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Metallurgical Project

A. H. Compton, Project Director

* * *

O.S.R.D., Chicago Patent Group

H. E. Metcalf, Group Head



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# A BRIEF GENERAL DESCRIPTION OF THE ARGONNE URANIUM-GRAPHITE PILE (CP-2)

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# A BRIEF GENERAL DESCRIPTION OF THE ARGONNE URANIUM-GRAPHITE PILE (CP-2)

Compiled by H. E. Metcalf
Chicago O.S.R.D. Patent Group Head

## INTRODUCTION

A general description of the Argonne uranium-graphite pile was required by the Chicago OSRD Patent Group. Some original sketches were available, together with a notebook having drawings of each layer, made as the pile was assembled. From these data and various laboratory reports, the following description and drawings were made. It is to be noted that only the main features of the pile are shown. Minor variations in the lattice are not indicated, nor are all slots or openings spotted. It is believed, however, that the main features of the pile are adequately represented.

## DESCRIPTION

Fig. 1 shows the outside of the pile as seen in front, top, and left side perspective. The shielding around the pile is formed by 5 foot concrete walls, with 6 inches of lead and 40 inches of wood on top, through which the thermal column projects.

The control and shim rods enter the front of the pile from supporting platforms, and a platform is provided on which removable stringers can be drawn out.

Safety rods enter the left side of the pile slightly above the plane of the control and shim rods. The construction and operation of these rods is described in more detail in CP-413. A large central removable section can be drawn out of the pile onto a rear platform that is not shown in Fig. 1.

The concrete walls were first poured with the front and top open, leaving a vault on which the pile proper could be built up, layer by layer, in a space 22 feet deep and 20 feet wide.

As in the West Stands pile (CP-413) the basic construction unit used to build the Argonne pile was a graphite block 4-1/8 inches by 4-1/8 inches, used in a number of

lengths. Some 4 inch by 4 inch blocks were also used. The general shape of the blocks is shown in Fig. 2.

Some of the blocks were bored with cylindrical recesses spaced 8-1/4 inches center to center. Others were bored with recesses 8 inches center to center. The uranium bodies were inserted in these recesses, and for convenience this type of block can be called "live" graphite. Other graphite blocks were not bored, but were used as spacing blocks. These can be termed "dead" graphite.

The uranium bodies were of several kinds; one form being cast uranium cylinders of several weights as later listed. Other bodies were pseudospheres of $UO_2$ made as described in CP-413. Some $U_3O_8$ cylinders were also used.

The graphite blocks were cut to proper length and the uranium bodies were placed in the recesses to provide "live" graphite rows spaced by rows of "dead" graphite blocks across the pile to form horizontal layers, each horizontal uranium bearing layer being spaced from the layer below by a horizontal "dead" graphite layer to form a lattice. For more uniform distribution of weight, alternate layers may have the graphite blocks crossed at right angles. All of the blocks were closely piled to reduce air spaces and three layers of dead graphite were first laid down to start the reflector.

Construction was continued layer by layer, with the uranium lumps spaced to form a cubic lattice, with at least 12 inches of "dead" graphite between the uranium bearing portion of the pile and the inner face of the concrete walls, to carry the reflector upward on all sides of the structure.

As the Argonne pile was designed to have a central portion where the lumps are of uranium metal, blocks bearing about 10 tons of metal lumps were piled in stepped relation in the various layers to form a central lattice mass about 15 feet wide, 10 feet deep and 10 feet high positioned between the 16th and the 48th layer of the pile, as shown in Figs. 3, 4 and 5.

Along lines passing from front to back of the pile close to the center of the pile, removable stringers were provided, only three being indicated in the figures. The "live" graphite blocks were keyed together in such a manner that as one stringer is drawn out of the front of the pile, another stringer can be drawn into the pile from the rear. These stringers can be used to test materials as set forth in other laboratory reports.

A horizontal removable section, 8 rows wide and 8 rows high was provided extending from front to back of the pile through the metal bearing central portion of the pile. Those blocks in this removable section were keyed as shown in Fig. 6. The position of this removable section is shown in Figs. 3, 4 and 5.

As the pile was being stacked, a 2-5/8 inch hole was provided extending downwardly from the top of the pile to the 10th layer, centrally and just at one side of the removable section. An ionization chamber was also installed just below the safety rods, in the periphery of the pile. The circuit arrangements are shown in CP-413.

As the pile was being built various slots were provided for the control, shim and safety rods. Other slots were also provided for monitoring the neutron activity of the pile during construction following the procedure set forth in CP-413. In Fig. 7 the results of indium foil measurements are shown plotted against the number of layers placed on the pile during construction. The pile was predicted to become chain reacting at the 50th layer, and actually, critical size was attained at slightly above the 50th layer in May, 1943.

With all the rods in the pile, four additional layers of dead graphite blocks were then added above the 50th layer, to complete the reflector across the top of the pile. This addition increased the effective size of the pile sufficiently to provide a reproduction ratio greater than unity, and thereby gave the pile a satisfactory neutron density doubling time. The effect on the pile activity of adding the reflecting layers was as follows:

| Layer | Time for Doubling the Neutron Density |
|---|---|
| 50.09 | 60 infinite period |
| 51 | 50 seconds |
| 52 | 32.9 seconds |
| 53 | 19.0 seconds |
| 54 | 12.5 seconds |

After the 54th layer was added, a graphite pier, (shown in Figs. 1 to 5 inclusive) was built upwardly to act as a thermal neutron column.

The front of the pile was then closed with 5 feet of concrete, except for required openings. The top was covered with a 6 inch layer of lead and 50 inches of wood pierced by the downwardly extending 2-5/8 inch hole and the upwardly extending thermal column. A laboratory enclosure (not shown

in the drawings) was built on top of the pile, in which experimental research work can be conducted.

More detailed specifications of the Argonne U-graphite pile are given below:

| | |
|---|---|
| Total number of U lumps in pile | about 17,702 |
| Total number of U metal lumps in central and removable sections (mostly 6, 7 and 8 pounds each) | 3,202 about 10 tons |
| Total number of U oxide lumps around central section (mostly $UO_2$, 6 pounds each: about 5% $U_3O_8$, 5 pounds each, positioned in outer layers and rows only) | about 14,500 |
| Total weight of U in pile | 52 tons |
| Total weight of graphite in pile (including reflector) | 472 tons |
| Average K | about 1.065 |

The greater part of the materials used in the Argonne U-graphite pile was taken from the West Stands pile after it was dismantled. However, the Argonne pile was built substantially cubical in shape and had more metal in the center.

FIG. 1. *Perspective View*

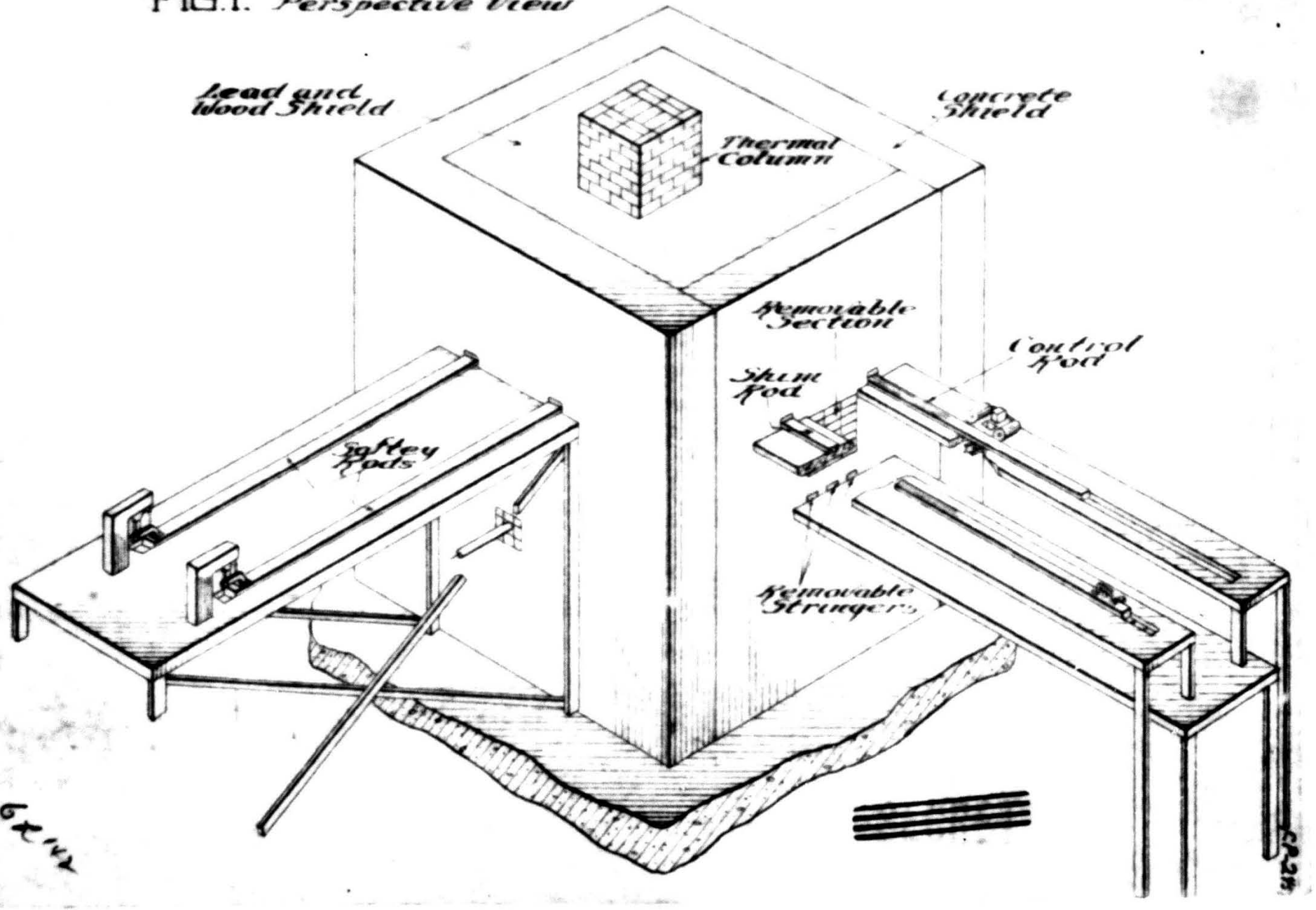

FIG. 7.

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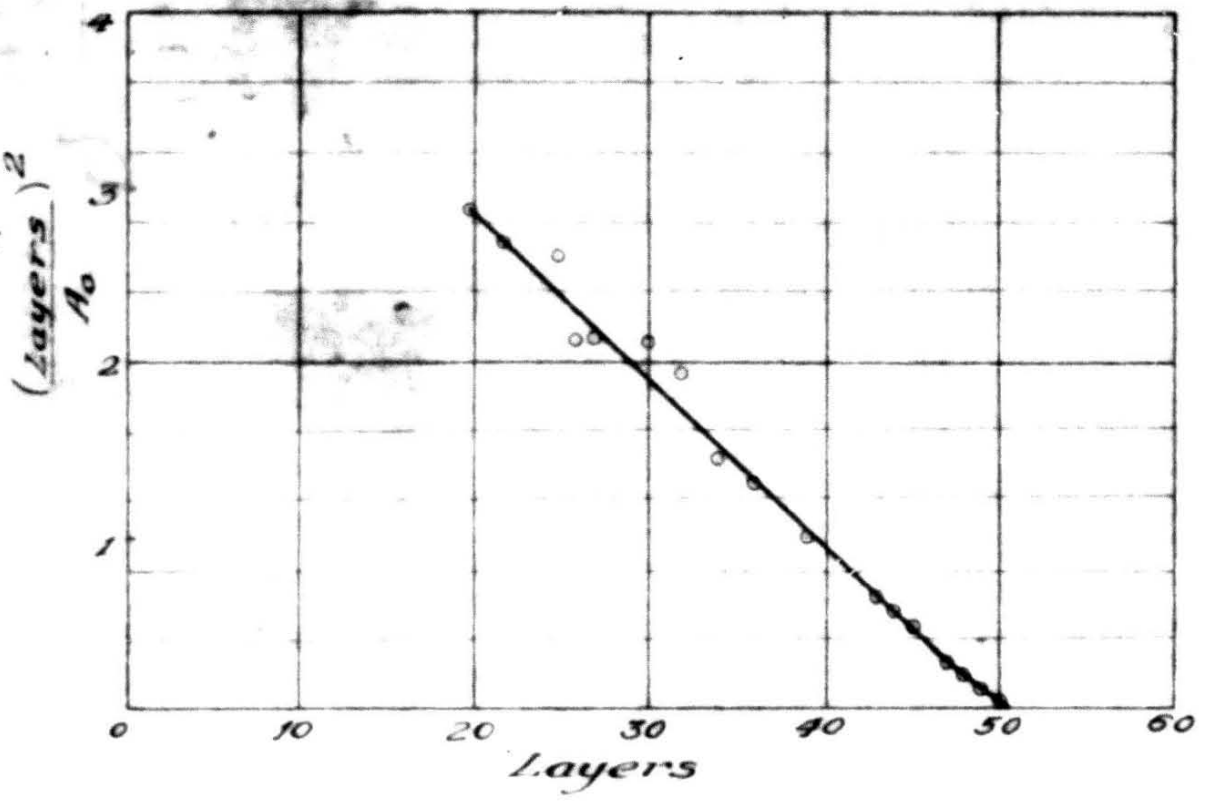


FIG. 2.

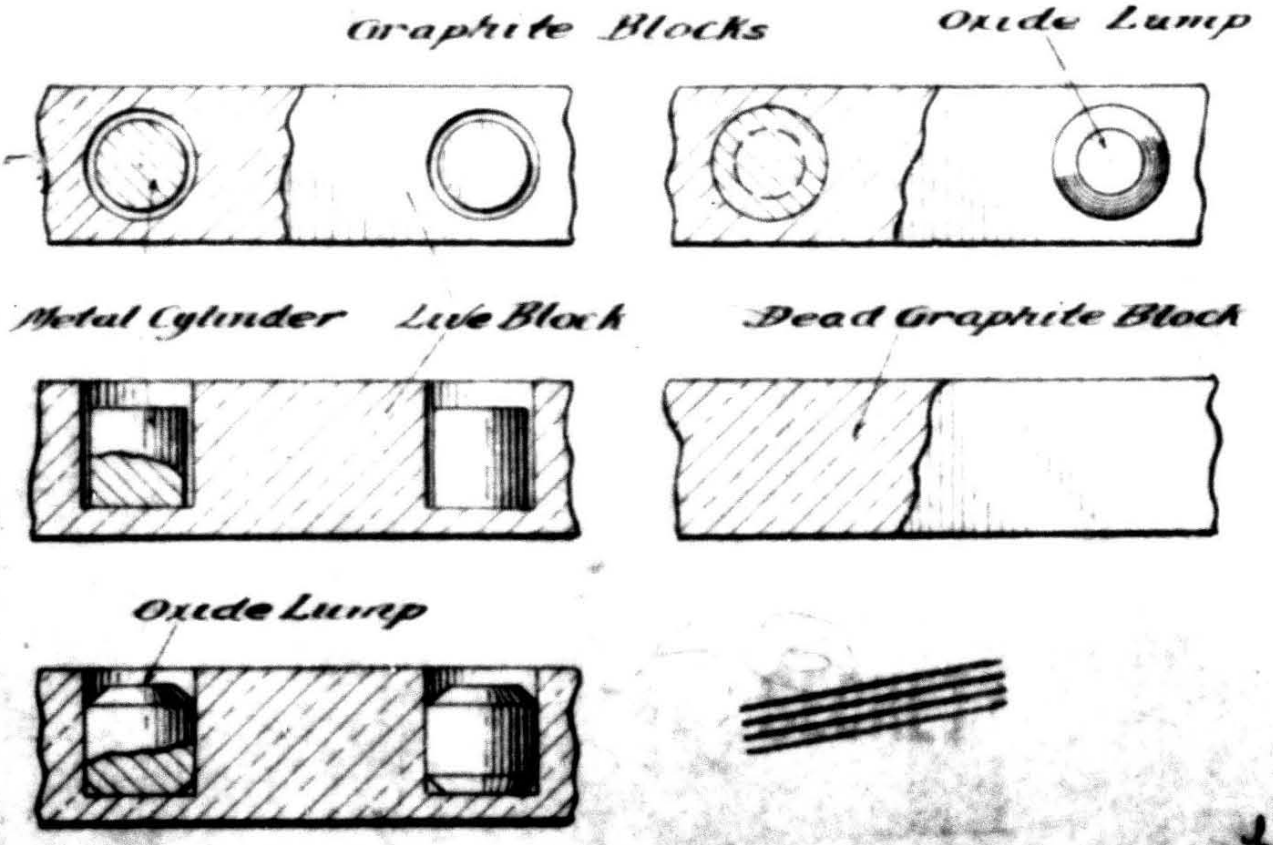

FIG. 3. Front Plan View. Vertical Center Section in Part

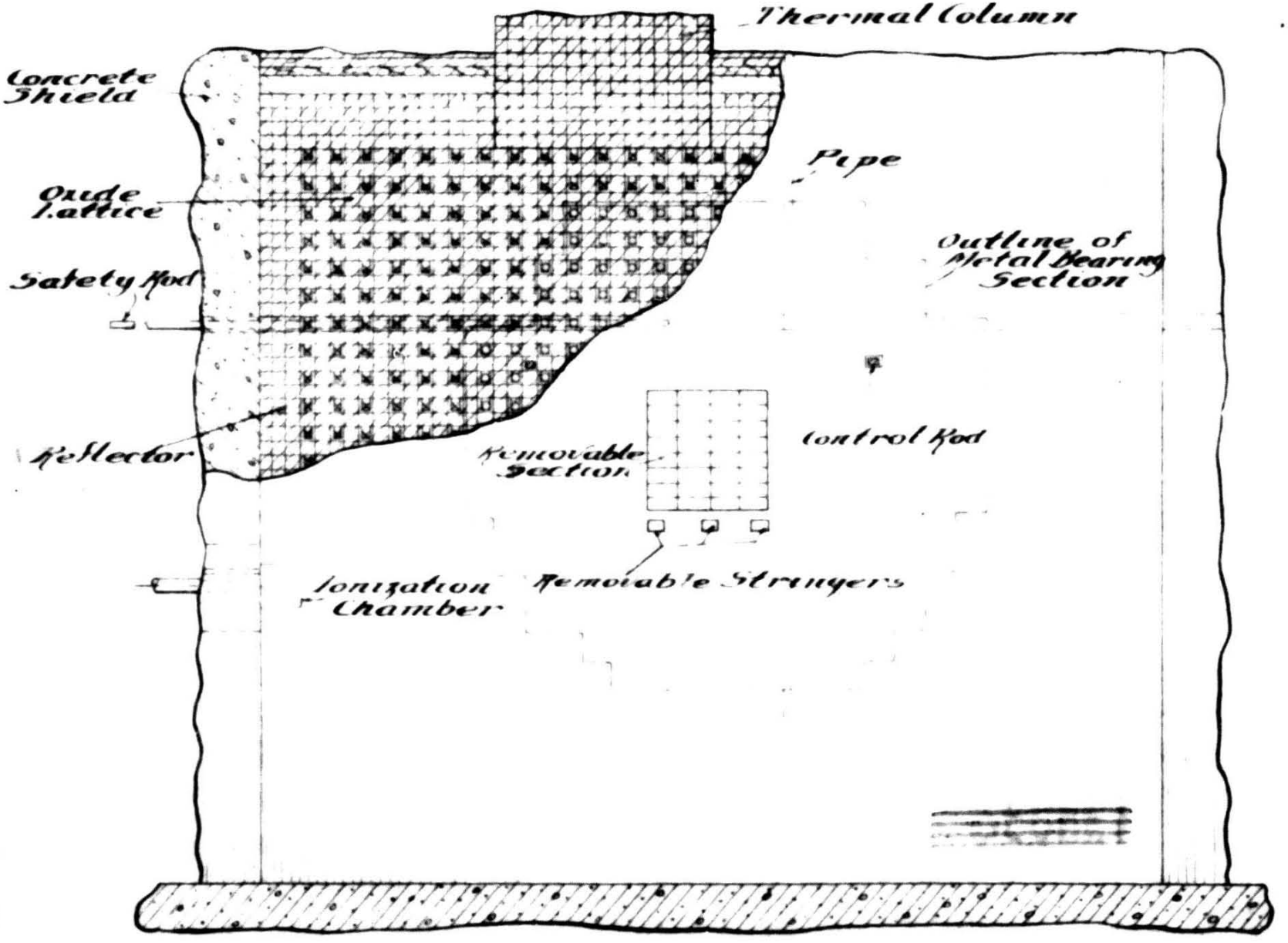


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FIG. 4. *Top Plan View, Horizontal Center Section in Part*

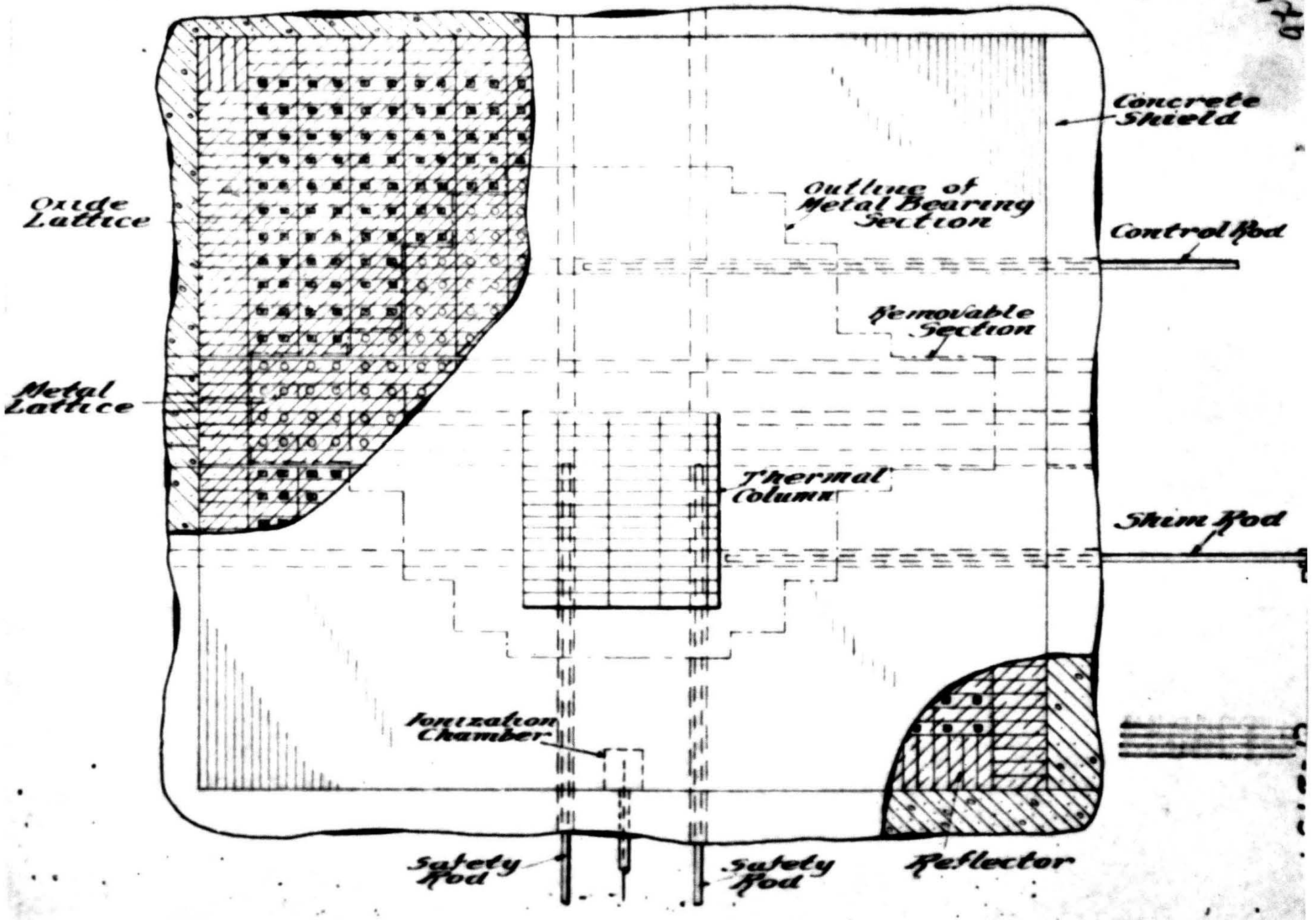

FIG. 5. *Side Elevation View Vertical Center Section in Part*

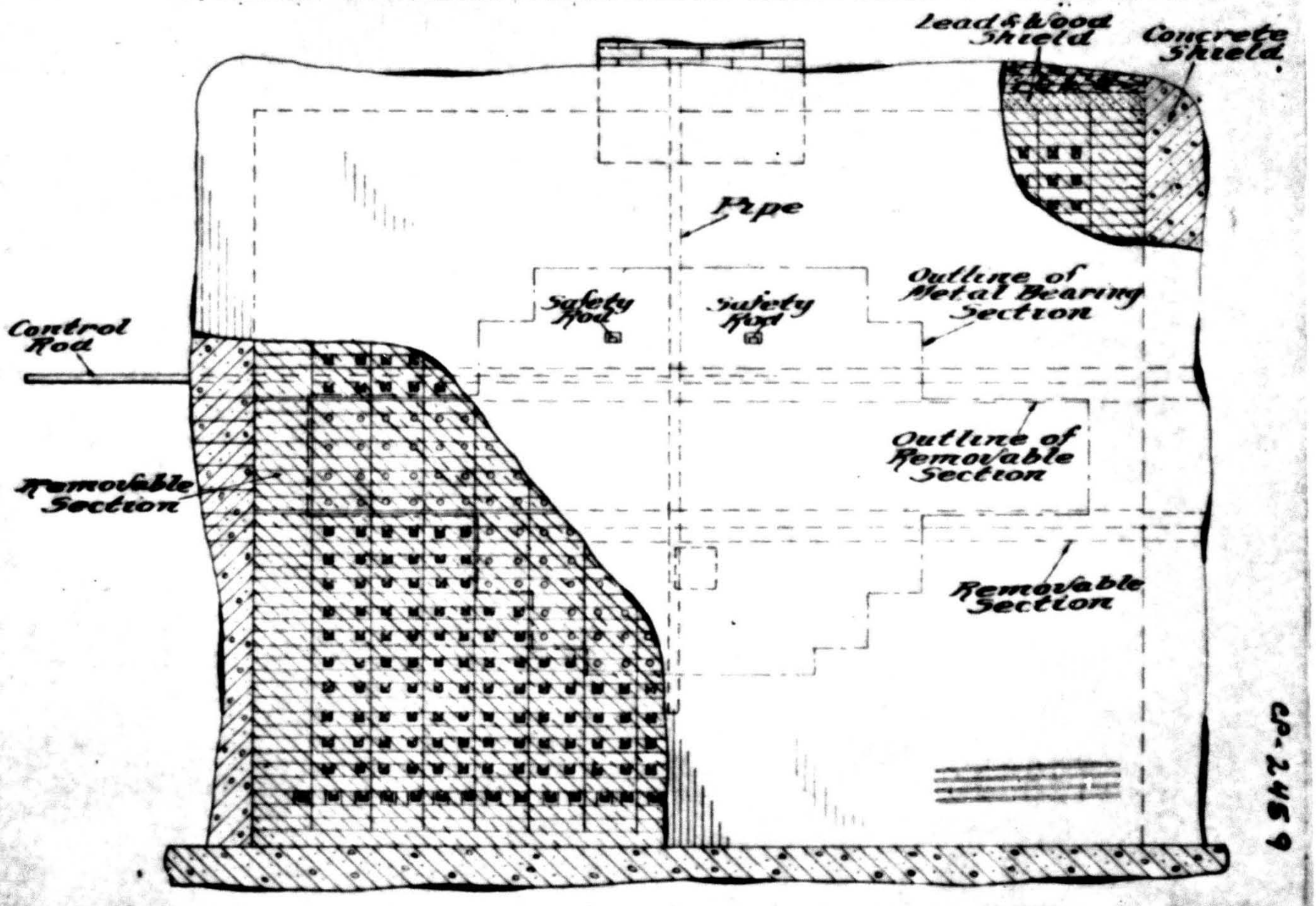


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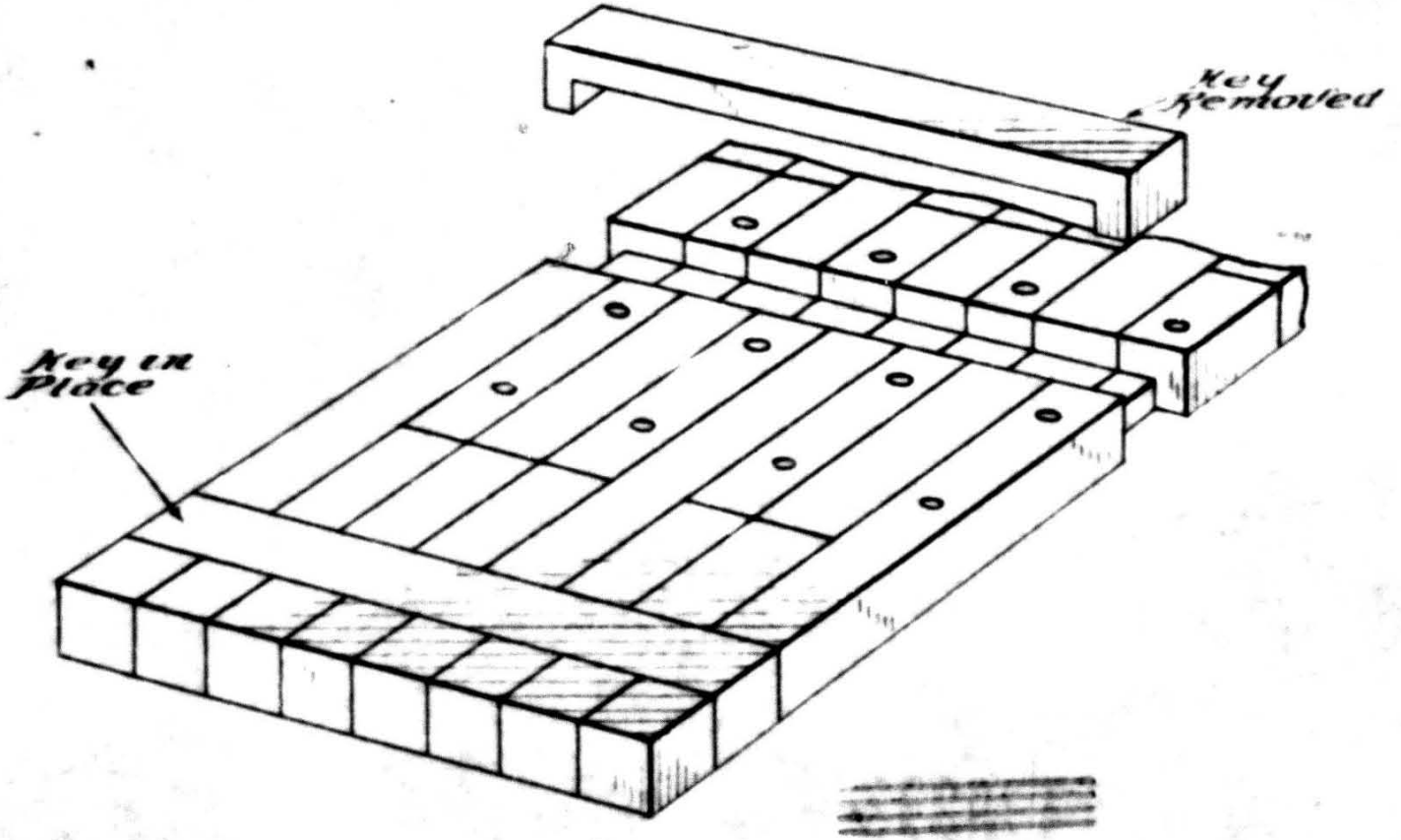
FIG.6.

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