TRANSMISSION OF HEAT THROUGH TILE & CONCRETE FIREPROOFING

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A Study

of

THE TRANSMISSION OF HEAT THROUGH TILE AND CONCRETE FIREPROOFING

A THESIS

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in Fire Protection Engineering.

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CONTENTS.

ILLUSTRATIONS AND DATA.

PREFACE

Although considerable thought and attention has been given to the value of various materials as fire retardents, and thorough tests have been made to ascertain their ability to resist destruction by fire, only a small amount of work has been done to determine the amount of heat actually passing through the materials at the high temperatures which are found in burning buildings. It is the purpose of this thesis to establish, through experiment, a basis from which the transmission of heat through tile or concrete fire-proofing may be determined.

THE TRANSMISSION OF HEAT
THROUGH TILE AND CONCRETE FIREPROOFING.

EQUIPMENT.

Construction of Tile Blocks.

The blocks were made from tile slabs, so placed that there was an air chamber between. The slabs were about 17-1/2" long and 12-1/4" wide, none varying more than 1/8" from the above measurements in either length or width, and were medium burned and rather porous. The blocks were built up by placing shellacked wedge forms between each slab 1-3/4" in from each side on three sides, and filling in up to them on the three sides of the block, with concrete. This concrete was a 1 - 3 mixture, having one part portland cement to three parts 1/8" screened torpedo sand. It was re-enforced by two wire rods on the rear side, and one wire rod on each end of the block. The concrete extended from the wedge forms out a distance of 3-1/4", making a wall of concrete around the tile 1-1/2" thick, not including the concrete between the slabs. This can readily be seen in figure No. 3, which is block No. 2 cut through the center after the test.

The block was allowed to set for forty-eight hours before removing the wedge forms. The cells were then measured, and the block was buttered up with concrete on the fourth, or front, side, leaving a space of about 1-1/2" for the introduction of the thermocouples, as shown in Fig. 2. The block was then allowed to set for one week, at the end of which time it was placed in a drying kiln and kept at a temperature of from 212° F. to 220° F. for sixty-six hours. The block was then ready for the test.

All measurements for each tile block are given on plate No. 4. The slab thicknesses given on plate No. 4 are the average of eight measurements taken on each slab just before being built into blocks.

The depth of cell measurements given are the average of three measurements taken with internal calipers just before the block was buttered up, on the front side, and a measurement taken after the test when the block was parted centrally. This latter measurement was taken on a line 6" from the right side of the cells, and 6-1/8" in from the buttered up face of the block. In all cases the latter measurement checked within 1/32" of the average of the first three readings taken. The length of the cells was found to be 13-1/2" and the width 9-1/2", making an area of tile section 128.25 square inches, straight through the block. The concrete in the buttered up side, as shown in figure No. 3, appears to enter the cells to a considerable depth but on close examination it was found that it only adhered to the tile slabs for an inch in, or less, the remainder merely projecting into the cell but not touching the tile.

Construction of Concrete Blocks.

The concrete blocks were made in a mold or form, constructed as follows:- The sides are each 8" in height and 18" long. The ends are 8" in height and 12" long. The sides and ends overlap each other in such a way that a double joint is formed, making a water tight corner. They both have guide strips at their lower edges, which overlap the bottom of the mold and serve not only to keep the sides and ends in place, but they are staunch enough to prevent any warping of those parts. The bottom of the mold is made of heavy 2" planking through which six holes are drilled to allow for the placing of six 5/16" drill rods. These holes are located on the circumference of a circle, 6" in diameter, having its center in the center of the 12" x 18" face, and are each 3" apart. The drill rods project up through the bottom of the mold to heights of 7", 6", 5", 4", 3" and 2" from the bottom. This allows the thermocouples, which are placed in the holes thus made in the concrete, to penetrate into the block at distances of 1", 2", 3", 4", 5" and 6" from the exposed face. The mold is

held together by four boards hinged at the corners and brought up tightly by means of two wedges. The entire inside of the mold is heavily shellacked and the rods are thoroughly greased.

A 1-3-5 mixture was used in making the blocks. The sand used was torpedo bank sand, passing a 1/8" screen, while the aggregate consisted of pebbles less than 1/2" in diameter, together with some very coarse gravel. Enough water was added to make the mixture quite workable, then it was shoveled into the mold, tamped, and the top struck off even with the top of the mold. By following the above method in each case, each block resulted in being exactly the same in all respects, as the others.

The concrete blocks were allowed to set for three weeks before they were dried out. During the first week of setting, they were wetted once each day. At the end of three weeks the blocks were placed in the drying kiln and kept at a temperature of from 212° F. to 220° F. It was the intention of the writer to dry each block for sixty-six hours, but the burner under the kiln was tampered with while blocks No. 1 and No. 2 were being dried, and it was found out later on that they were only dried for a period of fifty-two hours. Block No. 3, having been dried out at a different time, was given the full sixty-six hours of drying. The purpose of the drying was to drive out all of the uncombined water, and thus enable the test conditions to be accurately duplicated, which could not be done if varying quantities of water were contained within the concrete.

A view of one of the concrete blocks, showing the 12" x 18" face opposite the 12" X 18" face which is to be exposed, is shown in Fig. 4.

Construction of Furnace.

A rear view of the furnace used for these tests is shown in Fig. 1. The front or open face of the furnace contains an opening 33" wide and 35" high, measuring from the keystone of the arch to the base of

the opening. This base is 17" from the floor. The inner walls, base and arch are made of the best quality fire-brick, cemented with a portland cement mortar. The outer walls are made of pressed brick and an air space separates them from the inner walls.

Four burners, which are in principal, large Bunsen burners, enter each side of the furnace and all eight burners are directed against the back wall of the furnace. In this way an even, uniformly distributed heat reaches the front face of the opening. The arch which forms the top of the furnace contains five rather large openings which allows the gaseous products of combustion to escape. A blower, which is operated by a motor that can be run on a 110 V. or 220 V. circuit, supplies the air to the burners at a point just beyond the gas control valves. A small hole in the right side of the furnace allows for the placing of the furnace thermocouple.

Construction of Thermocouples.

Four of the seven thermocouples used were made of platinum and iridium, while the other three were made of copper and constantan. The platinum iridium couples were made of platinum and iridium wires, the terminals of which were welded in an electric arc. This comprised the hot junction which was always placed where the temperature measurement was desired. The wires passed from the hot junction through a porcelain tube, having two separate chambers. From the porcelain tubes they ran through concentric asbestos tubes, one wire passing through the center and the other through the space between the tubes. The wires were then soldered to copper leads, these joints being the cold junction which was kept in ice during the test. The copper constantan couples were made in the same way except that they could be welded with a blow pipe instead of the electric arc.

METHODS

Calibration of Thermocouples.

The melting points of copper, zinc, tin and ice were utilized in calibrating the platinum iridium couples. The material that is to be used for calibrating is placed in a crucible and placed in a small electric furnace and melted. The hot junction of the thermocouple is placed in the center of the molten metal, the cold junction is placed in tubes which extend into ice, while the ends of the copper leads are connected to a galvanometer. The electric furnace is then turned off and the metal is allowed to cool while readings are taken on the galvanometer. The point or temperature at which the metal begins to solidify is indicated by a succession of constant readings on the galvanometer. The taking of readings is taken a little beyond this point to make certain that the true freezing or melting point has been obtained. The same method is used with each metal. Knowing the melting points of each metal used and getting the corresponding galvanometer readings a calibration curve may be drawn for each thermocouple, plotting temperatures as ordinates and miltivolts or galvanometer deflections as abscissa.

The copper constantan couples are calibrated in exactly the same way as the platinum iridium couples, except that the melting point of copper is not utilized for obvious reasons. Copper constantan couples are not considered reliable for measuring temperatures above 1000° F. so for all temperatures above that the platinum iridium couples must be used.

Position of the Blocks.

Each block that was tested was placed in the movable partition shown in Fig. 1. The opening in the brick partition was so located that where the partition was rolled into place in front of furnace the block was in the center of the furnace opening. In the tests on tile blocks the partition opening was made 16" high and 21" wide. This allowed about 3/8" on the sides and bottom for asbestos packing

and about 3/4" at the top for the same. A rack was made on the frame-work back of the partition to support that part of the tile block extending beyond the brick-work of the partition.

The tile block, after having been dried out, was placed in the partition with the side containing the openings uppermost. The space between the brick-work and the block was then thoroughly plugged up with asbestos fibre. In Fig. 5 one of the tile blocks is shown in the partition placed as described above. Although this photograph was taken after the test, it shows the way the tile blocks were laid into the partition. Care was taken to have the exposed face of the block in the same plane as the face of the partition.

In the case of the concrete blocks the same method of placing the block in the partition was used, but the brick-work had to be rebuilt to accomodate the smaller exposed face of these blocks. In figure 1 a concrete block is shown in place in the partition, and ready for the test.

Position of Thermocouples.

The furnace thermocouple was so placed that when the movable partition was rolled into the position for testing its hot junction was within 1/4" of the face of the block, being tested and at the center of the exposed face.

In the tile blocks the thermocouples were placed as follows:- Each couple was lowered to a depth of 6" in the cells and was placed against the face of the slab farthest away from the source of heat. This located the point of the couple 1/8" away from the rear face of each cell. For example: the couple in cell No. 1 is at a distance of the thickness of the first slab, plus the depth of the cell minus 1/8" from the exposed face of the block. The distance of each couple from the exposed face can be figured in a similar manner. After the couples were so

placed, the openings through which they were suspended were plugged up with asbestos fibre, thus holding the coupled in place, and completely closing the cell. Due to the high temperatures which were anticipated and which did occur in cells Nos. 1, 2 and 3, the platinum-iridium couples were used in these cells. The copper-constantan couples were used in cells Nos. 4, 5 and 6, where the temperatures never were above 1000° F.

The holes made in the concrete blocks by the drill rods were 1/32" larger in diameter than the porcelain tubes containing the couple wires. This gave a very close fit, making it unnecessary to do any filling with asbestos fibre. The depth of each hole was re-measured before inserting the couples in them, and they were all found to be accurate to 1/64" of an inch. As previously stated, the holes were so made that the points of the couples were 1", 2" and 3" 4", 5" and 6" away from the exposed face. Platinum-iridium couples were used at the 1",2" and 3" depths and copper-constantan couples were used at the 4",5" and 6" depths.

In all tests each couple was so connected that it could be thrown into series with a galvanometer by a double throw, double pole, knife blade switch.

Procedure During Test.

The partition was first lined up so that it could be rolled within 1" of the open face of the furnace. A shield made of sheet iron backed up with asbestos paper was hooked on to the furnace so that it covered the entire front face. The pilot lights were then lit and the blower started. The gas to the burners was then turned on and the furnace brought up to the required temperature of the test. Cracked ice was placed in the junction bottles and a zero, or the starting reading was taken. The furnace shield was then unhooked and removed and the partition rolled into place. The partition was jammed tight against

the furnace face by means of long bars, and was kept there by means of wedge blocking. The furnace temperature was then regulated and maintained constant for four hours. The ice in the junction bottles was replenished from time to time and all necessary observations were made.

The blocks were allowed to cool normally after each four hour test, no water being thrown on them.

Readings.

Temperature readings were taken every three minutes for the first half hour, and every five minutes from then on to the end of the test. The readings for the first half hour were taken closer together than those of the last three and a half hours in order to get more accurately the effect that any retained moisture might have on that part of the blocks near the exposed face, for the temperature here rises very rapidly and the true shape of the curve, which is ploted from these readings, could not be obtained unless this were done.

The readings taken were in milli-volts as represented by the deflection of the galvanometer needle. The deflection is due to the electro-motive force generated by the thermocouples. This electromotive force is in proportion to the difference in temperature between the hot and cold junctions of the couples. If the cold junction is maintained at a constant temperature, it is obvious that the galvanometer reading depends on the temperature of the hot junction at the point where it is desired to measure the temperature.

The temperature in degrees Fahrenheit, as shown on the data sheets opposite the milli-volt reading, was obtained in each case by referring to the calibration curve of that particular thermocouple. It was found that one and one-half minutes was needed to obtain all seven thermocouple readings at each three or five minute interval. This cannot be considered as

instantaneous, but since the readings are relative this does not affect the value of the data in any way.

DISCUSSION OF RESULTS

Condition of Blocks After Test.

Although this part of the subject is not directly connected with the work at hand, it may be of interest to know the condition of each block after the test, therefore this data is tabulated as follows:

Tile Block No. 1. Test No. 1. 1300 ° F.

The concrete around slab No. 1 was heavily cracked and came off upon removal of block from partition. That part of the concrete which fell off could be quite readily broken with the hands.

Slab No.1 heavily cracked and slightly separated down through the center. This slab could be broken up with the hands. It was a much lighter color than before the test.

Slabs Nos.2,3 and 4, lightly cracked across center.

Slabs Nos.5,6 and 7, all sound.

Tile Block No. 2. Test No. 2. 1600 ° F.

This block was affected in the same manner as block No. 1, only the cracks in slabs Nos. 1, 2, and 3 were more severe.

This block is shown in Fig. 5, as it was just after the test. The dark spots noticeable on the exposed face are due to rust from the iron re-enforcing wires which were looped under the block in the process of building and were afterwards cut off even with the surface. The heavy cracking referred to is plainly noticeable here.

The cracking of the concrete in this block is noticeable in Fig. 3.

Tile Block No. 3. Test No. 3. 1900 ° F.
All slabs were cracked, slabs Nos. 1 and 2 being

very heavily cracked. Slab No. 1 was in a crumbly condition and much lighter in color.

Concrete Block No. 1. Test No. 4. 1300 ^{0} F.

The exposed face was covered with a network of very fine surface cracks, and was a bluish grey in color. The concrete was discolored to a depth of 4-1/8" from exposed face. The color of the stones in the aggregate varied from a dark salmon red at the face (having some red spots in the center due to iron oxide) to a light salmon color, having no bright red spot in center to a depth of about 3" from exposed face, and at 4" from exposed face, the stones were a dull brownish red.

The general coloring of the concrete was:
Brownish grey to a depth of 1/2"}
Salmon red from 1/2" to 1-3/4" in from exposed face
Muddy grey from 1-3/4" to 3-3/4" " " " "
Yellowish grey from 3-3/4"to 4'8" " " "

A screw driver could be forced in to a depth of 1/4" without pounding.

Concrete Block No. 2. Test No. 5. 1600 ^{0} F.

Discolored to a depth of 4-7/8".
Exposed face blue grey and covered with surface cracks.
Coloring:
Blue grey - 3/8" in from exposed surface,
Light pink tinge - 3/8" to 1-3/8" in from exposed face
Muddy brown - 1-3/8" to 3-5/8" " " " "
A Pink tinged with purple, 3-5/8" to 4-7/8" " "
The remainder of the block was a little lighter grey than normal concrete.

A screw driver could be forced into a depth of 1/2" without pounding.

Concrete Block No. 3 Test No. 6. 1900 °F.

About 1" of exposed face came off near lower corners when block was removed from partition.

Exposed face blue grey in color and covered with fine surface cracks.

Discolored to a depth of 5-3/4"

Coloration:

Very dark grey - 1" in from surface.
Purplish brown - 1" to 2-1/4" in from surface
Grey - 2-1/4" to 4-1/2" " " "
Pinkish grey - 4-1/2" to 5-3/4" " "

A screw driver could be forced in to a depth of 1" without pounding.

The foregoing coloring described was in every case very faint and the colors were in all cases only tints and not as vivid as the description might imply.

Discussion of Temperature Curves.

The curves plotted from the reading of the tests on tile will be considered first, and their significance discussed before dealing with those plotted from the readings of the tests on concrete.

The readings of tests Nos. 1, 2 and 3 are plotted on plates Nos. 10, 11 and 12, respectively. Since these curves are ploted with time as the abscissae, the slope of the curves shows the rate of change of temperature in the cells throughout the tests. The points as plotted were so close to each other that it seemed advisable not to strike a smooth curve through them, so they were connected to each other by straight lines, and in this way each curve is accurately defined.

In each of these three sets of curves the effect of replenishing the supply of ice in the junction bottles is quite noticeable, especially where a considerable length of time elapses between the periods where

fresh ice was added. It is obvious that this rise is due to the greater difference in temperature between the cold and hot junctions, which occurs when fresh ice is added.

It will be noticed that the furnace temperature curves rise and fall very steeply for about the first half hour. This could not be avoided because the placing of the partitions in position at the start, tended to make the furnace temperature drop and in bringing it up again it always overshot the desired temperature, so the resulting curve is very irregular. This, however, has practically no affect on the block curves, as the block is only at room temperature when placed in the test position, while the furnace temperature is very much higher.

The irregularities of the curves having been explained, their general form may now be considered:

All curves on plates Nos. 10, 11 and 12 continue to rise throughout the entire four hours. This indicates that equilibrium of the block temperatures is never reached. If equilibrium were reached, the quantity of heat passing through the part of the block near the exposed face would be exactly equal to the heat going through another part of the block farther out from the furnace, otherwise equilibrium is impossible. This is evidence showing that most of the heat entering the blocks goes to raise the temperature of the latter, only a small percentage passing through and being lost by radiation. If, however, tests were made for a longer period of time, it is fair to assume that equilibrium would be established in a few more hours. The curves indicate that this would be so, for they tend to become horizontal, which means that a constant temperature is being approached. If such a condition did obtain, all of the heat entering the blocks would be lost in radiation.

The significance of the above will be shown farther on in this report.

The readings of tests Nos. 4, 5 and 6 are

plotted on plates Nos. 13, 14 and 15 respectively. The same statement in regard to the furnace temperature curves of the tile block applies to these concrete block curves.

The effect of adding new supplies of ice to the junction bottles is noticeable on these curves to about the same extent that it is on the tile block curves, and the explanation for it is the same. The concrete block curves, however, differ from the tile block curves in two respects, namely, the effect of moisture in the concrete blocks shows up in all three sets, and these curves are at a greater angle to the horizontal time axis during the last hour of each run

This latter fact indicates that it would take a longer time for concrete to reach equilibrium temperatures than it would in the case of tile blocks It will be noticed that the effect of moisture in the curves of test No. 6 on plate No. 15 is less pronounced than in the curves of tests Nos. 5 and 6. Probably the reason for this is that concrete block No. 3 was dried for fourteen hours longer than either of the other two concrete blocks. This change of direction of the curves in the vicinity of 212 °F may not be due entirely to uncombined retained water, but it may be influenced somewhat by the water of crystalization in the concrete itself. It is safe to say that fully as much, and probably in all cases, more moisture will be found in the concrete used in building construction than was contained in any of the concrete blocks tested.

By further comparison of these curves with the tile block curves, it will be noted that the first point curves are lower in concrete than the first cell curves in the tile tests, but that the curves of points Nos. 2, 3, 4, 5 and 6 are higher than the curves of cells Nos. 2, 3, 4, 5 and 6. It is not fair, however, to compare these curves in this way since the tile couples in the tile cells are all considerably farther away from the exposed face than those corresponding thereto in concrete blocks.

A further basis of comparison may be shown by the curves on plates Nos. 16 and 17. These curves have distances from the exposed face as abscissae and temperature as the ordinates. The readings at the end of two and three-quarter hours were plotted on plate No. 16 for all six tests. This time was chosen because all conditions of furnace temperature were practically constant for a considerable period before this time, and the concrete block curves had risen above the 212 °F region. The curves on plate No. 17 were made in the same manner as those on plate No. 16, except that the time was the end of four hours, instead of two and three-quarter hours. The reason for not plotting the curves of test No. 6 was that the readings beyond two hours and fifty minutes are not considered reliable as noted in the data on data sheet No. 12.

In both of these sets it will be noted that for the same distances out from the exposed surfaces, the concrete block curves show a lower temperature than the tile block curves. However, the difference in construction of the two types of blocks and the detaining effect of moisture should be considered before drawing definite conclusions. This will be considered later in the report.

The quantity of heat flowing by conduction from one plane to another, through any portion of material, depends on the difference of temperature between these two planes and upon the resistance to the heat flow. With the same temperature difference, if the resistance is high, only a small quantity of heat flows through; whereas if the resistance is low a large quantity of heat flows through. If the quantity of heat remains constant the temperature difference must be large, if the resistance to the flow is high, and small if the resistance is low. When the quantity of heat passing between any two planes parallel to the exposed face is the same, the temperature difference between any two planes indicates the resistance which the material or space between the two planes offers to the flow of heat.

For example, if the difference in temperature between, say 2" of concrete is high, it may be said that the resistance of concrete to the flow of heat is high. Thus it is possible to rely on the temperature differences, being a true indicator of high or low resistance to heat flow between any two planes which are parallel to the exposed face. This condition of equal quantities of heat passing through all parts of the block is only obtained at equilibrium, therefore, the results obtained from the tests made at this time can be used to indicate the relative heat resistance of the two kinds of fireproofing and not to obtain the absolute values of this heat resistance.

In the preceding discussion the flow of heat by conduction only has been considered, but in the case of tile blocks the flow of heat by radiation is of prime importance, and is discussed in detail under "Physical Laws". It has generally been assumed that an air space was a very good heat insulator. This is only true at the lower temperatures. While heat does travel very slowly through the air by conduction, it leaps over the air space readily by radiation. Although this latter mode of heat propogation is common in nature, the laws governing it are not generally known and taken into consideration.

DISCUSSION OF PHYSICAL LAWS.

The quantity of heat passing through a portion of solid block or partition by conduction depends on the difference between the temperatures of the two planes limiting the portion of partition or block, but the quantity of heat that passes across the air spaces in tile blocks depends on the difference of the fourth powers of the absolute temperatured of the surfaces enclosing the air spaces. It follows that in case the heat passes by conduction through a solid block, the amount of heat passing will remain the same so long as the difference in temperature of the two limiting planes remains constant, no matter

what that temperature may be. On the other hand, the heat passing across an air space by radiation increases very rapidly with the rising temperature of the enclosing surfaces, although the difference in temperature may remain constant.

The old law of raidation given by Isaac Newton, which stated that the heat radiated from a hot body to a cold surrounding body was proportional to the difference of their temperatures, has been proven faulty by Boltzmann and Stefan, who about twenty-five years ago demonstrated mathematically that from the principles of thermodynamics the fourth power law should hold exactly for an ideal black body.

This law is expressed by the following equation:

(1) $$H = C \ (T_1^4 - T_2^4)$$

Where H = the net heat exchanged between the hot and cold surface per unit of the hot surface per unit of time.

T_1 = the absolute temperature of the hot surface.

T_2 = the absolute temperature of the colder surface.

C = A constant depending on the units used.

If H. is expressed in B.T.U per sq. ft. of the hot surface per minute and T_1 and T_2 are expressed in degrees Fahrenheit on the absolute scale, then

$$C = 2.66 \times 10^{-"} = \frac{2.66}{100,000,000,000.}$$

The above constant is only good for black surfaces and the hot surface must not "see" anything but the colder surface.

For surfaces not blackened this law must be modified. As a brick surface does not radiate so much heat as a blackened surface, the net heat exchange between two such surfaces is less than that exchanged between blackened surfaces at the same temperatures. Therefore in the case of tile faces, (which may be considered as radiating and absorbing heat in the same manner as brick) a co-efficient must be used in formula No. 1. This co-efficient has been found to be about .5 at 700 °C absolute temperature.

(2) $$H = .5 \times C \left(T_1^4 - T_2^4\right)$$

If in the tests made on the tile blocks the temperatures of the faces enclosing each cell has been taken, the actual conductivity of the tile slabs and the air spaces could be accurately figured and the amount of heat transmitted by each could be determined. That the air space is less effective at high temperature than at low ones is known by makers of "thermos" bottles, who claim that such bottles keep liquids cold seventy-two hours and keep liquids hot only twenty-four.

The law of heat by conduction is quite simple and may be expressed as follows:

(3) $$H = \frac{c}{d} \left(T_1 - T_2\right)$$

Where H = the quantity of heat conducted per unit of area per unit of time.

c = the conductivity of the material, which varies somewhat with the temperature.

d = the distance between the two parts of the body

T_1 = the temperature of the hotter part

T_2 = the temperature of the colder part.

The curves on plates Nos. 16 and No. 17 seem to indicate that the conductivity of the material varies somewhat with the temperature, but since these temperatures are taken before equilibrium is established

it would not be proper to say that this is proven by those curves.

Knowing the surface area, the time, the temperatures, distances d, and c, H can be easily found or knowing H, c can be readily found. All but H and c can be obtained from the data taken. A method of determining this "H", or quantity of heat transmitted would be to simply place an enclosed tank containing water at the unexposed face of the block, having an insulating covering on all sides, except that adjoining the block and measuring the quantity and rise in temperature of the water. This is, of course, only true after equilibrium has been established. Having "H" as stated "c", or conductivity of the block material, could be readily calculated.

The tile fireproofing as constructed, always contains air spaces, so the conditions as they are in the experimental work should be considered comparable to those met with in actual construction. Therefore, the curves on plates Nos. 16 and 17 may be considered as giving some evidence that concrete fireproofing, when of the same thickness as tile fireproofing, will transmit less heat through it. It is the belief of the writer that, knowing the foregoing physical laws, and using the results of the tests made as a basis, the transmission of heat through all types of tile and concrete fireproofing can be determined.

TEST No. 1

TILE BLOCK [illegible]

	Furnace		Cell 1		Cell 2		Cell 3		Cell 4		Cell 5		Cell 6		
	Couple No. 120		Couple No. 11[illegible]		Couple No. 111		Couple No. 11[illegible]		Couple No. [illegible]		Couple No. [illegible]		Couple No. [illegible]		
T.	MV	°F.	MV	°F.	MV	°F.	MV	°F.	MV	°F.	MV	°F.	MV	°F.	NOTES
0	290	1240	.10	70	.10	70	.10	70	.43	63	.51	68	.49	62	
3	320	1335	.15	95	.10	70	.10	70	.45	66	.50	67	.42	61	
6	318	1330	.30	150	.10	70	.10	70	.43	64	[illegible]	66	.45	61	
9	340	1400	.65	270	.10	70	.10	70	.40	62	.40	64	.46	61	
12	330	1370	.90	335	.10	75	.10	70	[illegible]	62	.40	60	[illegible]	63	
15	320	1335	111	340	.15	90	.10	70	[illegible]	[illegible]	[illegible]	[illegible]	.50	[illegible]	Cracked slightly near top center of tube
18	280	1205	135	445	.20	110	.10	70	.40	62	.40	[illegible]	.50	62	
21	28[illegible]	1265	152	480	.20	110	.10	70	[illegible]	64	.42	[illegible]	.50	[illegible]	
24	31[illegible]	1300	170	520	.20	145	.10	70	[illegible]	66	[illegible]	64	.50	[illegible]	
27	312	1310	183	550	[illegible]	160	.11	75	.46	66	[illegible]	62	[illegible]	[illegible]	
30	310	1300	200	585	.40	185	.11	75	.45	66	[illegible]	62	.50	[illegible]	
35	310	1300	219	620	.50	220	.11	75	.44	65	.45	64	.49	[illegible]	
40	313	1312	239	66[illegible]	.60	250	[illegible]	80	[illegible]	64	[illegible]	62	[illegible]	[illegible]	
45	311	1307	253	690	.70	280	[illegible]	95	[illegible]	[illegible]	[illegible]	61	[illegible]	[illegible]	
50	312	1310	270	717	.80	305	.18	105	[illegible]	[illegible]	[illegible]	6[illegible]	[illegible]	[illegible]	
55	312	1310	280	735	.88	330	.20	115	.45	[illegible]	[illegible]	[illegible]	.42	[illegible]	[illegible]
1H	313	1312	290	755	.99	355	.22	125	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
5	312	1310	299	770	[illegible]	385	[illegible]	140	.62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
10	312	1310	310	795	120	410	[illegible]	155	.73	[illegible]	[illegible]	67	.60	66	
15	311	1307	318	805	128	[illegible]	.36	170	.90	99	.51	[illegible]	.60	[illegible]	
20	310	1300	323	815	137	447	.40	190	[illegible]	[illegible]	.51	[illegible]	[illegible]	[illegible]	
25	31[illegible]	1310	332	830	143	455	[illegible]	205	[illegible]	[illegible]	.53	65	[illegible]	[illegible]	
30	311	1307	338	840	150	475	.48	215	[illegible]	[illegible]	.57	[illegible]	[illegible]	[illegible]	
35	311	1307	342	850	158	490	.50	220	[illegible]	106	.58	[illegible]	[illegible]	68	
40	312	1310	347	860	161	500	.52	225	[illegible]	104	.59	[illegible]	.58	[illegible]	
45	310	1300	350	865	168	515	.58	245	121	115	.62	74	.58	67	
50	310	1300	352	870	171	520	.60	250	128	119	.65	76	.58	67	
55	311	1307	357	875	178	535	.62	260	137	125	.68	78	.58	67	
2H	310	1300	360	880	181	540	.67	270	141	128	.70	79	.56	65	

TIME	Furnace Couple No. 120		Cell 1 Couple No. [illegible]		Cell 2 Couple No. [illegible]		Cell 3 Couple No. [illegible]		Cell 4 Couple No. [illegible]		Cell 5 Couple No. [illegible]		[illegible]		Notes
[illegible]	MV	°F	MV	°F	MV	°F	MV	°F	MV	°F	MV	°F	MV	°F	
5	312	1310	362	[illegible]	182	555	170	[illegible]	148	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
10	315	1320	360	890	191	560	171	285	148	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	1300	368	[illegible]	[illegible]	565	[illegible]	290	149	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	310	1300	372	904	[illegible]	585	[illegible]	305	150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	1300	376	[illegible]	[illegible]	600	[illegible]	315	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
30	[illegible]	1300	380	[illegible]	[illegible]	604	[illegible]	330	[illegible]	166	[illegible]	[illegible]	[illegible]	[illegible]	
35	311	1307	[illegible]	[illegible]	[illegible]	610	[illegible]	[illegible]	[illegible]	171	[illegible]	[illegible]	[illegible]	[illegible]	
40	311	1307	[illegible]	920	213	620	[illegible]	[illegible]	[illegible]	176	[illegible]	100	[illegible]	[illegible]	
45	312	1310	386	925	220	624	[illegible]	[illegible]	[illegible]	180	[illegible]	[illegible]	[illegible]	[illegible]	
50	311	1307	389	[illegible]	225	630	100	360	[illegible]	186	[illegible]	103	[illegible]	[illegible]	[illegible]
55	311	1307	390	[illegible]	226	[illegible]	[illegible]	365	[illegible]	189	[illegible]	110	[illegible]		[illegible]
3H	311	1307	396	940	[illegible]	[illegible]	[illegible]	385	[illegible]	195	[illegible]	[illegible]	[illegible]		[illegible]
5	311	1307	398	946	232	[illegible]	[illegible]	390	[illegible]	[illegible]	[illegible]	115	[illegible]		[illegible]
10	[illegible]	1300	398	946	[illegible]	650	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
15	[illegible]	1300	400	950	[illegible]	658	[illegible]	[illegible]	[illegible]	210	[illegible]	[illegible]	[illegible]		[illegible]
20	310	1300	401	953	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
25	[illegible]	1298	406	959	[illegible]	[illegible]	[illegible]	[illegible]	296	221	[illegible]	[illegible]	[illegible]		
30	[illegible]	1298	407	961	[illegible]	[illegible]	[illegible]	407	[illegible]	225	[illegible]	[illegible]	[illegible]		
35	311	1307	408	[illegible]	[illegible]	[illegible]	[illegible]	410	309	229	[illegible]	[illegible]	[illegible]	[illegible]	
40	310	1300	[illegible]	963	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
45	[illegible]	1300	[illegible]	966	250	[illegible]	[illegible]	415	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	[illegible]	1299	410	968	253	685	125	425	[illegible]	247	[illegible]	141	[illegible]	[illegible]	[illegible]
55	310	1300	411	970	[illegible]	[illegible]	129	430	[illegible]	250	[illegible]	[illegible]	[illegible]		
4H	310	1300	411	970	258	696	[illegible]	430	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

	Furnace Couple No. 120		Cell 1 Couple No. 114		Cell 2 Couple No. [illegible]		Cell 3 Couple No. [illegible]		Cell [illegible]		Cell [illegible]		Cell [illegible]		Remarks
T.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	
0	360	1470	10	70	10	[illegible]	[illegible]	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
3	380	1535	12	80	[illegible]	70	[illegible]	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
6	398	1580	28	135	10	70	10	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
9	407	1622	62	240	[illegible]	[illegible]	10	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
12	412	1640	120	400	[illegible]	[illegible]	[illegible]	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
15				MISSED		READING									[illegible]
18	417	1657	197	575	22	140	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	420	1668	222	627	28	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	417	1657	245	[illegible]	35	180	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
27	410	1634	276	[illegible]	48	200	11	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
30	395	1583	288	[illegible]	[illegible]	[illegible]	[illegible]	80	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
35	400	1600	312	800	70	265	14	90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
40	401	1603	[illegible]	[illegible]	83	[illegible]	[illegible]	100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
45	406	1620	[illegible]	862	100	[illegible]	20	108	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	410	1634	370	900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	402	1606	383	922	120	[illegible]	30	140	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1H.	400	1600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	400	1600	404	[illegible]	[illegible]	[illegible]	[illegible]	170	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	405	1618	415	980	[illegible]	[illegible]	[illegible]	190	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	400	1600	421	995	[illegible]	520	[illegible]	208	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	400	1600	430	1010	[illegible]	[illegible]	[illegible]	220	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	400	1600	437	1020	193	565	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
30	400	1600	445	1035	[illegible]	590	[illegible]	260	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
35	400	1600	456	1045	212	[illegible]	[illegible]	270	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
40	401	1603	454	1051	219	620	76	275	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
45	400	1600	460	1060	230	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	400	1600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	295	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	398	1596	470	1078	[illegible]	665	[illegible]	310	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2H.	407	1622	474	1085	250	681	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

T E S T No. 2

T I L E B L O C K No. 2[illegible]

T.	Furnace Couple No. 120 MV.	°F.	Cell 1 Couple No. 114 MV.	°F.	Cell 2 Couple No. 111 MV.	°F.	Cell 3 Couple No. 113 MV.	°F.	Cell 4 Couple No. [illegible] MV.	°F.	Cell 5 Couple No. [illegible] MV.	°F.	Cell [illegible] Couple No. [illegible] MV.	°F.
2H.														
5	399	1598	479	1095	253	690	92	330	204	[illegible]	95	90	52	
10	401	1603	481	1097?	258	695	98	340	216?	[illegible]	[illegible]	[illegible]	[illegible]	
15	401	1603	486	1105	257	715	101	350	[illegible]	[illegible]	109?	100	[illegible]	
20	399	1598	490	1111	270	720	102	353	[illegible]	[illegible]	[illegible]	101	[illegible]	
25	400	1600	491	1115	[illegible]	726	107	362	[illegible]	[illegible]	[illegible]	103?	[illegible]	
30	400	1600	497	1122	280	[illegible]	111	377	251	196	120	107	[illegible]	
35	400	1600	500	1130	283	745	118	390	[illegible]	200	[illegible]	109	[illegible]	
40	400	1600	502	1134	288	752	120	400	[illegible]	215	[illegible]	114	[illegible]	
45	401	1603	507	1140	293	764	122	404	292	220	140	120	[illegible]	
50	401	1603	511	1148?	298	770	127	411	[illegible]	225	[illegible]	[illegible]	[illegible]	
55	400	1600	513	[illegible]	300	775	130	430	[illegible]	228	[illegible]	[illegible]	[illegible]	
3H.	400	1600	515	1155	305	785	[illegible]	430	[illegible]	232	[illegible]	[illegible]	[illegible]	
5	401	1603	517	1157	309	791	138	440	[illegible]	237	[illegible]	[illegible]	[illegible]	
10	400	1600	519	1160	310	799	139	445	332	241	[illegible]	[illegible]	[illegible]	
15	400	1600	[illegible]	1165	316	804	[illegible]	450	342	[illegible]	[illegible]	[illegible]	[illegible]	
20	401	1603	522	1168	319	810	[illegible]	451	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
25	401	1603	527	1174	322	815	149	461	[illegible]	[illegible]	[illegible]	149	[illegible]	[illegible]
30	400	1600	530	1180	327	825	149	461	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
35	400	1600	531	1182	328	825	150	467	[illegible]	[illegible]	200	[illegible]	[illegible]	[illegible]
40	399	1598	532	1184	329	828	152	471	391	[illegible]	[illegible]	[illegible]	[illegible]	
45	399	1198	532	1184	330	830	153	472	395	270	210	153	[illegible]	
50	400	1600	533	1185	330	830	156	473	400	277	214	[illegible]	[illegible]	
55	401	1603	537	1190	338	[illegible]	160	490	[illegible]	[illegible]	220	[illegible]	[illegible]	
4H.	400	1600	539	1193	340	840	161	492	[illegible]	[illegible]	224	173	[illegible]	[illegible]

[illegible] added [illegible]

[illegible] added [illegible]

T E S T No. 3

[illegible] B L O C K No. 3

	Furnace Couple No. 120		Cell 1 Couple No. 114		Cell 2 Couple No. 111		Cell 3 Couple No. 116		Cell [illegible] Couple No. 14		Cell [illegible] Couple No. 6		Cell [illegible] Couple No. 15		
T	MV	°F	MV	°F	MV	°F	MV	°F	MV	°F	MV	°F	MV	°F	NOTES
0	440	1734	.10	70	.10	70	.10	70	[illegible]	67	[illegible]	65	.52	66	
3	462	1800	.20	103	.10	70	.10	70	.50	69	[illegible]	[illegible]	.56	[illegible]	
6	510	1965	.40	175	.10	70	.10	70	.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
9	520	1997	108	367	.12	80	.11	75	.51	70	.52	[illegible]	[illegible]	[illegible]	
12	518	1994	160	490	.18	100	.11	75	.51	70	.50	[illegible]	.60	[illegible]	
15	508	1960	210	600	.20	108	.11	75	.51	70	[illegible]	67	[illegible]	[illegible]	
18	503	1942	248	678	.23	120	.11	75	.52	71	[illegible]	66	.60	[illegible]	
21	490	1900	290	758	.31	143	.12	80	.52	71	[illegible]	66	.60	72	
24	470	1833	318	809	.41	177	.12	80	.52	71	.52	[illegible]	.60	72	
27	492	1904	337	845	.50	206	.12	80	.52	71	.51	[illegible]	[illegible]	72	[illegible]
30	495	1914	360	882	[illegible]	240	.16	85	[illegible]	71	[illegible]	[illegible]	[illegible]	[illegible]	
35	490	1900	388	933	.79	289	.18	100	.54	73	[illegible]	[illegible]	[illegible]	72	[illegible]
40	490	1900	411	[illegible]	.90	320	.20	108	.57	75	[illegible]	[illegible]	[illegible]	72	[illegible] added to
45	490	1900	432	1013	107	362	.24	[illegible]	[illegible]	77	[illegible]	[illegible]	.61	[illegible]	[illegible]
50	491	1902	451	1047	[illegible]	402	.31	143	.65	79	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	492	1904	456	1076	[illegible]	440	.38	168	.68	81	[illegible]	68	.63	[illegible]	
1H	490	1900	480	1095	150	467	.41	177	.74	84	[illegible]	68	[illegible]	[illegible]	[illegible] added to
5	491	1902	493	1115	163	500	.49	202	.80	87	[illegible]	68	.61	[illegible]	[illegible]
10	490	1900	509	1144	[illegible]	530	.52	212	.89	95	[illegible]	[illegible]	.61	[illegible]	[illegible]
15	490	1900	518	1158	186	555	.60	235	.97	100	[illegible]	70	.61	[illegible]	
20	491	1902	535	1171	199	575	.66	251	107	105	[illegible]	[illegible]	[illegible]	[illegible]	
25	490	1900	532	1183	209	598	.71	270	[illegible]	110	[illegible]	[illegible]	[illegible]	[illegible]	
30	490	1900	540	1196	218	[illegible]	.78	287	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
35	490	1900	5.50	1212	229	640	.83	300	[illegible]	[illegible]	.67	[illegible]	[illegible]	72	[illegible]
40	490	1900	5.57	1225	236	653	.90	322	141	128	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
45	490	1900	561	1232	242	664	.93	330	155	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	490	1900	569	1242	253	690	1.01	350	180	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
55	490	1900	573	1252	260	700	1.05	360	190	159	[illegible]	[illegible]	[illegible]	[illegible]	
2H	490	1900	579	1260	267	715	1.10	373	199	163	[illegible]	88	[illegible]	[illegible]	

Data Sheet No. 16

4/30/4[illegible]

T E S T No. 5

T I L E B L O C K No. 3

	Furnace Couple No. 120		Cell 1 Couple No. 114		Cell 2 Couple No. 111		Cell 3 Couple No. 113		Cell 4 Couple No. 14		Cell 5 Couple No. 6		Cell 6 Couple No. 1[illegible]		
T	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	NOTES
2 H.															
5	490	1900	583	1270	272	723	114	383	210	171	89	88	69	76	
10	490	1900	589	1275	280	739	120	400	238	187	100	94	70	[illegible]	
15	490	1900	592	1281	288	752	125	410	248	192	105	98	74	80	Ice added
20	490	1900	596	1287	293	764	130	420	258	198	109	100	75	80	to Junction
25	489	1898	602	1300	302	780	140	447	270	206	111	101	76	81	Bottles
30	490	1900	608	1307	308	790	143	450	289	216	113	102	80	[illegible]	
35	490	1900	611	1312	314	800	148	461	300	222	130	112	80	83	
40	491	1902	618	1321	321	814	152	471	320	234	131	113	80	[illegible]	
45	491	1902	621	1328	325	820	154	480	322	236	140	120	80	85	
50	490	1900	623	1331	330	830	160	490	331	240	143	121	80	[illegible]	Ice added
55	490	1900	628	1340	334	838	162	498	345	248	143	123	81	[illegible]	to Junction
3H.	490	1900	631	1345	340	848	170	512	368	260	155	129	89	[illegible]	Bottles
5	490	1900	636	1351	347	860	177	530	377	265	160	131	90	90	
10	490	1900	639	1356	350	867	179	535	384	269	163	133	92	[illegible]	
15	490	1900	640	1358	352	870	181	540	400	277	170	138	92	91	Ice added
20	490	1900	641	1360	359	880	189	556	409	282	178	142	97	95	to Junction
25	490	1900	645	1366	362	890	192	562	422	290	188	149	100	97	Bottles
30	490	1900	648	1371	368	900	198	575	442	300	200	157	113	103	
35	490	1900	650	1375	371	902	200	580	450	304	203	160	110	103	Ice added
40	490	1900	650	1375	373	905	202	584	456	310	216	163	112	104	to Junction
45	491	1902	652	1379	378	910	207	594	482	320	220	170	114	108	Bottles
50	490	1900	657	1384	380	920	211	602	491	327	232	177	127	113	
55	490	1900	659	1388	382	923	213	608	501	331	239	180	130	115	
4H.	490	1900	660	1390	384	926	217	613	510	336	242	183	132	117	

TEST No. [illegible]

CONCRETE BLOCK No. [illegible]

	Furnace		Cell 1		Cell 2		Cell 3		Cell 4		Cell 5		Cell 6		
	Couple No. 120		Couple No. 113		Couple No. 114		Couple No. 111		Couple No. 14		Couple No. 6		Couple No. 13		
T.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	NOTES
0	316	1300	.11	75	.11	75	.11	75	.57	75	.54	56	.55	[illegible]	
3	319	1333	.22	120	.11	75	.11	75	.51	75	.56	67	.57	[illegible]	
6	323	1345	.55	220	.17	[illegible]	.12	80	.52	75	.57	67	.59	71	
9	310	1300	.68	260	.28	132	[illegible]	85	.65	76	[illegible]	68	.54	[illegible]	
12	306	1290	.84	308	.41	177	.13	100	.60	77	.57	68	.58	[illegible]	
15	312	1308	.97	[illegible]	.50	206	.20	108	.62	78	.57	68	.57	[illegible]	Ice added to junction bottles
18	310	1300	1.11	377	.53	215	.22	120	.67	[illegible]	.61	69	.55	[illegible]	
21	220	1337	1.30	420	.58	227	.28	[illegible]	[illegible]	86	.61	70	.60	72	
24	[illegible]	1235	1.47	457	.61	238	[illegible]	[illegible]	[illegible]	87	.66	73	.60	[illegible]	
27	303	1281	1.58	485	.63	242	[illegible]	168	[illegible]	96	.70	75	.60	72	
30	328	1365	1.69	510	.68	260	.41	177	107	107	.73	78	.61	72	
35	311	1305	189	556	.78	287	.49	202	126	120	.83	83	.64	74	
40	312	1308	202	584	.83	305	.52	217	145	132	.91	88	.70	77	
45	310	1300	220	622	.91	322	[illegible]	237	170	147	100	94	.74	80	
50	310	1300	231	649	[illegible]	362	.69	262	[illegible]	159	112	101	.81	[illegible]	
55	322	1345	245	671	121	401	.75	280	[illegible]	190	[illegible]	110	.90	90	
1H	310	1300	260	700	[illegible]	450	.82	300	268	[illegible]	140	120	.97	96	
5	311	1305	270	720	159	487	.89	317	280	213	152	127	102	99	Ice added to junction bottles
10	310	1300	277	732	168	509	.93	330	284	215	157	136	110	104	
15	310	1300	290	756	172	520	102	353	293	220	187	149	121	110	
20	305	1287	296	767	[illegible]	542	109	370	306	227	208	162	130	115	
25	312	1308	301	777	[illegible]	560	111	377	318	231	230	[illegible]	140	121	
30	308	1298	309	793	[illegible]	575	119	393	326	237	253	190	150	126	
35	310	1300	313	800	202	583	122	404	330	240	262	195	161	134	
40	311	1305	320	812	210	602	128	417	320	233	270	200	170	[illegible]	Ice added to junction bottles
45	311	1305	324	820	213	610	131	423	318	232	275	204	180	147	
50	310	1300	330	830	222	627	140	447	326	237	297	217	202	160	
55	310	1300	334	836	227	636	143	450	333	242	302	220	[illegible]	[illegible]	
2H	310	1300	339	845	231	645	146	461	338	244	311	220	[illegible]	176	

T E S T No. 1.

C O N C R E T E B L O C K No. 1.

	Furnace Couple No. 120		Cell 1 Couple No. 113		Cell 2 Couple No. 114		Cell 3 Couple No. 111		Cell 4 Couple No. 14		Cell 5 Couple No. 6		Cell 6 Couple No. 13		
T.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	NOTES
5	310	1300	342	852	237	657	151	469	342	247	323	233	239	182	
10	309	1299	347	860	241	665	157	485	347	249	333	240	250	190	Ice added
15	310	1300	350	867	246	673	160	490	350	250	341	245	259	195	to Junction
20	309	1299	357	878	250	681	166	505	355	252	359	255	270	202	Bottles
25	310	1300	360	883	254	691	170	512	389	270	370	262	275	205	Hot Junction
30	311	1305	361	885	259	700	173	522	372	261	380	270	277	207	Couple #14
35	311	1305	363	890	261	703	177	530	510	335	390	276	278	208	removed and
40	310	1300	363	890	264	710	180	538	541	352	399	281	282	211	drop of oily
45	310	1300	367	897	269	718	183	542	568	365	408	287	290	215	substance
50	317	1325	369	900	271	722	188	555	590	377	418	292	299	219	covering it.
55	312	1308	371	903	275	730	190	560	607	386	427	300	307	225	thoroughly
3H.	310	1300	372	904	278	737	192	562	620	392	434	304	313	229	wiped off.
5	310	1300	375	910	281	741	199	576	630	398	444	310	322	238	Ice Junction
10	309	1299	380	920	282	742	199	576	659	440	451	320	338	243	Bottle #1
15	309	1299	381	922	283	744	200	580	673	418	475	328	348	250	Bottle #2
20	311	1305	382	924	285	747	204	590	699	430	482	332	352	252	
25	310	1300	386	928	291	760	209	600	710	436	[illegible]	339	359	257	Ice added
30	309	1299	389	933	293	764	211	603	725	443	502	345	365	260	to Junction
35	308	1298	391	940	296	765	217	617	730	447	515	353	375	266	Bottles
40	315	1313	393	943	300	777	220	621	740	450	522	359	380	270	
45	310	1300	396	947	304	785	221	622	751	455	530	363	389	274	
50	310	1300	399	951	308	790	223	628	763	461	540	369	395	279	
55	311	1305	401	957	309	792	227	633	771	465	548	373	400	282	
4H.	309	1299	402	960	311	797	229	640	782	470	554	378	405	284	

Data Sheet No. 9

4/27/13

TEST No. 5.

CONCRETE BLOCK No. 2.

	Furnace		Cell 1		Cell 2		Cell 3		Cell 4		Cell 5		Cell 6		
	Couple No. 120		Couple No. 113		Couple No. 114		Couple No. 111		Couple No. 14		Couple No. 6		Couple No. 15		
T	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	Notes
0	410	1634	.09	65	.09	65	.09	65	.50	69	.48	61	.48	64	
5	411	1636	.50	206	.11	75	.10	70	.50	69	.50	63	.48	64	
9	430	1700	.59	232	.23	120	.11	75	.51	70	.50	63	.48	64	
12	393	1580	.70	256	.43	185	.12	80	.51	70	.50	63	.48	64	
15	404	1612	.80	295	.62	218	.18	100	.56	74	.51	64	.48	64	
18	410	1630	.89	318	.58	215	.22	120	.60	77	.52	65	.48	64	
21	400	1600	.99	341	.60	235	.30	140	.70	82	.53	65	.50	65	
24	399	1598	102	353	.62	240	.36	160	.80	89	.56	67	.51	65	Couples 113, 114, 111 placed more firmly in holes
27	402	1606	120	400	.62	240	.42	180	.92	98	.60	69	.52	66	
30	401	1603	171	517	.61	238	.48	200	108	108	.64	72	.53	66	
35	399	1598	211	603	.69	252	.54	217	147	132	.77	80	.56	72	
40	400	1600	230	642	.72	273	.59	232	198	162	.86	86	.62	[illegible]	
45	400	1600	249	680	.80	295	.68	260	272	207	100	94	.70	77	
50	401	1603	263	707	.83	305	.71	273	290	219	116	104	.80	83	
55	400	1600	278	735	.85	308	.78	287	290	219	130	112	.91	91	Ice added to junction bottles.
1H.	400	1600	290	757	110	374	.82	309	289	218	147	123	108	101	
5	403	1610	310	793	149	461	.90	320	290	219	157	136	135	119	
10	399	1598	315	800	157	505	.95	335	291	220	180	143	158	131	
15	399	1598	321	813	192	562	104	360	291	220	197	155	193	151	
20	400	1600	330	830	201	583	109	370	295	222	210	163	210	164	
25	399	1598	338	864	211	602	111	377	300	224	225	173	231	179	
30	400	1600	347	860	220	621	118	390	303	225	236	180	252	190	
35	402	1606	351	868	230	643	123	404	308	228	258	192	273	203	
40	400	1600	360	883	237	657	133	441	312	230	270	200	281	208	
45	400	1600	367	897	243	670	149	464	335	242	285	210	282	210	
50	401	1603	370	900	250	681	152	471	340	245	291	214	283	211	
55	402	1606	377	912	257	695	160	490	348	250	307	222	282	210	
2H.	400	1600	381	922	261	703	166	505	400	271	327	235	281	209	

REMARKS:- More time than usual was taken to remove the asbestos and iron shield from the furnace making it impossible to take the three minute reading, so a five minute reading was taken instead of the three and six minute readings.

Data Sheet No. [illegible]

4/[illegible]/[illegible]

T E S T No. 5

C O N C R E T E B L O C K No. 2

T.	Furnace Couple No. 120 MV.	°F.	Cell 1 Couple No. 115 MV.	°F.	Cell 2 Couple No. 114 MV	°F	Cell 3 Couple No. 111 MV	°F	Cell 4 Couple No. 14 MV	°F	Cell 5 Couple No. 6 MV	°F	Cell 6 Couple No. [illegible] MV.	°F	NOTES
2 H.															
5	399	1598	385	928	268	716	170	512	468	312	328	236	282	210	
10	400	1600	389	935	271	722	176	522	499	328	337	241	280	[illegible]	
15	400	1600	392	940	279	736	180	538	530	346	350	250	280	208	Ice junction
20	399	1598	395	945	282	742	186	550	550	357	360	258	279	207	Bottle #2
25	402	1606	399	951	289	754	190	560	575	368	377	267	286	213	#1
30	398	1596	401	958	295	766	198	575	598	380	390	276	288	215	
35	399	1598	406	965	300	776	201	582	620	392	410	289	285	[illegible]	
40	406	1620	411	978	301	778	204	590	632	400	415	292	282	210	
45	413	1645	415	982	308	790	210	601	649	406	422	297	285	212	
50	420	1668	420	991	312	798	215	610	673	419	440	308	290	216	
55	410	1633	426	1001	316	802	218	619	684	425	448	311	310	227	
3H.	400	1600	431	1012	320	811	220	622	697	430	453	316	[illegible]	[illegible]	
5	402	1606	437	1022	323	820	227	633	715	439	457	322	328	240	
10	400	1600	441	1030	326	825	230	643	730	446	464	329	340	245	
15	400	1600	444	1035	330	830	237	656	750	445	480	337	350	250	
20	400	1600	447	1040	332	833	239	660	762	461	500	343	355	255	Ice added
25	400	1600	451	1048	335	840	242	667	778	472	511	351	362	260	to Junction
30	400	1600	456	1053	340	850	245	671	795	477	520	352	380	270	Bottles
35	400	1600	460	1060	345	856	250	681	813	485	545	372	390	275	
40	400	1600	461	1062	349	862	251	683	825	491	552	377	396	279	
45	399	1598	461	1062	350	866	257	693	840	499	570	387	408	287	
50	399	1598	462	1064	353	871	260	700	853	504	577	390	411	290	
55	400	1600	463	1068	357	878	262	704	868	511	589	399	420	294	
4H.	400	1600	465	1070	360	882	265	710	880	518	594	401	425	[illegible]	

Data Sheet No. 11.

[illegible]5/13

TEST No. 6

CONCRETE BLOCK No. 2

	Furnace Couple No. 120		Cell 1 Couple No. 113		Cell 2 Couple No. 114		Cell 3 Couple No. 117		Cell 4 Couple No. [illegible]		Cell 5 Couple No. 6		Cell 6 Couple No. [illegible]		
T.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	MV.	°F.	NOTES
0	400	1600	.20	108	.20	105	.20	106	[illegible]	[illegible]	[illegible]	74	.61	[illegible]	
3	453	1777	.42	180	.23	120	.21	110	[illegible]	[illegible]	[illegible]	77	.63	[illegible]	
6	480	1866	.61	237	.27	130	.21	110	[illegible]	[illegible]	[illegible]	77	[illegible]	[illegible]	
9	[illegible]	1932	.80	295	[illegible]	152	.22	120	[illegible]	[illegible]	[illegible]	77	[illegible]	[illegible]	
12	495	1928	118	390	[illegible]	220	[illegible]	128	[illegible]	[illegible]	[illegible]	77	.68	[illegible]	
15	500	1932	147	[illegible]	.64	249	.30	141	[illegible]	[illegible]	[illegible]	78	.70	[illegible]	
18	500	1932	170	[illegible]	.70	[illegible]	.35	150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
21	502	1937	190	[illegible]	.75	[illegible]	.40	175	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
24	499	1928	209	[illegible]	.79	[illegible]	.47	195	[illegible]	[illegible]	[illegible]	80	[illegible]	[illegible]	
27	499	1928	228	618	.88	317	.57	[illegible]	[illegible]	110	[illegible]	81	[illegible]	[illegible]	
30	496	1918	240	662	100	346	.60	235	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] added
35	494	1913	270	720	112	[illegible]	[illegible]	240	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40	490	1900	297	[illegible]	140	[illegible]	.70	270	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
45	490	1900	311	795	157	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
50	491	1902	[illegible]	830	[illegible]	520	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
55	490	1900	[illegible]	866	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
1H	490	1900	[illegible]	882	[illegible]	580	[illegible]	350	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
5	490	1900	[illegible]	903	[illegible]	605	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
10	490	1900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
15	490	1900	395	945	[illegible]	650	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
20	490	1900	[illegible]	965	243	[illegible]	132	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] added
25	490	1900	411	978	250	[illegible]	140	447	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	490	1900	424	1000	263	706	149	464	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	490	1900	[illegible]	1015	271	[illegible]	154	480	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
40	491	1902	440	1029	[illegible]	[illegible]	160	490	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
45	490	1900	447	1040	[illegible]	750	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
50	490	1900	450	[illegible]	[illegible]	[illegible]	170	[illegible]	[illegible]	[illegible]	[illegible]	226	[illegible]	[illegible]	
55	490	1900	[illegible]	[illegible]	[illegible]	772	[illegible]	528	530	[illegible]	[illegible]	249	[illegible]	[illegible]	
2H.	490	1900	[illegible]	1065	305	[illegible]	180	[illegible]	[illegible]	[illegible]	[illegible]	261	[illegible]	[illegible]	

Data Sheet No. [illegible]

[illegible]

TEST No. 6

CONCRETE BLOCK No. [illegible]

	Furnace Couple No. 120		Cell 1 Couple No. [illegible]		Cell 2 Couple No. [illegible]		Cell 3 Couple No. [illegible]		Cell 4 Couple No. [illegible]		Cell 5 Couple No. [illegible]		Cell 6 Couple No. [illegible]		
T	MV	°F.	MV	°F.	MV.	°F.	MV.	°F.	MV	°F.	MV	°F.	MV	°F.	Notes
2H.															
5	490	1900	470	[illegible]	[illegible]	[illegible]	185	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
10	490	1900	[illegible]	[illegible]	[illegible]	802	190	550	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
15	490	1900	480	[illegible]	[illegible]	[illegible]	200	580	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
20	490	1900	486	[illegible]	[illegible]	[illegible]	[illegible]	590	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
25	490	1900	490	[illegible]	[illegible]	840	215	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
30	490	1900	[illegible]	[illegible]	[illegible]	850	220	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
35	490	1900	497	[illegible]	[illegible]	[illegible]	224	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
40	492	1904	500	[illegible]	350	[illegible]	229	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
45	[illegible]	1895	505	[illegible]	355	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
50	[illegible]	1895	510	[illegible]	360	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
55	[illegible]	1950	525	[illegible]	380	920	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
3H.	[illegible]	1900	527	[illegible]	[illegible]	920	[illegible]	710	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
5	[illegible]	1900	[illegible]	[illegible]	395	[illegible]	272	725	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
10	[illegible]	1900	530	[illegible]	400	964	277	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
15	[illegible]	1900	532	[illegible]	402	960	281	740	870	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
20	488	1895	535	[illegible]	404	963	[illegible]	746	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
25	490	1900	[illegible]	1190	406	[illegible]	[illegible]	748	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
30	[illegible]	1900	[illegible]	1199	410	[illegible]	287	750	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
35	491	1902	[illegible]	1207	413	[illegible]	[illegible]	756	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
40	490	1900	[illegible]	1212	416	[illegible]	293	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
45	490	1900	560	[illegible]	418	[illegible]	300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
50	490	1900	[illegible]	[illegible]	421	[illegible]	303	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
55	490	1900	[illegible]	[illegible]	422	[illegible]	305	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
4H.	[illegible]	1900	[illegible]	[illegible]	[illegible]	1000	308	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

PLATE 1.

FIGURE 1.

PLATE 2.

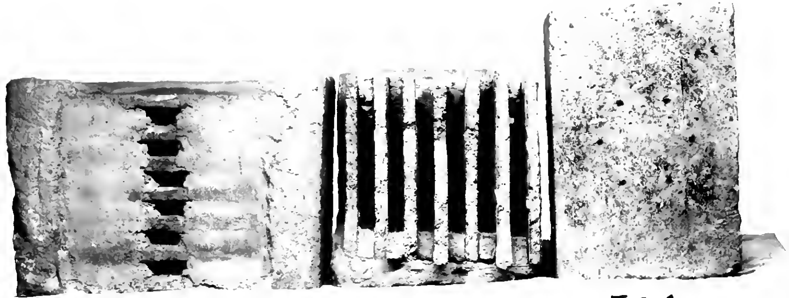


FIG. 2 FIG. 3 FIG. 4

FIG. 2 – TILE BLOCK NO. 3 COMPLETED AND READY FOR TEST.
FIG. 3 – TILE BLOCK NO. 2 AFTER TEST, CUT THROUGH CENTER.
FIG. 4 – CONCRETE BLOCK NO. 1 BEFORE TESTING.

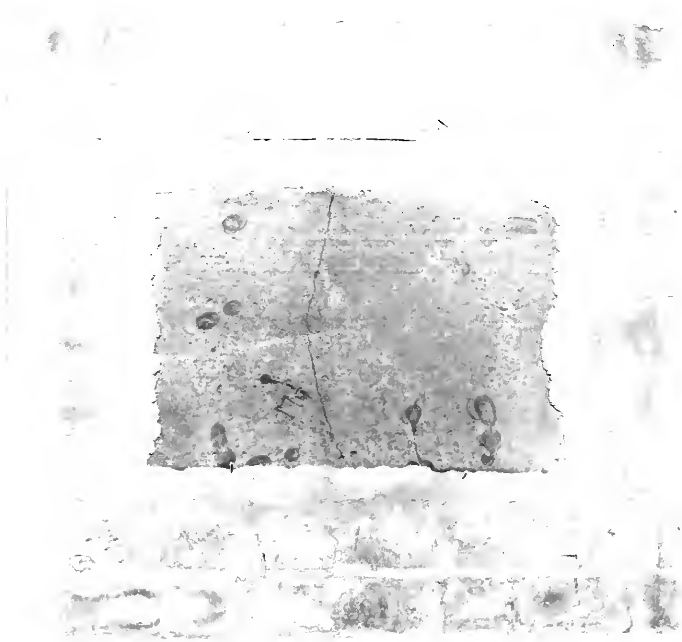


FIG. 5

TILE BLOCK NO. 2 IN PARTITION
AFTER TEST.

TILE BLOCK DIMENSIONS.

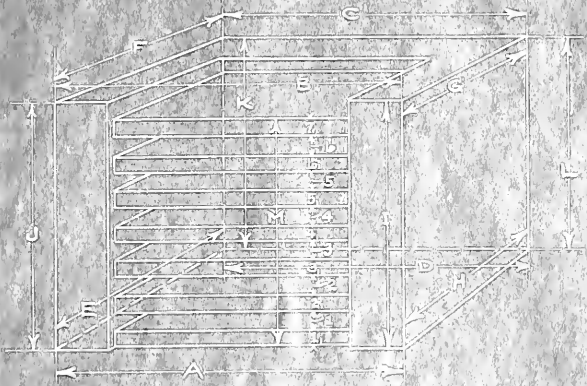


FIG. 6

OVER ALL MEASUREMENTS

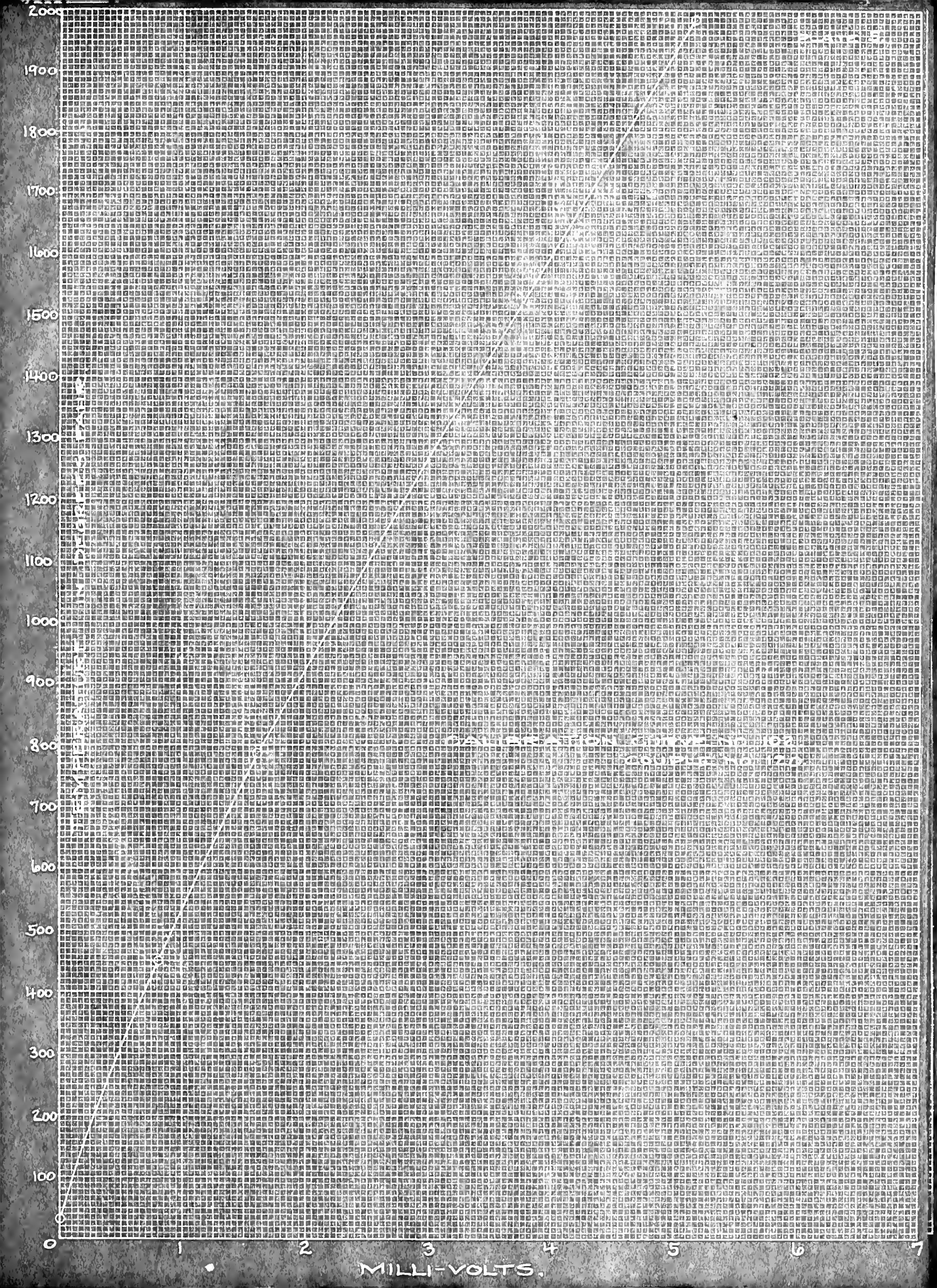
	BLOCK No. 1	BLOCK No. 2	BLOCK No. 3
A	20 1/8"	20 1/8"	20"
B	20 3/8	20 3/8	20 7/8
C	20 1/4	20 1/2	21
D	20 1/4	20 1/4	20 1/2
E	14 5/8	14 5/8	14 3/4
F	14 1/2	14 1/2	15.
G	14 3/4	14 3/4	14 7/8
H	14 3/4	14 3/4	14 5/8
I	13 5/8	14.	14.
J	13 3/4	14.	14 1/4
K	13 3/4	14.	14.
L	14.	14 3/8	14 1/4
M	12 7/8	12 3/4	12 7/8

AVERAGE OF CELL MEASUREMENTS

	BLOCK NO. 1	BLOCK NO. 2	BLOCK NO. 3
1	1 11/64"	1 9/64"	1 3/64"
2	1 4/64	1 8/64	1 3/64
3	1 3/64	1 13/64	1 10/64
4	1 8/64	1 9/64	1 3/64
5	1 11/64	1 8/64	1 9/64
6	1 8/64	1 13/64	1 6/64

AVERAGE OF TILE SLAB MEASUREMENTS

1.	55/64	5/64"	56/64"
2.	53/64	52/64	56/64
3.	55/64	54/64	54/64
4.	56/64	53/64	52/64
5.	53/64	52/64	56/64
6.	56/64	55/64	58/64
7.	62/64	52/64	52/64



2000
1900
1800
1700
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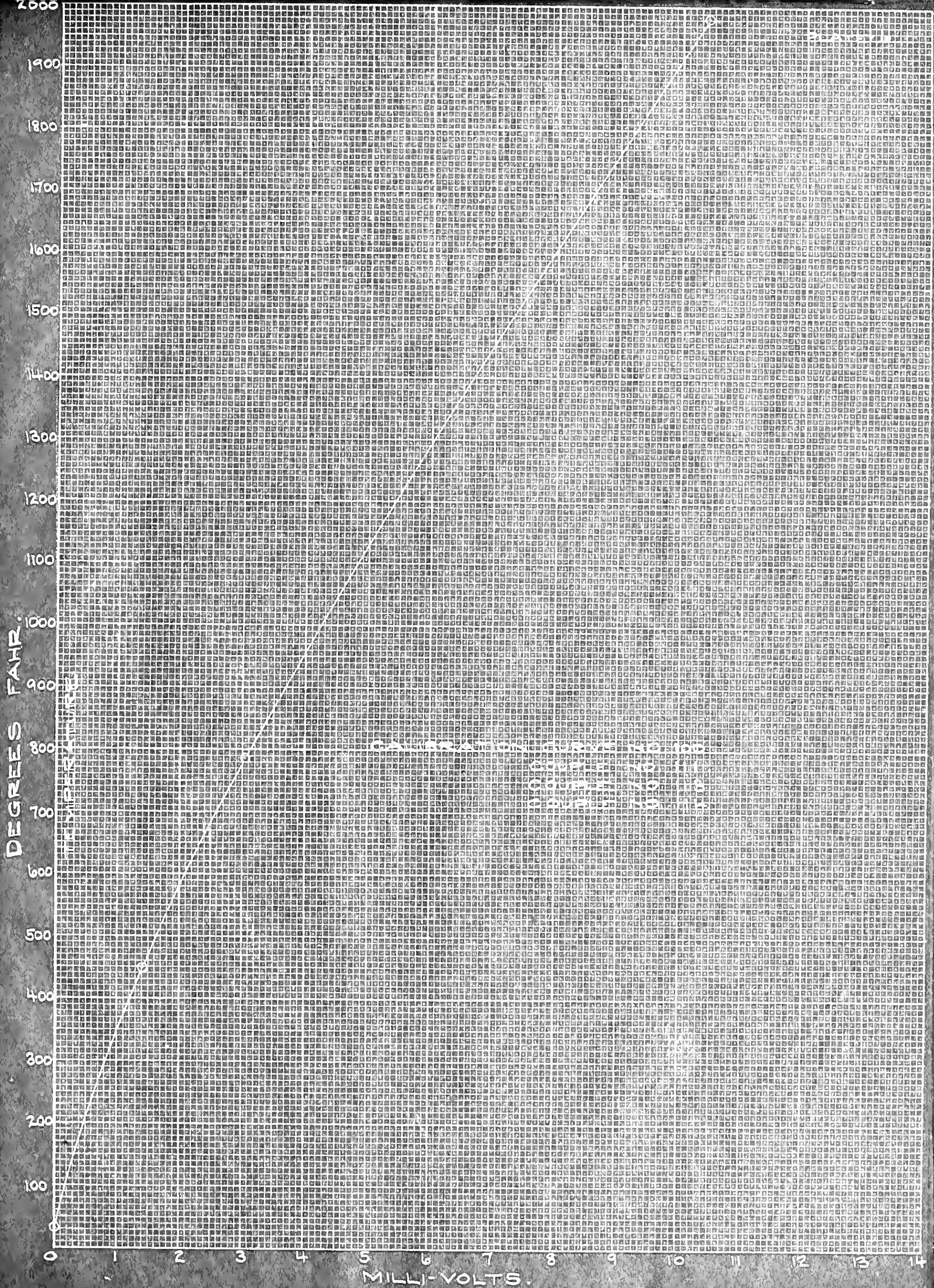
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
TEMPERATURE IN DEGREES FAHR.
CALIBRATION CURVE
1
2
3
4
5
6
7
MILLI-VOLTS.



DEGREES FAHR.
2000
1900
1800
1700
1600
1500
1400
1300
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1000
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800
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400
300
200
100
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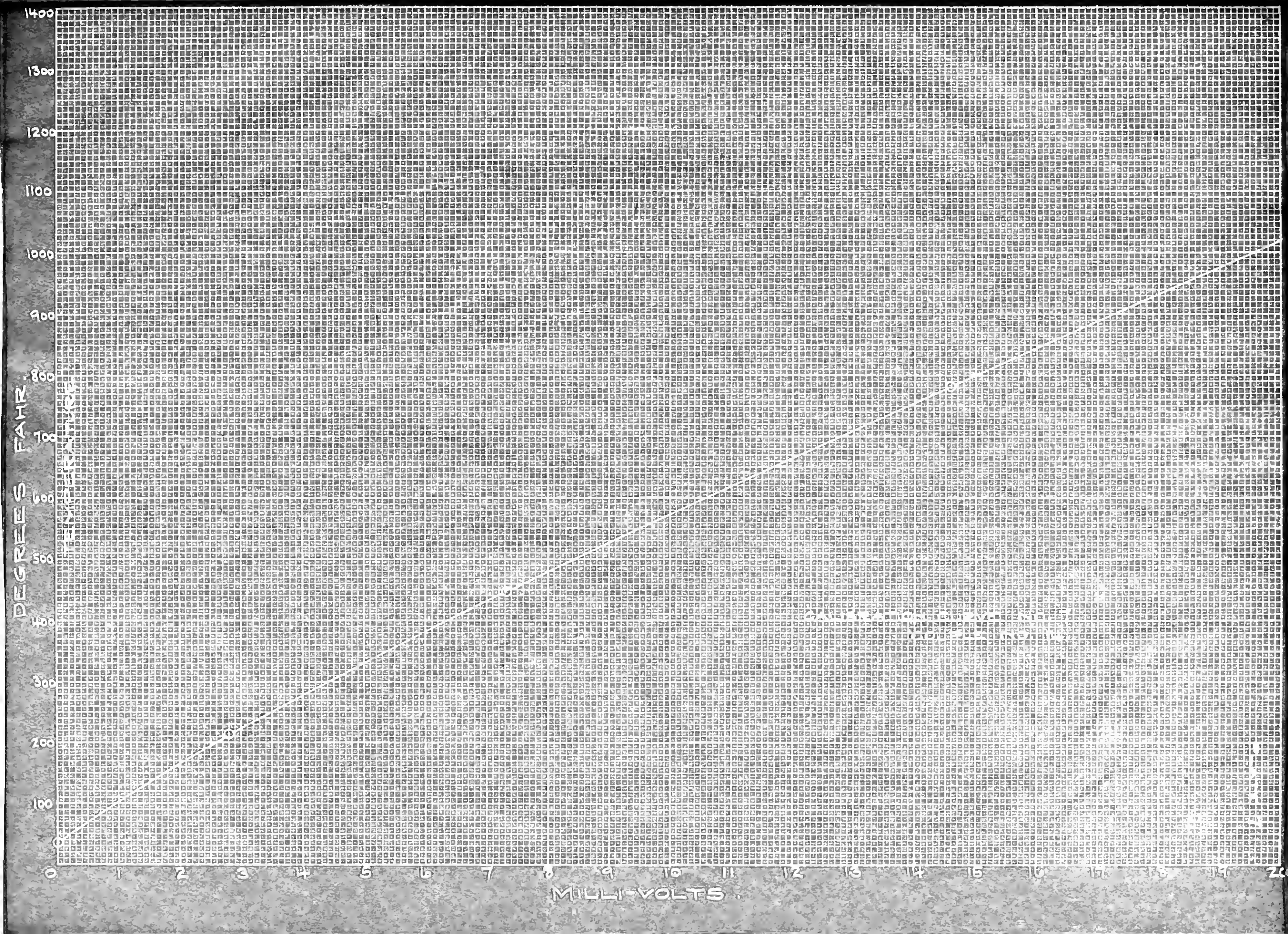
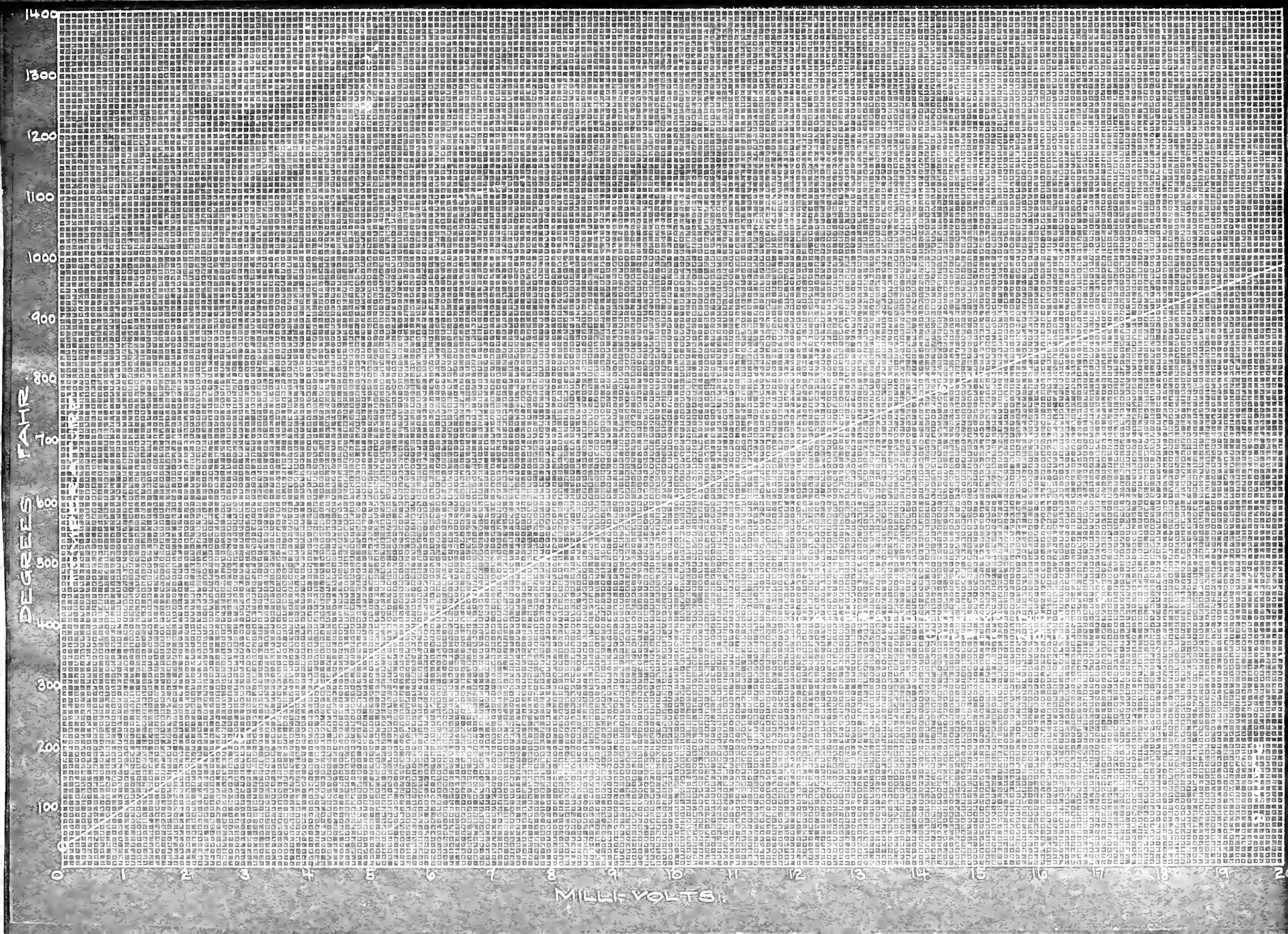
5
6
7
8
9
10
11
12
13
14
MILLI-VOLTS.
CALIBRATION CURVE


DEGREES FAHR.
TEMPERATURE
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
MILLI-VOLTS.


TEMPERATURE
DEGREES FAHR.
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
MILLI-VOLTS.
0
1
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4
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6
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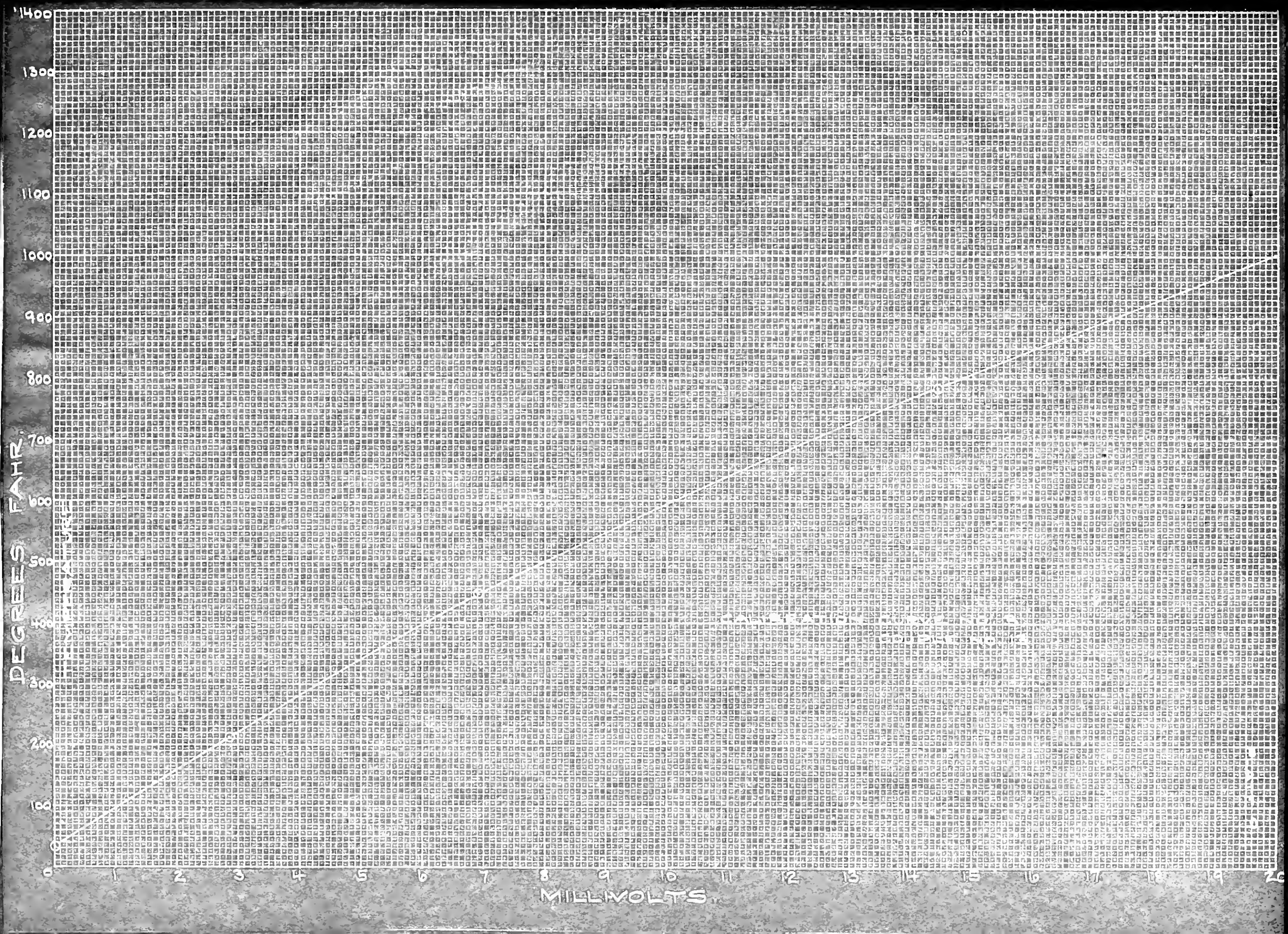
9
10
11
12
13
14
15
16
17
18
19
20


DEGREES FAHR.
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1
2
3
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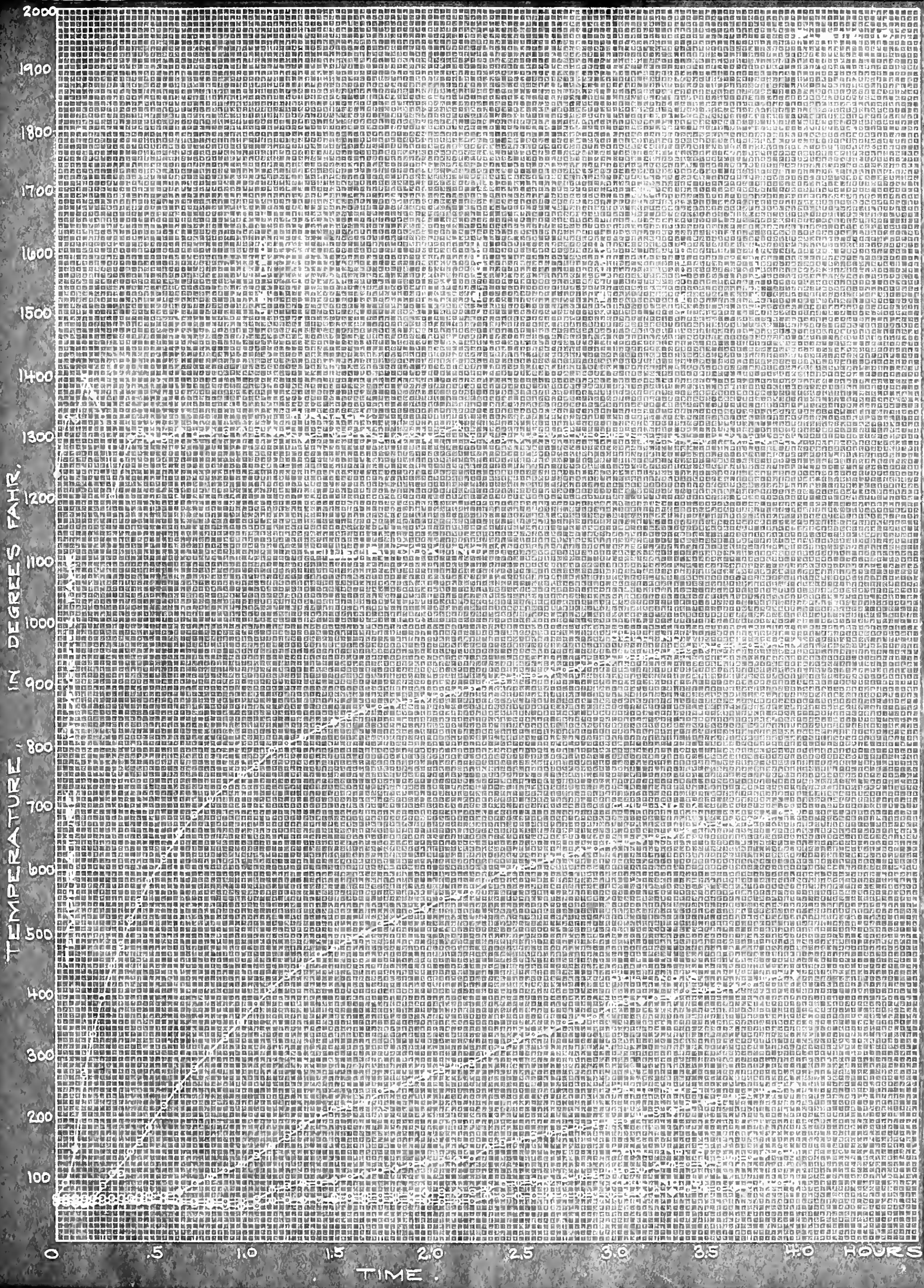
13
14
15
16
17
18
19
20
MILLIVOLTS


TEMPERATURE, IN DEGREES FAHR.
2000
1900
1800
1700
1600
1500
1400
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1200
1100
1000
900
800
700
600
500
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300
200
100
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.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
HOURS
TIME.

2000
1900
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1000
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800
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300
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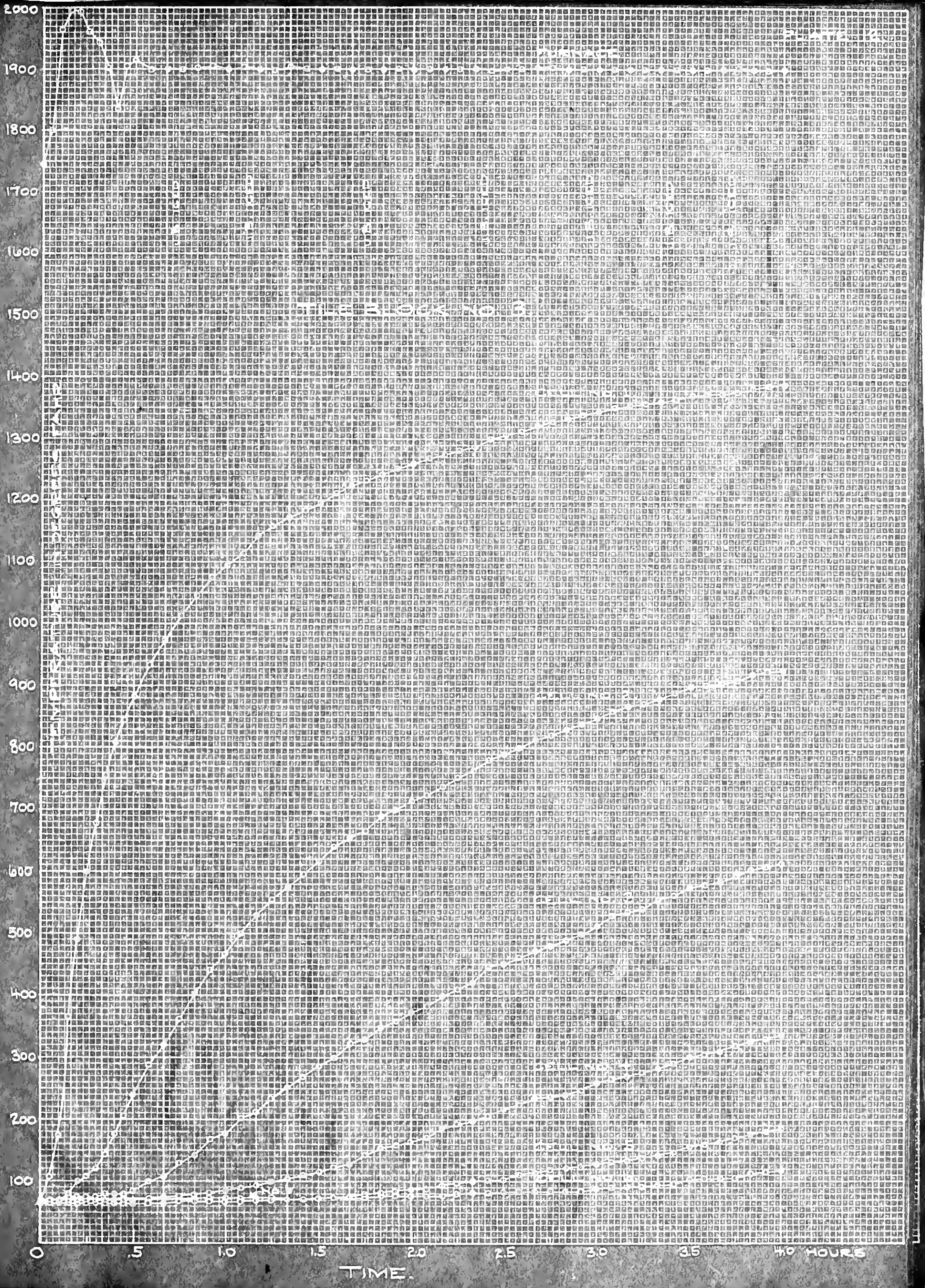
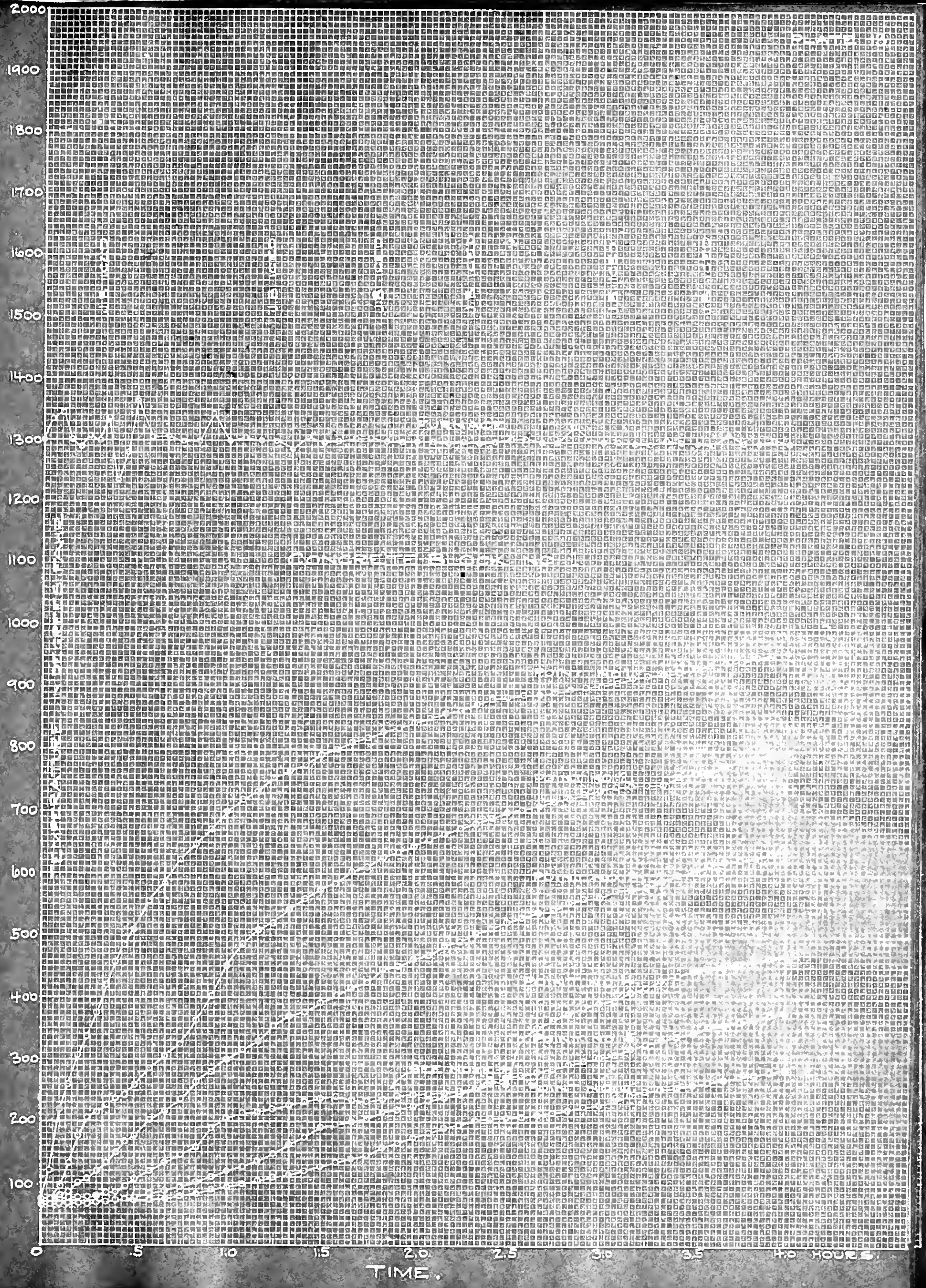
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
HOURS
TIME.

8


TILE BLOCK NO. 3
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0 HOURS
TIME.


2000
1900
1800
1700
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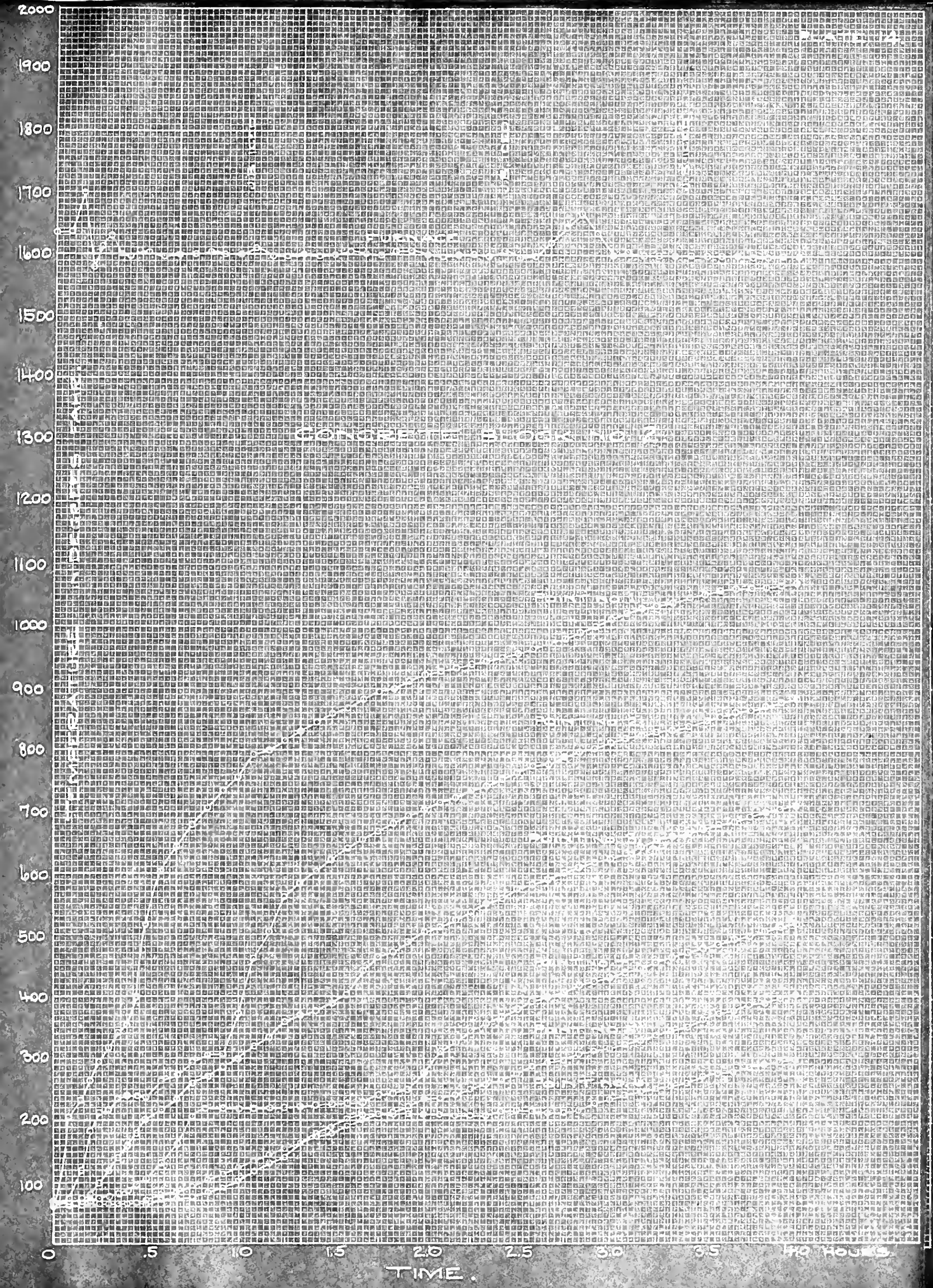
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
CONCRETE BLOCK
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0 HOURS.
TIME.


FURNACE
CONCRETE BLOCK NO. 2
TEMPERATURE IN DEGREES FAHR.
2000
1900
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100
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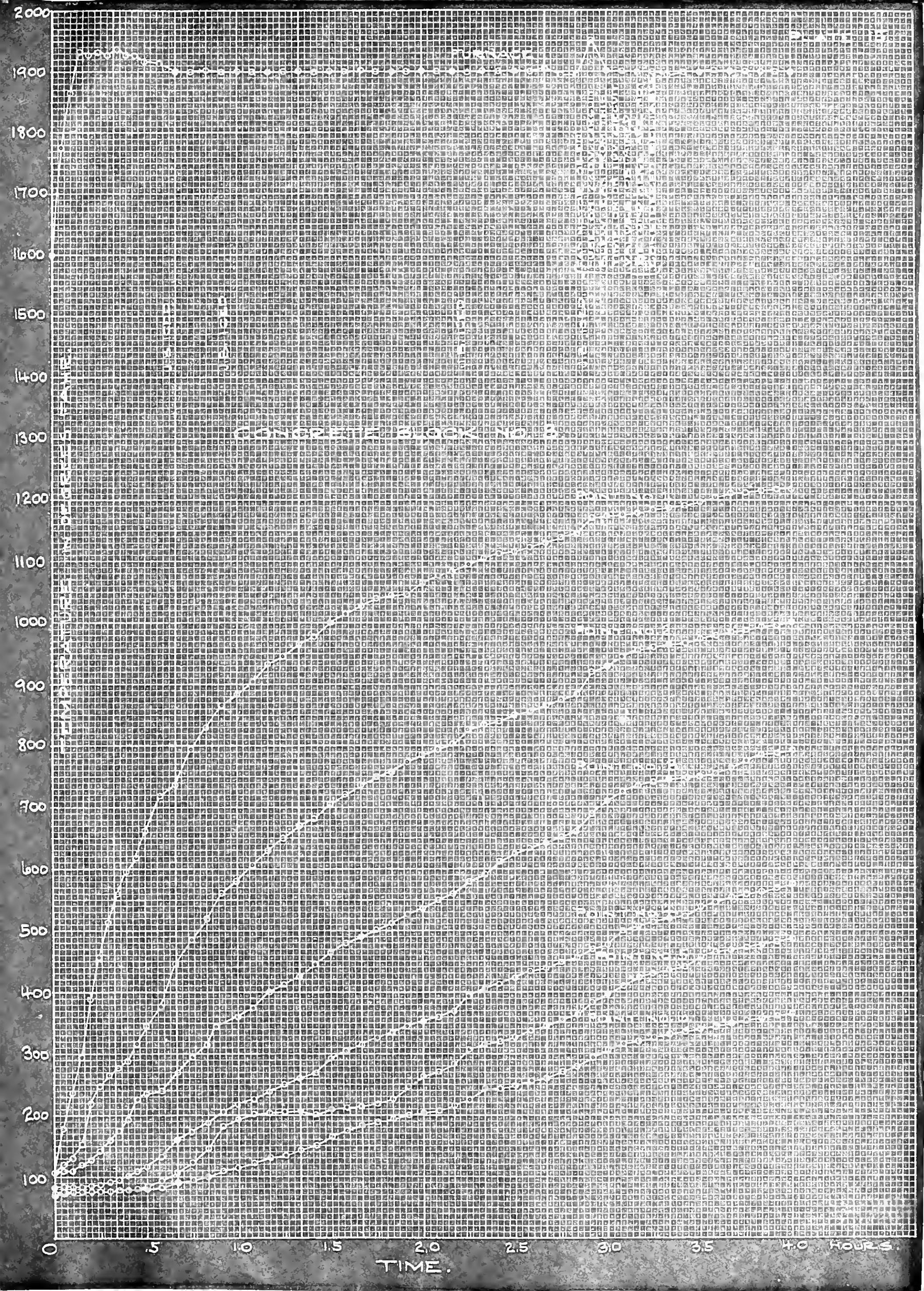
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0 HOURS
TIME.


FURNACE
CONCRETE BLOCK No. 2
POINT No. 1
POINT No. 2
POINT No. 3
TEMPERATURE IN DEGREES FAHR.
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
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800
700
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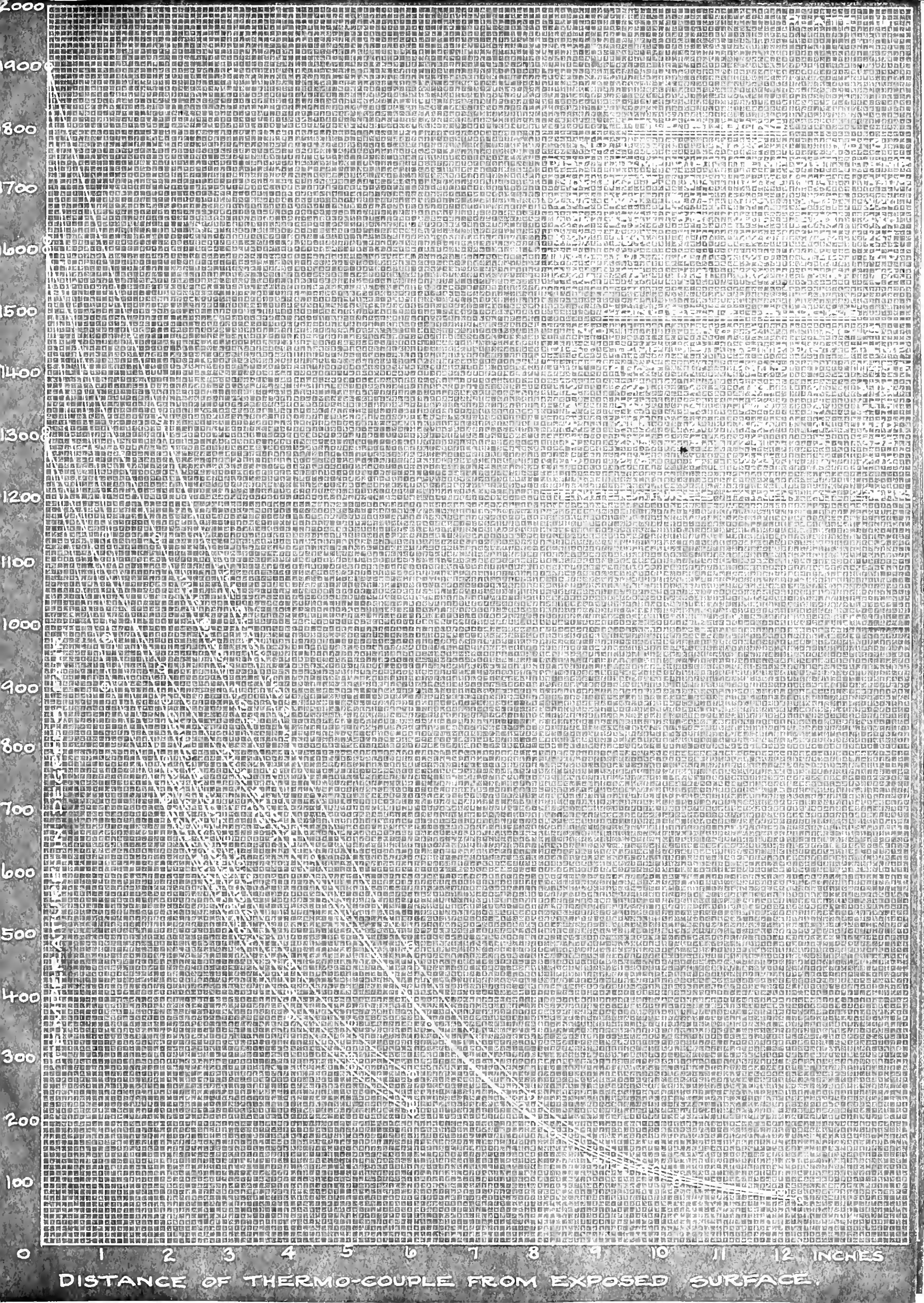
500
400
300
200
100
0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
HOURS.
TIME.


TEMPERATURE IN DEGREES FAHR.
2000
1900
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1600
1500
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900
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700
600
500
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300
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100
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10
11
12
INCHES
DISTANCE OF THERMO-COUPLE FROM EXPOSED SURFACE.

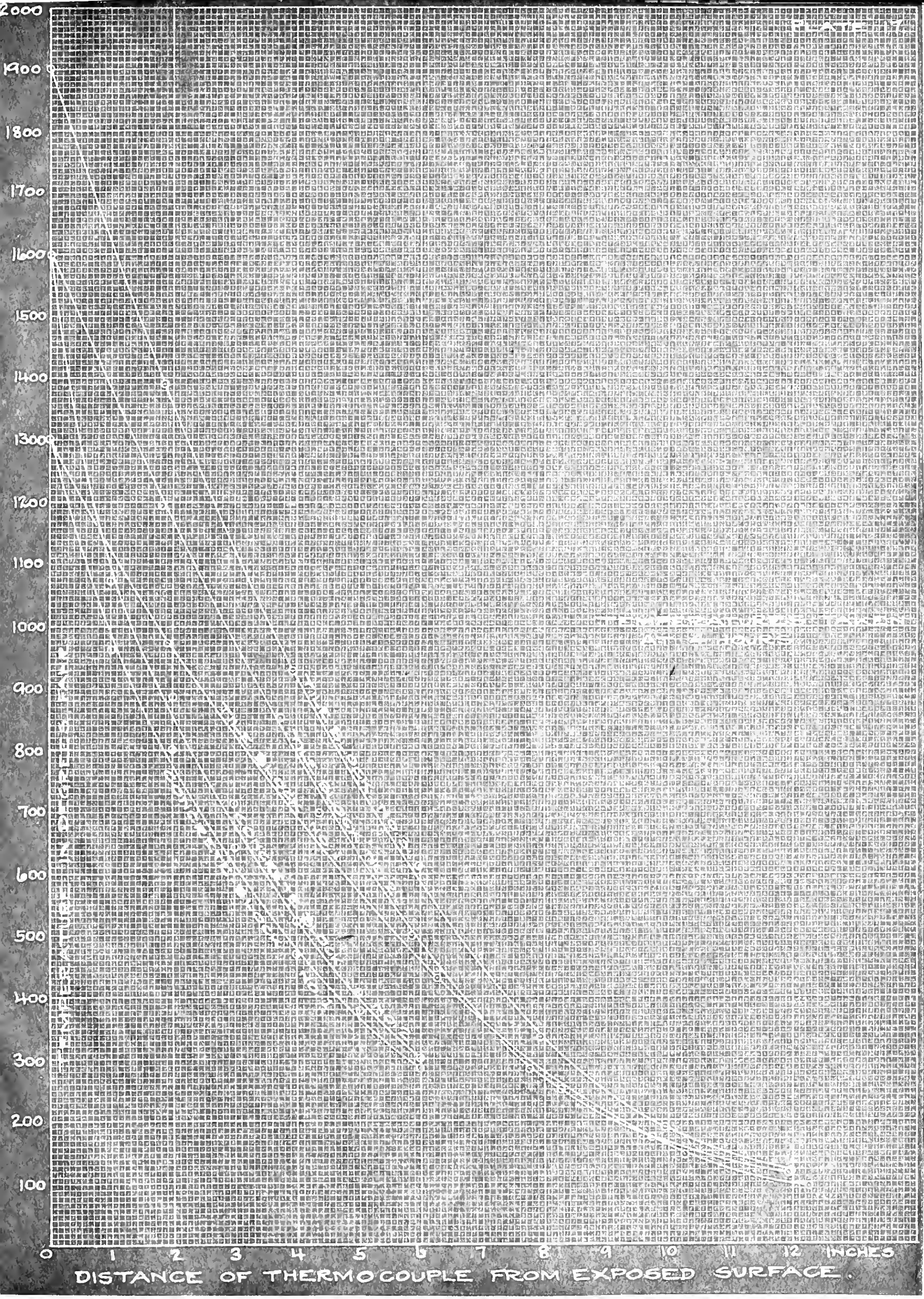

PLATE 17
2000
1900
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1700
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200
100
TEMPERATURE IN DEGREES FAHR.
0
1
2
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4
5
6
7
8
9
10
11
12
INCHES
DISTANCE OF THERMOCOUPLE FROM EXPOSED SURFACE.