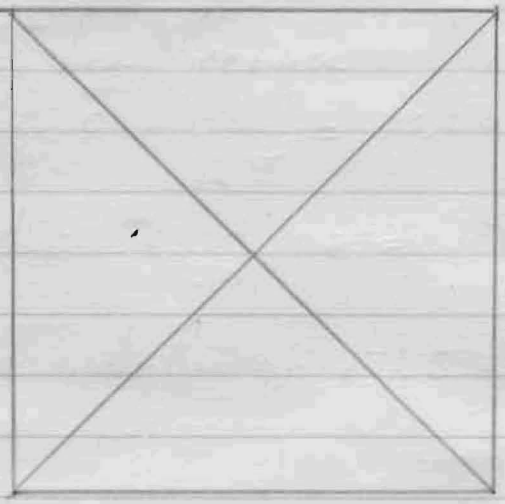
12-9-50

Turntable Design



Diag. Length of Turntable with 12" box Length is

$2(1'4\frac{7}{8}" + 10'0" + 6") = 83'9\frac{3}{4}"$

$= 83.8125' = \log^{-1} 1.9233088$

$\sqrt{3} = \log^{-1} .1505150$

Length of one side $= 59.26438' = \log^{-1} 1.7727938$

$= 59'3\frac{1}{4}"$

2.8125 | 56,45188

Length of pipe on one side $= 59.26438 - 3.1407 = 57.1235$ feet

~~Length of end box for side of pipe = 28.5618 = 28' 6 3/4 inches~~

Exact Length of Track is $\pi \times 82.0$ feet

$\log \pi = .4971499$

$\log 82.0 = 1.9138139$

$\log^{-1} 2.4109638 = 258.2045$ ft

$= 258$ feet $2\frac{7}{16}$ inches

center length of pipe on one side is

~~57.1235~~ $- 40.0000 = 17.1235' =$ ~~17' 1 1/2" long~~

$56,45188 - 40.0000 = 16,45188' = 16'5\frac{7}{16}"$ long

This error found on 8-21-51

12-10-50

Moment of inertia of a circle in relation to its diameter is $I = \pi t r^3$ inches^4

The bending due to own weight as a simple beam is $y = -\frac{5wl^4}{384EI}$ inches at center.

The maximum stress due to bending is $s = \frac{wlr}{8I}$ pounds/sq. inch.

Let pipe be 12" dia., .141" wall, ~~57.12~~ 56.45 ft long
$E = 3 \cdot 10^7$ 17.8 lbs/foot.

$w = 17.8/12 = 1.483$ #/inch

$I = \pi \cdot .141 \cdot 6^3 = 96$ inches^4 $l = 56.45 \cdot 12 = 676$ inches

$$y = -\frac{5(17.8/12)(\overset{56.45}{\cancel{57.12}} \cdot 12)^4}{384 \cdot 3 \cdot 10^7 \cdot 96} = \overset{-1.412}{\cancel{-1.485}} \text{ inches at center}$$

$$s = \frac{(17.8/12)(\overset{56.45}{\cancel{57.12}} \cdot 12)^2 \cdot 6}{8 \cdot 96} = \overset{5340}{\cancel{5460}} \text{ pounds/sq. inch}$$

These are satisfactory

(over)

10-9-51

According to Merriman page 399, 4th Edition

$$y = \frac{wl}{24EI}\left(2x^3 - \frac{x^4}{l} - l^3x\right)$$

where x is distance from one end
When $x = 20$ feet $= 240$ inches, and $l = 56.45\text{ft} = 676$ inches

$$y_x = \frac{\frac{178}{12}\,676}{24 \cdot 3 \cdot 10^7 \cdot 96}\left(2 \cdot 240^3 - \frac{240^4}{676} - 676^2 \cdot 240\right)$$

$$= \frac{.1454}{10^7}\left(2.765 \cdot 10^7 - .490 \cdot 10^7 - 11.00 \cdot 10^7\right)$$

$-.1454 \cdot 8.72 = -1.268$ inches deflection at joint

Thus joint should be $\boxed{1\tfrac{3}{8}''}$ above ends of pipe.
This will cause center of pipe to be
$1.412 - 1.375 = .037$ inches low while joint
will be $1.375 - 1.268 = .107$ inches high.

10-9-51

The radial or diagonal members will have bending as follows computed as a beam supported at ends

$$y = -\frac{5wl^4}{384EI} \qquad l = 40.0 \text{ ft} = 480 \text{ inches}$$

$$y = -\frac{5 \cdot 1.483 \cdot 480^4}{384 \cdot 3 \cdot 10^7 \cdot 96} = -\frac{.394 \cdot 10^{12}}{1.107 \cdot 10^{12}} = -.356 \text{ inches.}$$

Thus joint should be about 3/8 inch above end of pipe

$$s = \frac{wl^2 r}{8I}$$

$$s = \frac{1.983 \cdot 480^2 \cdot 6}{8 \cdot 96} = 2670 \text{ lbs/sq inch}$$

which is low.

If center of diagonal is unsupported the deflection will be $-.356 \times 2^4 = -5.69$ inches

stress will be $2670 \times 2^2 = 10700$ #/sq inch.

This is obviously impossible due to large stress and great bending.

(over)

10-10-57

The radial member is really a beam fixed at one end and supported at other end. According to Merriman page 353 (4th Edition) the deflection equation is

$$y_x = \frac{w l x^2}{EI}\left(\frac{x^2}{24l} - \frac{5}{48}x + \frac{l}{16}\right)$$

where x starts from fixed end.

When $x = l/2$

$$y_x = \frac{w l^3}{4EI}\left(\frac{l}{96} - \frac{5}{96}l + \frac{l}{16}\right) = \frac{w l^4}{192 EI}$$

when $l = 480$, $w = 1.483$, $E = 3 \cdot 10^7$, $I = 96$

$$y_x = \frac{1.483 \cdot 480^4}{192 \cdot 3 \cdot 10^7 \cdot 96} = \frac{787 \cdot 10^8}{5530 \cdot 10^8} = .142 \text{ inches}$$

The maximum deflection will be

$$y = .00543 \frac{w l^4}{EI}$$

$$y = \frac{.00543 \cdot 1.483 \cdot 480^4}{3 \cdot 10^7 \cdot 96} = \frac{9.27 \cdot 10^8}{28.8 \cdot 10^8} = .148 \text{ inches}$$

Apparently the center joint should be raised about $\boxed{3/16 \text{ inch}}$ compared to ends

10-29-51

Bending Results

The before (10-18-51) and after (10-29-51) welding while still on cribing agree quite well. The transit was set about .016 ft higher on (10-18-51)

On 10-29-51 when radial cribing only was removed these pipes dropped .024 ft or .288 inch This is between the value of .356 inches for a beam supported at ends (10-9-51) and value of .142 inches for a beam fixed at one end and supported at other (10-10-51) Thus it may be deduced the center box is not entirely rigid to produce the effect of a beam fixed at one end.

On 10-29-51 when side cribing was removed the radial pipes dropped .050 ft more for a total of .074 ft or .89 inches. This means corner boxes are fairly rigid and transfer some of slope of side pipes to radial pipes and therefore increase bending. The slope of radial pipe effectively increased .89/.29 = 3.1 times. This is equivalent to artificially loading radial beam at point 3/8 way from supported end.

On 10-29-51 when side cribing was removed the side members bent .139 ft or 1.61 inches. This is somewhat in excess of the 1.27 inches computed on 10-9-51 Perhaps some of the welds are not full thickness or else the weight of tar on inside + outside give significant additional loading over plain pipe. Probably this is effect. 27% added weight.

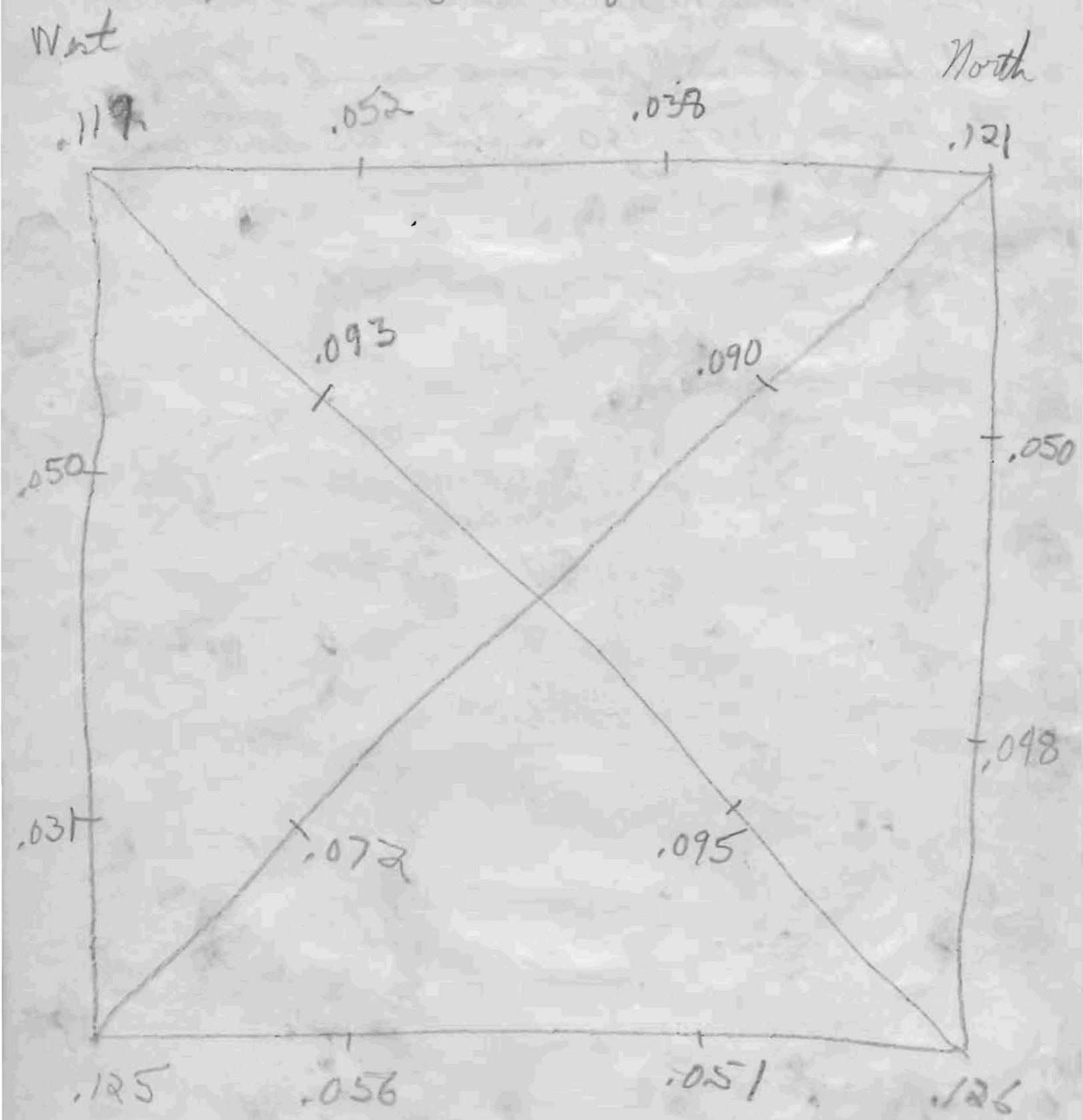
10-24-51

Bending measurements.

	10-18-51 Before Welding Measured	Mean	10-24-51 after Welding Measured	Mean	10-24-51 Removed Radial Crib Measured	Mean	10-24-51 Removed Side Crib Measured	Mean
Corners	.127	.136	.120	.121	.120	.122	.119	.123
	.134		.122		.121		.121	
	.145		.122		.123		.126	
	.136		.120		.122		.125	
Radials	.178	.177	.168	.160	.138	.137	.093	.088
	.180		.158		.136		.090	
	.173		.162		.142		.095	
	.178		.152		.130		.072	
					Individual Bending			
Sides	.198	.197	.190	.179		.140	.052	.047
	.196		.174			.138	.038	
	.202		.181			.133	.050	
	.193		.177			.131	.048	
	.193		.165			.116	.051	
	.200		.176			.122	.056	
	.197		.177			.148	.031	
	.198		.195			.147	.050	
					mean	.134		

seem like transit had slightly different tip

after removing curbing 10-24-51

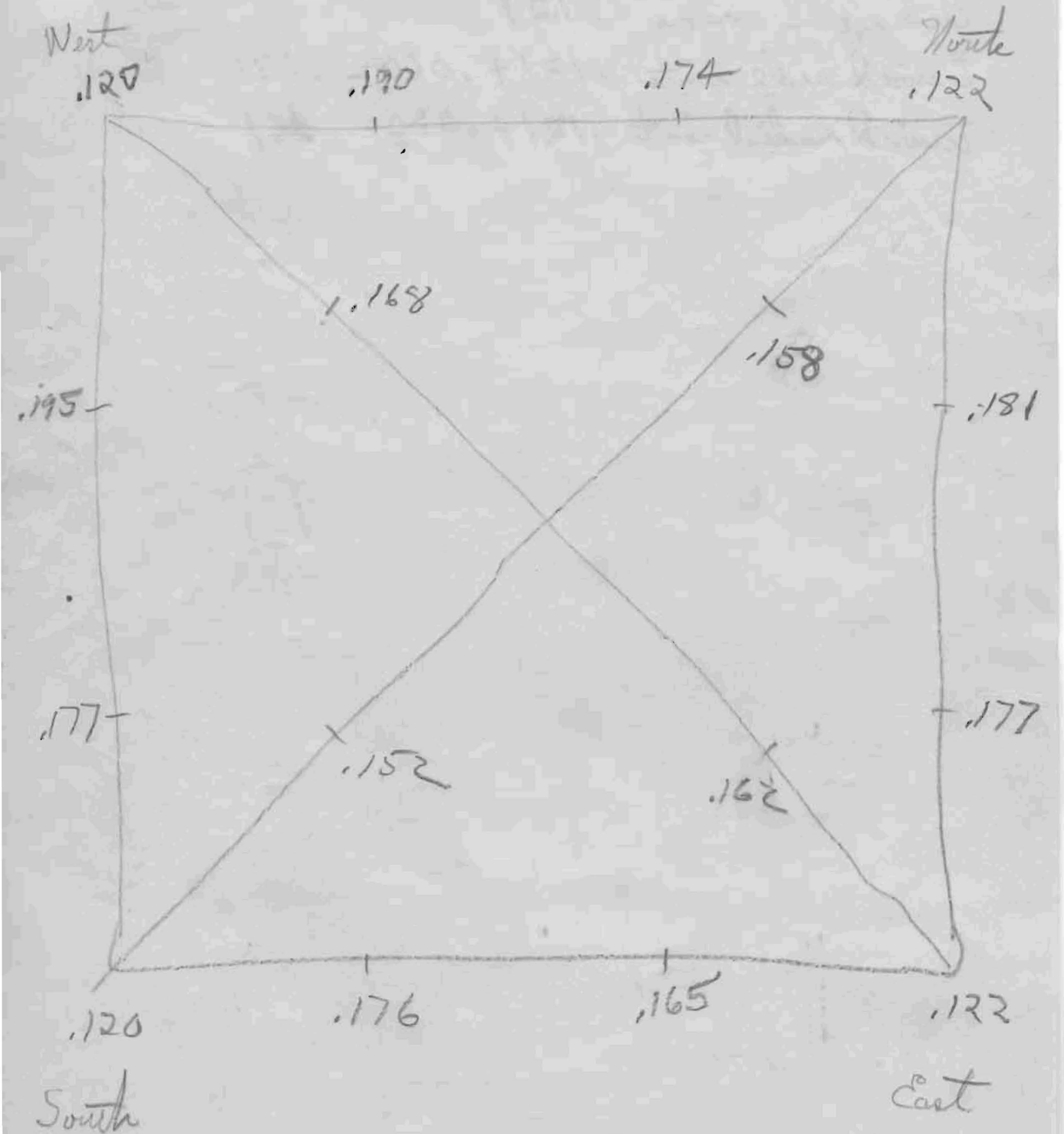


(over)

First the cribbing on radial members only was removed. The height of radial joints was measured and found to be from .130 to .190 or about .015 above camber.

$l = 676''$
$r = 4.2''$
$l/r = 150$

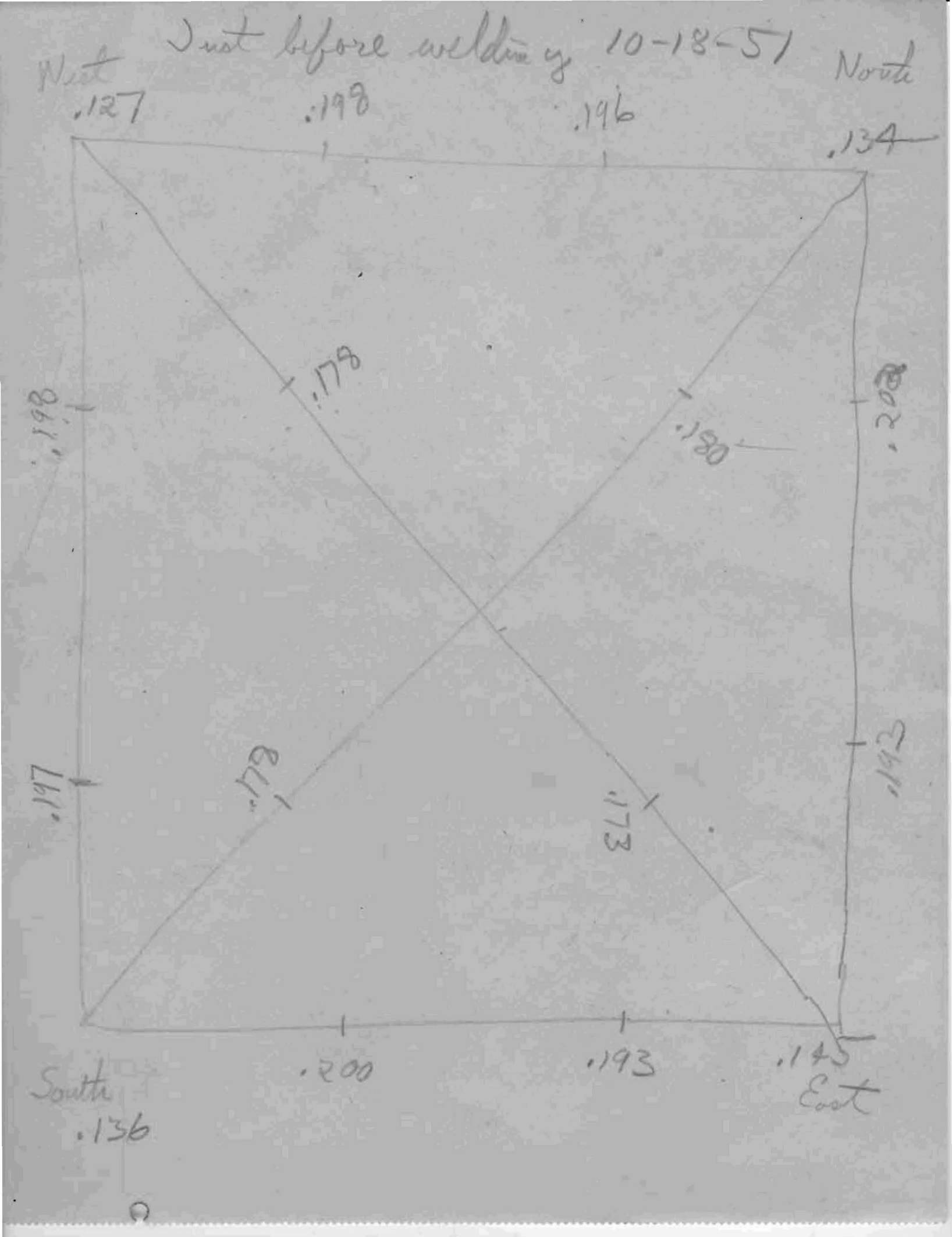
after Welding with ostering 10-24-51

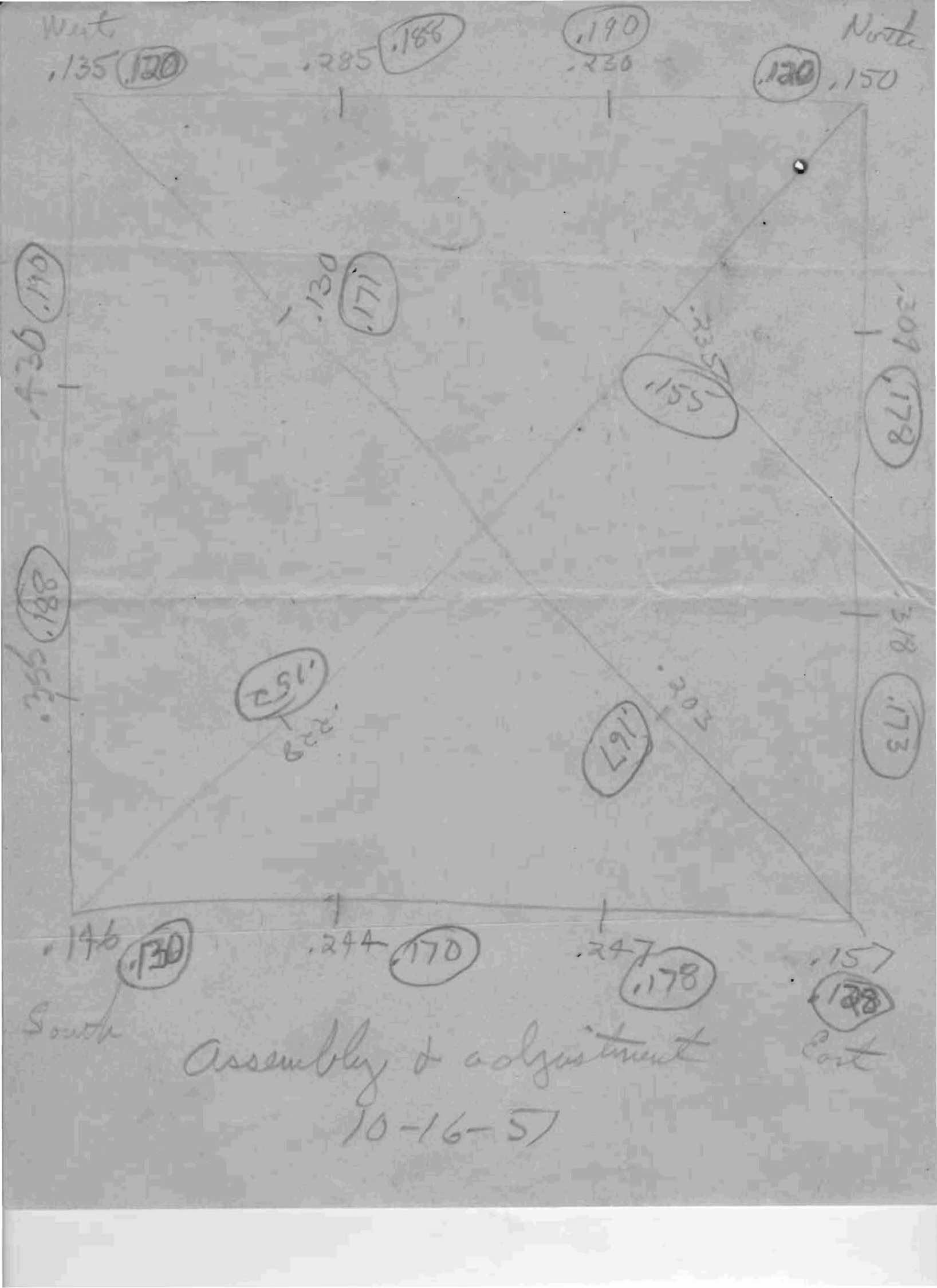


Average of corners .121

Desired side joints .121 + .060 = .181

Desired radial joints .121 + .090 = .211


Just before welding 10-18-51
West
.127
.198
.196
North
.134
.178
.198
.180
.208
.197
.178
.173
.143
South
.136
.200
.193
.145
East

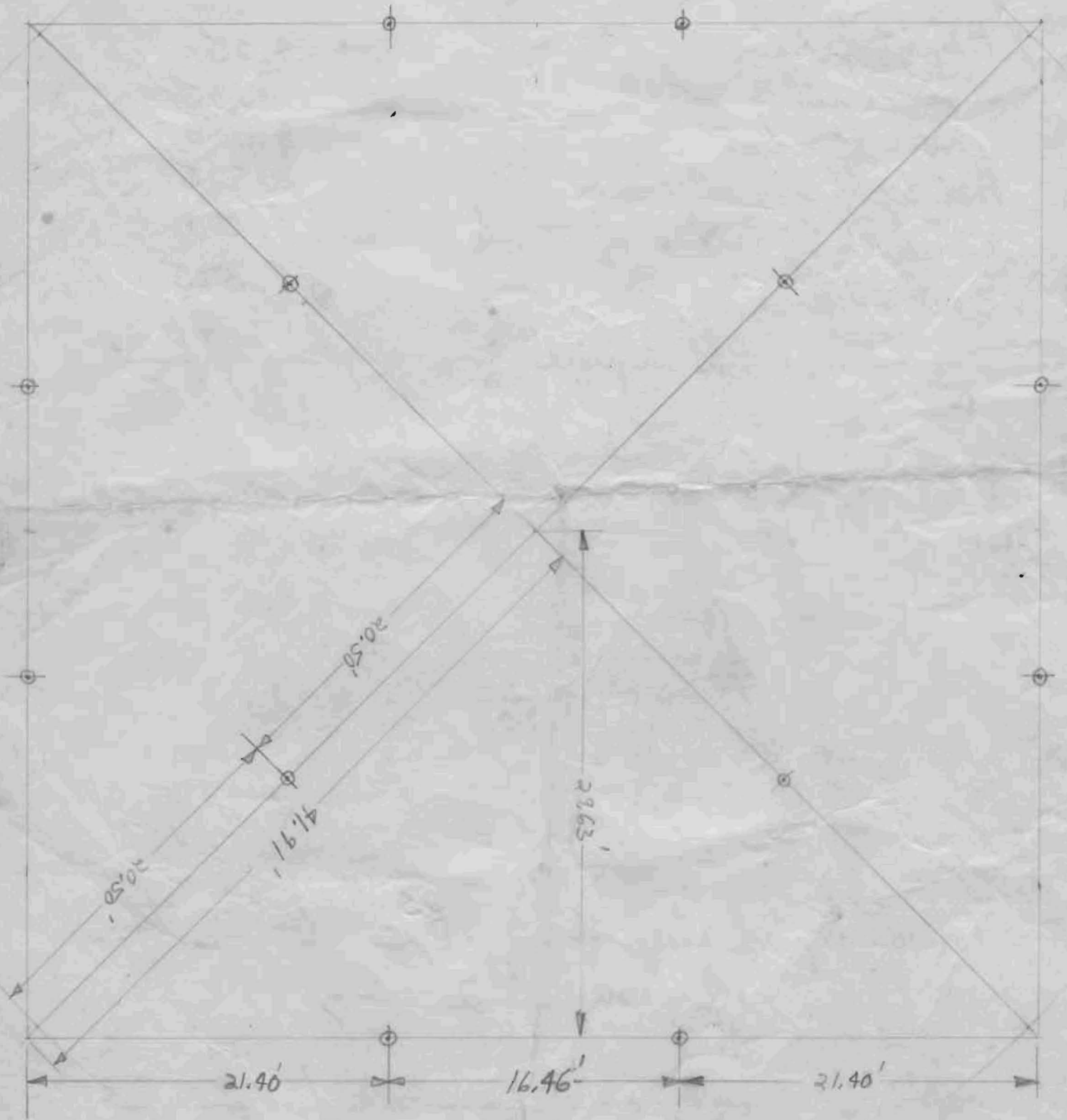


Assembly & adjustment

10-16-57

Layout of Pipe Cubing

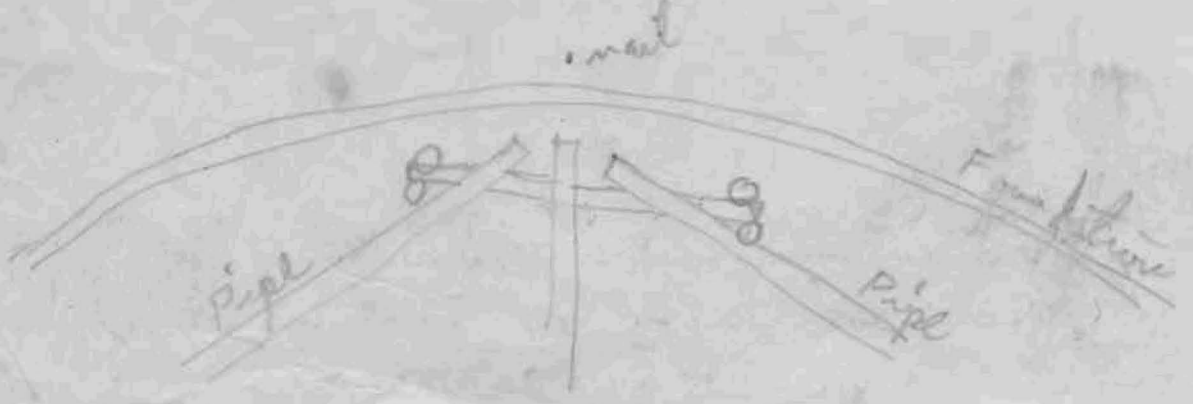
7-24-51



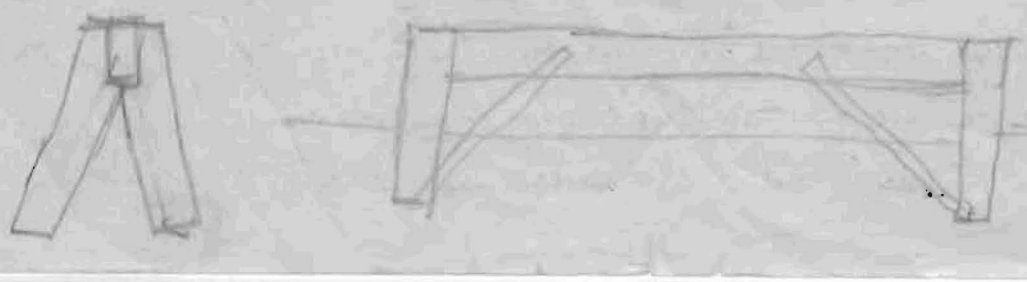
7-26-51

Height of rail	4.250
Clearance rail to wheel	.125
Radius of wheel	8.000
Height of journal boxes	2.875
Thickness of bottom of truck	.500
Bend in pipe	1.375
Remaining arch in pipe	.500
	17.625

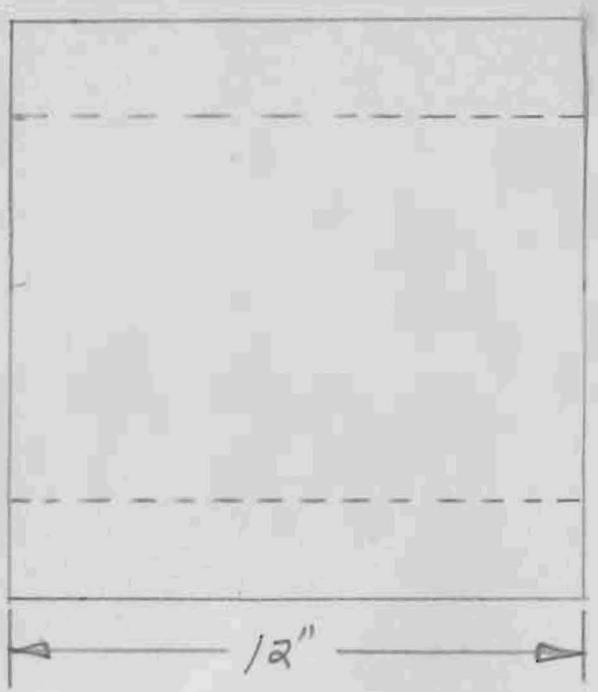
Height of cribbing above foundation $17\frac{5}{8}" = 1.47$ ft

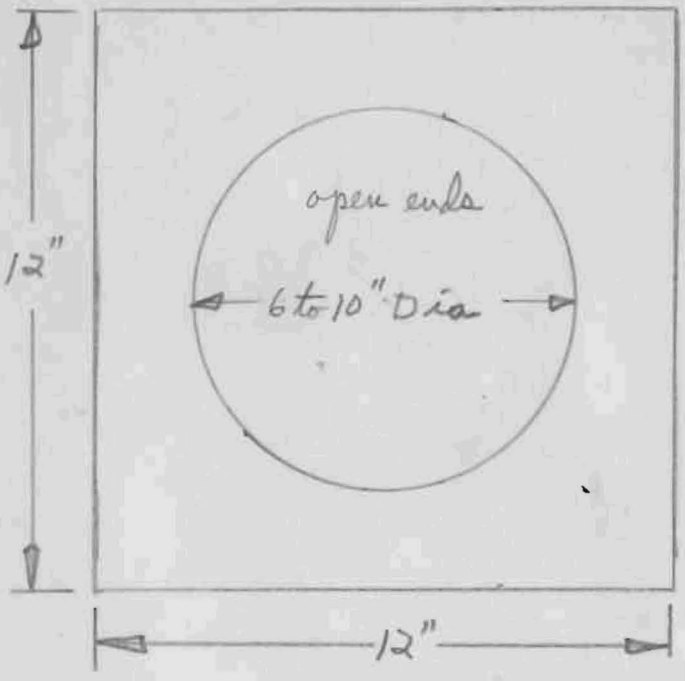


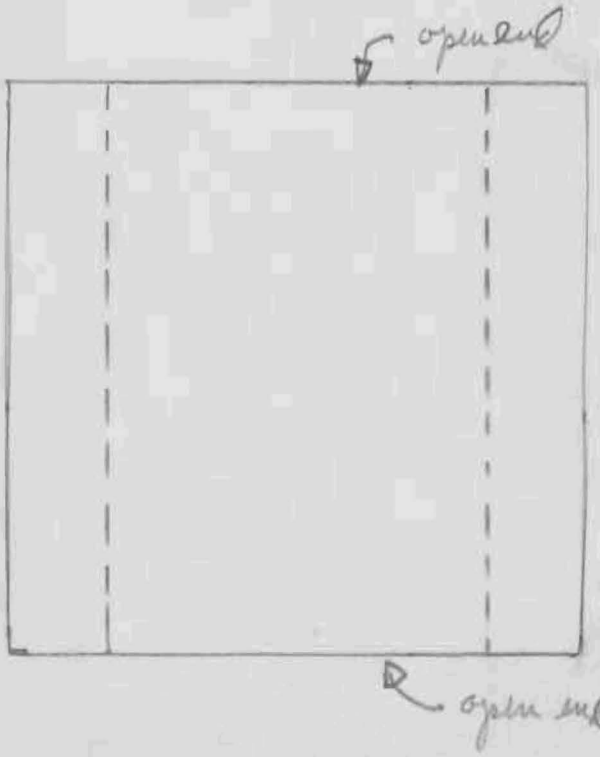
Top of corner cribbing $15\frac{3}{4}"$ above top of foundation ring



Center Box







Hollow cube of steel plate
12" outside dimensions.
Hollow steel tube thru center

Grote Reber