NATIONAL BUREAU OF STANDARDS REPORT

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To
OFFICE OF THE CHIEF OF ENGINEERS

Progress Report
to June 30, 1954

on

UNDERGROUND PIPE INSULATION

by

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NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Progress Report to June 30, 1954

Full Scale Trench Test

In order to conduct tests on Gilsulate insulation simulating actual use, a watertight box 4' x 4' x 12' long was constructed, as shown in the attached figure, along the longitudinal center line of which was placed a 4" I. P. S. test pipe. The box was filled with earth, which had previously been dried, to approximately mid-height of the box. At this point a wooden form was placed around the pipe and filled with Gilsulate in the form of a square about 12" on a side, simulating its application in a trench. After removing the form, the remainder of the box was then filled with earth. Both materials were tamped with an 8" x 8" steel tamper as they were added.

Five thermocouples were fastened to the top of the pipe at positions 23" apart starting at the center and extending in both directions. Also a thermocouple was fastened to the pipe at its entrance to and at its exit from the box. In addition, eleven thermocouples were located in the Gilsulate or the earth in each of three directions in a plane perpendicular to the steam pipe at its center. The thermocouples were spaced one at 1/2", four at 1", three at 2", and two at 4" separation in a downward, sideways, and upward direction from the pipe.

In order that the water table in the earth in the box might be adjusted and measured, six vertical 1/2" diameter pipes were equally spaced along each side of the box extending from the top to the bottom. A 100' length of rope was placed on the bottom of the box to provide distributing channels for water introduced

through these vertical pipes. Two 1" diameter vertical pipes were placed 1' from the side and 1' from either end of the box to serve as wells for measuring the actual water table level.

The 12' steam pipe was divided into three sections by two internal half-moon dams set 4' apart isolating a "measuring section" at the middle of the pipe. Separate condensate drain lines were brought out from each section and connected to steam traps, float traps being used for the first two sections, and a bucket (air-venting) trap for the last section. In each case the condensate from the trap was arranged to pass through a water-cooled heat exchanger to cool it below 212°F so that the condensate could be collected in open weighing vessels and the rate of condensation in each section of the 12' pipe measured. An electrically-heated steam boiler capable of producing steam at the necessary pressure was constructed, installed and insulated. Its water level is maintained by a float control opening a solenoid valve in a line from a water supply tank maintained at a higher pressure than that of the boiler.

A first test run has been started, but sufficient data have not been obtained at the time of this report to yield significant results.

Laboratory Tests of the Properties of Gilsulate

Laboratory work was commenced for evaluation of the temperature-wise properties of "Gilsulate". The available literature through these vertical pipes. The 1" diameter vertical pipes were placed 1' from the side and 1' from either end of the bar to serve as wells for measuring the natural water table level.

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Laboratory Tests of the Properties of Gilsulate

Laboratory work was commenced for evaluation of the temperature-wise properties of "Gilsulate". The available literature was reviewed and conferences held to determine the scope and magnitude of the work.

An apparatus for determining the temperature characteristics of the insulation at various pipe temperatures was designed and constructed. The apparatus consists of a 1-inch galvanized pipe with an electric heater wound on one end. Power to this heater is controlled by a thermostatic switch. Thermocouples are peened into the pipe at equal intervals along the pipe. The pipe is enclosed in a cement-asbestos board box which is used to contain a minimum of 4 inches of the insulating material radially around the pipe. In use, the temperature of the pipe decreases with distance from the hot end. Successive transverse sections of the surrounding insulation are thus subjected to different pipe temperatures in one test, the duration of which may be several days or weeks. Later examination of the condition of the insulation at different sections indicates the effect of different pipe temperatures, as shown below.

Five tests were completed with this apparatus and a sixth is under way. The results of the first test have been analyzed and conclusions drawn. The results of the other four tests are being analyzed.

The results of the first test are presented on the enclosed drawing and shown on the enclosed photograph. The conclusions based on this test were as follows:

1. Pipe temperatures greater than 444°F caused considerable

slumping of the granular material, due to shrinkage as it consolidated or melted.

2. Estimated initial sintering temperature was about 193°F. Material that sintered at temperatures lower than 226°F was too weak to withstand gentle handling.

3. The minimum temperature of pipe for sintering to obtain moderate strength and cohesiveness of the sintered annulus was 226°F. This sintered material showed only slight fusion of particles.

4. "Glassy consolidation" occurred at temperatures higher than 371°F. This material is a uniform voidless "solidified liquid" when cool. In general the glassy material was found under the level of the pipe, as a result of plastic or liquid flow into this region from above. A thin layer of glassy material up to 1/2 inch thick was found on the top surface of the pipe where its temperature was between 371 and 491° F. At pipe temperatures higher than 491°F the material evidently became quite liquid and a void was formed above the pipe by melting out of material which flowed and collected under the pipe. The void was roofed by granular consolidated material with a skin of glassy fused material.

5. The sintered material under the pipe, between 300°F

and 371°F slumped away from the pipe slightly, leaving a gap into which a flow of plastic material entered from the hotter end. This flow persisted until it reached a temperature of 310°F.

6, It is concluded from this test that this particular material

a) sinters to a significant degree above 226°F.

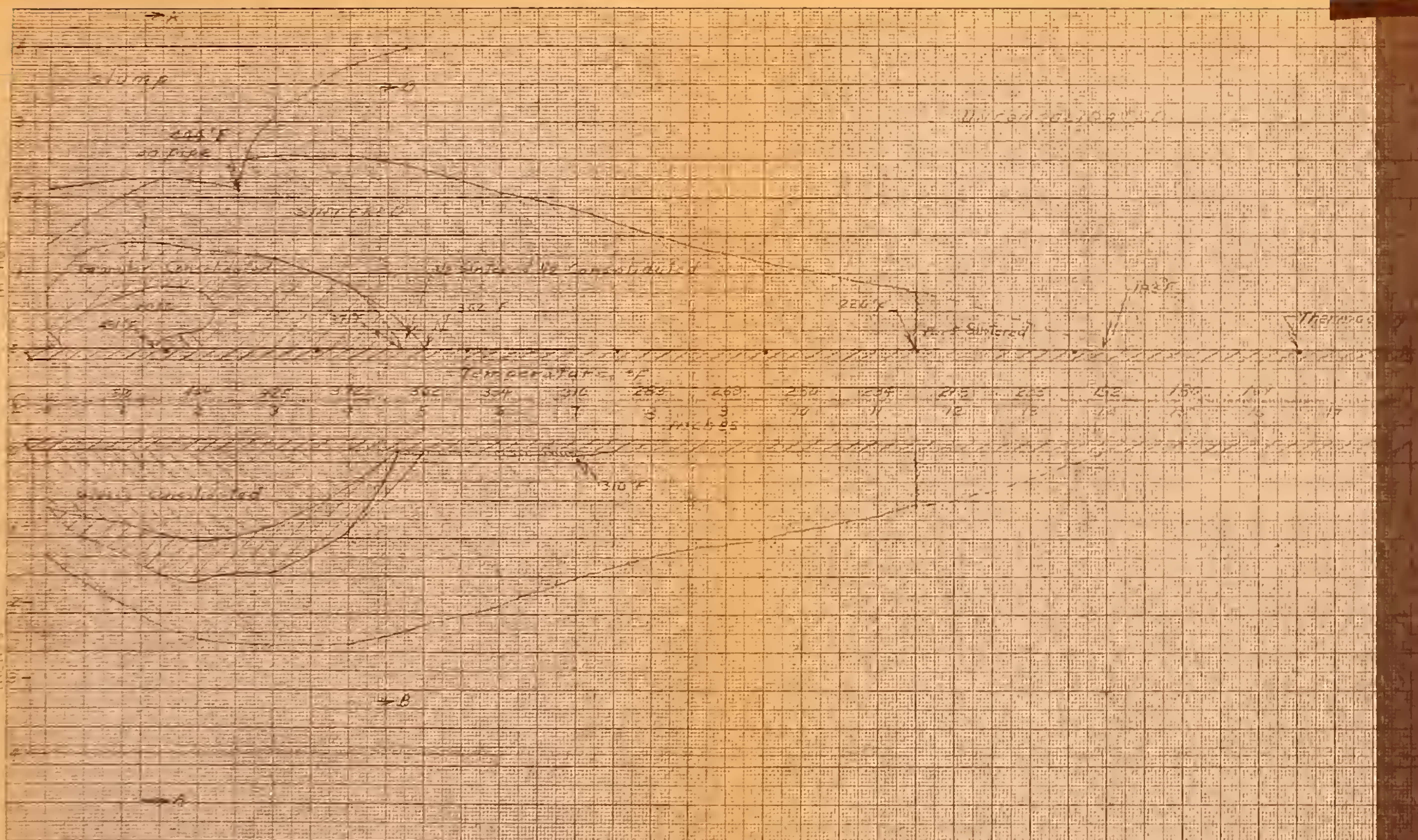
b) consolidates at about 371°F.

c) is quite plastic, or liquid, above 455°F.

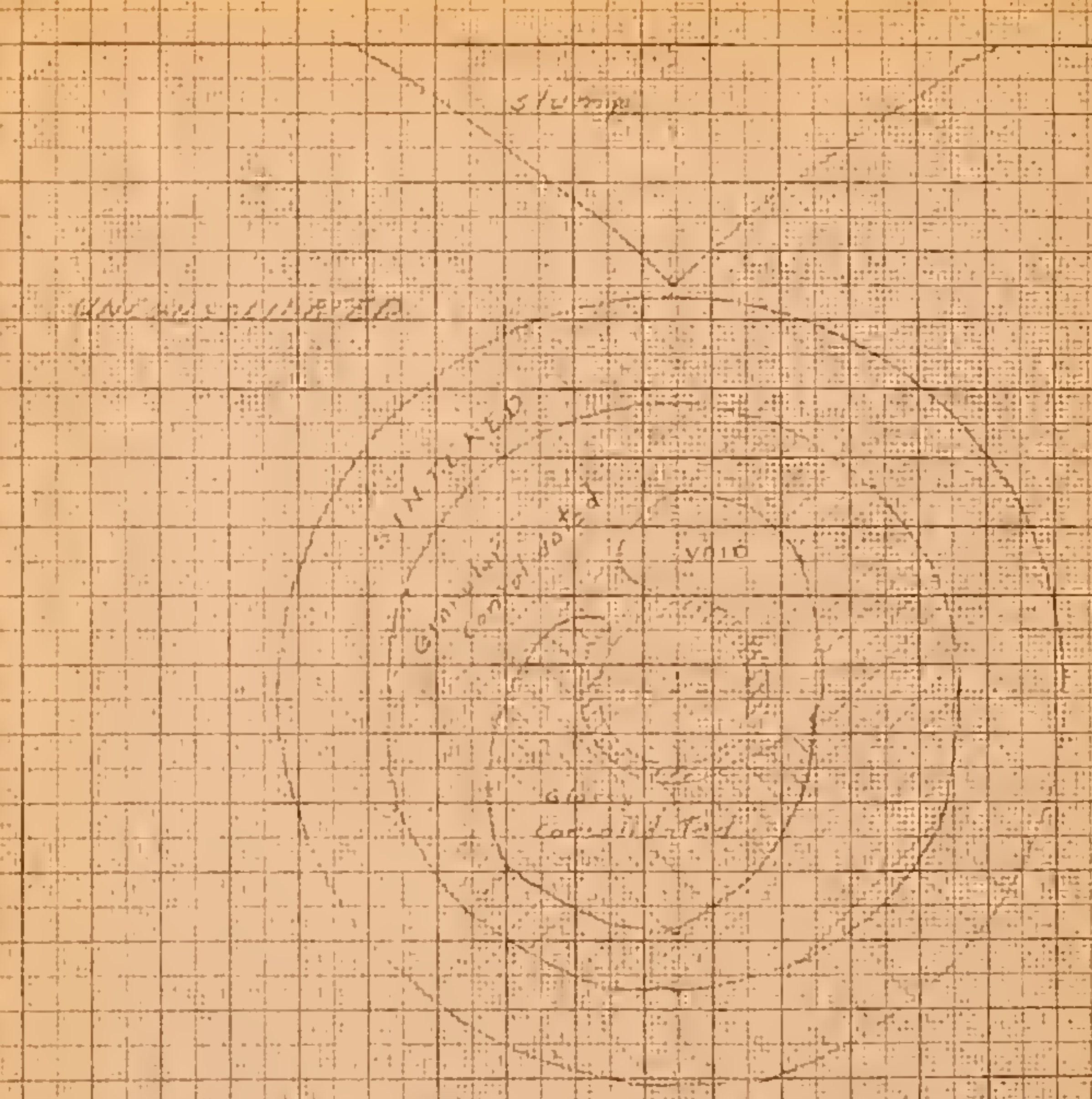
d) at pipe temperatures of 450°F and above, voids can be expected to develop over the pipe.

7. The "as received" density of the material was 39 lb/ft^3 as determined in accordance with Federal Specification HH-I-521c.

An apparatus was designed for measuring the thermal conductivity of loose or granular fill materials. This apparatus will be used to make measurements on "Gilsulate" in the consolidated, sintered and unconsolidated conditions at appropriate ranges of temperature. Construction of the apparatus will commence upon receipt of ordered materials.

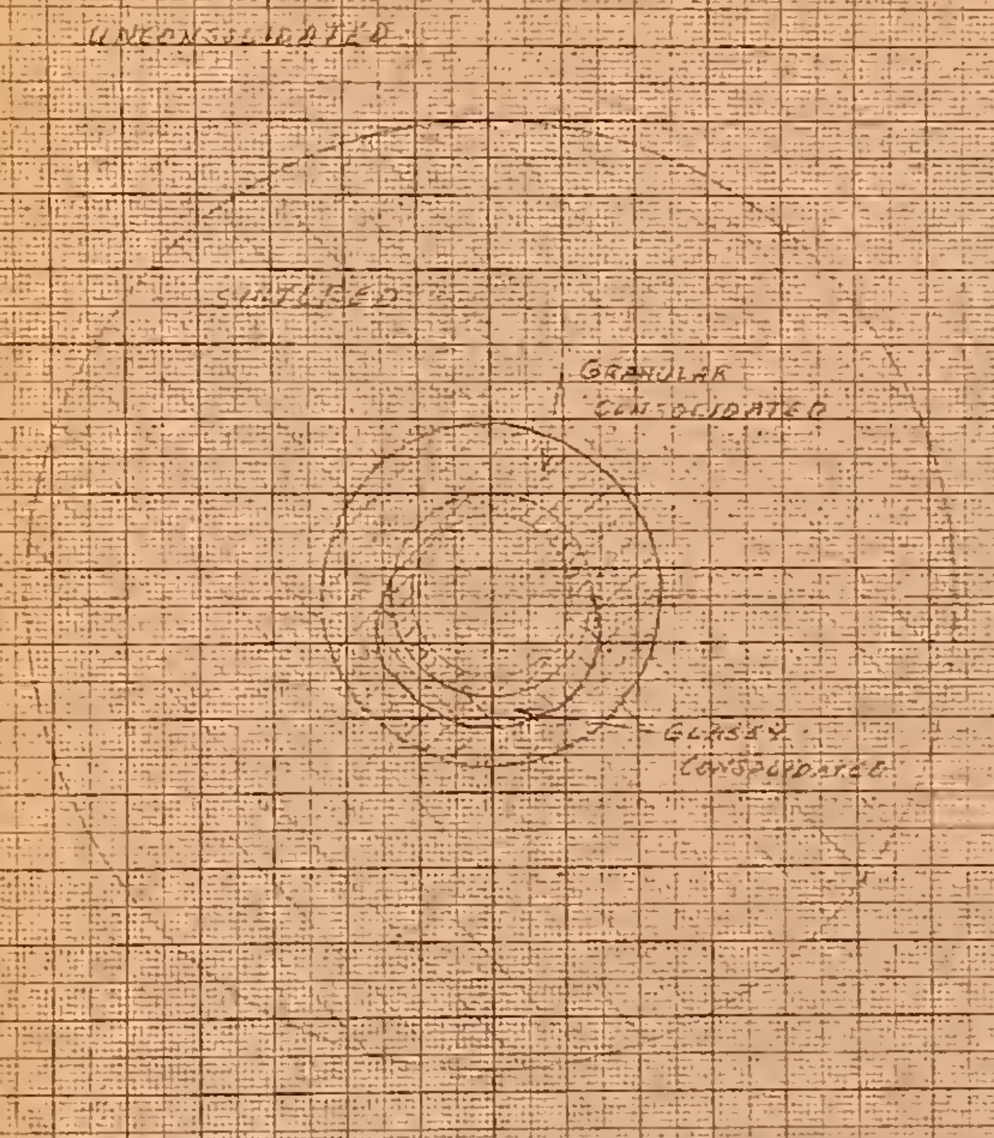


GILSULATE TYPE "B"



SECTION A-A

Pipe Temp.

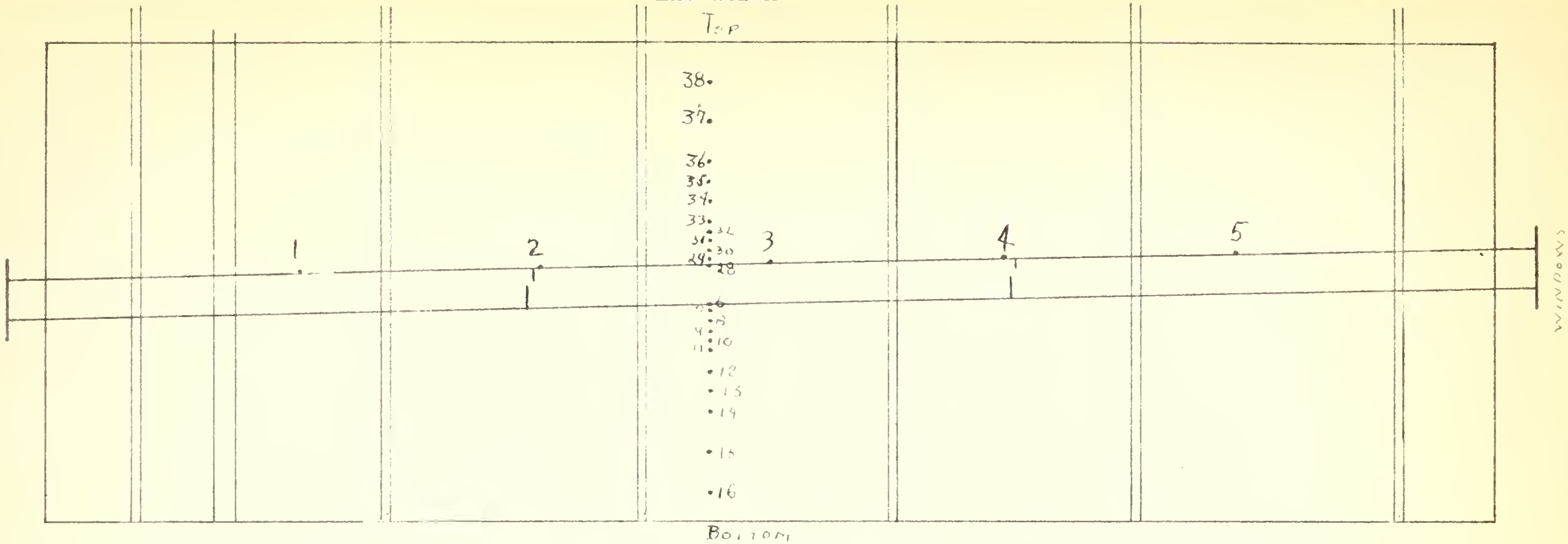


SECTION B-B

Pipe Temp.

23901

Elevation



Plan