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CONSTRUCTION OF A FROST-FREE PLANT HOUSE

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SUMMARY

A timber-framed, plastic sheeted plant house is described and temperature data are provided.

I. INTRODUCTION

Additional space for pot experiments was required at the Charleville Pastoral Laboratory in south-western Queensland. As it was evident that a frost-free structure would be beneficial, a timber-framed and plastic-sheeted plant house was locally designed and constructed.

II. DESCRIPTION

The size of the building is 30 ft x 19 ft 9 in., with a height of 8 ft 8 in. The basic frame consists of semi-circular timber arches each made of two struts for ease of handling and attached to base timbers bolted to a concrete block which forms the floor. The building is sheathed in corrugated plastic and is provided with glass louvres and doors.

III. CONSTRUCTION DETAILS

(a) Construction of Struts

Specifications.—Each strut consists of two lengths of 2 in. x ½ in. hardwood, preformed and spaced with 4 in. x 4 in. x 2 in. blocks at 18 in. centres when measured on the outside strip (Figure 1). Each length must be at least 16 ft for a building 19 ft 9 in. wide. Overlap at each end to prevent splitting when nailing is thus provided for. Uniformity in the struts is essential, and to ensure this only one assembly jig should be used.

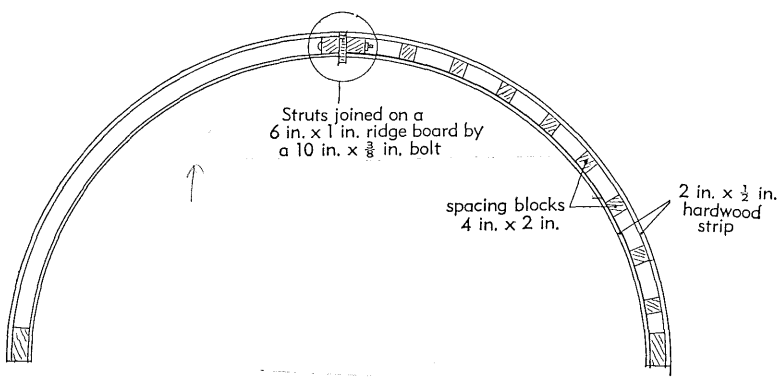

Fig. 1.—Details of arch 18 ft wide and 9 ft high (external measurements).

The finished struts may vary slightly from the specifications; for example, those made at Charleville formed a plant house 19 ft 9 in. x 8 ft 8 in. in cross section, instead of the planned 18 ft x 9 ft semi-circular section. The difference was caused by jig inaccuracies and changes in the thickness of the timber, which caused variations in the curves obtained from the hardwood strips. However, so long as these variations are consistent and not excessive, no difficulty should be experienced in the erection of the frame of the plant house.

Assembly jig for strut construction.—A full-size master diagram of the strut should be laid out on a flat surface such as a floor (Figure 2). It is suggested that the diagram be blocked in with paint. The positions of all the spacing blocks should be clearly marked, so that the jig shows accurately the positions and dimensions of all components.

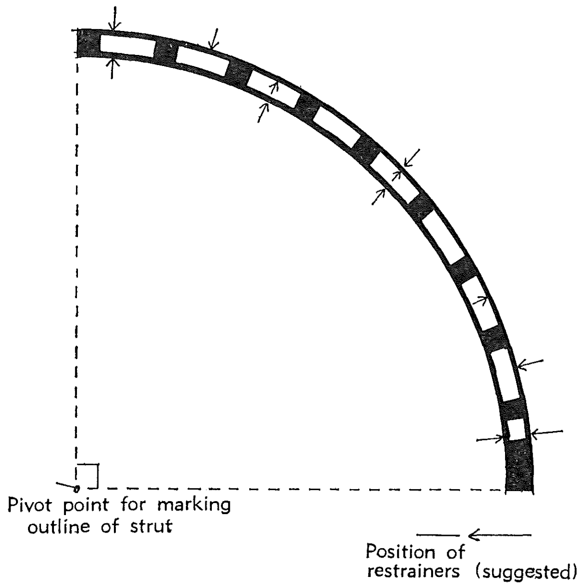

Fig. 2.—Layout of strut assembly jig.

At suitable points around the edge of the diagram, restrainers such as heavy nails or wood blocks should be securely fixed to the base to hold the hardwood strips in position. Optimum positions for the restrainers may be found by placing the two hardwood strips on the diagram and locating the critical points where movement during assembly would be most likely. Stability of the jig is essential.

Construction of struts.—Two 2 in. x ½ in. strips of hardwood are placed in the jig, and spacing blocks measuring 4 in. x 4 in. x 2 in. are then placed as indicated on the master diagram and fixed with glue and 2 in. nails. Resorcinol-formaldehyde should be used, as it is strong and waterproof. The block at the lower end of each strut should be 12 in. x 4 in. x 2 in. to facilitate securing the struts in position when erecting the framework.

The struts should be left in the jig until the glue sets. Pressure may have to be applied by means of clamps to keep the strips securely fastened to the end blocks. When the glue is set, the ends of the strips should be trimmed off level with the end blocks. A ⅜ in. hole should be drilled through the upper end block so that a joining bolt may be inserted (Figure 3). The position of this hole must be carefully measured so that it is equidistant from the outer strip on all struts.

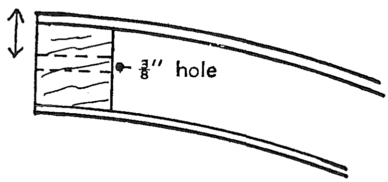

Fig. 3.—Position of hole for joining bolt. Distance shown by the arrow must be the same for all struts.

A ¼ in. bolt may be put through the end block (Figure 4) to prevent the hardwood strips from breaking away should the struts be roughly handled or the wood become warped. This hole must be placed so that it misses the joining bolt hole.

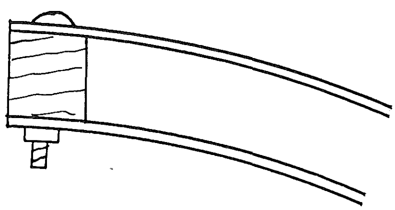

Fig. 4.—Position of cuphead bolt.

When all the struts are completed, they should be matched to compensate for irregularities. They should then be set up in a vertical stack (Figure 5) and bolted together. Two blocks of 3 in. by 1 in. timber should be placed between the butted ends, one on each side of the bolts, and the bolts tightened (Figure 6).

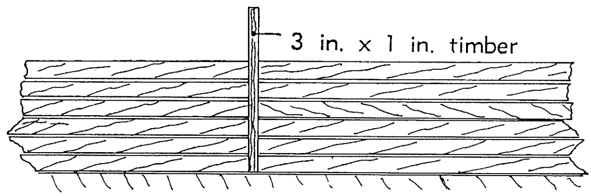

Fig. 5.—Struts assembled on a level surface and stacked one on the next.

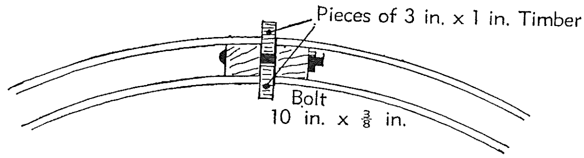

Fig. 6.—Method of bolting stacked struts together.

Blocks of 4 in. by 1 in. timber should be placed next to the spacing blocks in each pile of struts (Figure 7). This forces the struts into line. The struts must be checked for any variations in length; these may be overcome by using pieces of timber as fillers, provided the discrepancies do not seriously alter the line of spacing blocks established with the 4 in. x 1 in. spacers.

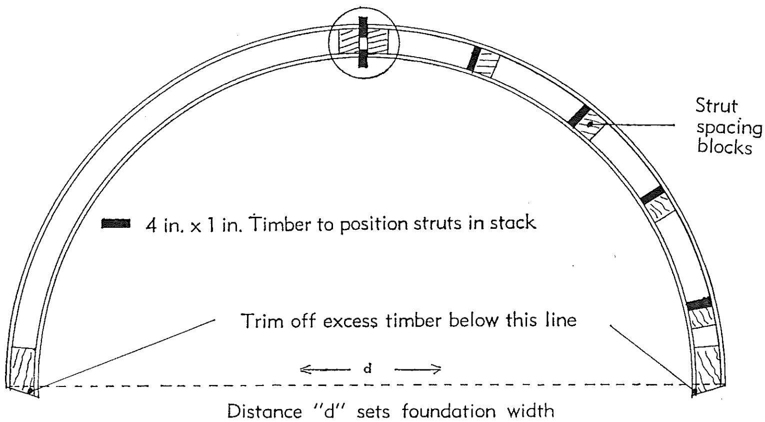

Fig. 7.—Method of forcing stacked struts into line. Every second spacing block is shown.

A level of the base blocks should be established, and the excess timber cut off.

The distance between the outer edges should be measured, as this figure governs the width of the concrete floor on which the arches are to be mounted. The arches should be unbolted before painting, and each strut should be identified so that the pairs may be successfully coupled again. Three or four coats of paint should be applied.

At Charleville, the arches were set at 6 ft centres, a 30 ft building thus requiring 12 struts.

(b) Plant House Foundations

The building is set on a concrete block. Standard concreting techniques should be used. Dimensions of the building at Charleville are 30 ft x 19 ft 9 in., with a thickness of 3 in. Bolts $\frac{3}{8}$ in. thick and $5\frac{1}{2}$ in. long were placed in the slab 2 in. from the edge (Figure 8). The bolts, with a large washer to prevent pulling out, should be sunk in the concrete to a depth of 3 in. The base boards are tied down with these bolts. Spacing of bolts should be at 3 ft centres starting 18 in. from each end, and should be such that the bolts do not coincide with the 6 ft arch spacings. Additional bolts should be set in the floor 15 ft from the edge to make a firm union where base boards are joined.

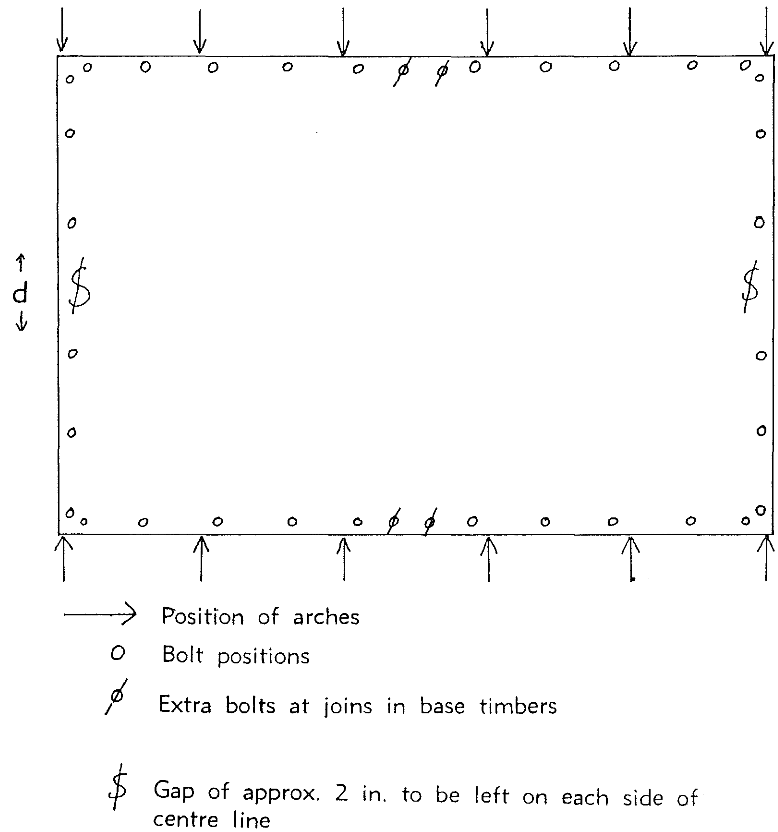

Fig. 8.—Plan of foundation block.

The floor should have a fall of 1 in. per 15 ft to encourage drainage.

The base timbers (4 in. x 2 in.) are drilled and bolted down to the foundation block along the 30 ft sides. The cross timbers should not yet be positioned, but spare material should be placed over the upstanding bolts to prevent injury to feet.

(c) Assembly Procedure

(1) Make 12 fish plates of 6 in. x 2 in. x $\frac{1}{4}$ in. steel, drilled with a $\frac{3}{8}$ in. hole 1 in. from each end, and also 4 X-shaped props of 3 in. x 1 in. timber 10 ft long.

(2) Set one strut in position and hold in place with a prop. Drill a $\frac{1}{4}$ in. hole in the base board and in the toe of the arch. Position a fish plate, which may have to be bent to fit properly (Figure 9).

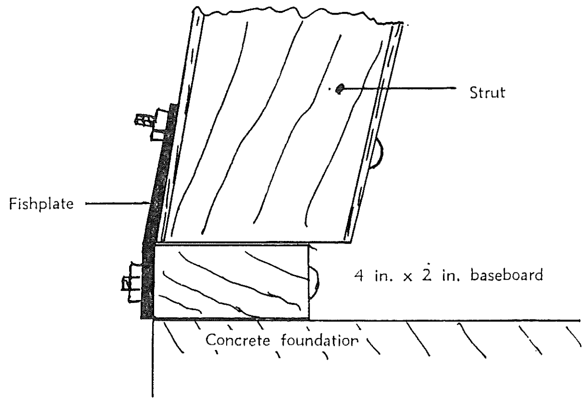

Fig. 9.—Position of fishplate.

(3) Drill two 15 ft x 6 in. x 1 in. hardwood ridge beams with $\frac{3}{8}$ in. holes at 6 ft centres (Figure 10). These holes should be the same distance from one edge as the $\frac{3}{8}$ in. hole in the upper end of each strut was from the outer strip. Position this on the end of the strut with a 10 in. x $\frac{3}{8}$ in. bolt (Figure 11).

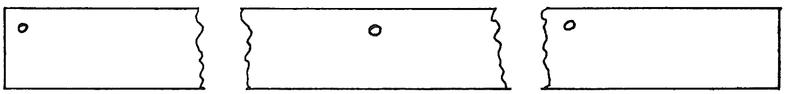

Fig. 10.—Position of drilled holes in ridge beam.

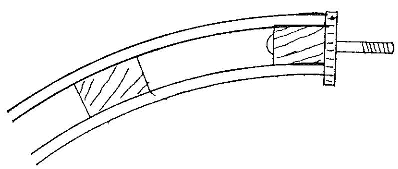

Fig. 11.—Positioning ridge beam on strut.

(4) Fit the other strut onto the bolt, and prop and fix the toe as in (2). Fit nut and washer to the $\frac{3}{8}$-in. bolt, but do not tighten.

(5) Erect the second and third arches, using the procedure described above. Nail two lengths of 2 in. x $\frac{1}{2}$ in. timber to each side of the arches, so that the props can be removed (Figure 12).

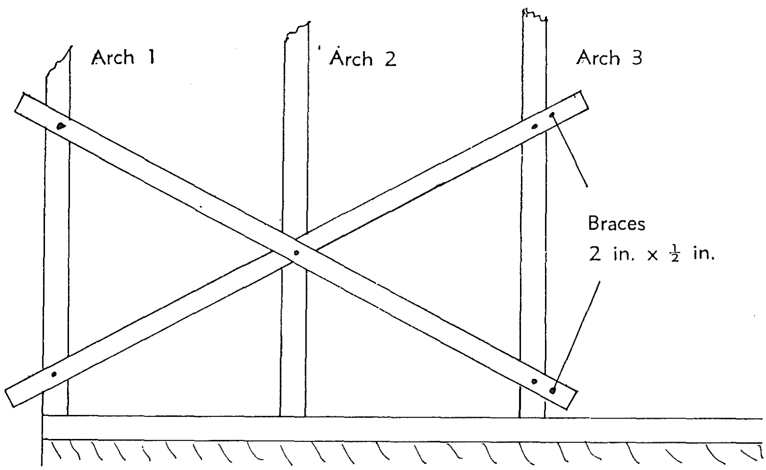

Fig. 12.—Braces nailed through arch spacing blocks.

(6) Erect the remaining arches.

(7) Join the two lengths of ridge board with a 2 ft length of 6 in. x 1 in. timber. Three $2\frac{1}{2}$ in. x $\frac{1}{4}$ in. cuphead bolts should be used on each side.

(8) Fit battens to support the plastic covering. These battens of 3 in. x 1 in. timber are positioned on alternate rows of spacing blocks between the two strips of each strut. They must be notched on the edge to clear the outer strip and provide a flat surface (Figures 13 and 14). These notches also position the struts, which are relatively flexible. If the battens have to be joined, short lengths of timber and suitable bolts should be used. Care should be taken to ensure that batten ends butt.

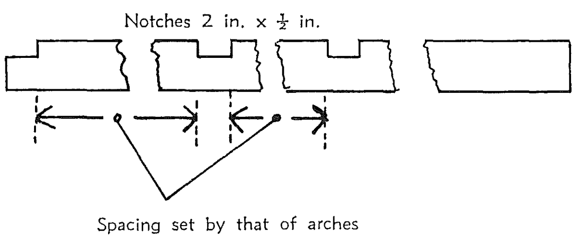

Fig. 13.—Notches in batten.

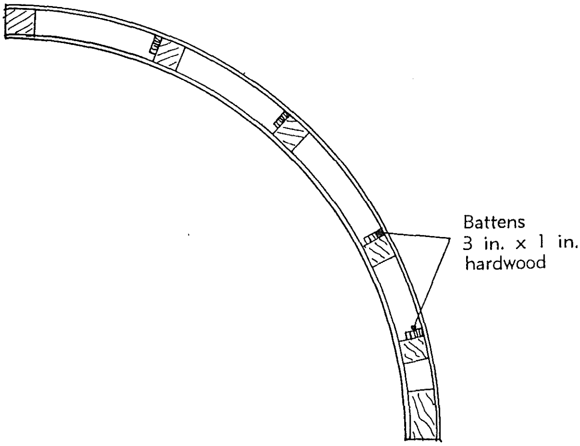

Fig. 14.—Positioning of battens. Outer edge of batten flush with outer edge of strut. Battens on every second spacing block.

(9) Refit the braces so that there are two at each end and one on each side. They should be attached to the inside edges of the arches so that they do not interfere with the plastic sheeting.

(10) Apply three or four coats of paint to the battens and braces.

(d) Construction of End Frames

The final dimensions of the arches will govern the lengths of timber and sizes of doors and louvres which will be required. In this example, 14-frame louvres with 23 in. glass and 30 in. doors were used. Frames should be fitted as shown in Figure 15.

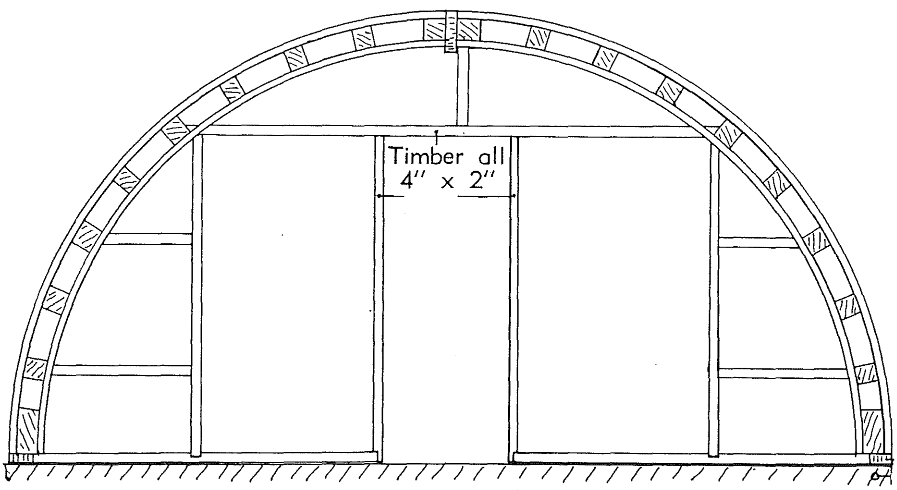

Fig. 15.—Details of end structure. Size of openings is set by the arch width and height.

The base boards are fitted after ascertaining the position of the door. No base is fitted in the doorway. Some paring with a chisel may be necessary to fit the board over the bolt nearest the toes of the arch, as the toe is wider than the 4 in. base. Some of the foundation bolts may have to be countersunk to allow the louvres to close properly.

A plumb line should be dropped from the centre line of the ridge pole to check the symmetry of the struts and to mark the position of the door. The width of louvres and the availability of space for the door must be calculated, after allowing for the intervals taken up by their frames. The door should not be less than 2 ft 6 in. wide, and preferably wider. Louvre blades can be ordered to suit. The upright timbers should be mortised into the base boards, and bolts used to secure the structure where appropriate.

The louvres may be installed using standard techniques. The doors are made from 3 in. x 1 in. pine and covered with the plastic. Bolts are used in the joinery.

(e) Fitting the Plastic Covering

The frame is sheathed in corrugated sheet plastic, 6 ft x 26 in. in size. The length of the perimeter of the arch governs the number of sheets required. Five were used in this example, each overlapping the preceding sheet by 2 in.

If the spacing of the battens necessitates the joining of the sheets independent of the battens, the sheets should be set against a straight-edge, drilled and bolted together with 3/16 in. tank bolts. Care must be taken to calculate correctly the optimum overlap; about 3 in. should be allowed to overhang the edge of the building. Adjoining sheets should be overlapped by at least two corrugations. The sheeting should be fastened to the battens with the special nails and seats usually supplied with it. The non-louvred space at the ends of the building should be clad with the sheeting after trimming to size.

It should be noted that all measurements mentioned in this article pertain to a 30 ft building. However, the principle can easily be applied to buildings of other sizes, where appropriate dimension adjustments will be necessary.

Appendix 1

Temperature Data

Observation of minimum winter temperatures indicates that these temperatures can be expected to stop falling at a point about 6°F higher than the eventual minimum recorded outside. Thus in an area such as Charleville, where the July minimum averages 39·9°F, but light frosts (36–32°F screen temperatures) occur 19·6 times a year and heavy frosts occur 7·2 times a year, the plant house reduces the temperature drop so that frosts become much less significant. Winter daytime temperatures averaged 13°F higher inside the plant house.

Summer minimums averaged 8°F higher inside. The mean and median summer daytime temperatures were only 1°F higher inside the plant house. The summer maximum temperatures inside the plant house in a period of abnormally high temperatures averaged 5°F higher than the outside observations.

Temperature data for four consecutive days in both August and November are presented hereunder.

Date	Time	Temperature (°F)		Maximum Temperature (°F)		Minimum Temperature (°F)	
		External	Internal	External	Internal	External	Internal
Aug. 5	9 a.m.	60	68	82	98	32	38
	11 a.m.	69	81				
	1 p.m.	79	98				
	3 p.m.	78	84				
	5 p.m.	68	78				
Aug. 6	9 a.m.	62	70	86	106	33	44
	11 a.m.	72	90				
	1 p.m.	82	104				
	3 p.m.	84	105				
	5 p.m.	70	80				
Aug. 7	9 a.m.	68	80	88	104	51	55
	11 a.m.	78	94				
	1 p.m.	85	99				
	3 p.m.	80	92				
	5 p.m.	76	84				
Aug. 8	9 a.m.	75	84	91	110	58	60
	11 a.m.	80	96				
	1 p.m.	86	106				
	3 p.m.	88	102				
	5 p.m.	80	86				
Nov. 19 ..	9 a.m.	97	98	124	124	66	77
	11 a.m.	118	114				
	1 p.m.	125	116				
	3 p.m.	116	116				
	5 p.m.	106	109				
Nov. 20 ..	9 a.m.	101	98	118	120	70	79
	11 a.m.	108	108				
	1 p.m.	114	115				
	3 p.m.	118	125				
	5 p.m.	104	109				
Nov. 21 ..	9 a.m.	92	97	114	122	75	77
	11 a.m.	108	108				
	1 p.m.	109	113				
	3 p.m.	113	114				
	5 p.m.	98	105				
Nov. 22 ..	9 a.m.	98	103	118	127	71	80
	11 a.m.	119	121				
	1 p.m.	119	117				
	3 p.m.	120	112				
	5 p.m.	101	104				

The mean November maximum is 91·5°F (1931–1960).

Appendix 2

Construction Materials
(Costed on Brisbane prices)

		$
90 6 ft x 26 in. ripple corrugated PVC sheets		135
112 6 in. x 23 in. glass louvres		60
8 pr 14-blade louvre frames		53
294 super feet hardwood		64
14 super feet 3 in. x 1 in. pine (for door frames)		6
34 bags cement	for slab 30 ft x 20 ft x 3 in.	38
3 cu. yd sand		10
4 cu. yd gravel		14
12 x $5\frac{1}{2}$ in., 26 x $4\frac{1}{2}$ in., 6 x 10 in. carriage bolts		5
2 gal raw linseed oil		6
2 gal white paint		16
7 ft 2 in. x $\frac{1}{4}$ in. steel strap		1
Waterproof glue		3
Nails and bolts (miscellaneous)		9
		$420

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