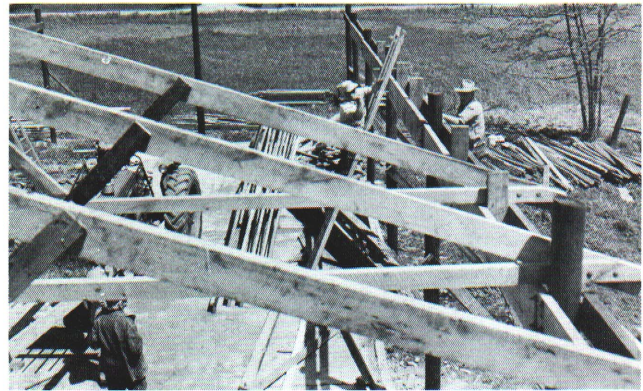


Fig. 17.



Every third truss is secured to a pole and the intervening ones to vertical bridging.



Trusses are raised into position on the building with a farm tractor and loader. An extended frame has been built on the loader to provide for the necessary lifting height.

to the eave as a guide for placing the first sheet of roofing. If this line is not parallel to the first rafter, you might be able to rack the roof until it is. If not, let the metal overhang vary at the end of the building.

67. Continue, putting on the lower row of sheets lapping $1\frac{1}{2}$ corrugations, nailing with $2\frac{1}{2}$ screw-shank nails.

68. Put on the other rows of roofing, starting at the same end of the roof.

69. Install the siding on the ends and butt it up to the roofing on the gable ends.

70. Nail the 2 by 8 inch trim board over the siding to the ends of the roof girts. Then bend the metal overhang over the 2 by 8 inch trim and nail with galvanized roofing nails.

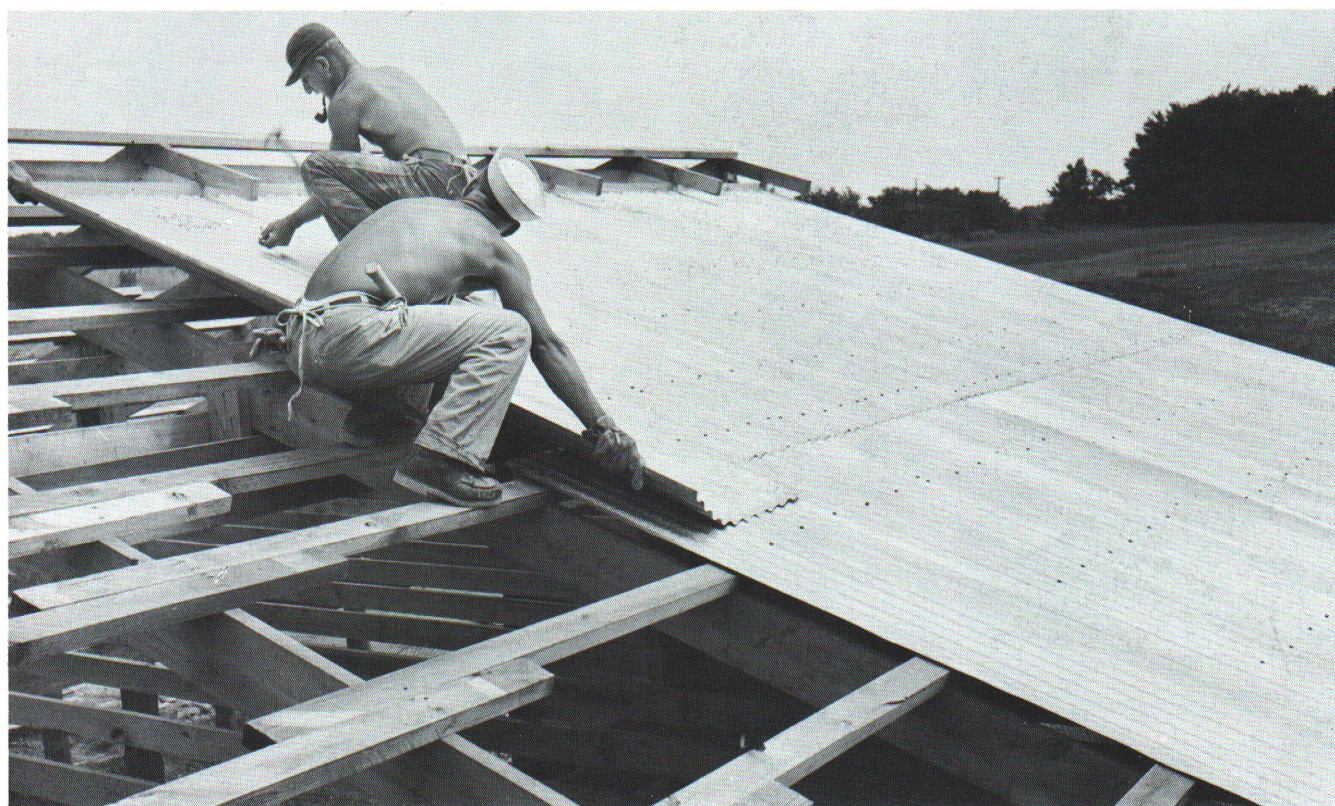
71. Install eave troughs and down spouts on the lot side of the building, so water will not run on the concrete lots. Where buildings are more

than 40 feet long, provide down spouts at both ends.

72. Finish putting on siding, installing braces and adding other accessories.



This roof framing and gable end of the pole building has been readied for the application of the sheet metal roofing. A ridge ventilator is being constructed on this building.



The $2\frac{1}{2}$ -inch corrugated sheet metal roofing is placed in position over roof girts two feet apart. Nails are placed in every second corrugation at ends of sheets and every third

at intervening girts. A ridge ventilator is being put on this poultry house.