A BORDER AND A CENTRAL PANEL FOR A FLOOR IN THE FOYER OF THE ART BUILDING

By

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A Thesis

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for the degree of

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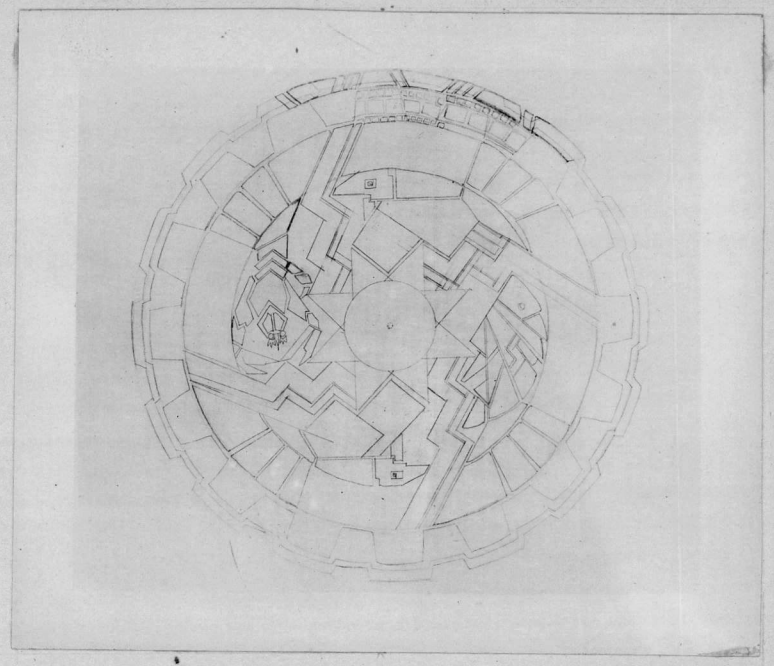

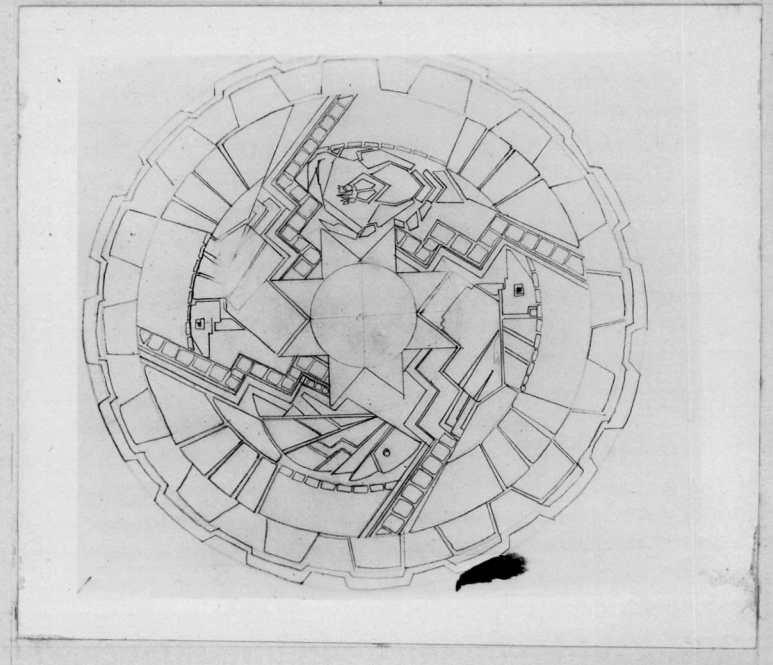

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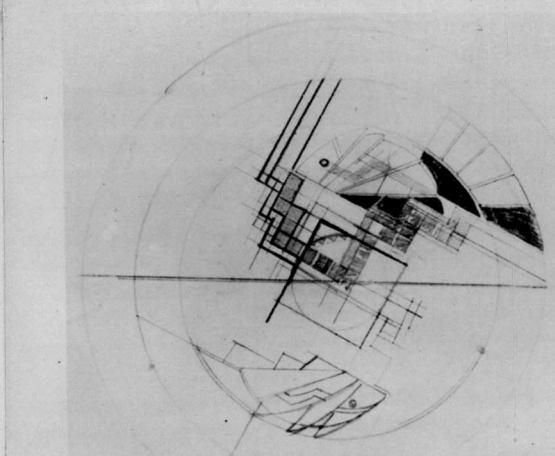

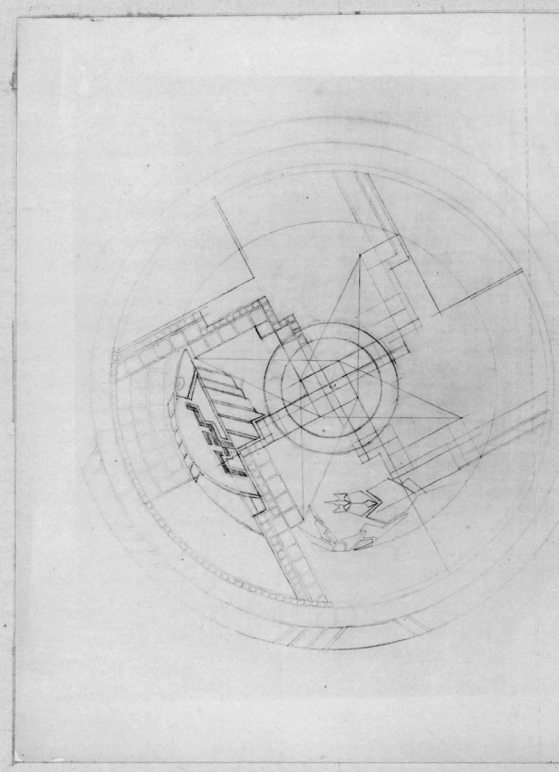

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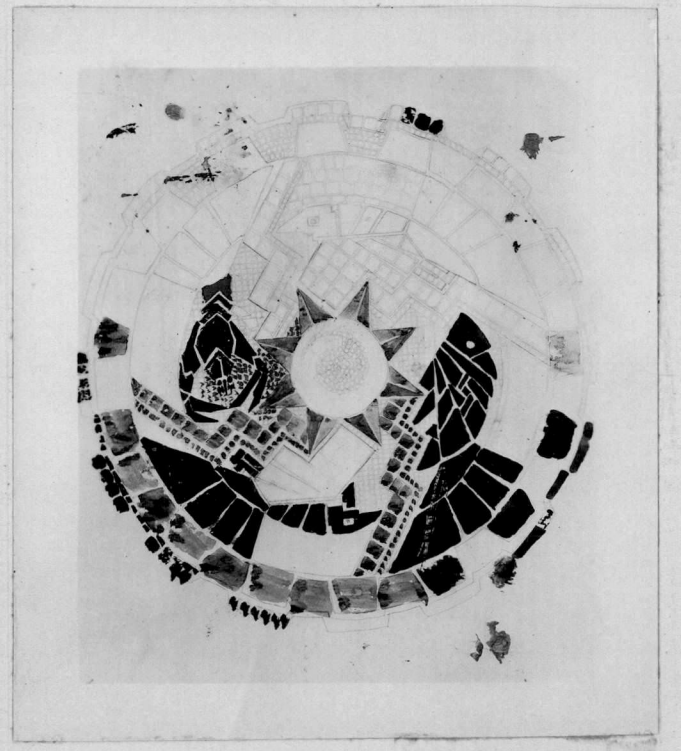

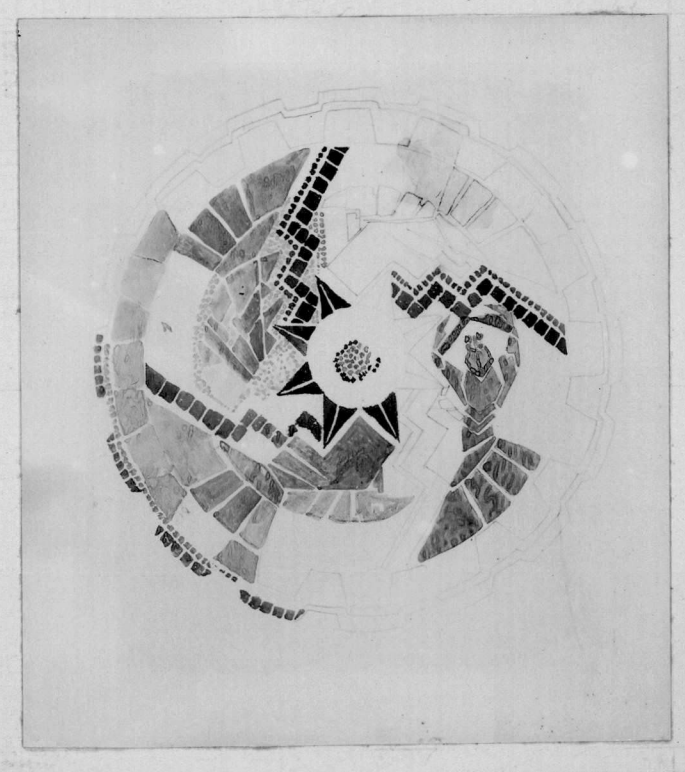

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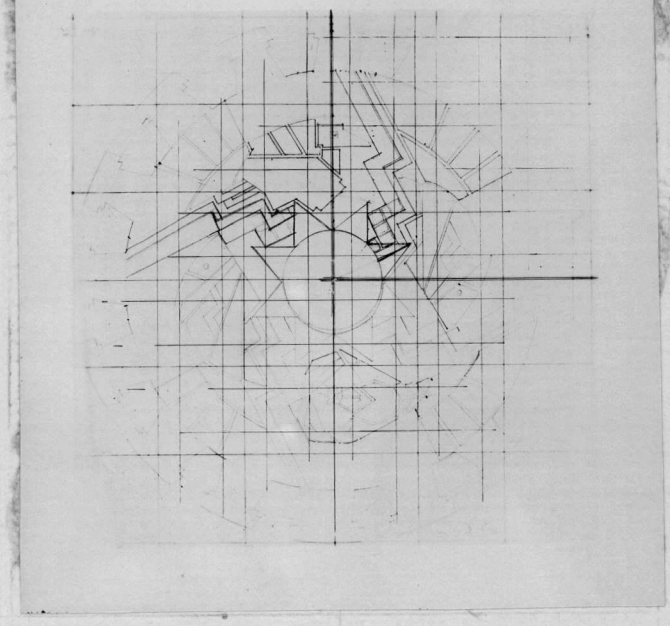

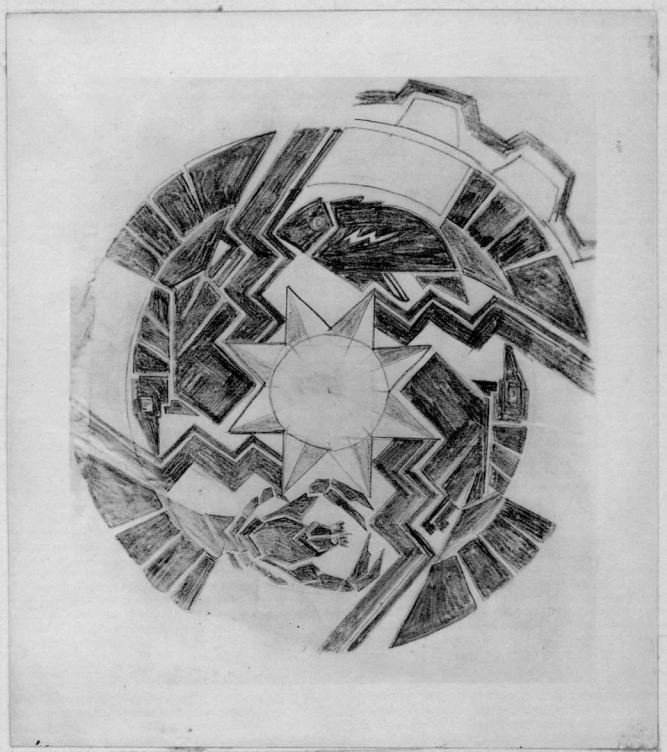

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OF

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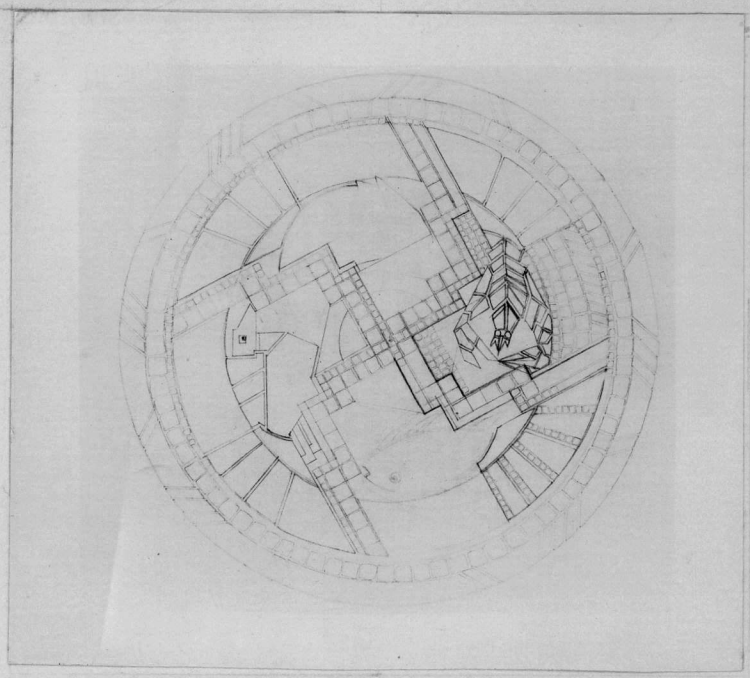

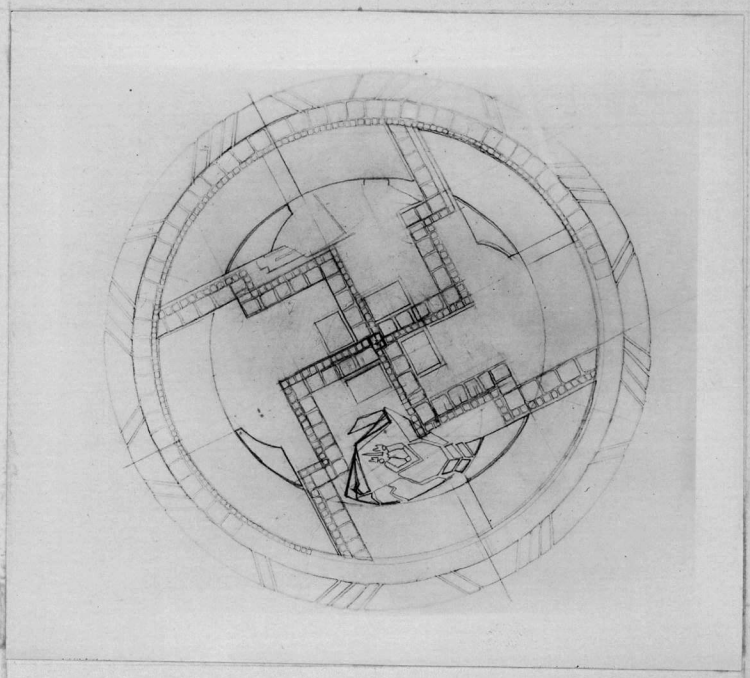

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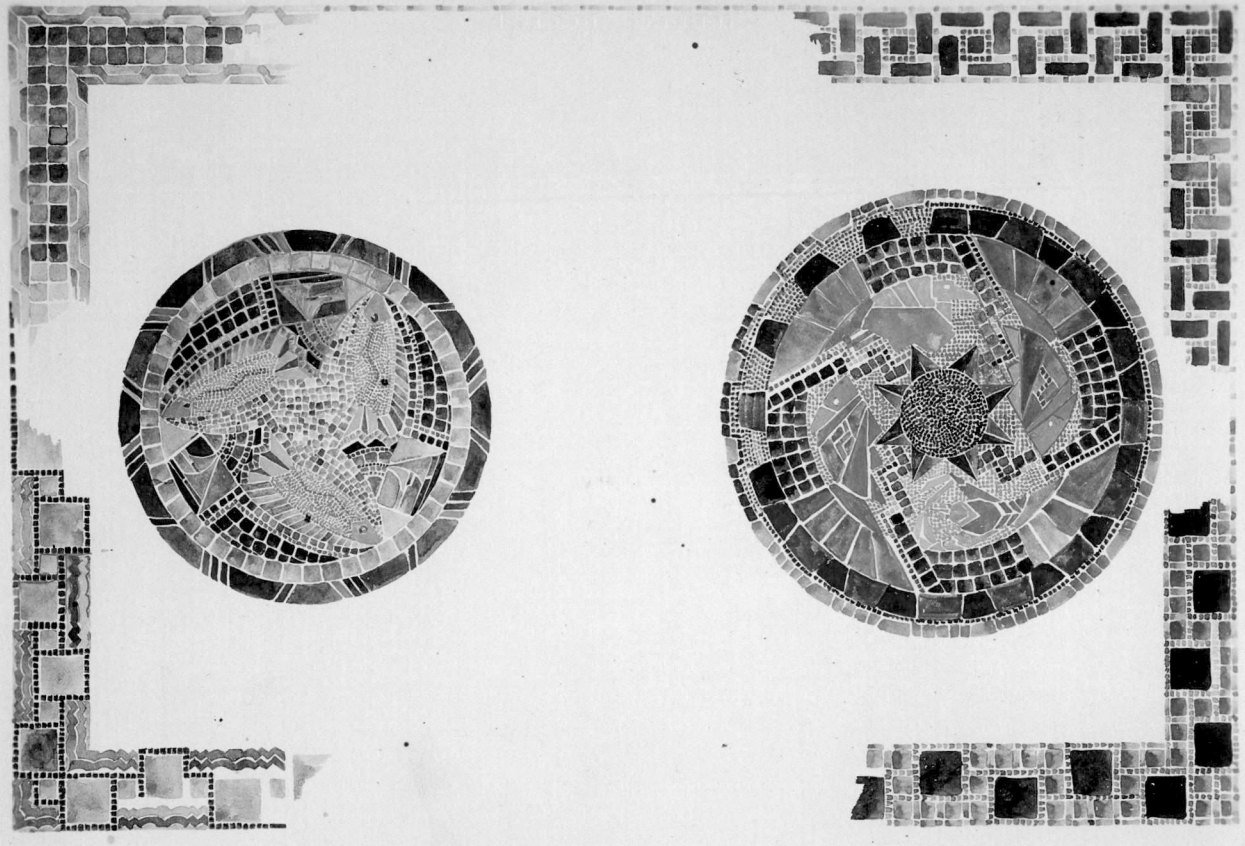

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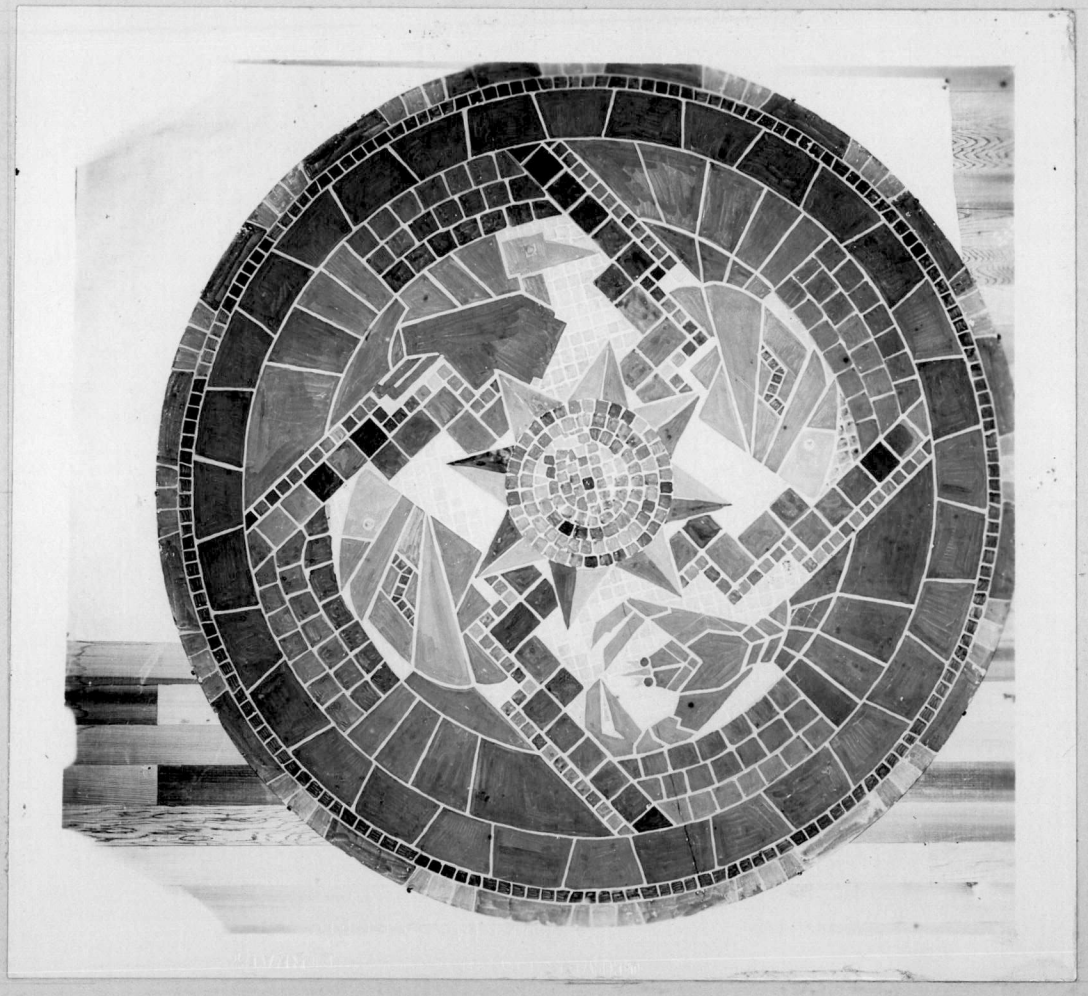

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FULL SCALE DETAIL

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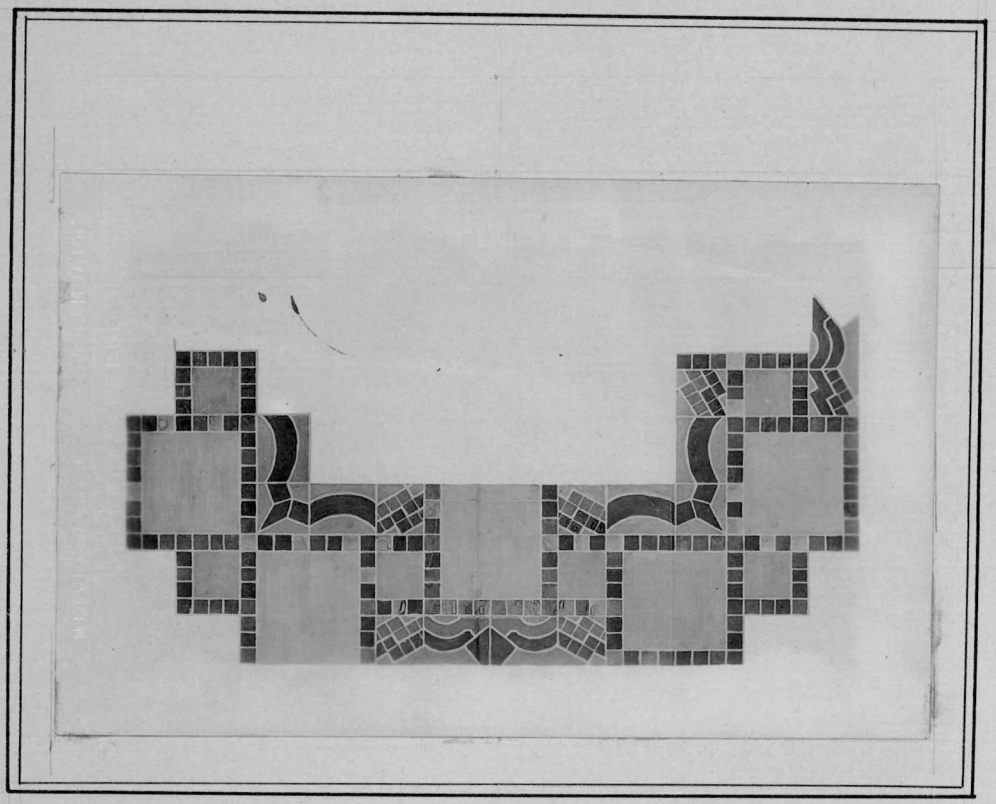

GLAZE

RESEARCH

GLAZE RESEARCH

"All glazes belong to a class of chemical compounds known as silicates.

CLEAR or what are sometimes called 'Majolica' glazes are compound silicates of lead, zinc, lime, potassium, sodium aluminum and boron.

MATT glazes are characterized by certain of these elements being present in excess.

STANNIFEROUS or tin glazes are rendered opaque by the use of oxide of tin.

RAW glazes are those made from a commercially prepared substance."[1]

A glaze is usually expressed as a chemical formula. In this there are three divisions, each of which expresses a distinct function.

On the LEFT hand are the bases, the foundation of the glaze. These indicate the type, such as a lead glaze, a lime glaze, an alkaline glaze, etc. All glazes being silicates, this is the usual way of distinguishing them.

In the CENTER are the aluminum and the boron oxides. These regulate the behavior of the glaze in the fire. They make it viscous or sluggish as it melts and prevent too rapid a flow. The aluminum is infusible, the boron fusible, but

[1] Binns, Practical Pottery, Chapter XV.

boron cannot be used in a raw glaze.

At the RIGHT stands the silica, the dominating factor with which all of the other ingredients combine, and which controls the behavior of the whole as regards the fitting of the glaze to the body. The very simplest form of glaze is a bi-silicate of lead, or in its chemical formula, Pb O--SiO2[1] or one equivalent of lead oxide to one of silica.

In planning on the kind of glaze that would be the most suitable for this particular problem, the color, temperature and surface quality were the tests in deciding. Each type of glaze has a certain range in color, they vary greatly in the firing temperature required and the surface may be a very high gloss or a dull finish. After a thorough test of all of the available glazes both majolica and matt, a matt glaze was decided upon as the most desirable for a floor tile to carry out the idea for the design to be used.

Matt glazes are not underfired glazes but are produced in two ways:

1. An excess of aluminum.
   This causes a chemical reaction in the compound quite simple to produce.
2. An excess of silica.
   This produces a devitrified surface. A silica matt is very difficult to produce. In a studio kiln it is practically impossible, as these small kilns cool too rapidly.

[1]All chemical formulas from Binns, Practical Pottery, ahd

Bisilicate or bright glazes for low firing have an oxygen ratio of 1:2. Aluminum matt glazes have an oxygen ratio of 3:4 secured in the following manner: RO may consist of any of the bases used in a bright glaze. (RO a symbol used for the sake of brevity and indicates that no matter how many bases are introduced the total must always be unity). The proportion is adjusted in accordance with the desired point of fusion. The aluminum content is somewhat higher in a matt than in a bright glaze and should not fall much below a .3 equivalent. A .35 is even better. The RO content should not be too fusible. Lead oxide is desirable up to a .5 equivalent and it is an advantage to use faldspar so the K2O may be introduced. Calcium oxide is good but zinc oxide must be used sparingly as it is likely to suffer if overfired.

RECIPE FOR A MATT GLAZE FIRING TO A CONE 1 AND .02.

PbO	.50				
CaO	.30	—— Formula	Al2 O3 .34	SiO2	1.48
K2O	.20				

RECIPE FOR A MATT GLAZE FIRING TO A CONE 7.

CaO	.75				
		—— Formula	Al2 O3 .55	SiO2	2.10
K2O	.25				

To obtain a colored glaze add to the above any of the following:

Cobalt oxide

Nickel oxide

Iron oxide
Copper oxide
Chrome oxide
Zinc oxide
Uranium oxide

In glazing a matt piece more than half of the success lies in the application of the glaze. It must be very thick or the true texture will not be developed. Matt glazes do not correct their own faults in the firing as the majolica glazes do. Every imperfection will show as this type of glaze does not flow readily.

In glazing the tiles for this problem, a coat of glaze at least 1/16" in thickness was applied to each piece. All of the glazes were strained very carefully at least twice through a forty mesh sieve. The surface of the tile was sponged to be sure that it was clean and then dipped into the glaze. This method worked very well for all of the colors except the high fire red (RH 2016). After much experimenting with this particular red it was found that this glaze had to be applied in successive coats in order to avoid blisters and crater-like formations on the surface of the glaze. In the case of this color a very thin coat was brushed on, fired to a cone 1 (1150 C), dipped a second time to the thickness of 1/16" and then refired again to cone 1 (1150 C). In some cases a few of these tiles had to be glazed and fired a third time before the desired surface was obtained.

The color palette for this design included nineteen glazes. These glazes fell into three distinct groups for firing. The two reds were the extremes in temperature and the blues and greens ranged half way between. The Drakenfeld red was the lowest cone of all, fusing at an .09 (970 C). This red was extremely sensitive to the slightest variation in temperature. When placed on a shelf twelve inches square the color will vary from yellow through orange to red. At a cone .011 (920 C) this glaze is a clear yellow, orange at a temperature of 950 C. or cone .010, and a definite red at cone .09 (970 C). Increase of heat intensifies the red until at cone 1 or 2 it becomes a clear glaze.

The blues and greens were the easiest to fire as they have a possible variation in temperature from cone .03 (1090 C) to a cone .01 (1130 C) without harming the surface quality of the tile.

The RH 2016 red was a rather high fire glaze, the temperature ranging from cone 1 (1150 C) to cone 2 (1170 C).

Insufficient heat in any of the firings resulted in the glaze forming globules due to lack of proper fusion. All of the glazes were subjected to three separate tests in firing:

1. Underfired.
2. Overfired.
3. Correct temperature.

This was a great help in determining the possible firing range of each glaze and also made it possible to check on what actually happened to the glaze under these conditions.

The Drakenfeld red did not prove to be a true matt under even the best of firing conditions, so we took the slight gloss from the surface with successive coats of dilute Hydrofleuroric acid.

ESTIMATE FOR GLAZE ORDER. MARCH 15, 1933.

Area to be glazed - 80.27 square feet.

Glaze required - 9 oz. per square foot.

720 oz. or 45 pounds of glaze required for 80 square feet.

Totals in the three main colors.	Required amount.	20% Margin.
Greens and blues, central	100 oz.	120 oz.
Greens and blues, border	273 oz.	328 oz.
Tans and yellows, central	36 oz.	43 oz.
Reds and browns, central	135 oz.	160 oz.
Reds and browns, border	200 oz.	240 oz.

Required amount for 80.27 square feet of floor - 45 pounds, 7 ounces.

Amount required with a 20% margin added - - - - 54 pounds, 8 ounces.

Colors used:

Light blue	Am#3	Matt Medium	1260D
Dark blue	Am#4	Green blue	1250D
Blue-green	Am#7	Willow green	2017
Yellow	Am#17	Mulberry green	2023
Cream white	Drak. Co.	Red	2016
Bright red	Drak. Co.	Brown hickory	2003
Deep blue	Drak. Co.	Blue green	1260D
Fawn yellow	Drak. Co.		
Tan yellow	Drak. Co. 2013		
Leopard	2011		
Silver green	2002		
Delft blue	1251D		

FIRING TEMPERATURE USED FOR THE FOLLOWING GLAZES:

Am#3	Light blue	Cone 03 to 01	1090 C - 1130 C.
Am#4	Dark blue	" " " "	
Am#7	Blue green	" " " "	
Am#17	Yellow		
Drak.	Cream white		
Drak.	Bright red	.09 (970 C)	Very sensitive to any variation in heat. Yellow at .010. Brillian gloss at .07.
Drak.	Deep blue	.04-.03	
Drak.	Fawn yellow	.03-.01	
RH 2015	Tan Yellow	.02-1	
RH 2011	Leopard	.03-.01	
RH 2002	Silver Green	.03-.01	
RH 1251D	Delft blue	.03-.01	
RH 1261D	Matt Medium	" "	
RH 1250D	Green blue	" "	
RH 2017	Willow green	.03-.02 (gloss at cone 1)	
RH 2025	Mulberry green	.03-.01	
RH 2003	Brown Hickory	.02-1	
RH 1260D	Blue green	.03-.01	
RH 2016	Red	Cone 1-2	Takes not less than a high cone 1 and must be put on in several coats.

CLAY

RESEARCH

CLAY RESEARCH.

PACIFIC STONEWARE. PORTLAND, OREGON.

Red Clay. Fires to a cone .05. Price per lb. $0.05 moist.

Color, a soft orange.

Shrinkage, green ware 1½" x 3" before sanding.

Biscuit 13/8" x 2 3/4.

Approximate shrinkage 8.3%.

Not practical for tiles in this case as the temperature required for firing the glaze exceeds that used for firing the clay.

Fairly hard and durable.

White Clay. Fires to a cone 2. Price per lb. $0.05 moist.

Color, buff white.

Shrinkage, approximately 8.3%.

Durable, easily handled in clay stage.

AMACO. 4717 W 16th Street, INDIANAPOLIS, INDIANA.

Clay flour. Fires to a cone 1. Price per lb. $0.05 /C. dry.

Color, light buff.

Shrinkage, approximately 8.3%.

Easily handled in the green stage, durable.

Buff. Fires to a cone 1. Price /C $0.05 dry, per lb.

Shrinkage, 8.3%.

White. Fires to a cone 5. Price /C $0.08 dry, per lb.

Color, chalky and very smooth.

Shrinkage, very consistent. 8.3%.

This clay is very difficult to handle in the stage before firing. Hard to spread out smoothly, very prone to split while drying, and too fragile to sand with any degree of safety. Once it has been fired, it is quite durable.

Red. Fires to a cone 1. Price /C $0.06, per lb., dry.

Color, very attractive red orange.

Shrinkage, green ware stage, 1½" x 3".

Biscuit stage, 15/16" x 2 5/8" or 12½%.

Durability, good texture and very hard.

Black. Fires to a cone 1. Price per 100# $0.06 per lb. dry.

Color, dead black.

Shrinkage, 20.8%.

Very difficult to work with. The percent of loss in the green stage is about 50%.

Very hard once it has been fired, but rather rough in texture.

DRAKENFELD. 45-47 Park Place, NEW YORK CITY.

Powdered Gray. Fires to a cone 1. Price /C $0.04 3/4 per lb. dry.

Color, dull, off-white.

Shrinkage, consistent. 8.3%.

Easy to work with, fine in texture, dries rapidly.

Powdered White. Fires to a cone 1. Price /10lbs. $0.10, dry.

Color, chalky white, very soft, powders off even after it has been fired. Splits in the second firing when glaze is not suited. Can be broken with extreme ease. Not in the least durable. Difficult to spread when wet. Almost impossible to sand.

LEWIS INSTITUTE. CHICAGO, ILLINOIS.

Tile Clay. (no Grog) Not a dead white but usuable as a color. Very soft at cone 1, not suitable as floor tile.

Tile Clay and Grog. Too soft for a floor tile.

This clay was underfired so the test was not a fair one. Company specified a cone 3 as the correct firing temperature, and we used only a cone 1.

CERAMIC ATELIER.

This clay was fired to a cone 1. No specifications for firing were sent by the company. From the results, the cone should have been at least a cone 3. However, cone 1 gave a reasonably hard tile of a soft buff color.

WESTERN STONEWARE. MONMOUTH, ILLINOIS.

Fires to a cone 2, and gives a good hard body at this cone. The color is a little off white, very similar to Pacific Stoneware from Portland, Oregon.

The price per lb. /C moist is $0.04. (School price $0.02).

RESULTS OF THE CLAY TESTS:

After testing all of the above clays, it seemed best to use a local clay from the Pacific Stoneware in Portland, Oregon:

1. Close at hand, more available.
2. Shipping charges were a great deal less.
3. The color was agreeable.
4. Body durable and the cone temperature (1170 C or

2138F). Practical for our plans.

RECORD OF THE CLAYS:

A sample and record of each clay tested kept on file.

TECHNICAL PROCEDURE

Method of making the tiles.

"There are two methods of making tiles recommended by Professor Binns in his book, The Potter's Craft.

1. Dust pressed, which gives a somewhat mechanical surface but suitable for any type of flat color treatment.

2. Plastic; the more artistic method, allows more freedom for individual expression."[1]

The method chosen will be determined by the use of the tiles. For large tile the ordinary potter's clay is too close in grain. For the small tesserae any kind of clay can be used. The tiles for this problem were all small enough that it was not necessary to use grog in order to assure the proper porosity. Several tests were made with various kinds of clay and different amounts of grog, but only as an experiment as it was not needed in the problem.

The tiles in the design that were of a uniform size were cut first. After all of the preliminary steps of experimenting were completed and the percent of shrinkage determined, two boards 5/8" thick and about 32" in length were used as a gauge to determine the thickness of the tiles. Clay of the proper consistency was spread on a cement floor

[1] Binns, op. cit., Chapter XVI.

(helps to absorb the moisture) and a steel edge used to level the surface. A 'T' square and a ruler were the only implements used for these regularly shaped tiles. For the others a separate templet of tin plate was cut from an accurate drawing of the design. A rather thick bladed paring knife was used as a cutting tool. The tiles were not cut until the clay had reached the soft leather stage as they held their shape much better when cut at this time.

After the tiles were thoroughly dry the surface was sanded, both top and bottom and the edges carefully chamfferd.

The kiln used for firing was a Revelation Kiln, serial no. 27, Egle Pattern, built by the H. J. Calkins Co. of Detroit. It was possible to fire about 45 feet of biscuit ware at one firing and between 12 and 20 feet of glaze in a glaze fire. A margin loss, totaling about 15%, made it necessary to have three biscuit fires (cone 2) in the large kiln, and one biscuit fire in the small kiln. Glazing the tiles was accomplished in the ten firings in the large kiln, and eight in the small one. The testing of the glazes in the small kiln took twelve firings. An accurate chart was kept of each firing with a check on the following points: date, type of fire, gas used, cones used, the amount of gas consumed each hour, the length of the fire and any special notation concerning the ware either during or after the firing.

ASSEMBLING THE PATTERN

All of the non-interchangeable tiles were numbered in the biscuit stage to facilitate assembling. These numbers correspond to the similar numbers on the drawing in the case of the central unit. This plan of numbering made it possible for another person not familiar with the design to set the tiles accurately with as little loss of time as possible.

The floor was prepared by cutting out the old concrete to the depth of about one inch, which allowed for a bed of cement and the thickness of the tiles, the latter to be on a level with the surrounding concrete floor.

The tiles were set in a slightly colored cement mortar, proportionately one part Columbia river sand and one part Portland cement. After the tiles were set and the mortar dry, a coat of wax was applied to the surface of the glaze to insure a perfect finish.

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