RAND ESTATE
NIAGARA- ON- THE- LAKE

2009

EXISTING CONDITIONS AND SALVAGE PLAN
LORD AND BURNHAM GLASSHOUSE

SCHOOL OF THE RESTORATION ARTS AT
WILLOWBANK

2009

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000423

South Elevation of Glasshouse

South Entrance Elevation of Glasshouse

1. EXECUTIVE SUMMARY

This report is about the proposed salvage of a greehouse in Niagara-on-the-Lake, Ontario, by the students and staff of the Willowbank School of Restoration Arts in Queenston, Ontario. The greenhouse is a c.1920s Lord and Burnham 'Modified Curved Eave Construction' glasshouse. The current owner Calvin Rand, founder of the Shaw Festival Theatre in Niagara-on-the-Lake and a significant supporter of the arts in Buffalo and Niagara-on-the-Lake has generously offered to donate the Glasshouse, to the Willowbank School of Restoration Arts, in the hope that it will be restored and re-located to the WillowbankEstate and School.

The greenhouse is currently in very poor condition. This is due primarily to the structural collapse of the masonry walls that form the base of the structure. The masonry wall is laid out in a running bond configuration and is capped with a single header row. The brick courses have separated and no longer adequate supports the supper structure above it. The brick wall has lost much of it's mortar adhesion due to being in a harsh climate and always being super saturated by the humidity of the green house. As a result of this movement, some of the structural wood and metal elements have cracked and there has been considerable loss of glass.

The idea for salvaging the greenhouse is to concentrate on removal and storage of the original manufactured elements, in particular the overall steel frame, the internal wood sash and framing members, and the original glass. Particular attention will be given to saving the original curved glass panels. With the assistance of Willowbanks faculty and friends all of the current damaged elements can be fixed/ replicated without the need for external contracting. This assumption is dependent upon successful dismanteling of the glasshouse with minimal further damage. The brick walls will not be salvaged for reuse - they will remain on the property and be used in the development of the landscape. The rest of this report will provide more technical details.

Stone wall and Entrance to the Randwood Estate from Railway Line

2. INTRODUCTION

Introduction

The 1919 Rand Glasshouse is located directly behind a modernhouse built by Calvin Rand the on property he severed from his family's estate some time around 1980. There is a large Garage nearby which probably dates from the same period as the Glasshouse. Other architectural and landscape features on the site appear to be the remnants of an earlier landscape scheme which may have included the Rand Glasshouse. Calvin Rand, founder of the Shaw Festival Theatre in Niagara-on-the-Lake and a significant supporter of the arts in Buffalo and Niagara-on-the-Lake, would like to see the Glasshouse restored to its former state. He has generously offered to donate the Glasshouse, which holds many fond childhood memories, to the Willowbank School of Restoration Arts, in the hope that it will be restored and re-located to the WillowbankEstate and School.

Rand Glasshouse behind modern residence of Calvin Rand

Garage Building .c. 1919

1.2 The Rand Estate

Calvin Rand's property at 200 John Street East was origianlly part of a much larger estate that his grandfather-George F. Rand purchased in 1910 from the Lansing family. At that time the Estate was called Randwood. This property has great historical significance because it is the site of the first brick house in Upper Canada. The original house built for William Dickson in the 1790s was destroyed in the War of 1812 but was re-built shortly after. It is this early 19th century 2-storey red brick house that formed the nucleus of the house owned and altered by the Lansings between 1874 and 1908 and by the Rands from 1920 till 1970.. In 1971 Calvin Rand founded the Randwood School of Philosophy and some time later extensive renovations

were carried out at Randwood by Chapman Murray Associates of Niagara-on-the-Lake to accommodate one hundred students in dormitory-style rooms. In 2006, Randwood and the Rand Estate, with the exception of Calvin Rand's property, was purchased by Trisha Romance whose family owns the two adjoining estates on John Street.

Randwood, formerly called Woodlawn

The Rand Landscape

When Calvin Rand's grandfather George F. Rand purchased the estate in 1910 he immediately began making changes to the landscape which included building a stone wall along Charlot St. and Railway Line at the back of the property. Stables and the first large pool in town where also located at the back of the property. According to an article published in The Times, this work was supervised by Mr. McCreary a well known architect from Buffalo. McCreary was a partner in the architectural firm of McCreary, Wood and Bradney whose work in Buffalo included the John D. Larkin Jr. House at 65 Lincoln Parkway in 1912. George F. Rand was president and chairman of the board of directors of Marine Midland in Buffalo. He was a prominent figure in Buffalo and the Rand Building on Layfayette Square, the city's tallest building when it opened in 1929, was named in his honor.

George F. Rand House 1180 Delaware Avenue, Buffalo (1918-1923)

Rand appears to have had a considerable interest in architecture. At the same time that the Glasshouse, out-buildings and landscape were being carried out at Randwood in Niagara-on-the-Lake, the Rands were building a large home in Buffalo located at 1180 Delaware Avenue. This Tudor Revival home was designed by Franklyn and William Kidd, a prominent Buffalo firm. This house was sold by the Rands in 1925 and is now owned by Canisius High School a private preparatory school established by the Jesuits. Tragically, George F. Rand was killed in a plane crash in 1918 and his wife died shortly after just as construction was to begin on their Buffalo home. The Rands were survived by their four children George, Calvin, Gretchen and Evelyn. The Buffalo house, and presumably the changes at Randwood., were completed by George F. Rand Jr. to plans prepared for his father. A 1919 article in The Times describing work at Randwood reported that George Rand Jr. built two cottages on the property as well as a barn and clubhouse on Charlotte Street. He purchased the adjoining property from Mrs. Lewis, raised the existing stone house, and put up a new one for his sister Evelyn, who had just married Lt. Col. H.B. Sheets of the US Marines. The Glasshouse may have

Garden Temple, c. 1919

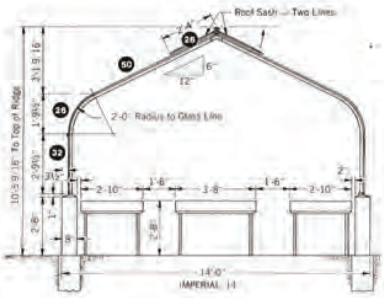
View for Randwood Glasshouse from the Circular Grove

been part of a large landscaping scheme undertaken at this time. The 1919 article refers to a lily pond and a long curved driveway. A small temple-like structure to one side of this curved drive and a circular grove of trees around a central mound located only a short distance from the Rand Glasshouse may also be remnants of this scheme. This landscape should be further investigated and recorded. George Rand Jr. raised dairy cows at Randwood and his sister Evelyn was an accomplished equestrian. In 1919, stables and a milk-house were built to serve these pursuits. These structures, located on Weatherstone Court and Charlotte Street, have since been converted to private residences but retain much of their original charm. Though no longer part of the Randwood Estate or the Calvin Rand property, they are contemporaries to the Rand Glasshouse and once formed a single ensemble. The stables and milk-house were designated in 1988 as buildings of architectural significance. Also notable is the former Randwood Gatehouse on Charlotte Street in Niagara-On-The-Lake.

Randwood Gatehouse on Charlotte Street, c.1919

The Rand Glasshouse

The Rand Glasshouse was a prefabricated structure manufactured by Lord & Burnham, a noted American greenhouse manufacturer and builder of major public conservatories in the United States. The company began in 1849 building wood and glass greenhouses for private clients in Buffalo, New York. In 1856 the company moved to Syracuse, New York and then to Irvington, New York to be closer to customers in the large Hudson River estates. In 1881 the firm constructed the first steel-framed curvilinear greenhouse in the United States for railroad magnate Jay Gould at Lyndhurst. Lord and Burnham also pioneered the use of ground glass in the windows so that single panes of glass could be made to fit a larger surface. The company experimented with several boiler types that would provide dependable, adjustable and evenly distributed heat to large areas. In 1914 the company established Lord and Burnham Ltd. in St. Catharines in order to produce greenhouses for the Canadian market. It seems likely that the Rand Glasshouse was manufactured in St. Catharines, transported to Randwood and assembled on site. A frame constructed of cypress and iron allowed for a large span with large sheets of glass. The Rand Glasshouse is an example of the 'Modified Curved Eave Construction' – a model that Lord & Burnham introduced in 1919.



Lord & Burnham Modified Curved Eave Construction

Former Rand Stables, Designated 1988

The company's 1920 catalogue explained that this construction, like the Standard Curved Eave, came in answer to two demands;

One; to give a more pleasing handling from an architectural standpoint, to the side ventilation. The other; to give greater height on the side benches for the taller growing plants.

The curved panes of glass along the eaves and the added architectural details such as the roof finials and the wood and glasscanopy over the entrance made this a very attractive and popular model for private estates. The frame is constructed of cypres pieces and were cut by hand.

Lord & burnham, Restoration Project, Hatley Castle, BC

Restored Lord & Burnham Glasshouse at Blithewold Mansion, Rhode Island, c. 1910

Lord & Burnham Co. Advertisement

Interior West wall

3. CURRENT OVERALL CONDITIONS

The Rand Estate Lord and Burnham Modified Eave Glass house c.1920 is in serious threat structurally. Due to the deterioration of the knee wall and separation of the brick courses the superstructure above it is not adequately supported and is very unstable.

The knee wall has caused the 7 main metal rafter sections to become very unsafe and most of the metal eave fittings have broken at the cast sills and above the wooden lower sashes, most of these pieces may be welded back together. The rest of the metal structure is in good condition structurally although it is begin to rust badly. At one point all of the metal elements were coated in a white lead based paint, at this time due to neglect the majority of the paint has failed resulting in. Other notable metal features are the hand cranked metal gear and cam system used to open and close the sash windows along the roof line and below the gutter. In the small entrance room there is one section of the original hot water heating coils. There are also 5 sets of cast iron shelf brackets on the west wall, which appear to be original to the structure.

All wood elements of the greenhouse are comprised of Southern cypress wood. This timber is specially suited for exterior structures and greenhouses in particular, it is lightweight, medium textured with a closed straight grain and few knots. The heartwood of the cypress tree produces a natural preservative oil (cypressine) creating a resistance in the wood to insects, fungus, and harsh climates. The Lord and Burnham Company used cypress wood exclusively in the construction of its greenhouses until the wood elements were replaced with aluminium. Random tests were done for rots and little to none were found. There are some breaks in the rafter caps and raftes at the curves which are a result of the brick knee wall bulging outward.

The condition of the brick knee wall at the Lord Burnham glasshouse is a major concern. It appears to be the original foundation from the 1920's. The wall is laid out in a running bond configuration and is capped with a single header row. The brick courses have separated and no longer adequately supports the super structure above it. The separation of the brick courses has caused the metal, wood and glass to break in some areas. The brick foundation has lost much of it's mortar adhesion due to being in a harsh climate and always being super saturated by the humidity of the green house. The brick from the knee wall will be left in place by the request of the property owner.

The glass is a combination of original rolled plate glass, newer flat glass and Plexiglas panels. Due to weathering and lack of maintenance and the shifting of the building; some pieces have completely fallen out. Of those still in place, many have slipped down from their original position and now overlap the panes below them. The glass panes are held in place by a layer of putty on both sides with zinc nails along the bottom edges. Much of the putty has failed and has separated from the wood muntins causing the panes to slip down. In general the glass is very unstable and there is broken glass lying on the ground from pieces that have fallen off. Inside the greenhouse there are several unbroken panes that have been removed and stacked against the wall. During the dismantling great attention must be given to the curved glass pieces along with the old wavy glass.

Cracked rafter connection at gutter

3.1 WOOD ELEMENTS

Condition

Most of the damage to the cypress wood has occured in the areas of the curved eave, this is a result of the knee wall bulging outward and creating tension on the curve. The rafters, and rafter caps were painted with white aluminium paint, all other wooden elements were painted with white lead paint, to increase durability and for aesthetic reasons. A majority of the wood is in very good condition, but there is swelling due to exposure to the elements and most of the paint has peeled off

Red Circle imndicates area common to breaks

Components

Wood rafters: the wood rafters run parallel to the cast iron rafters, 16" o/c apart, and are comprised of two parts running from the ridge vent to the sill sash; 6' straight portion, 2' curved portion. The rafters along with the rafter caps support the glazing while their profile incorporates a groove which collects interior condensation and channels it down the rafter into the exterior gutter.

Rafter Caps: the rafter caps cover the exterior edge of the metal rafters running from the sash windows to the ridge of the structure, the lower section of the metal rafter is covered by the exterior decorative caps. The rafter caps support the glazing and again incorporate a drip channel to remove interior condensation in their profile.

Exterior Decorative Caps: these cover the bottom portion of the metal rafter between the sash windows. Vent sash windows/ridge vent: the moveable sash and ridge vent windows are six panes wide by one pane high running along the sill and ridge respectively.

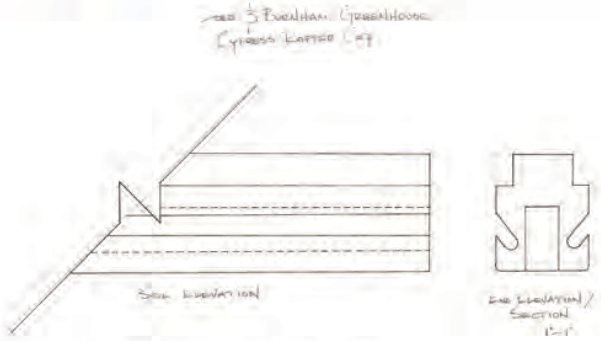
Muntins: The glazing on the interior and end wall is supported by wood mutins running vertically from the sill to the curved rafters.

Doors: The south access door and the door in the dividing wall. They are both 3-over-4, 12-pane single French doors. All original doors and door frames are also comprised of cypress.

Canopy: situated above the south entry door.

South West corner - 3 missing curved wooden rafters

The following pages contain detailed analyses for the damaged wood elements of the glasshouse.



Rafters Cap - Elevation and Section

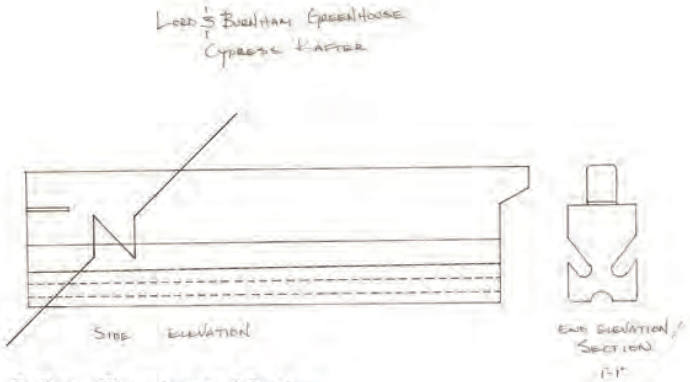
North Elevation

Bay 1, rafter 2, 3 & 4: bottom curved portion of rafter unattached
Bay 3, rafter 3 curved portion at sill cracked
Sash wood rotted at bottom
Rafter cap D cracked at bottom and top of curved portion
Rafter cap E exterior decorative cap loose at bottom
Bay 5, rafter 4 cracked a bottom of curved portion
Rafter cap F exterior decorative cap missing
Rafter cap G cracked at bottom of curved portion

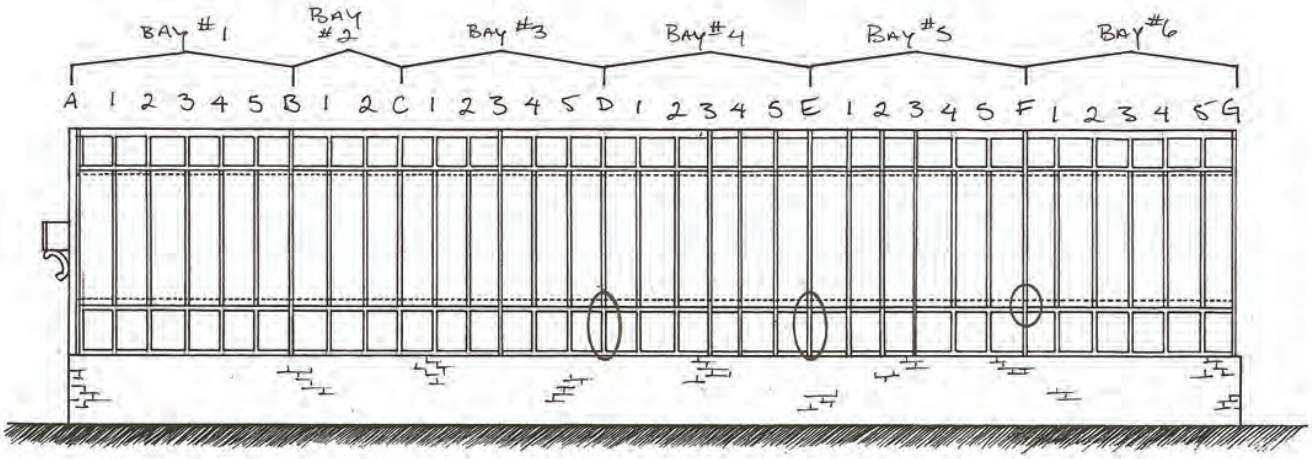
South Elevation

Rafter cap D exterior decorative cap unattached
Rafter cap E exterior decorative cap loose at bottom
Rafter cap F cracked at bottom of curved portion

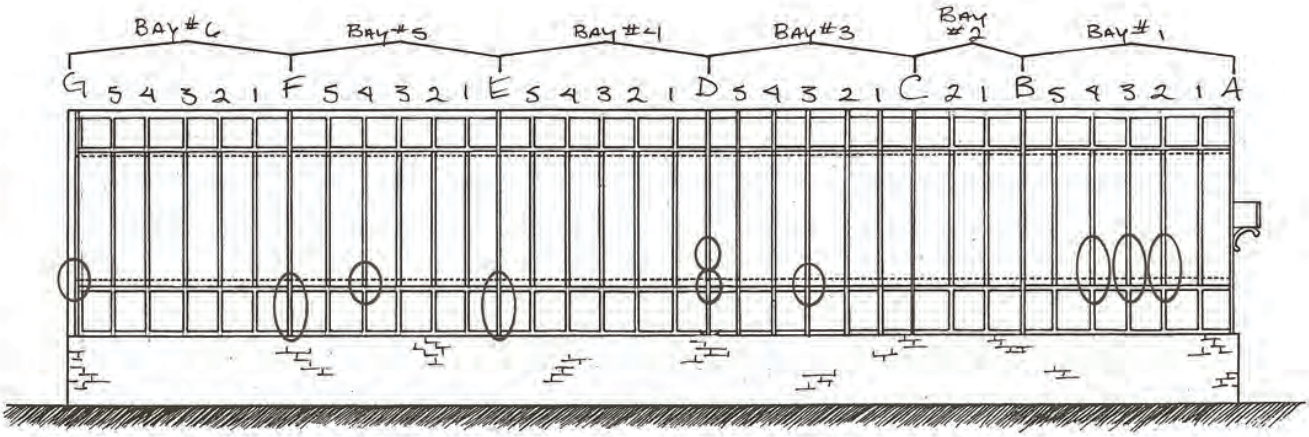
Please note: all items described as unattached are still on site and in good condition unless otherwise noted.



Rafter - Elevation and Section



EAST ELEVATION



WEST ELEVATION

Glazing in partition wall

3.2 GLASS ELEMENTS

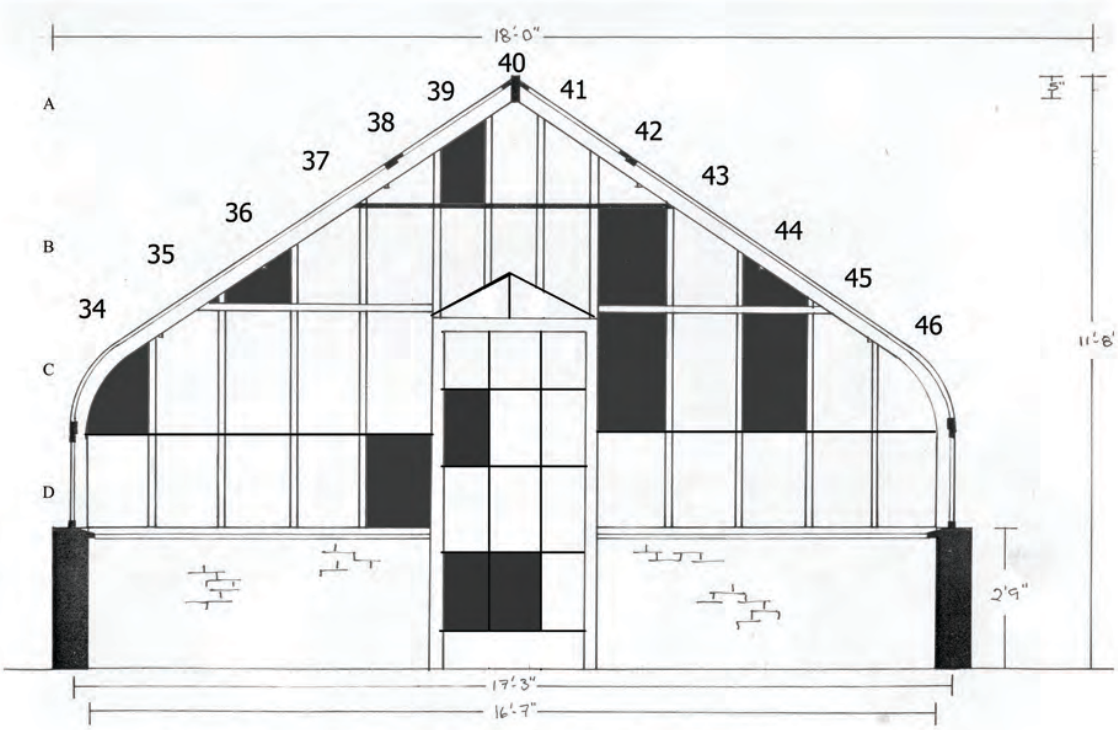
Condition

The glass is a combination of original rolled plate glass, newer flat glass and Plexiglas panels. Due to weathering and lack of maintenance and the shifting of the building some pieces have completely fallen out. Of those still in place, many have slipped down from their original position and now overlap the panes below them. The glass panes are held in place by a layer of putty on both sides with zinc nails along the bottom edges. Much of the putty has failed and has separated from the wood Rafters causing the panes to slip down. Some panes have stayed in place with the original overlap of 3/8ths of an inch but most have slipped out of place and dirt has penetrated between the panes. In general the glass is very unstable and there is broken glass lying on the ground from panes that have fallen off. Inside the greenhouse there are several unbroken panes that have been removed and stacked against the wall.

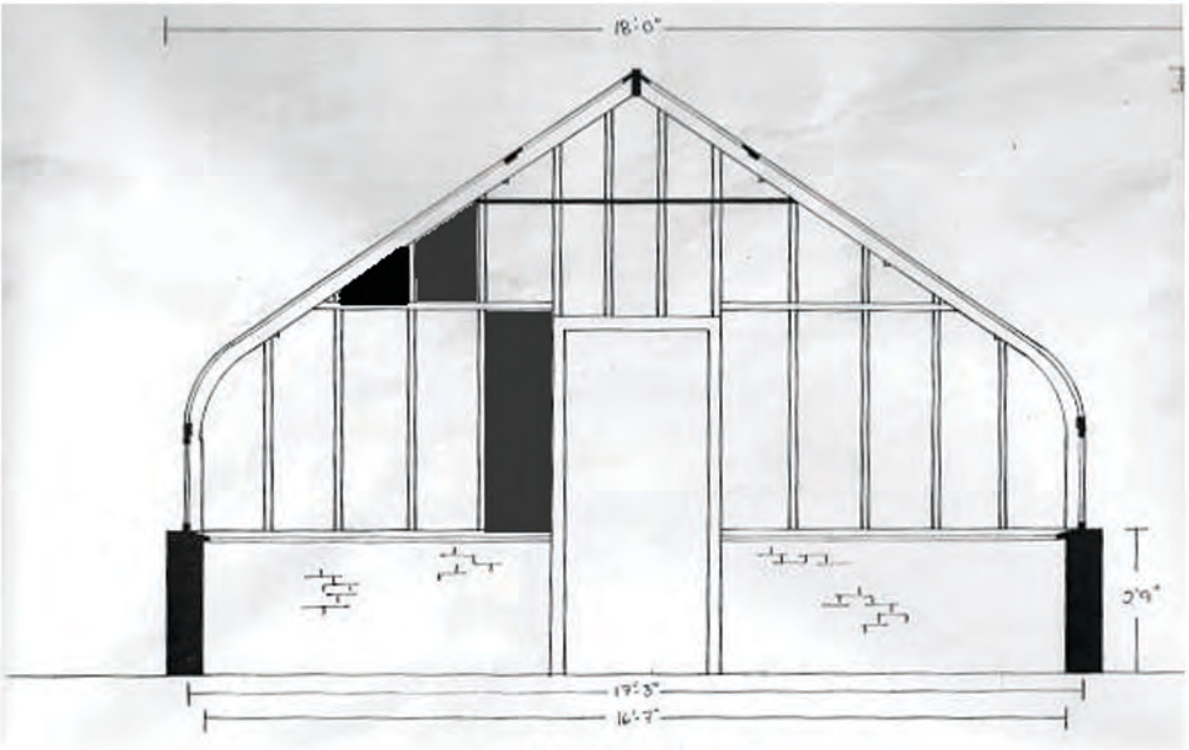
Glass Total Chart

	Damaged Glass
East Elevation	36
South Elevation and Partition	16
West Elevation	24
Total	66

* The Potential for additionally damaged glass pieces during removal should be taken into account

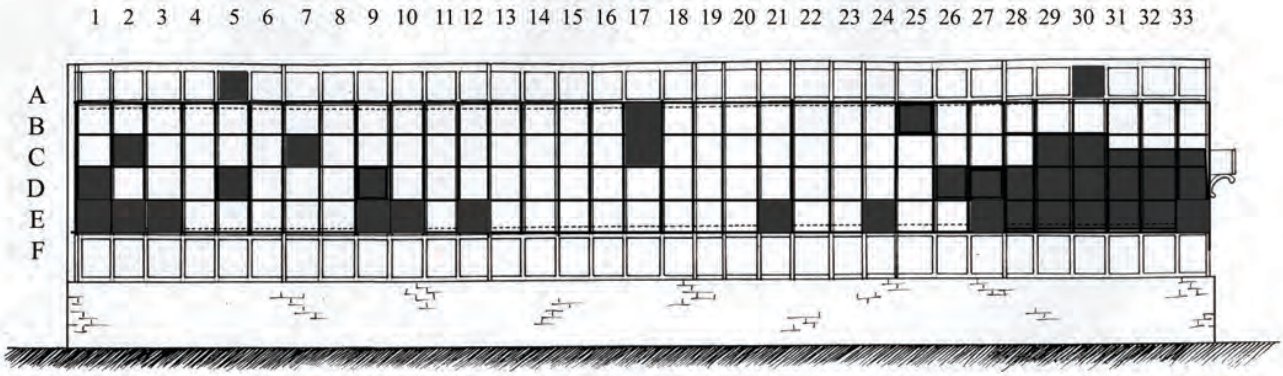


South Elevation

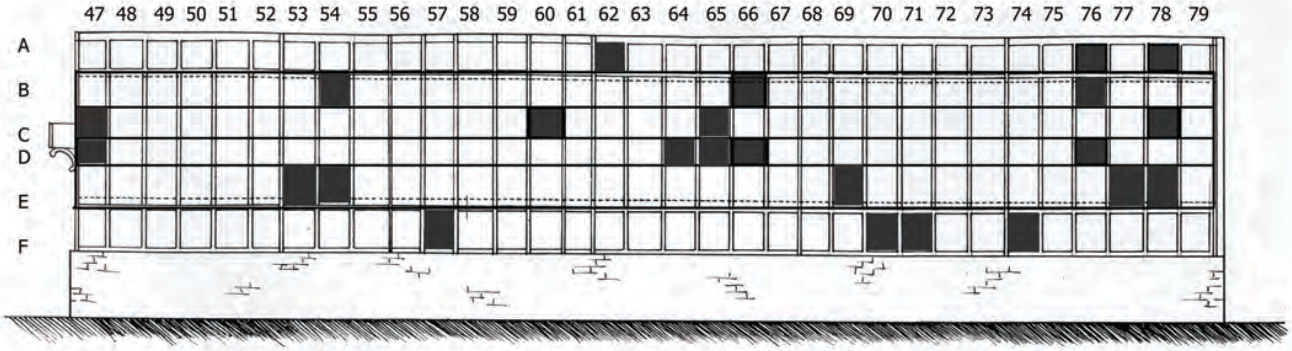


Partition Wall

* Black squares show where glass is presently broken



EAST ELEVATION



WEST ELEVATION

* Black squares show where glass is presently broken

Gutter End

3.3 METAL ELEMENTS

Condition

Large amounts of the cast iron element are still intact although due to the deterioration of the knee wall and separation of the brick courses the seven main metal rafter sections have become very unsafe and most of the Metal Eave fittings have broken at the cast sills and above the gutter. To better illustrate where these breaks have occurred the next 2 pages have labelled diagrams showing the exact locations of the breaks.

At one point all of the metal elements were coated in a white lead based paint, at this time due to neglect the majority of the paint has failed. This has caused the paint to peel and most of the metal has begun to rust. Great care must be taken when taking apart metal parts, as replacement parts are no longer in production and will be very expensive to have remade. Any broken pieces are to be kept; most parts may be welded back together.

Other Important Metal Components

All of the following metal components, except for some rust are in very good condition.

-The sash windows along the roof line and below the side eaves, which are opened and closed by a hand cranked metal gear and cam system.

-In the small entrance room there is one section of the original hot water heating coils, which appears be an original heating system radiator (see appendix for catologue). In the small entrance room there is one section of the original hot water heating coils.

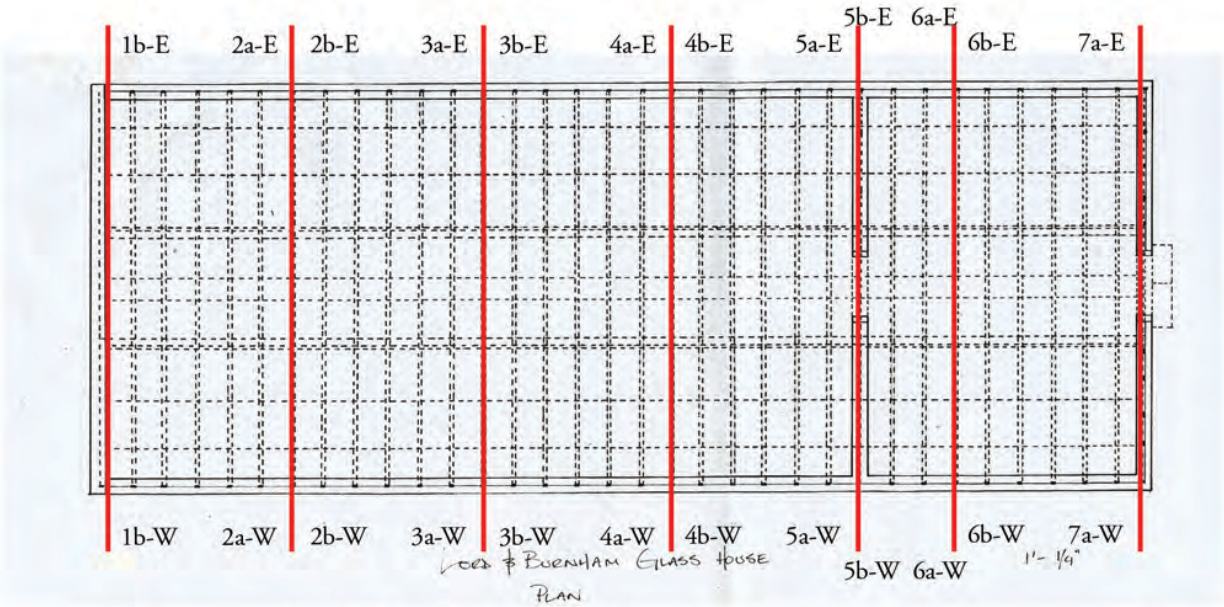
-There are also 5 sets of cast iron shelf brackets on the west wall, which appear to be original to the structure.

Gears for roof line windows

Hand crank for the side windows

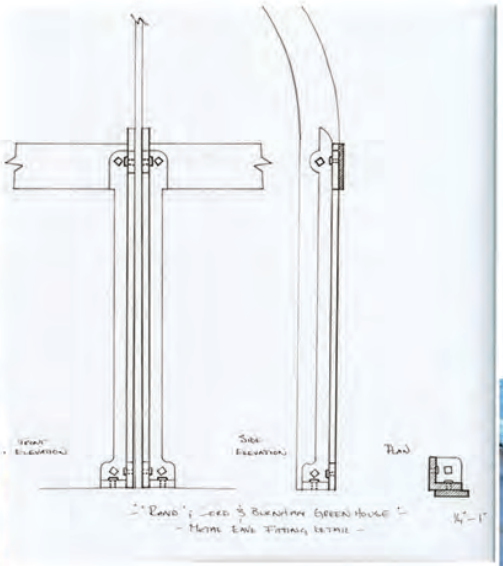
Hot water heating coil

Metal Rafter Plan of Sections Indicating Cracks



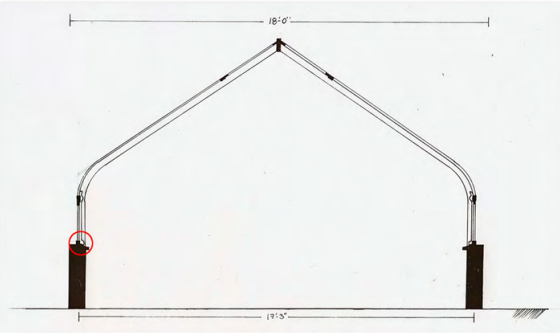
* Please Note Section 7 is not shown on the next pages, there are no breaks

Weldable crack at top joint

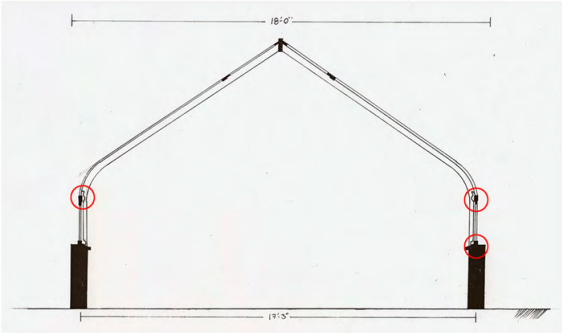


Drawing of indicated cranked part

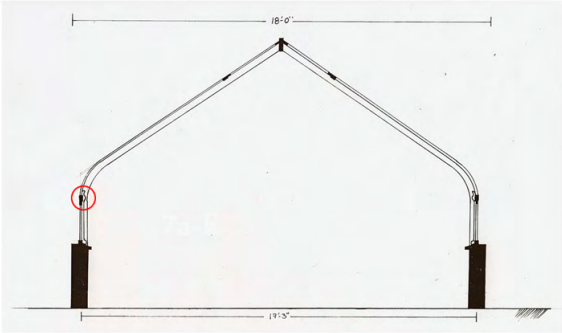
Non weldable crack at top joint



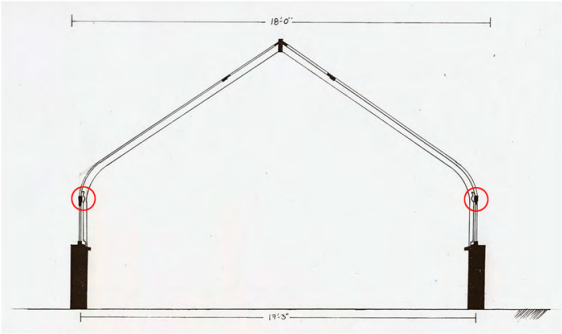
1b-W 1b-E



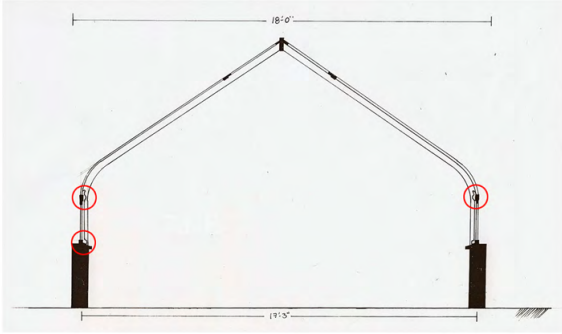
2a-W 2a-E



3a-W 3a-E



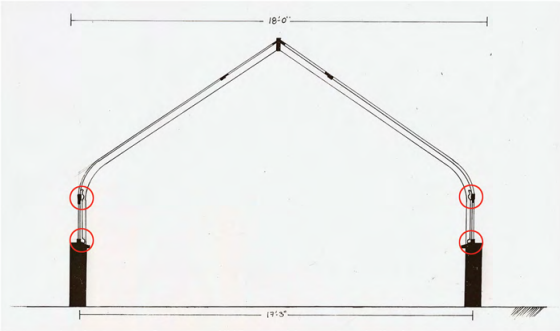
2b-W 2b-E



3b-W 3b-E

3.3 METAL ELEMENTS

3.3 METAL ELEMENTS



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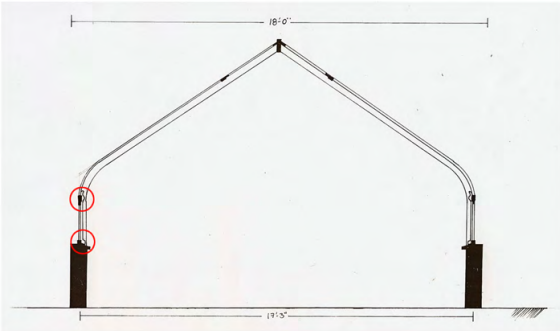
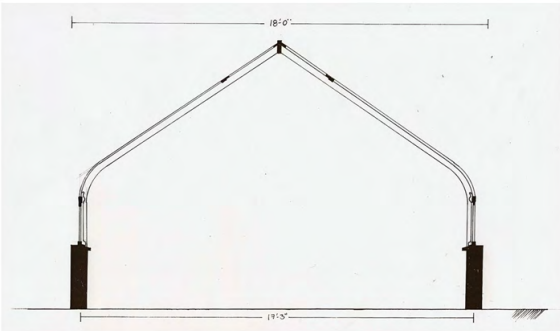
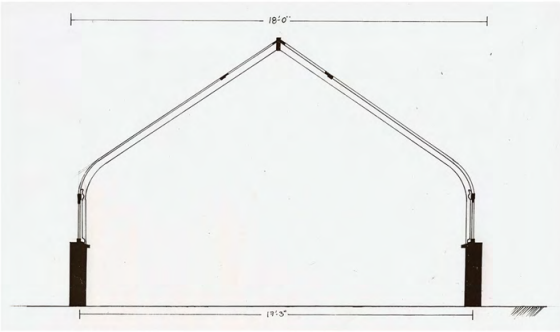


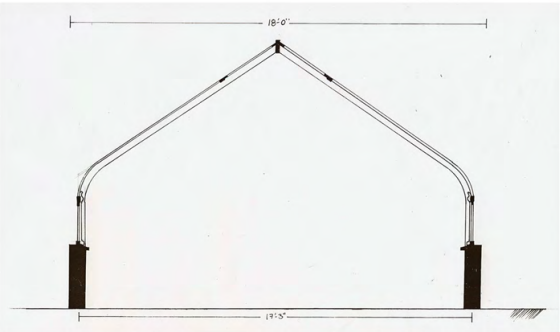
5a-E 5a-W



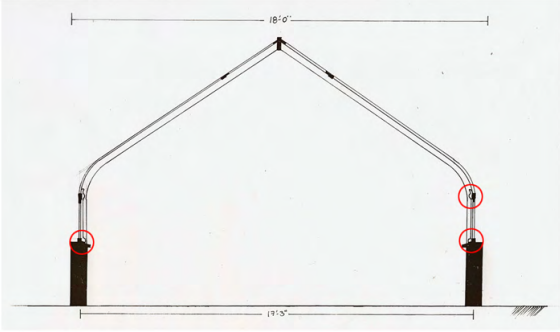
6a-E 6a-W



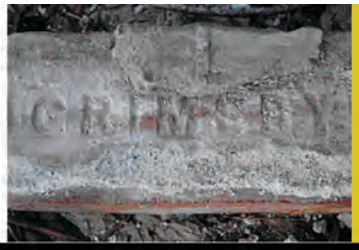
4b-W 4b-E



5b-E 5b-W



6b-E 6b-W



Brick from masonry wall, stamped Grimsby

3.4 BRICK ELEMENTS

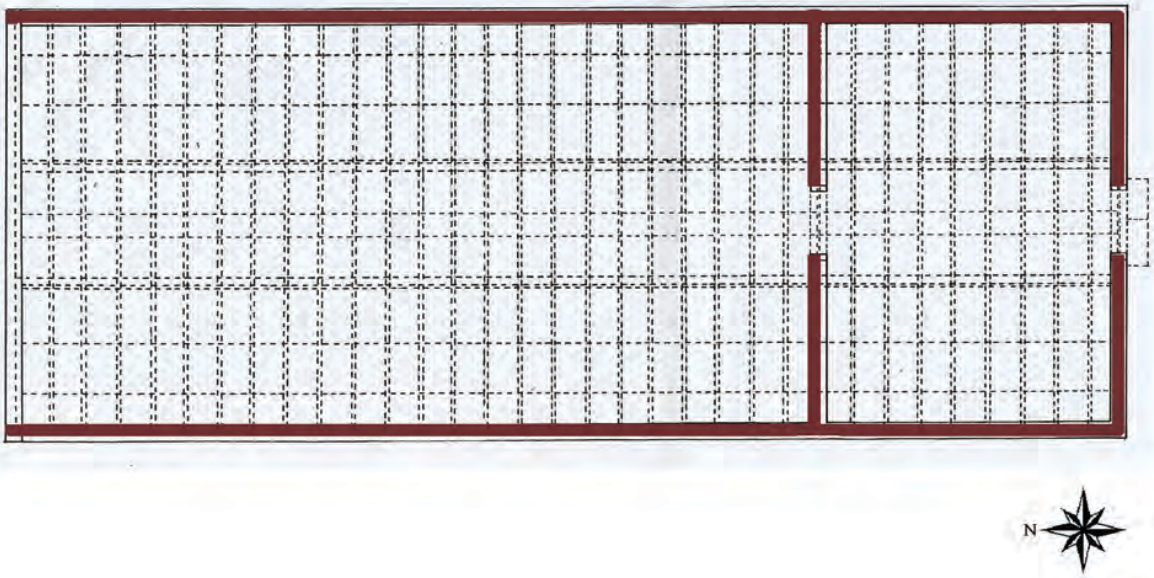
Condition

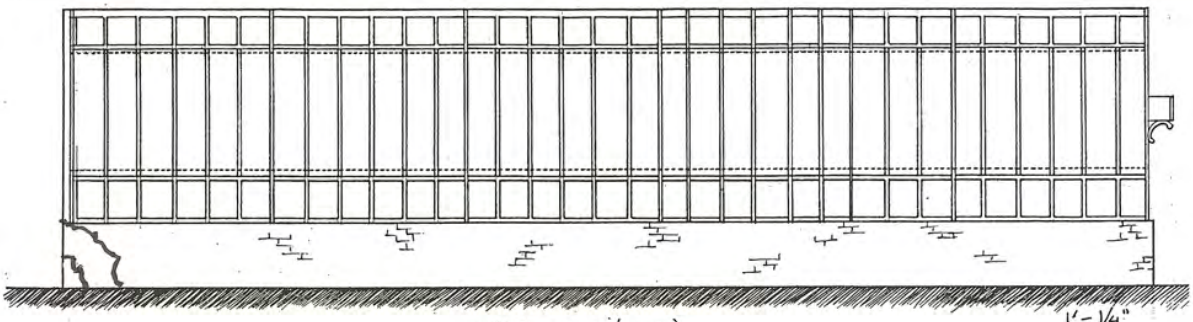
The condition of the brick supporting wall at the Lord Burnham glasshouse is of major concern. It appears to be the original foundation from the 1920's. The bricks are made of red clay and stamped Grimsby. The wall is laid out in a running bond configuration and is capped with a single header row. The brick courses have separated and no longer adequately supports the super structure above it. The brick will be left on site by the request of the property owner to further develop the landscape.

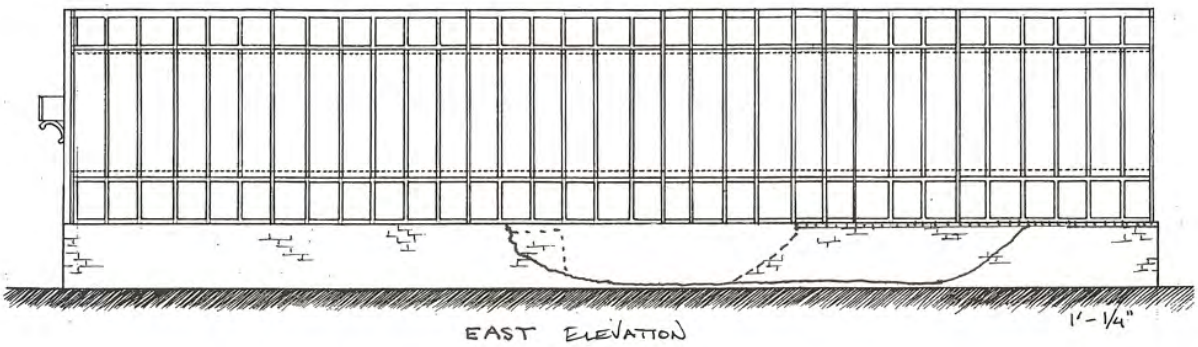
To illustrate the overall condition of the brick elements the next two pages are labelled to show exactly where the deterioration and collapse of brick has occurred.

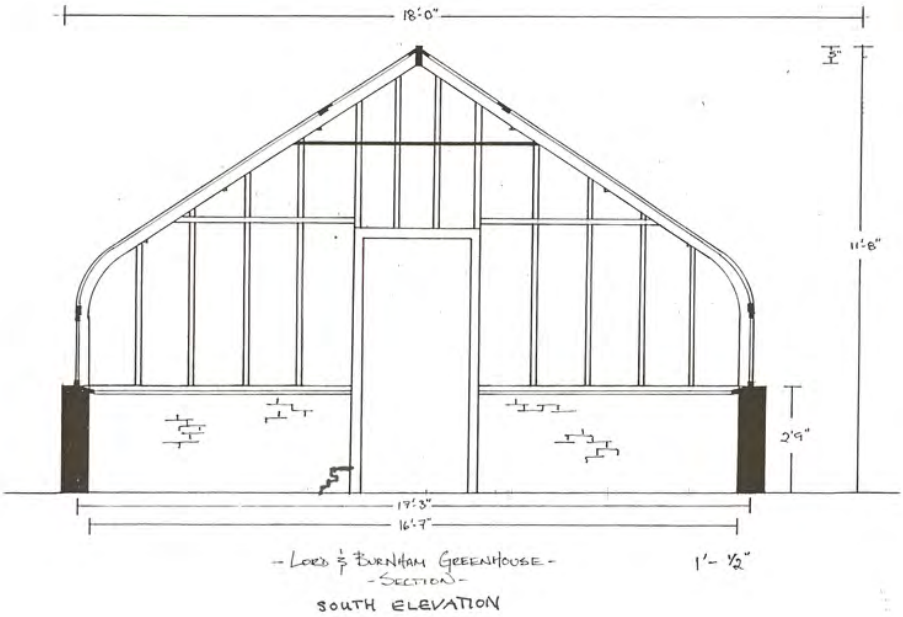
Example buildings mortar condition - South Wall

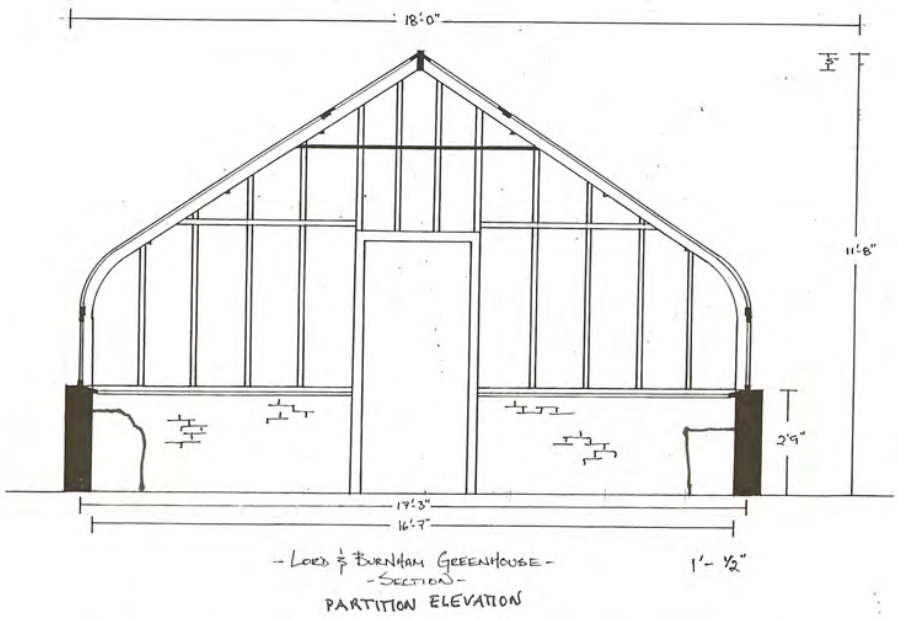
Brick Knee Wall Plan




WEST ELEVATION
1'-1/4"


EAST ELEVATION
1'-1/4"





Left Hole

Right Hole

** The brick division wall has 2 holes roughly 22" high by 16" wide these hole were most likely used to connect the radiator pipes between rooms.

MEASURED DRAWINGS

MEASURED DRAWINGS

MEASURED DRAWINGS

5.1 DISMANTLING OVERVIEW

Preparation

a) Safety: All participants must wear safety equipment at all time when on site. The green house itself has many damaged areas and certain sections could prove to be unpredictable. Mandatory Protective Equipment for use on site: Gloves, Hard hats, Steel toe boots, Safety-glasses, also, masks when dealing with peeling paint and corroded metal parts.

b) Crates built to specifications for the safe transportation and storage of glass, wood and metal parts (drawing #)

c) Designated Areas on Site will be assigned for the packing of different materials to expedite later removal from site in two stages.

1) Glass (flat panels), Glass (curved panels), Wood (cyprus), Sash and Doors.

2) Metal (structural) Metal (fasteners), Recyclables / Scrap.

d) Site preparation before dismantling begins is essential. Obstacles such as broken glass, logs, old chairs, gardening equipment, and debris will only slow later process of deconstruction.

e) Power and water need to be disconnected. A certified licensed electrician should be involved to ensure proper procedure and code is observed.

f) Work bench space should be provided.

Stabilization

The glasshouse is experiencing serious structural issues; it is recommended that steps be taken to stabilize the metal frame to ensure worker safety and ease of disassembly.

a) Wood horizontal bracing with Jacks could be used to add additional support to the iron frame. Positioning of these must be carefully thought through to enable access to the site, and carriage of load. They should likely be spaced in pairing with the cross section bracing, but at eave level, taking advantage of removed sash to allow passage through to the exterior. (see drawing #) This bracing system is precautionary and is not expected to lift the structure at any time, but to serve as support.

b) The wood horizontal bracing should have blocking affixed to prevent any movement of the structure to the west and east. (see drawing #)

c) The Jack posts should be affixed to wood foot boards to provide better ground contact

Dismantling

This will be organized into four stages as a singular project to salvage the glasshouse itself. The brick foundation knee wall is unlikely to be reused at this time, however, the site should be left clean and tidy and processes to this end will be laid out as a fifth part of the dismantling project.

Glazing, Doors and Sash (Under onsite advisement of John Wilcox)

a) All glass should be labeled and stored with alike measurments.

b) Glass removal should begin at the south end and work north, this end having experienced the largest loss of glazing thus enabling better access. The glass is lapped and so should be removed from the ridge line first. This will require the use of scaffold to provide stable support for multiple workers. A group of workers should be on hand to provide support of glass through all stages. Glass should be inspected for condition, recorded, and then should be immediately packed. Any fixings should be retained, bagged, and labeled.

c) Sash should be labeled with their designated part numbers (see drawing #). Operator fixings will need to be removed from the sash; screws should be retained, bagged, and labeled. Sash can then be removed; screws should be retained, bagged, and labeled.

Cypress Rafters

a) All rafters should be labeled with their designated part numbers (see drawing #).

b) The rafters should be removed, inspected for condition and recorded, and then grouped to their matching configurations and packed for shipment.

c) Screws and fixings should be retained, bagged, and labeled.

Wood members (other)

a) All parts should be labeled with their designated part numbers (see drawing #), inspected for condition and recorded, and then packed for shipment.

Iron Trusses

a) All iron pieces should be labeled with their designated part numbers (see drawing #).

b) All fixings should be treated with WD-40 a minimum of 24 hrs in advance with in the hope for easier re moval

c) Please only try this next step if you are in an environment where you can use a hand held propane torch. If it is a screw or bolt you are trying to loosen, use a propane torch and have the torch flame hitting the top of the screw/ bolt head moving the flame around slightly to heat the entire head. Usually 30 seconds or less of heat time is enough. Put your gloves on since it will be very hot and you don't want to touch it by accident and burn yourself. Now try to loosen the screw with your screwdriver while the screw head is still hot. Always remember to turn the torch off when you are not using it.

c) One section at a time should be removed, likely best starting from the south end. Fixings should be removed, bagged and labeled.

d) Metal parts need to be inspected for condition and recorded for repair / replacement

Further Work:

a) The hot water coils are thought to be an original part of the building and a decision should be made as to whether they can be removed and reused.

b) The brick knee walls do not need to be dismantled as they will remain onsite for future reuse.

c) Waste materials need to be removed and disposed of in a responsible manner. Recycling of the patio doors installed on the north wall can possibly be reused elsewhere with the permission of the owners.

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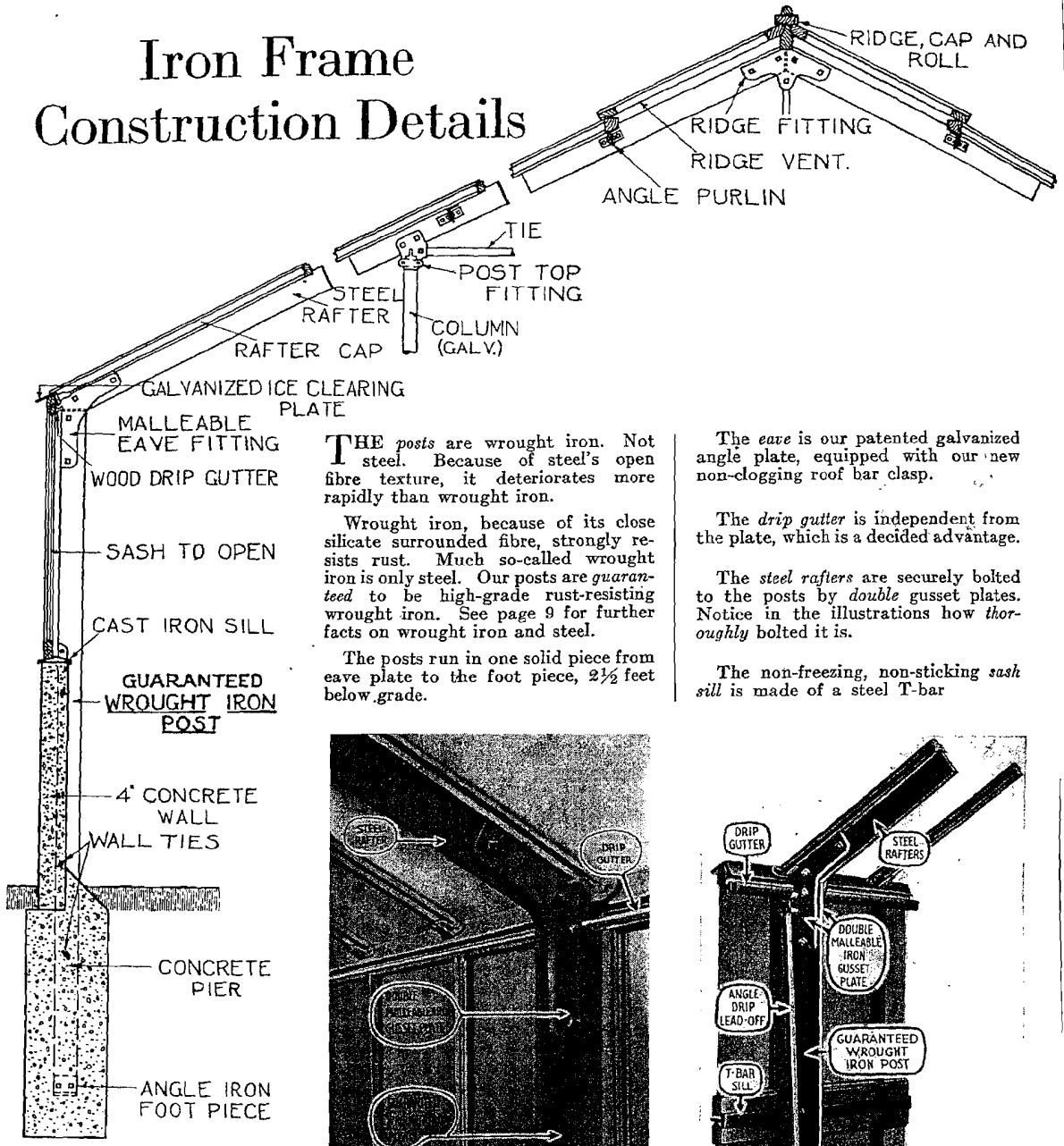
Iron Frame Construction Details



Details of our iron frame house, used with 5 feet 10 inch high sides and in widths up to and including 40 feet. The rafters are spaced 8 feet 4 inches apart.

THE *posts* are wrought iron. Not steel. Because of steel's open fibre texture, it deteriorates more rapidly than wrought iron.

Wrought iron, because of its close silicate surrounded fibre, strongly resists rust. Much so-called wrought iron is only steel. Our posts are *guaranteed* to be high-grade rust-resisting wrought iron. See page 9 for further facts on wrought iron and steel.

The posts run in one solid piece from eave plate to the foot piece, 2½ feet below grade.

The *eave* is our patented galvanized angle plate, equipped with our new non-clogging roof bar clasp.

The *drip gutter* is independent from the plate, which is a decided advantage.

The *steel rafters* are securely bolted to the posts by *double* gusset plates. Notice in the illustrations how *thoroughly* bolted it is.

The non-freezing, non-sticking *sash sill* is made of a steel T-bar

Close up view of the eaves used on houses up to 40 feet wide. Note that the steel rafter and the wrought iron post are joined together by a double malleable iron gusset plate. The Cypress drip gutter is secured directly to the top rail of the side sash.

This shows a detail of the side when they are built 7 feet high. Note that the sash sill is a steel T-bar. Although the sash always shuts tight, it never sticks.

Prices Subject to Discount

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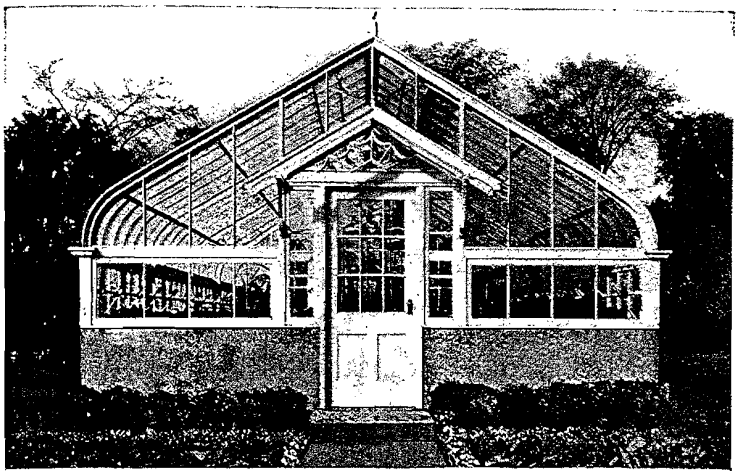


No. 327.—By comparing this gable view with the one on the opposite page, you can the better distinguish the contrasting differences between the two constructions.

Modified Curved Eave Construction

THIS construction, like the Standard Curved Eave, came in answer to two demands:

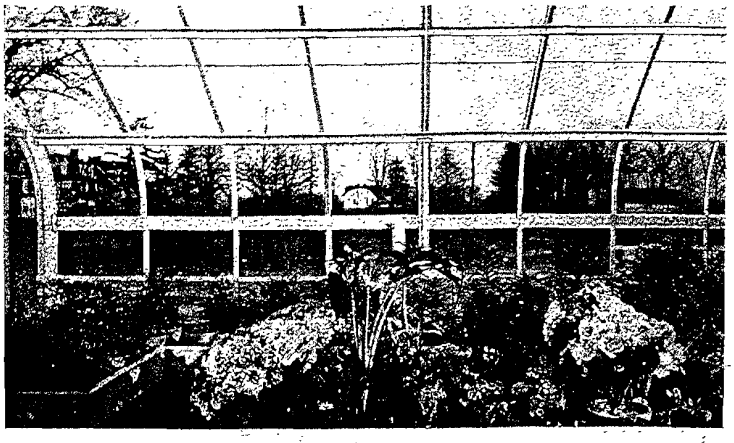
One: to give a more pleasing handling from an architectural standpoint, to the side ventilation.

The other: to give greater height on the side benches for the taller growing plants.

To bring this about, instead of putting the gutter on the sill, as in the other curved eave construction, we placed it at the bottom of the curved eave and then hinged the ventilating sash directly to it. The height of the curved portion was also increased, giving greater head room for the side bench plants.

Many of our architect friends welcomed this change because they felt the Standard Curved Eave house was a bit barren and lacked the essential emphasis of the gutter at the eave line.

Among the gardeners, it was also welcomed as an entirely satisfactory solution of their side ventilation problem.



No. 327A.—This interior side view of the Modified Curved Eave Construction well shows both the gutter line, at the base of the eave, and the added height secured for the side bench plants.

Eave Plate

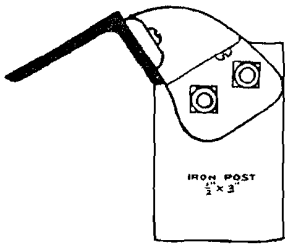


Figure 8. Post with eave plate secured to it by the eave bracket.

After the posts are set, fasten on the eave plate to the top of the posts.

It should be seen that the eave plate is perfectly straight without sags up and down, and should there be any hollow place this is the time to make it good.

The eave plate and narrow cast - iron sill, when used in place of cypress sill, are gotten out a scant 1/16 inch short. This is to allow for expansion.

Therefore, these should be put up with a scant 1/16 inch between joints.

Before putting up the eave plate it is best to attach the sash bar clasps.

Now sight along the eave plate. If it is placed in proper alignment, we are ready to fill the concrete in around the posts, having checked the spacing with a steel tape.

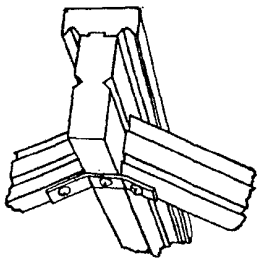


Figure 9. Before putting up, screw the ridge brackets to the ridge. The holes are already spaced and started. The bars are screwed to the bracket and toe-nailed to the ridge.

Ridge Bars

After the posts and eave plate are all set, it is an easy matter to put up the ridge bars and the rest of the woodwork.

Ventilating

The ventilating shafting can now be put up, and, in doing this, the hangers should first be fastened to the bars and the shafting slid through, putting on the necessary arms for each bay at the same time. The shafting comes in bundles, one bundle being one complete run with coupling to attach to gear.

Consult Plans

In following out these instructions, the plans should be consulted frequently, and the person doing the erection work must make himself very familiar with them so that the work will go along smoothly and accurately.

Figure 10. Ventilating shaft hanger screwed to the roof bar.

The above instructions are general, and are as full as can be made in a book of this kind. When materials for a Greenhouse are purchased from us, full detailed instructions accompany the order.

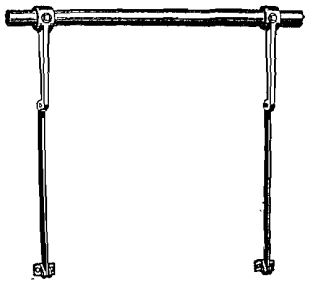
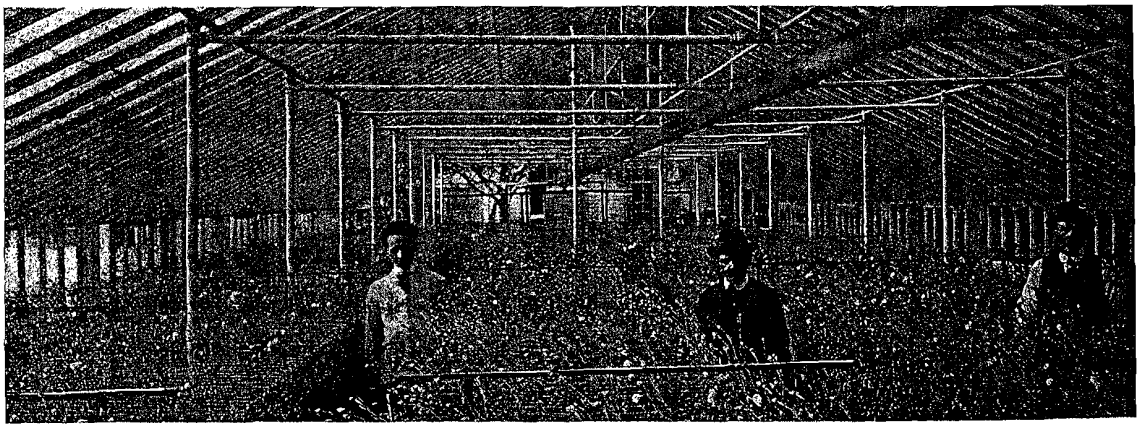


Figure 11. The arm, rod and sash bearers come all assembled ready for slipping on the shaft. Be sure to slip the required number on the shaft before it is slipped through each bearer. With the sash down tight and the arms pulled snug, then fasten down the set screws.



This is a glimpse in Thomas Lesys' house, at Cleveland, Ohio. It is 28 feet 2 inches wide. This is the width we build the most of, in the semi-iron construction.

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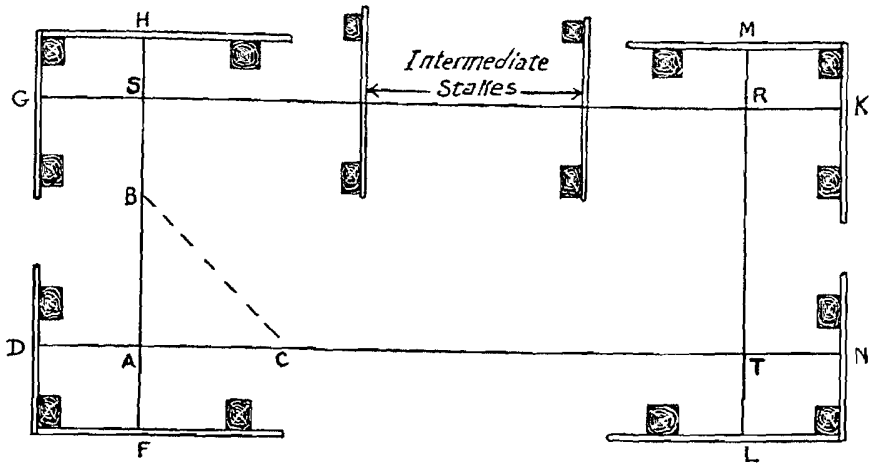


Figure 1. The first step in laying out, is driving of stakes for nailing on the batter strips. This gives you a safe and sure method of getting both the post lines and grade right.

Instructions for Erecting Greenhouses

IN laying out a greenhouse, the first process is to drive two stakes whose distance apart is approximately the width of the greenhouse. Around these two stakes drive other stakes to which are nailed batter boards. See Figure 1.

In the same way put up the batter boards at the other end of the house, keeping these as nearly at right angles to the first stakes as possible. These batter boards should be at least 2 feet away from the exact width and length of the house, so that they will not be in the way of erection. It is a good plan to keep the batter boards 1 foot or some convenient distance above the finished inside grade line.

If the house is to be given a pitch, the high end of the house should be the farthest side from the workroom. The batter boards raised at the high end according to the pitch the house is given.

Laying the First Lines

There are two methods for laying out the lines, one by drawing the lines through the center of the post hole, and one by drawing the line to one side. The last method is preferred and is used in these instructions, for the posts can be set straighter if they are set away from a straight line than by setting them exactly on the lines.

By a straight line is meant a cord line that is taut, and no sags in it. If sags occur, enough intermediate stakes should be put in (see Figure 1) to carry the line without sagging.

Measurements should be made with a steel tape.

How to Square Up the Lines

To lay out the cord lines, first fasten the line DN (Fig. 1) to the top of the batter boards.

Then fasten the line FH permanently at F and temporarily at H.

Next see that these two lines are square or at right angles to each other. To do this, lay off a distance AC on DN equal to 3 feet.

Then lay off a distance AB on FH equal to 4 feet.

Then if the two lines DN and FH are at right angles to each other, the distance BC will be 5 feet. If BC does not equal 5 feet, adjust the line FH at H (the temporary fastened end) by moving the line one way or the other until the distance BC equals 5 feet and AB equals 4 feet, AC equals 3 feet.

It is well to take longer distances for AB and AC if possible, as the larger the triangle formed, the less chance for inaccuracy. Therefore, the table is given below.

In table: C=AC B=AB A=BC

For example, if your house is 30 by 75, then from table take AC 15 feet, AB equal 20 feet, then BC would be 25 feet.

After squaring these two lines, lay the cord line GK exactly the width (from outside to outside of iron) of house from the line DN and parallel to it.

Then lay the line ML parallel to FH and a distance away equal to the exact length of the house (iron to iron, outside measurement).

Check the corner at R to see if these last lines are square.

If the distance between the points A and R is exactly the same as the distance between the points S and T, the house is exactly square.

TABLE FOR SQUARING UP LINES

C	B	A
3	4	5
6	8	10
9	12	15
12	16	20
15	20	25
18	24	30
21	28	35
24	32	40
27	36	45

C=AC B=AB A=BC

By following the measurements in this table and the directions under heading of "How to Square Up the Lines," you can be sure your lines are laid out square. Don't slight this part. It is of greatest importance that your *start is right.*

Fastening Lines to Batter Board

When the lines are laid out square with each other and the right distances apart, they should be permanently fastened to the batter boards as shown in Figures 3 and 4.

Figure 3 shows a notch and line fastened by nail underneath. Figure 4 shows a nail driven on each side of line and as close as possible and line fastened underneath by a nail.

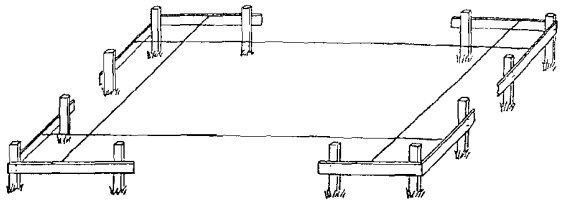


Figure 2. Another view of stakes and batter strips for carrying the final layout lines.

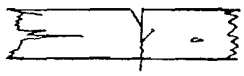


Figure 3. Showing batter strip with notch for holding line in place and nail to fasten it to.

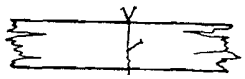


Figure 4. Batter strip with two nails driven V-shaped in place of notching the wood. One way is as good as the other.

Staking Post Holes

The next step is to stake the post holes.

First drive a stake under the crossing of the lines HF and DN at A and at the crossing drive a small wire nail into stake.

Slip ring of steel tape over the nail.

Then as the centers are 8 feet 4½ inches, a stake should be driven 8 feet 4½ inches from A, another at 16 feet 9 inches, another at 25 feet 1½ inches, at 33 feet 6 inches, at 41 feet 10½ inches and at 50 feet 3 inches. If the house is longer, repeat the operation.

All measurements being taken from original point, except when operation is repeated, when the stake at the 50 feet 3 inches is taken as the original point. In this manner all the post holes are to be staked out.

Caution About Staking Holes

A great danger in laying out the stakes for the post holes lies in the fact that the amateur taking a rule or rod and going along with this rod, spaces each one separately. If he should vary ¼ inch in one space or in each space, of course his holes will not come out right at the end. So follow our instructions in every detail and you can't go wrong.

(*Continued on next page*)

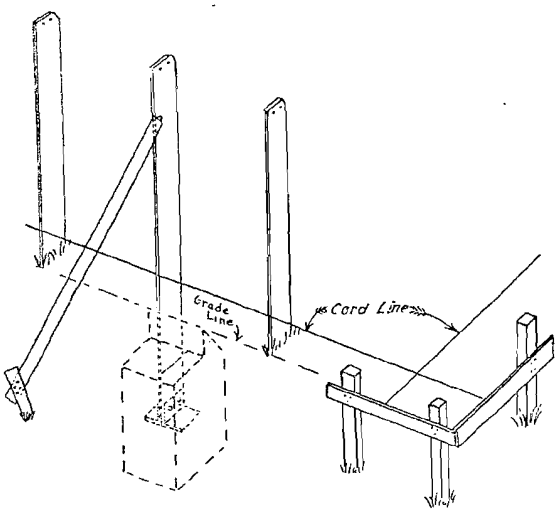


Figure 5. Here you have the outside edge of the posts faced up against the *inside* of the line.

Depth of Hole and Height of Concrete

In digging the post holes, the distance from the cord line to the bottom of the hole should be determined and a rod cut the proper distance from the line to the bottom of the hole.

The post hole should be 6 inches lower than the permanent foot of the rafter. This is to allow for 6 inches of concrete for the bottom of the hole.

If another rod is taken from the cord line 6 inches shorter than the first rod was made, this will locate the proper height of the concrete in the hole wherein the post foot sets.

By using this rod to each post, it makes the concrete absolutely correct and the proper pitch or level, as it may be the same, though it was located above ground by line.

Setting Posts

The ironwork is now started.

Take the posts as numbered on plan, and leave at post hole where they belong. On each post mark (file mark preferred) should be made on the outside edge of post (at a distance down from the top equal to the distance X, see Figure 7) from top of post to grade line minus the distance Y the cord line has been set above grade.

Now set the post in the hole making the file mark on the post come to the same level as cord line and just barely touch it.

Make the post plumb to cross grade but at right angles to grade in the length of the house. Brace post as shown by Figure 5.

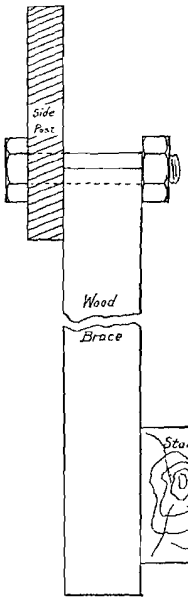


Figure 6. Method of bracing side post.

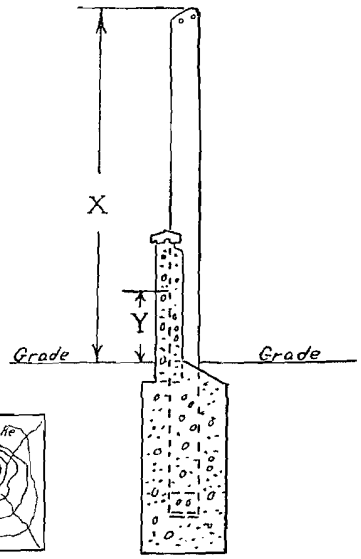


Figure 7. Cross section showing concrete sides and footing.

The corner post should be set first and a rod 8 feet 4 inches long should be used for spacing off sideways.

In the same manner set all the side posts so that each one just touches the cord line at the file mark. This would insure an absolutely straight line.

Care should be taken in spacing off sideways, to measure with a steel tape to check on rod.

It is important that the posts should be the same distance between the top and bottom and that they are plumb with those across the house.

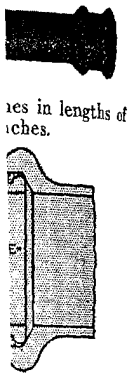
Gable posts and inside supporting columns should always be made plumb, both ways to grade.

Concrete Piers

The concrete piers in which the side posts are set should contain at least 2⅓ cubic feet of concrete composed of one part of cement, three parts of sand and five parts of stone. This should be placed in a hole not less than 1 foot in diameter and should be brought to grade.

From grade to 3 inches above grade, the top of the pier should be brought on a bevel up to the post in order to protect the post from the water on the inside of the house. See Figure 5. Top of level is shown as top of grade.

(Continued on next page)



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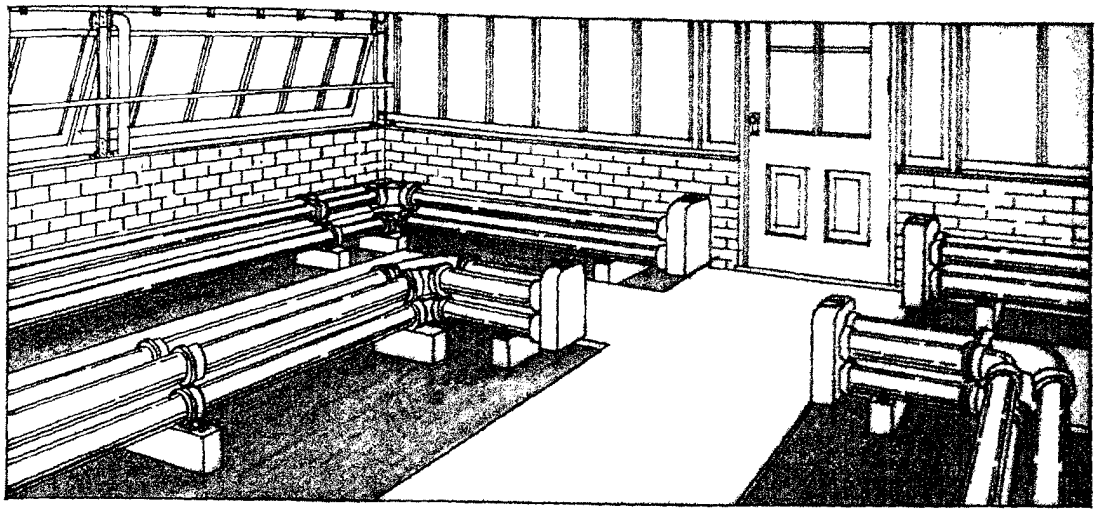
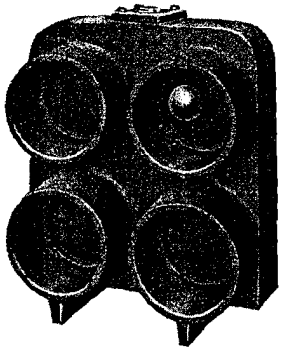


This sketch view of one of our houses before the benches were put in, shows you arrangement of headers at ends of coils.

Automatic Headers For Hot Water

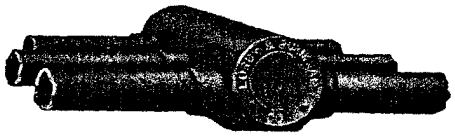


Header No. 704 for 3½-inch cast-iron pipe having caulked joints.
Note the float in upper right-hand opening.
See next page for all sizes and prices.

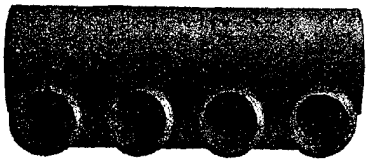
THEY are time savers. They are coal savers. Save time lost in making rounds to open pet cocks. Save coal because they never forget to free the coils of air at all times. Day and night they are right on the job, keeping the entire system air-freed.

Do not increase circulation friction, and have more actual radiating surface than return bends or similar fittings.

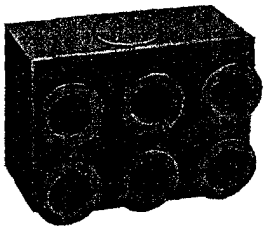
Construction is simplicity itself—positive in action and free from repair troubles.



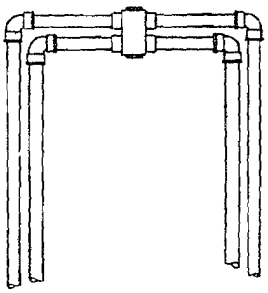
Three-Way Through Header. Made for 2-inch pipe, for both caulked and screw joints. Prices next page.



Four-way Header for caulked or screw joints for 2-inch pipe. See next page for sizes and prices.



Six-way Header for caulked or screw joints for 2-inch pipe. Prices next page.



This plan shows how Through Headers are used with connections on both sides, at highest point of continuous piping.

Use Order Blanks Back of Book

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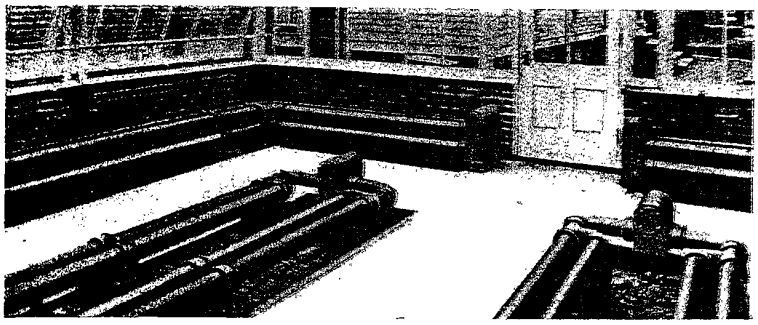


No. 334.—Glimpse of the way the heating coils are arranged before the benches are put in place.

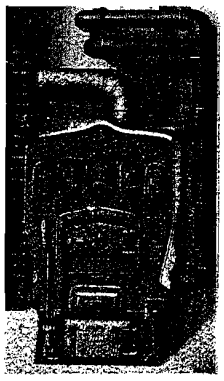
Heating

UPON the right installation of your heating plant, depends much of the success of your greenhouse. Its perfection involves the right amount of radiating surface so distributed as to insure best growing conditions and the desired temperature in each compartment. In order to obtain these results, you must have a boiler of proper size and capacity; ample mains for carrying water to the coils; sufficient grade to insure rapid circulation and even distribution. The coils must be arranged to prevent all air locks, and so planned that the temperature in each compartment shall be under proper control.

On the face of it, these problems seem simple enough, but as greenhouse heating is different from any other, in that it is all longitudinal work, with but little altitude, the realization of its special requirements and the ability to meet them, only come through experience.

The fact that we have met and mastered these problems for more than fifty years, is sufficient guarantee that we will give you a perfect work ing heating plant. The hot water system of heating is preferred because of its capacity to hold the desired night temperatures without the expense of a night fireman. It gives a more equable heat than steam. The hot water pipes being run at a lower temperature, the heat is less intense and does not dry out or bake the soil in the benches as steam sometimes does.

To meet the exacting demands of greenhouse heating, we make a special sectional boiler called the Burnham. It is made in sections and can be easily enlarged at any time, to take care of additions that may be made to the greenhouse.



No. 335.—No 18 Hot Water Burnham as it looks installed in a workroom cellar.

Town of Niagara-on-the-Lake Council and Committee Meeting Minutes + Reports