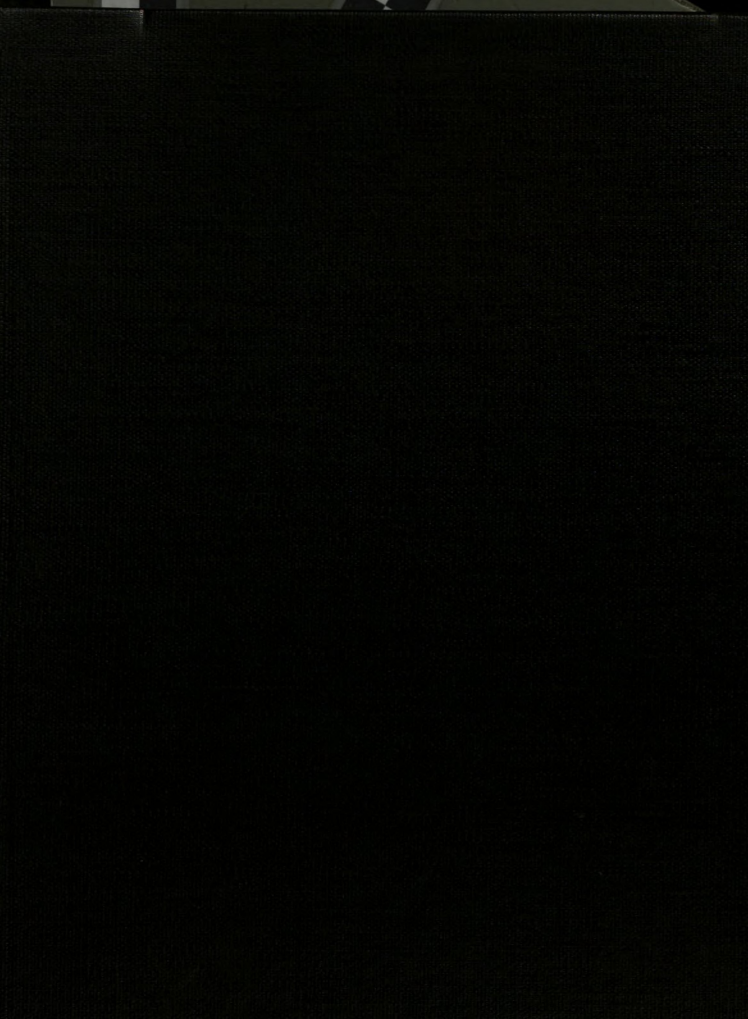




BUILDING CONSTRUCTION

Thesis for Degree of C. E.

Ralph Z. ^{Wagon}Hopkins

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**Application has been made
for patents to cover the substance
of this thesis.**

B U I L D I N G

C O N S T R U C T I O N

Knowledge of the newly awakened, irresistible demand for vastly increased economy and efficiency in building construction has led me to make an effort toward the solution of the problem.

Accepting concrete as the best fire-resisting, most durable and sanitary building material, I have designed a method of concrete construction with the following objects in view:

First: To be able to make a wall with skilled labor, of such a character as would insure speed of construction.

Second: To do away with form work and thus greatly decrease the expense.

Third: To make a wall that can be either solid or hollow. By the latter method the wall would be insulated against dampness and be kept from "sweating" due to difference in temperature.

Fourth: To make a wall that when hard would not have to be resurfaced, but could be given any desired decorative effect on the outside and be smooth enough on the inside to do away with plastering.

Fifth: To do away with mortar joints used with the ordinary concrete block construction. These are unsightly and, unless every precaution be taken, there will be open places in the joints.

Sixth: A combination wall combined of standard precast units and concrete poured in place to form a monolithic wall, having any desired thickness, any width of air space and any number of these spaces.

The precast units to serve the following purposes:

- A. To be designed so as to interlock and form a rigid wall.
- B. To serve as a permanent mold or casing for a continuous filling of concrete, which can be reinforced horizontally and vertically to give the wall its required strength.
- C. To be made in steel molds of such design as to make the units alike as to size and thus insure a smooth and true wall.
- D. To be made at a permanent plant where machinery and system can reduce the cost to a minimum.
- E. To be as light as possible for the wall covered so as to reduce the cost of handling and shipping.

The precast units are to be divided into the following three divisions:

Outer units (See drawings # 6 & #7)

Inner units (" " # 8 & #9)

Tie units (" " # 10)

The outer units form the outside and inside of the wall. The inside of an outer unit has one or more dove-tailed grooves running vertically throughout the height of the unit.

These grooves are spaced so that when laid in a wall the grooves in one unit are vertically above or below the grooves in the adjacent units.

The inner units are used to build up vertical division planes in the wall which serve to form continuous spaces that may be filled with concrete or left as air spaces. The upper and lower edge of the unit has one or more notches, these being one-eighth the depth of the unit and the same width as the thickness of the tie units. These notches are spaced the same as the grooves in the outer units and serve as a means of locking the inner units with the tie units, the outer and inner units being of the same height.

The tie units are used to space and tie the inner and outer units. The height of a tie unit is one half the height of the inner and outer units. A dovetailed tongue corresponding to the groove in the outer units is formed on each end of the tie unit. If the inner units are required in the wall the tie units will have one or more notches on the upper and lower edges, these notches to be one-fourth the depth of the unit and the same width as the thickness of the inner units.

D I V I S I O N S O F D R A W I N G S .

DRAWINGS #1 to 5 inclusive, show the different walls under this construction.

DRAWINGS #6 to 11 inclusive, show the detail of units used in the different walls.

DRAWINGS #12 to 14 inclusive, show the layout of assembled molds for the different units.

DRAWINGS #15 to 22 inclusive, show the detail of parts used in the molds.

DRAWINGS #23 to 25 inclusive, show the tables of materials and parts required to make up and fill a complete mold.

DIFFERENT WALLS UNDER THIS CONSTRUCTION.

DRAWING #1, FIGURE #1 shows the perspective of a wall built up of pre cast units laid up in four vertical planes, two outer and two inner, all connected by tie units forming three interior spaces. The spaces next to the outer plane of units are filled with concrete to form two continuous monolithic walls reinforced horizontally and vertically. This is possible because the tie units occupy only one half of the vertical space and are so arranged that they come half above and half below the horizontal inner section between the horizontal rows of units.

The units in the vertically adjacent rows of each plane are staggered so that the tie units lock an inner or outer unit in one horizontal row with two inner or outer units in the vertically adjacent row. This is also made more effective by staggering the units of the inner rows with those of the units in the outer rows, as shown.

DRAWING #1, FIGURES #2, 3, & 4 shows a single space hollow wall into which is formed beams and columns to make the wall more rigid and also to serve as structural support for floors and roof.

The wall consists of outer and tie units only. The outer units are shown grooved on the outside so that the wall may be plastered or stuccoed. The tie units consist of two different heights, one being the same height as the outer

unit and the other one-half that height.

Two of the adjacent vertical rows of tie units of the same height as the outer units form a vertical, enclosed space the width of the wall to a certain height. This space so formed being filled with concrete and reinforced with iron bars to form a column. The balance of this wall, to the same height, to be made up of tie units of less height so as to form a continuous air space on both sides of the column.

The top edge, of the upper row of these tie units, forms a support on which to lay a piece of sheet iron the width of the air space, on which a concrete beam is poured, the lower side being reinforced with iron bars. From the top of this beam a continuation of the column is formed in the same manner as described above.

DRAWING #2, FIGURE #1 shows a circular three-space hollow wall, for use in the construction of reservoirs, silos or any place where a circular walls is required. The construction is the same as in a straight wall. The inner and outer units differ in the fact that they are curved instead of straight and it is not possible to make them interchangeable as the units must be made shorter, owing to the shortening of the circumference as the center is approached.

DRAWING #2, FIGURE #2 shows a vertical section of a wall with a double air space, the construction being the same except that two more vertical planes of inner units have been added, also the lengthening out of the tie units. This construction to be used for ice houses, packing houses, or in any case where additional insulation is required.

DRAWING #2 FIGURE #3 is a horizontal section of a wall through a wall showing a pilaster. The construction is the same as in a straight wall, except at the pilaster, which required that two of the tie units be made longer and a special outer unit for the face of the pilaster, also a short piece that is used on either side. These pieces are only special in as much as their ends are mitered and rounded for the corners. This is obtained in the standard molds by using a different style of spacer.

DRAWING #2 FIGURE #4 shows a horizontal section through a hollow column or chimney. This required only two different units, an outer and a tie unit. The outer unit is the same as that used in the pilaster or can be of any length standard unit by changing the spacer in the mold to form the mitered and rounded corner. The tie unit is made the same as the standard unit without notches, with the ends reduced to one half their height as shown in Figures #5 & 6.

All units shown in drawings will be designated by

a symbol

A representing outer units

B " inner "

C " tie "

The following symbol (A - 8 - 484) stands for a standard 8" x 16" outer unit. The (8) or the second part of the symbol shows the height of the unit, the last part of the symbol or (484) shows the spacing of the grooves in the unit, the first groove being 4 inches from the end, the second groove 8 inches from the first and four inches from the other end of the unit, the sum of these distances being equal to 16 inches or the total length of the unit.

The symbol of an inner unit of the same size and spacing of notches would be (B - 8 - 484).

The inner and outer units for right angle corners are designated by adding (45°) to the end of the symbol. In the following symbol for a tie unit (C - 4 - 4½)

C represents the kind of unit

4 " " height of unit

4½ " " total width of wall with only one air space.

In the following symbol for a tie unit (C - 4 - 3(2½) 7) the last part of the symbol represents a 12" wall in which the 3" is the width in inches of the solid portion on the outside of the wall, the "2½" the width of the hollow space in the center of the wall and the "7" the width of the solid space on the inside of the wall. The

The sum of these or $12\frac{1}{4}$ " is the total width of the wall.

DRAWING #3 shows the different units that are required for a straight wall. The standard inner and outer units being 8" x 16". In order to form openings where required or of different widths, it is necessary to have units varying in length from 8" to 24" inclusive. This allows all horizontal dimensions to vary in steps of four inches. If it is necessary to vary the vertical dimensions less than eight inches, the above blocks may be duplicated in length but having a height of one-half the standard or four inches. This would require a total number of eleven inner units and eleven outer units.

DRAWINGS #4 & 5 show the different outer and inner units required at the corners for different widths of walls. By varying the width of the wall in steps of one inch, it will readily be seen by the drawings that the outer units will repeat themselves, viz:

The units in the two inch wall being the same as those in the ten inch wall.

Those in the four inch wall will be the same as those in the twelve inch wall.

Therefore if the outer units for corners are increased in one inch steps from eight to twenty-three inches, inclusive, it will give all the required lengths

for any width of wall.

The inner units are so designed that they can be placed to form a minimum space of one inch between the inner and outer units. This space is increased by steps of one inch. It will also be seen that the length of these units will soon repeat themselves so that it only required units from $6\frac{1}{2}"$ to $21\frac{1}{2}"$ inclusive, to form any width of space.

The walls shown on these two drawings represent the walls most used in standard practice. Each different width of wall required a different length of tie units for all parts of the wall.

DETAIL OF UNITS USED IN THE DIFFERENT WALLS.

DRAWING #6 shows the detail of all outer units used in the straight wall construction also giving the volume and the weight of each unit.

DRAWING #7 shows the detail of all outer units used at the corners.

DRAWING #8 shows the detail of all inner units used in the straight wall construction.

DRAWING #9 shows the detail of all inner units used at the corners for all widths of wall.

DRAWING #10 shows the detail of all tie units required to make up the standard walls shown in drawings #4 & 5.

DRAWING #11 shows a light sheet metal facing for the groove in the outer units and a tongue in the tie units and these are made so that the tongue nicely slips into the groove and serves to form a very firm connection between the outer and tie units. It will also be noticed that four clips are made on the back face of the sheet metal facing for the groove. This is to connect to and hold the rods used to reinforce the outer units as shown in Drawing #6, Detail #1.

In the sheet reinforcing for the tongue of the tie units there are two loops which serve as eyes into which can be dropped the hook ends of the tie rods as shown in Detail #6 of Drawing #10. These form a complete chain of metal ties which hold the reinforcing of the outer unit on one side to the reinforcing of the outer unit on the other side.

The sheet metal facings for the tongue and groove are made with very little cost as the steel is light and is formed by running it through a continuous machine operated by one man which rolls it into the required shape at a speed of approximately 25 feet per minute which would turn out enough facing to supply 5,000 units per day.

M O L D S

The units are to be made by pouring a "sloppy" mixture of concrete into steel molds. These molds are made up of standard sheets of cold rolled steel, cut to size and blanked out on presses, and cold rolled bars, rolled to size and cut to length with practically no machinery needed to assemble these to form a complete mold. This reduces the cost of the molds to but very little more than the cost of the steel itself.

The molds are assembled on platform cars for use on the ordinary industrial track. The cars are rolled under the mixer and the molds are filled with concrete. From there the cars are run into steam curing rooms and left from twelve to twenty hours. They are then hard enough so that the molds can be removed. This allows the use of the molds once every twenty-four hours.

THE LAYOUT OF ASSEMBLED MOLDS FOR THE DIFFERENT UNITS.

DRAWING #12 is a layout of one end of an assembled mold used for making the outer units. The mold as shown is for making the straight wall units. It differs from the mold required to make the corner units only in the kind of spacer used. The mold consists of division plates with attached form bars and spacers. The division plates are punched to receive the dowels in the spacers. These dowels are long enough to extend through into the spacer on the other side of the plate. The attached form bars are attached permanently to the division plates by rivets.

This mold will make sixty-five units in length and from two to six units in width, depending on the length of the unit, making a total of from 130 to 390 outer units per mold. The maximum dimensions of the mold being 4'6" wide by 8' long.

DRAWING #13 is a layout of an end of an assembled mold used for making the inner units. The mold consists of division plates, spacers and detached form bars. The division plates being punched to receive the dowels in the spacers. These dowels are long enough to extend through into the spacer on the other side of the plate. Notches are also punched in the upper and lower edges of these division plates to receive

the detached form bars which form the notches in the upper and lower edges of the inner unit.

This mold will make 100 units in length and from 2 to 7 units in width depending on the length of the unit, or a total of from 200 to 700 inner units per mold. The maximum dimensions being 4'6" wide by 8' long.

DRAWING #14, is a layout of one end of an assembled mold used for making the tie units. The mold consists of division plates with attached form bars, spacers and detached form bars, these being assembled as in above described molds.

This mold will make 80 units in length and from 4 to 30 units in width depending on the length of the tie unit or a total of from 320 to 2400 units.

The maximum dimension of the mold being 4'6" wide by 8' long.

DETAIL OF PARTS USED IN THE MOLDS.

DRAWING #15 shows the standard cold rolled shapes of steel bars used for molds.

Detail #1 is used to make spacers for outer units for straight walls.

Details #2, 3 & 4 are used to make spacers for outer units requiring mitered and rounded ends.

Details #5 & 7 are used to make spacers for inner units.

Detail #6 is used to make spacers for the tie units.

Details #8 & 9 are used for detached form bars, Detail #8 being used for tie units and #9 for inner units.

Detail #10 is used for attached form bars for forming grooves in outer units.

Detail #11 is used for attached form bars for tie units. The table of dimensions shows the length into which these bars are cut, and weight of each.

DRAWING #16 shows the different mold division plates required. The sheet steel is purchased rolled to width. The plates are cut off, notched and punched by the use of special dies in power presses.

DRAWING #17 shows the mould division plates with attached form bars for outer units. After the plates have been cut to length and punched as stated above they are put into a riveting fixture and the cold rolled steel

form bars are riveted in place.

DRAWING #18 is a table giving sizes, weights and number of mold division plates required for one mold of outer units.

DRAWING #19 is a table similar to #18 except that it is for inner units.

DRAWING #20 shows the mold division plates with attached bars for tie units. The attached form bars being small can be welded (electric) in place.

DRAWING #21 is a table showing the sizes, weights and number of mold division plates required for one mold of tie units.

DRAWING #22 shows spacers used in all molds, each spacer having two cold rolled steel dowels. These dowels can be made in automatic screw machines, and are to be a press fit in reamed holes in the spacer. The holes are drilled and reamed in a drilling fixture which makes their location exact. It will be noticed that all interchangeable parts of the molds must be made to exact dimensions as only plus or minus two thousandths of an inch being allowed or a total variation of four thousandths of an inch. This makes it possible to have every unit of the same symbol exactly alike.

TABLES OF PARTS AND MATERIALS REQUIRED
TO MAKE UP AND FILL A COMPLETE MOLD.

DRAWING # 23 is for outer units.

DRAWING # 24 is for inner units.

DRAWING # 25 is for tie units.

C O S T S O F M O L D S .

To get an idea of the cost of the molds, take the molds required for standard 8" x 16" units for a 12" wall.

The mold for outer units (A-8-484) will cast 195 units at a time and weighs 1850 lbs. complete. (See Drawing #23.) Say that we distribute the cost on the number of units made in one mold in one year's time allowing 300 working days and basing the cost of the mold at 5¢ per lb. which is ample. This mold would make 58,500 units at a cost of \$92.50. This is \$.0016 per unit.

The mold for inner units (B-8-484) will cast 300 units at a time or 90,000 units in a year. This mold weighs 1,297 lbs. and would cost at 5¢ per lb. \$65.00. This is \$.0007 per unit.

The tie unit (C-4-3(2 $\frac{1}{2}$)7) will cast 320 units at a time or 96,000 units per year. This mold weighs 2,266 lbs. and would cost \$113.00. This is \$.0012 per unit.

Cost of mold per outer unit	\$.0016
" " " " inner "	.0007
" " " " tie "	<u>.0012</u>
Total cost of one half of wall	\$.0035
As it requires 6 units to make up 8" x 16"	
of complete wall, the total cost for 128	
sq. in. is -	.0070

Cost per sq. ft. of wall surface - \$.0078

Allowing one cent per sq. ft. of wall would more than cover cost for any of the molds.

There being practically no wear on the molds, they should last at least four times as long as figured which would reduce the cost to \$.0025 per sq. ft. of wall surface for a 12" wall. The cost does not vary with the width of the wall as the difference in length of the tie unit would make very little difference.

COST OF MATERIAL.

In figuring the cost of material we will take the same size units used in figuring the molds.

Outer unit (A - 8 - 484) contains 154 cu. in. of concrete, .23 lbs. of steel for sheet facing and .22 lbs. 1/8" iron rods for reinforcement.

Inner unit (B - 8 - 484) contains 93 cu. in. of concrete.

Tie unit (C - 4 - 3 (2 1/2) 7) contains 39 cu. in. of concrete, .11 lbs. sheet metal facing and .08 lbs. 1/8" iron rods.

The amount of material contained in the three units is as follows:

286 cu. in. concrete.

.34 lbs. sheet metal facing.

.30 lbs. 1/8" rods.

Reducing this to one sq. ft. of wall surface for a twelve inch wall, we have the following amounts and costs:

644 cu. in. concrete @ 13¢ per cu. ft.	\$.047
76 lbs. steel facing @ 3¢ per lb.	.023
66 lbs. 1/8" rods @ 3¢ per lb.	<u>.02</u>
Total cost of wall per sq. ft.	\$0 .090

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The above cost is with the units reinforced.

For plain units the cost would be \$.07 per sq.
ft. for 12" wall.

COST OF MANUFACTURING THE UNITS.

Figuring on a plant to make units for 3,000 sq. ft. of 12" wall. This means approximately 40 cu. yds. of concrete per day or 50 cu. yds. or one car load of gravel and 55 bbls. or approximately $2/3$ of a car of cement.

In order to handle this amount of material to the best advantage it would mean dumping the gravel from gondola cars into a hopper below the track, from here to be carried to storage bins directly above the mixer by a belt conveyor which would require little or no labor. By buying cement in bulk it could be transferred to a storage bin in a similar manner by scraping it out of the side of the box car into a receiver and from there by conveyors to the storage bin above mixer.

By having the molds on cars running on the ordinary industrial track so that the molds could be transferred from the mixer to the steam curing rooms and from there to the storage yard by the use of very little labor. Estimating the cost of manufacturing in a rough but safe estimate, the cost of units per sq. ft. of wall would be as follows, labor being previously estimated:

Interest on principle and depreciation	
of equipment - - - - -	\$.04
Labor - - - - -	.02
Materials - - - - -	<u>.07</u>
Cost for plain units per sq. ft.	\$.13
" " reinforced units per sq. ft.	.15

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ESTIMATED COST OF WALLS,

MADE OF CONCRETE BY THE UNIT CONSTRUCTION METHOD AND COM- PARISON OF SAME WITH WOOD, BLOCK, BRICK, TILE AND MONOLITHIC CONCRETE CONSTRUCTION.

Unit constructed wall	per sq. ft. - @ 24¢ to 30¢
Frame wall	per sq. ft. - @ 16¢
Block wall	per sq. ft. - @ 26¢ to 33¢
Brick wall	per sq. ft. - @ 25¢ to 36¢
Tile wall	per sq. ft. - @ 23¢ to 28¢
Monolithic concrete wall " " "	- @ 35¢ to 44¢

The above prices are for walls finished on the outside and ready for plaster on the inside. A still further saving in the use of unit construction can be made by putting canvas on the wall to receive the decorating instead of plaster. This is possible because the units form a smooth wall.

UNIT BUILDING CONSTRUCTION:

Basing estimate on

8" x 16" units per sq. ft. of 8" wall	\$0.18
8" x 16" units per sq. ft. of 12" wall	0.20
Cost of laying up wall per sq. ft.	0.03
Cost of concrete filling per cu. ft.	0.15

2. The second part of the document focuses on the implementation of internal controls to prevent fraud and errors. It outlines the key components of a robust internal control system, including segregation of duties, authorization procedures, and regular monitoring and evaluation.

3. The third part of the document addresses the challenges faced by organizations in managing their financial resources effectively. It provides practical advice on budgeting, cost management, and the use of financial ratios to assess the company's financial health.

4. The fourth part of the document discusses the impact of external factors, such as market conditions and regulatory changes, on the organization's financial performance. It emphasizes the need for proactive risk management and strategic planning to navigate these challenges successfully.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of continuous improvement and the role of the accounting department in supporting the organization's long-term success.

The 3¢ per cu. ft. for laying up wall does not include labor on concrete filling which is 2" thick in the 8" wall and 6" thick in the 12" wall. Labor being estimated at the same rate as above. No lathing is required in this construction. The unit wall with concrete fill will cost ready to plaster on the inside as follows:

8" wall costs 24¢ per sq. or surface ft.

12" wall costs 30¢ per sq. or surface ft.

If the above units are reinforced add 2¢ per square or surface ft. of wall.

WOOD CONSTRUCTION:

Material used 2" x 4" studding, 7/8" sheathing, pine clap boards, pine lath and good grade of building paper.

Basing estimate on

Rough lumber at, per M. - - - - \$27.00

Siding at, per M. - - - - - 40.00

Carpenter work at, per day - - 3.75

The frame walls will cost \$0.16 per square or surface ft. including 10 per cent for waste. This is the approximate cost per sq. ft. for the outside walls of a frame house, lathed ready to plaster on the inside and ready to paint on the outside.

CEMENT BLOCK CONSTRUCTION:

Basing estimate on

8" x 8" x 16" blocks each - - - - \$0.15
8" x 12" x 16" blocks each - - - - 0.21
Mason per day - - - - - 4.80
Helper per day - - - - - 2.50
Furring and lathing per sq. ft. - - .03

The cement block walls will cost ready to plaster on the inside as follows:

8" thick 26¢ per square or surface foot
12" thick 33¢ per square or surface foot

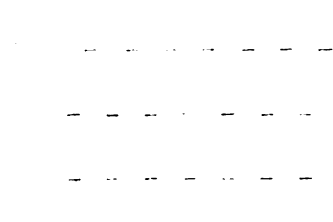
BRICK CONSTRUCTION:

Basing estimate on,

Brick, per M. - - - - - \$8.00
Mortar, per M. - - - - - 1.00
Mason per day - - - - - 4.80
Helper per day - - - - - 2.50
Furring & lathing per sq. ft. .03

The brick walls will cost ready to plaster on the inside as follows:

8" thick \$0.25 per square or surface feet
12" thick 0.36 per square or surface feet.



—

TILE CONSTRUCTION:

Basing estimate on

8" x 12" x 12" tile, each - - - - -	\$0.08
12" x 12" x 12" tile, each - - - - -	.12
Mason per day - - - - -	4.80
Helper per day - - - - -	2.50
Furring & lathing per sq. ft. - - -	.03
Stucco per sq. ft. - - - - -	.04

The tile walls will cost, ready to plaster on the inside as follows:

8" thick \$0.23 per square or surface foot

12" thick 0.28 per square or surface foot

MONOLITHIC CONCRETE WALLS:

Basing estimate on

Forms one side per square or surface foot @	\$0.10
Concrete per cu. ft. - - - - - @	.15
Rubbing with carberundum bricks to remove	
form work - - - - - @	.03
Furring & lathing per sq. ft. - - - - - @	.03
2" core per sq. ft. - - - - - @	.05

The Monolithic concrete walls will cost ready to plaster on the inside as follows:

8" solid wall 35¢ per square or surface foot

8" cored wall 30¢ per square or surface foot
12" solid wall 41¢ per square or surface foot
12" cored wall 44¢ per square or surface foot

C O N C L U S I O N .

The main points of this construction are viz:

Speed of construction

Insulation or air space

Adaptability to extensive decorative possibilities by
the use of pre-cast units.

Minimum cost for upkeep and insurance

Flexibility of these units over the larger ones that
have been so far used in unit construction work.

Strength is greater than other wall of the same cost of
construction.

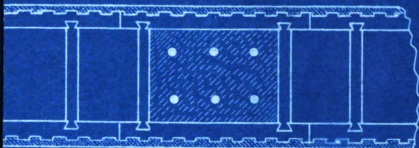
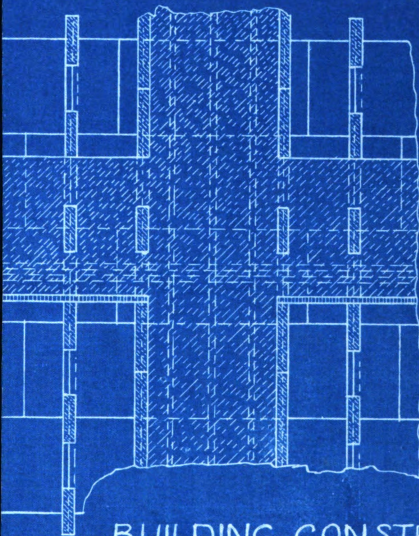


FIG. 4



BUILDING CONSTRUCTION

LAY OUT OF WALLS

ERM

DRAWING 1

SCALE $\frac{1}{4}$ SIZE

MAY 27-1915

R. Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR

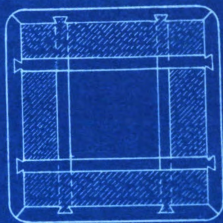


FIG. 4
HOLLOW COLUMN OR CHIMNEY



FIG. 5



FIG. 6

DETAIL OF TIE UNIT FOR
FIG. 4

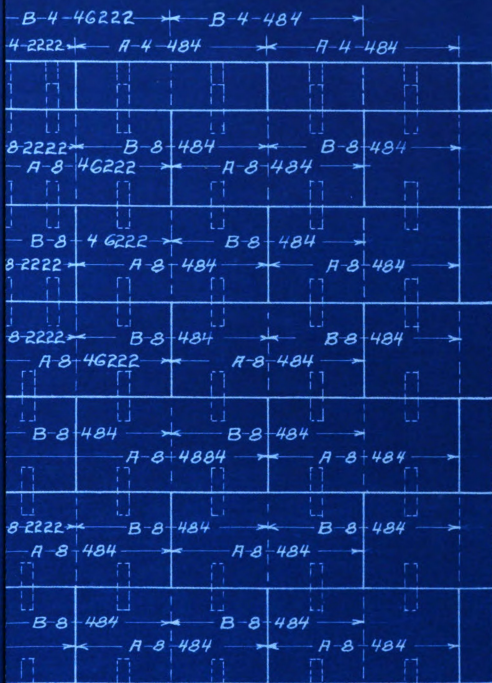
SECTION OF
WITH PILASTER

BUILDING CONSTRUCTION LAY OUT OF WALLS

DRAWING 2 SCALE $\frac{1}{4}$ " SIZE MAY 27-1915

R. Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR



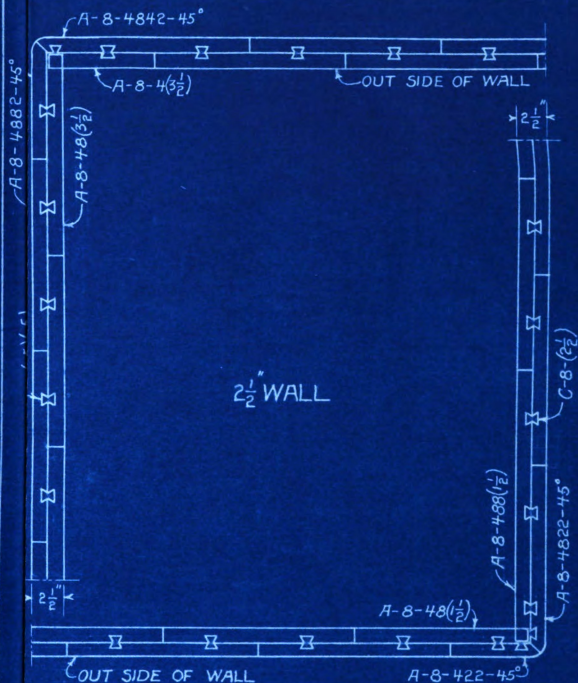
BUILDING CONSTRUCTION

12" WALL SHOWING STANDARD UNITS

DRAWING [#]3 SCALE $\frac{1}{4}$ " SIZE MAY 27, 1915.

R. Z. HOPKINS DETROIT, MICHIGAN.

PATENT APPLIED FOR.

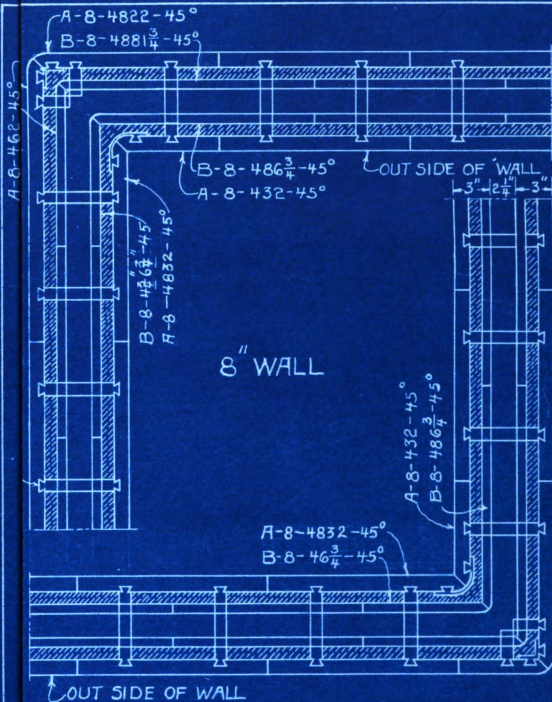


BUILDING CONSTRUCTION DETAIL OF WALLS AT CORNERS.

DRAWING #4 SCALE $\frac{1}{4}$ " SIZE MAY 27, 15.

R. T. HOPKINS, DETROIT, MICHIGAN

PATENT APPLIED FOR



BUILDING CONSTRUCTION DETAIL OF WALLS AT CORNERS.

DRAWING #5

SCALE ¹/₄ SIZE

MAY 27, 15.

R. Z. HOPKINS, DETROIT, MICHIGAN

PATENT APPLIED FOR

TABLE OF DIMENSIONS

DETAIL	LENGTH	HEIGHT	LOCATION OF NOTCHES					VOLUME CU IN.	WEIGHT LBS.
			C	D ₁	D ₂	D ₃	E		
#3	8"	8"	2"	2"	2"		2"	71.	6.2"
#1	12"	"	4"	6"			2"	114	9.9
1	16"	"	4"	8"			4"	154.	13.4
2	16"	"	4"	6"	2"	2"	2"	148.	12.9
3	20"	"	4"	8"	6"		2"	191.	16.6
3	24"	"	4"	8"	8"		4"	231.	20.0

BUILDING CONSTRUCTION DETAIL OF OUTER UNITS

DRAWING #6 SCALE $\frac{1}{4}$ " SIZE MAY 27-1915.

R. Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR

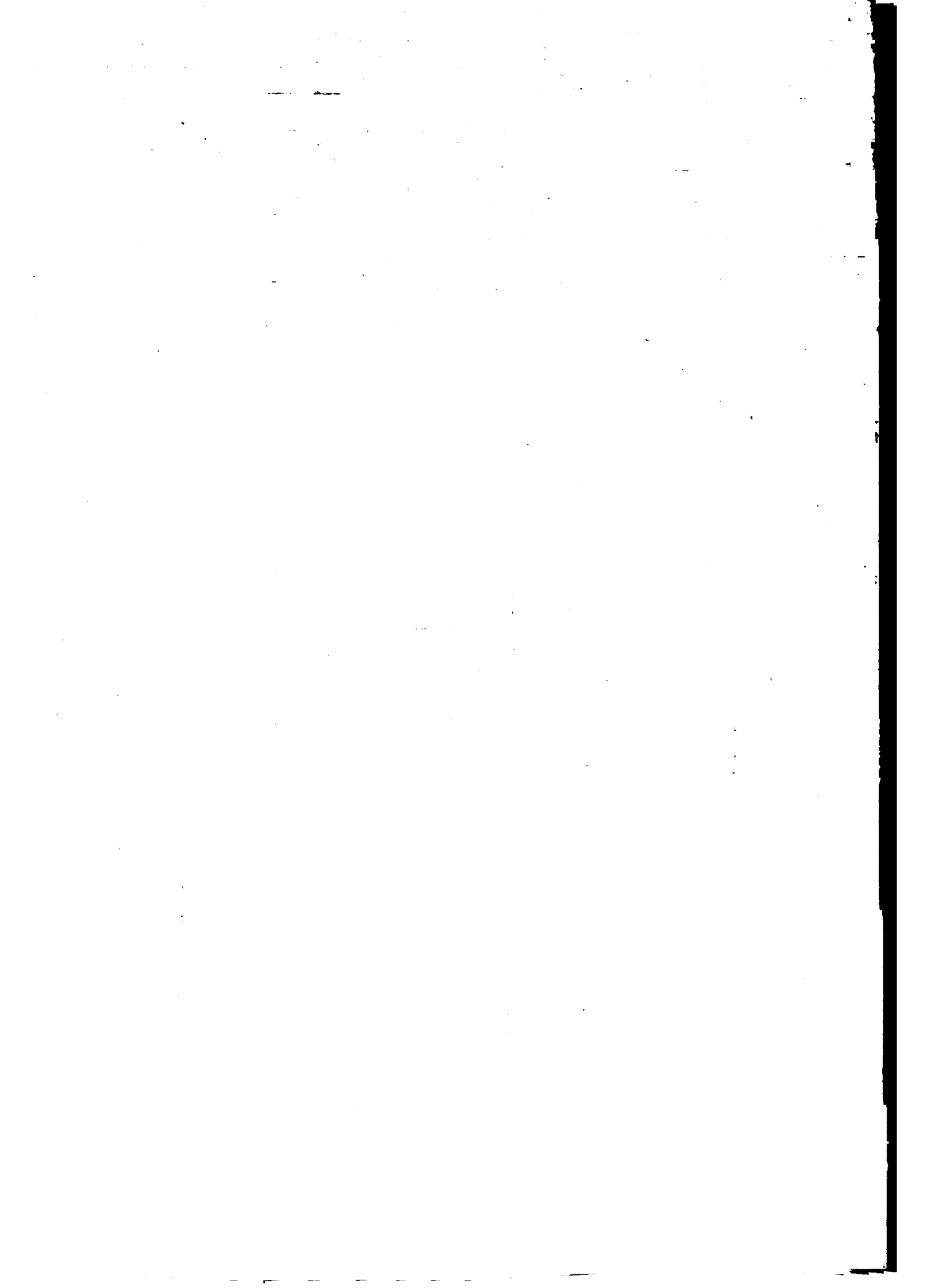


TABLE OF DIMENSIONS

DETAIL	LENGTH	HEIGHT	LOCATION OF NOTCHES					VOLUME CU. IN.	WEIGHT LBS.	
			A	B	C	D ₁	D ₂			D ₃
#1	8"	8"	4"	2"				2"	66.5	5.8
"	9"	"	"	3"				"	76.5	6.6
"	10"	"	"	4"				"	86.5	7.5
"	11"	"	"	5"				"	96.5	8.4
"	12"	"	"	6"				"	106.5	9.2
"	13"	"	"	7"				"	116.5	10.1
"	14"	"	"	8"				"	126.5	11.0
"	15"	"	"	9"				"	136.5	11.9
#2	16"	"	"	8"	2"			"	143.5	12.5
"	17"	"	"	"	3"			"	153.5	13.3
"	18"	"	"	"	4"			"	163.5	14.2
"	19"	"	"	"	5"			"	173.5	15.0
"	20"	"	"	"	6"			"	183.5	15.9
"	21"	"	"	"	7"			"	193.5	16.8
"	22"	"	"	"	8"			"	203.5	17.7
"	23"	"	"	"	9"			"	213.5	18.5

BUILDING CONSTRUCTION DETAIL OF OUTER UNITS FOR CORNERS

DRAWING #7 SCALE $\frac{1}{4}$ " SIZE MAY 27-1915.

FILE #3
#2

R. Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR

TABLE OF DIMENSIONS

DETAIL	LENGTH	HEIGHT	LOCATION OF NOTCHES					VOLUME CU. IN	WEIGHT LBS.
			C	D	D ₂	D ₃	E		
#3	8"	8"	2"	2"	2"		2"	43.5	3.8
#1	12"	"	4"	6"			2"	69.0	6.0
1	16"	"	4"	8"			4"	93.0	8.1
2	16"	"	4"	6"	2"	2"	2"	90.0	7.8
3	20"	"	4"	8"	6"		2"	115.5	10.0
3	24"	"	4"	8"	8"		4"	139.5	12.1

BUILDING CONSTRUCTION

DETAIL OF INNER UNITS

DRAWING #8 SCALE $\frac{1}{4}$ " SIZE MAY 27-1915

R. Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR

TABLE OF DIMENSIONS

DETAIL	LENGTH	HEIGHT	LOCATION OF NOTCHES					VOLUME CU. IN.	WEIGHT LBS.
			C	D	D ₂	D ₃	E		
#1	6 $\frac{3}{4}$	8"	4				2 $\frac{3}{4}$	36.0	3.1
#1	7 $\frac{3}{4}$	"	"				3 $\frac{3}{4}$	42.0	3.6
#1	8 $\frac{3}{4}$	"	"				4 $\frac{3}{4}$	48.0	4.2
#1	9 $\frac{3}{4}$	"	"				5 $\frac{3}{4}$	54.0	4.7
#1	10 $\frac{3}{4}$	"	"				6 $\frac{3}{4}$	60.0	5.2
#1	11 $\frac{3}{4}$	"	"				7 $\frac{3}{4}$	66.0	5.7
#1	12 $\frac{3}{4}$	"	"				8 $\frac{3}{4}$	72.0	6.2
#2	13 $\frac{3}{4}$	"	"	8"			13 $\frac{3}{4}$	76.5	6.6
#2	14 $\frac{3}{4}$	"	"	"			23 $\frac{3}{4}$	82.5	7.2
#2	15 $\frac{3}{4}$	"	"	"			33 $\frac{3}{4}$	88.5	7.7
#2	16 $\frac{3}{4}$	"	"	"			43 $\frac{3}{4}$	94.5	8.2
#2	17 $\frac{3}{4}$	"	"	"			53 $\frac{3}{4}$	100.5	8.7
#2	18 $\frac{3}{4}$	"	"	"			63 $\frac{3}{4}$	106.5	9.3
#2	19 $\frac{3}{4}$	"	"	"			73 $\frac{3}{4}$	112.5	9.8
#2	20 $\frac{3}{4}$	"	"	"			83 $\frac{3}{4}$	118.5	10.3
#3	21 $\frac{3}{4}$	"	"	"	8"		13 $\frac{3}{4}$	123.0	10.7

BUILDING CONSTRUCTION

DETAIL OF INNER UNITS

FOR CORNERS

DRAWING #9 SCALE $\frac{1}{4}$ " SIZE MAY 27-1915

R.Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR

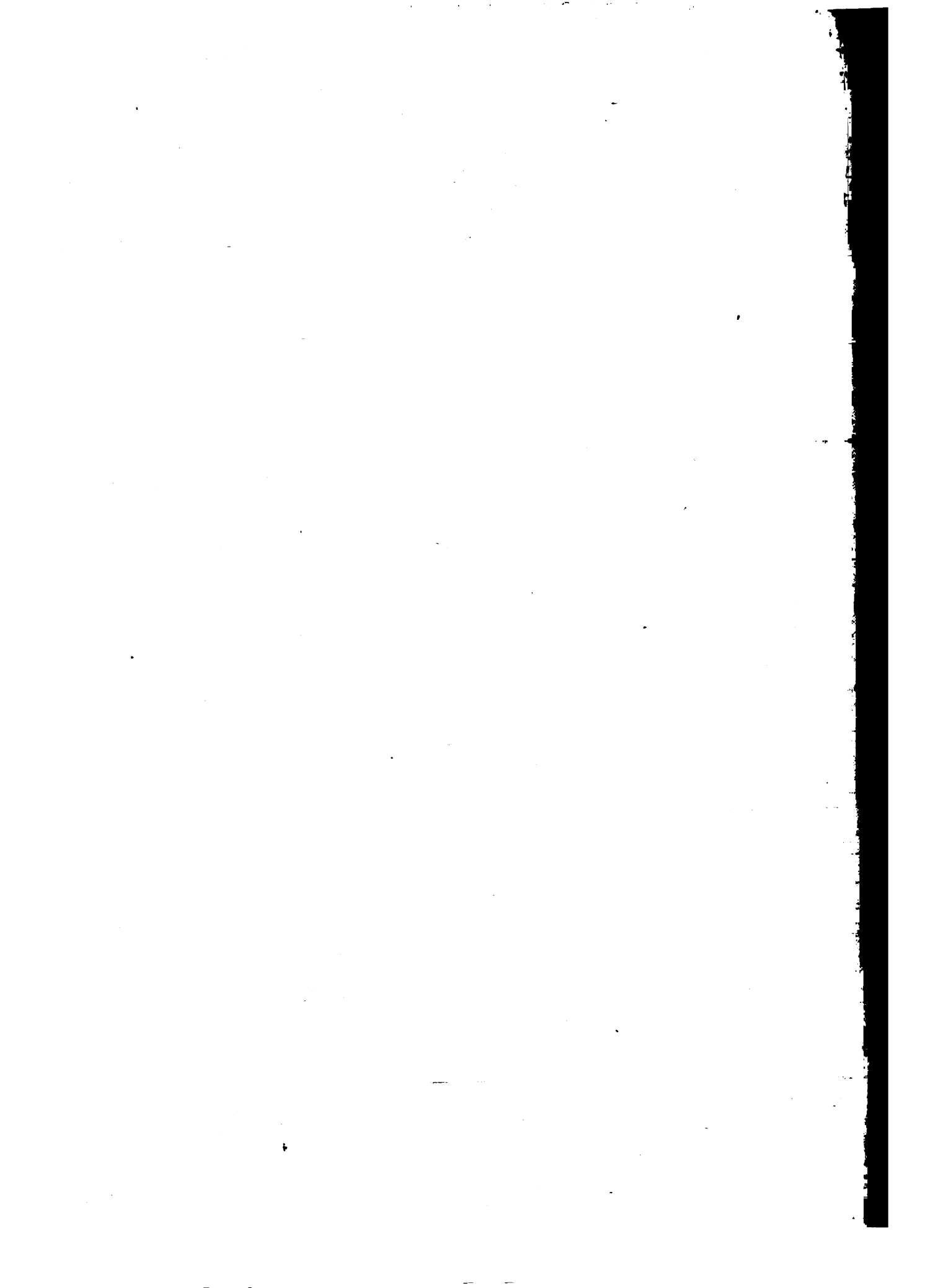
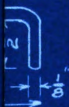


TABLE OF DIMENSIONS

HEIGHT	LOCATION OF NOTCHES								CONCRETE	
									CU. IN.	WT. LBS.
B	C	D ₁	D ₂	E	C'	D' ₁	D' ₂	E		
8"									6.0	.5
2									1.5	.1
4									10.0	.9
2									5.0	.4
4									18.0	1.6
2									9.0	.8
4	4	1 7/8"	3"		1 7/8"	1 7/8"	3"	1 7/8"	23.0	2.0
2		"	"		"				11.5	1.0
4	4	"	"		3 7/8"	"	"	3 7/8"	31.0	2.7
2		"	"		"				15.5	1.3
4	4	"	"		5 7/8"	"	"	5 7/8"	39.0	3.4
2		"	"		"				19.5	1.7



BUILDING CONSTRUCTION DETAIL OF TIE UNITS

DRAWING 10 SCALE 1/4" SIZE MAY 27-1915

R.Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR



TABLE OF DIMENSIONS.

UNITS	DETAIL NUMBER.	WIDTH UNFOLDED	GAUGE	WEIGHT LBS.	DIMENSIONS		
					A.	B.	C.
OUTER	#1.	3.35	#28	.112	7.990"	1"	2.
OUTER	#1.	3.35	#28	.056	3.990"	1"	2
TIE	#2.	3.35	#28	.056	3.990"	1 1/2"	1
TIE	#2.	3.35	#28	.028	1.990"	1/2"	1

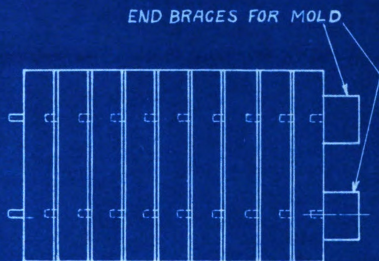
ole

TAIL #2. BUILDING CONSTRUCTION
TONGUE AND GROOVE
REINFORCEMENT

DRAWING #11 SCALE 1/4" SIZE MAY 27, 15.

R.Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR



SIDE VIEW OF ONE END OF MOLD

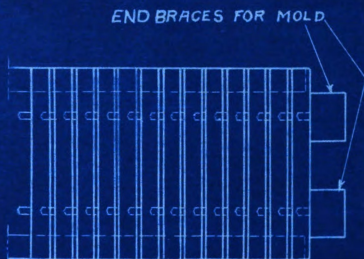
BUILDING CONSTRUCTION

MOLDS FOR OUTER UNITS

DRAWING #12 SCALE $\frac{1}{4}$ " SIZE MAY 27-1915

R. Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR.



SIDE VIEW OF ONE END OF MOLD

BUILDING CONSTRUCTION

MOLDS FOR INNER UNITS

DRAWING #13 SCALE $\frac{1}{4}$ SIZE MAY 27-1915

R.Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR



LENGTH



HEIGHT

SUPPORT FOR END OF MOLD



SIDE VIEW OF ONE END OF MOLD

BUILDING CONSTRUCTION

MOLD FOR TIE UNITS

DRAWING 14 SCALE $\frac{1}{4}$ SIZE MAY 27-1915

R.Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR

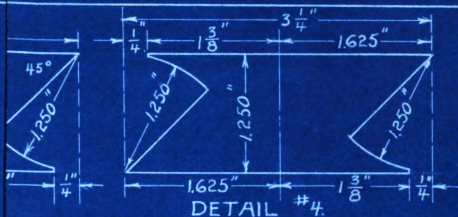


TABLE OF DIMENSIONS

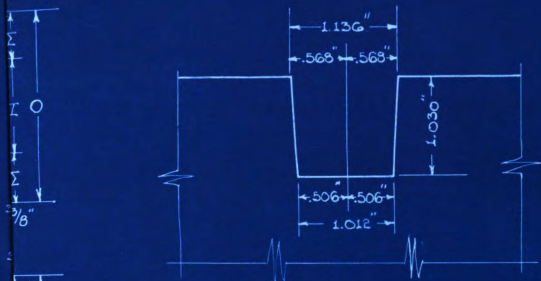
DETAIL NUMBER	LENGTH	WEIGHT LBS.	LENGTH	WEIGHT LBS.	LENGTH	WEIGHT LBS.	LENGTH	WEIGHT
#1.	7.990	2.12	3.990	1.06				
2.	7.990	4.27	3.990	2.14				
3.	7.990	6.40	3.990	3.20				
4.	7.990	6.40	3.990	3.20				
5.	7.990	1.28	3.990	.64				
6.	7.990	1.70	3.990	.85	1.990	.43		
7.	7.990	2.05	3.990	1.03				
8.	92.0"	21.5						
9.	90.0"	27.5						
10.	7.990	.85	3.990	.43	1.990	.21		
11.	7.990	.14	3.990	.07	1.990	.04		

BUILDING CONSTRUCTION
COLD ROLLED STEEL
BARS FOR MOLDS.

DRAWING #15 SCALE $\frac{1}{4}$ " SIZE MAY 27, 15.

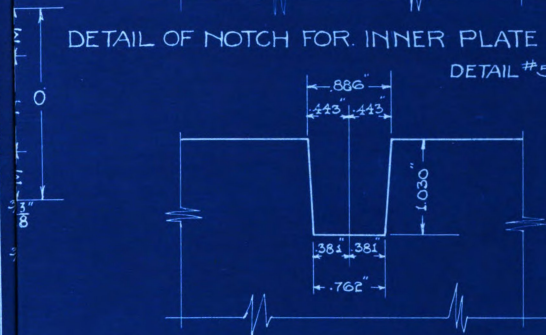
R. E. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR.



DETAIL OF NOTCH FOR INNER PLATE

DETAIL #5



DETAIL OF NOTCH FOR TIE PLATE

SEE TABLE OF DIMENSIONS

DETAIL #6

DRAWING NO. 18, 19, & 21.

BUILDING CONSTRUCTION MOLD DIVISION PLATES.

DRAWING #16 SCALE $\frac{1}{4}$ " SIZE

MAY 27, 15.

R. Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR



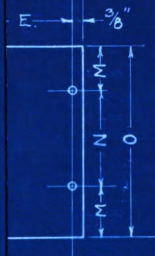
C.R.S. FORM BAR

SEC. A-A

NOTE

FORM BAR TO BE HELD IN PLACE BY $\frac{1}{4}$ " RIVETS, THE ENDS OF WHICH MUST BE GROUND OFF TRUE WITH OUTSIDE SURFACE.

SEE TABLE OF DIMENSIONS ON DRAWING NO. 18

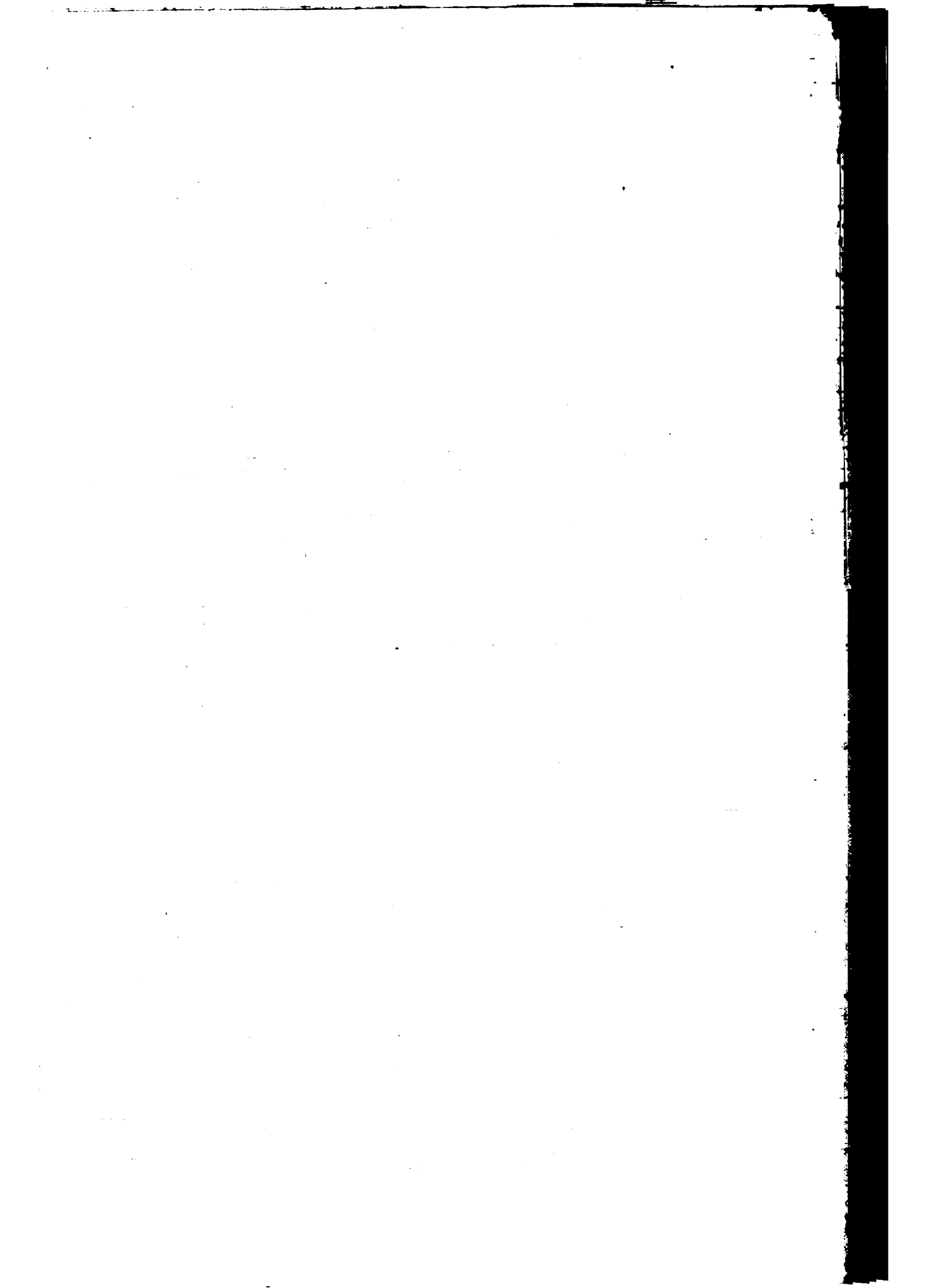


BUILDING CONSTRUCTION MOLD DIVISION PLATES FOR OUTER UNITS

DRAWING #17 SCALE $\frac{1}{4}$ " SIZE MAY 27, 15

R.T. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR.



MAY- 27-1915
DRAWING NO. 18

S		ATTACHED FORM BARS										TOTAL WEIGHT
ION	NUMBER PER UNIT	NUMBER PER PLATE	LOCATION						WEIGHT EACH	WEIGHT PER PLATE		
N			C	D ₁	D ₂	D ₃	D ₄	E				
04.000"	3	18	2.365"	2.000"	2.000"			2.365"	.85 [#]	15.3 [#]	30.4	
"	2	8	4.365	6.000				"	"	6.8	21.5	
"	2	6	"	8.000				4.375"	"	5.1	19.5	
"	4	12	"	6.000	2.000"			2.375	"	10.2	24.6	
"	3	6	"	8.000	6.000			"	"	5.1	17.1	
"	3	6	"	"	8.000			4.375"	"	5.1	19.3	
"	2	12	"	2.000				2.375	"	10.2	25.3	
"	2	10	"	3.000				"	"	8.5	22.5	
"	2	10	"	4.000				"	"	8.5	23.9	
"	2	8	"	5.000				"	"	6.8	20.3	
"	2	8	"	6.000				"	"	6.8	21.4	
"	2	6	"	7.000				"	"	5.1	17.0	
"	2	6	"	8.000				"	"	5.1	17.9	
"	2	6	"	9.000				"	"	5.1	18.8	
"	3	9	"	8.000	2.000"			"	"	7.7	22.2	
"	3	9	"	"	3.000			"	"	7.7	23.1	
"	3	6	"	"	4.000			"	"	5.1	16.0	
"	3	6	"	"	5.000			"	"	"	16.6	
"	3	6	"	"	6.000			"	"	"	17.2	
"	3	6	"	"	7.000			"	"	"	17.8	
"	3	6	"	"	8.000			"	"	"	18.4	
"	3	6	"	"	9.000			"	"	"	18.9	
								</				

INNER UNITS.

NOTCHES FOR DETACHED FORM BARS

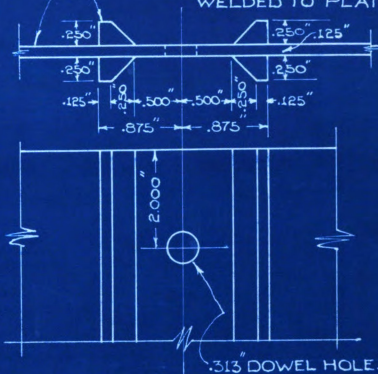
LOCATION

C	D ₁	D ₂	D ₃	D ₄	E	C'	D' ₁	D' ₂	D' ₃	D' ₄	E'
2.365	2.000	2.000			2.365	2.365	2.000	2.000			2.365
4.365	6.000				2.365	4.365	6.000				2.365
"	8.000				4.365	"	8.000				4.365
"	6.000	2.000	2.000		2.365	"	6.000	2.000	2.000		2.365
"	8.000	6.000			2.365	"	8.000	6.000			2.365
"	8.000	8.000			4.365	"	8.000	8.000			4.365
"					3.115	"					3.115
"					4.115	"					4.115
"					5.115	"					5.115
"					6.115	"					6.115
"					7.115	"					7.115
"					8.115	"					8.115
"					9.115	"					9.115
"	8.000				2.115	"	8.000				2.115
"	"				3.115	"	"				3.115
"	"				4.115	"	"				4.115
"	"				5.115	"	"				5.115
"	"				6.115	"	"				6.115
"	"				7.115	"	"				7.115
"	"				8.115	"	"				8.115
"	"				9.115	"	"				9.115
"	"	8.000			2.115	"	"	8.000			2.115

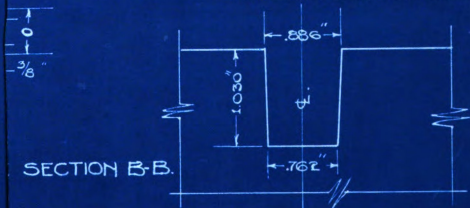
#11 GAUGE C.R.S. PLATE

C.R.S. FORM BARS ELECTRIC

WELDED TO PLATE.



FULL SIZE SECTION A-A.



BUILDING CONSTRUCTION MOLD DIVISION PLATES FOR TIE UNITS

DRAWING#20 SCALE $\frac{1}{4}$ SIZE

MAY 27, 15

R.Z. HOPKINS DETROIT MICHIGAN

PATENT APPLIED FOR

MAY- 27-1915

DRAWING NO. 21

MED FORM BARS

FORM BARS

ION

NO. PER
UNITNO. PER
PLATEWEIGHT
EACHWT. PER
PLATETOTAL
WEIGHT

E

C'

D'

D'₂D'₃D'₄

E'

4

120

.14*

16.8

31.9

"

120

.035

4.2

8.0

"

60

.07

4.2

11.7

"

60

.035

2.1

5.9

"

36

.07

2.5

9.6

"

36

.035

1.3

4.9

1.375

1.375

3.000

1.375

"

28

.07

2.0

8.3

1.375

3.000

1.375

"

28

.035

1.0

4.4

3.375

1.375

3.000

3.375

"

20

.07

1.4

7.6

1.375

3.000

3.375

"

20

.035

.7

3.8

5.375

1.375

3.000

5.375

"

16

.07

1.1

7.2

1.375

3.000

5.375

"

16

.035

.6

3.7



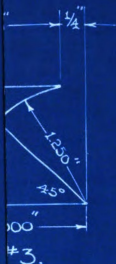


TABLE OF DIMENSIONS.

UNITS.	DETAIL.	WEIGHT.	DIMENSIONS.			
			A.	B.	C.	D.
OUTER.	#1.	2.1 lbs	7.990	4.000	1.995	1.245
OUTER.	2.	4.3	7.990	4.000	1.995	1.245
OUTER.	3.	4.3	7.990	4.000	1.995	1.245
OUTER.	1.	1.1	3.990	2.000	.995	1.245
OUTER.	2.	2.2	3.990	2.000	.995	1.245
OUTER.	3.	2.2	3.990	2.000	.995	1.245
INNER.	4.	1.3	7.990	4.000	1.995	.745
INNER.	5.	2.1	7.990	4.000	1.995	.745
INNER.	4.	.64	3.990	2.000	.995	.745
INNER.	5.	1.1	3.990	2.000	.995	.745
TIE.	6.	.9	3.990	2.000	.995	.995
TIE.	6.	.4	1.990	2.000	.495	.995

FIT.
D HOLE

BUILDING CONSTRUCTION SPACERS FOR MOLDS

TAIL #7.

DRAWING #22 SCALE $\frac{1}{4}$ SIZE

MAY 27, 15

R.Z. HOPKINS, DETROIT, MICHIGAN.

PATENT APPLIED FOR.

MAY-27-1915
DRAWING NO. 23

[illegible]

ER UNITS

MAY-27-1915

DRAWING NO. 24

[illegible]

UNITS

MAY- 27-1915

DRAWING NO. 25

[illegible]

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