NBS TECHNICAL NOTE

420

Drawings of Micrometer U-Tube Manometers For the Ranges up to 100 mm of Mercury

A. M. Thomas and J. L. Cross

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

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Alexander B. Trowbridge, Secretary
NATIONAL BUREAU OF STANDARDS • A. V. Astin, Director

TECHNICAL NOTE 420

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Allan M. Thomas and James L. Cross

Drawings with sufficient detail are presented so that micrometer U-tube manometers for use with mercury, oil, and water may be constructed. Measurements made with the oil manometer have an uncertainty of about 4×10^{-4} mm of Hg plus one part in 10^4 of the reading. Measurements made with the mercury manometer have an uncertainty of about 4×10^{-3} mm of Hg plus eight parts in 10^5 of the reading. The operation and an error analysis are described elsewhere.

Key Words: manometer, micrometer, U-tube, vacuum, medium-vacuum measurements.

1. Introduction

A family of U-tube manometers has been designed and constructed at the National Bureau of Standards to cover the range of pressures from 1×10^{-2} to 100 mm of Hg. In these instruments, the levels of the two liquid surfaces are measured by means of micrometers with conical points on the end of the spindles. The text and drawings collected in this Technical Note furnish the detailed information necessary for construction of these manometers.* Manometers were designed for use with mercury (Fig. 1) and with oil or water (Fig. 2). Measurements made with the oil manometer have an uncertainty of about 4×10^{-4} mm of Hg plus one part in 10^4 of the reading. Measurements made with the mercury manometer have an uncertainty of about 4×10^{-3} mm of Hg plus eight parts in 10^5 of the reading. A description of the operation of the manometers and a detailed error analysis has been published elsewhere and should be referred to before using this instrument for accurate measurements.[1]**

2. Construction Details

2.1. Micrometers

A sharp conical point ($\leq$ 0.003 inch radius), with an included angle of 30° or less is ground on the end of the spindles of standard micrometer heads with a two-inch range and with a vernier scale graduated to 0.0001 inch (0.00254 mm). The spindles are highly polished to provide an acceptable surface for a moving "O" ring seal. In the water manometer, stainless steel spindles are used. The micrometers are held in place by two 8-32 set screws.

*The National Bureau of Standards cannot give assurance that construction of these devices would not involve infringement of privately owned patents.

**Figures in brackets indicate literature references at the end of this paper.

2.2. Manometer Tubes

The glass manometer tubes are 1.5 inch precision bore pyrex tubing with two mm wall thickness and are one inch longer than the range of the manometers. The polished ends are parallel to within 0.003 inch and are chamfered on the inside and outside edges.

2.3. End Plates

The top and bottom end plates for the manometers (Figs. 3, 4, 5, 6, and 7) are stainless steel; however, other materials could be used if they are compatible with the system.

2.3.1. Vacuum Connections

Vacuum connections to be used depend on the use of the manometer, and therefore details have been omitted, but the approximate size and position of these ports have been scaled on the drawings (Figs. 3, 5, and 7). For greatest accuracy of measurement, four vacuum connections are used, two for pumping, and two for measurement; however, if large ports are used and if small gas loads are expected, two ports may suffice.

2.3.2. Liquid Connections

The holes in the bottom end plates (Figs. 4 and 6) connecting the two legs will result in over-damped motion of the particular manometer fluid. Damping can be reduced to the extent desired as discussed by Brombacher, Johnson, and Cross.[2] This may be accomplished by reducing the effective length for small changes in damping, or by increasing the diameter of the holes for larger changes. For the oil manometer, however, the connecting passage is shown about as large as is feasible.

2.3.3. Thermometer Wells

A hole drilled horizontally in the bottom end plate (Figs. 4 and 6) is used as a thermometer well for a three-inch immersion thermometer.

3. Assembly

Photographs of the mercury manometer (Fig. 1) and the oil manometer (Fig. 2) show the assembled instruments.

3.1. Levels

A level, sensitive to 16 sec of arc/div is mounted on the front of the end plate which bears the micrometers. A second, less sensitive, level (1 min of arc/div) is mounted on the base plate perpendicular to the plane of the micrometers. Mounting details are not included in these drawings.

3.2. Vacuum Seals

Gaskets cut from 0.010 inch Teflon sheet are used between the glass tubes and the end plates, and eight 10-32 socket head cap screws are used for clamping the assembly together.

Viton "O" ring seals are used at the vacuum ports and also for the moving seal around the micrometer spindle. The spindle diameter of the micrometers used is 0.235 inch, and 7/32 inch nominal I.D. "O" rings (dash number 009) are used for the moving seals.

3.3. Base Plates and Miscellaneous

The base plates and miscellaneous parts are shown in Figures 8, 9, and 10. The assembly of these parts is clearly shown in the two photographs (Figs. 1 and 2).

4. References

[1] Micrometer U-Tube Manometers for Medium-Vacuum Measurement, A. M. Thomas and J. L. Cross, J. Vac. Sci. and Tech. 4, No. 1, p. 1 (1967).

[2] Mercury Barometers and Manometers, W. G. Brombacher, D. P. Johnson, and J. L. Cross, NBS Monograph 8, Nat. Bur. Stds. (1960).

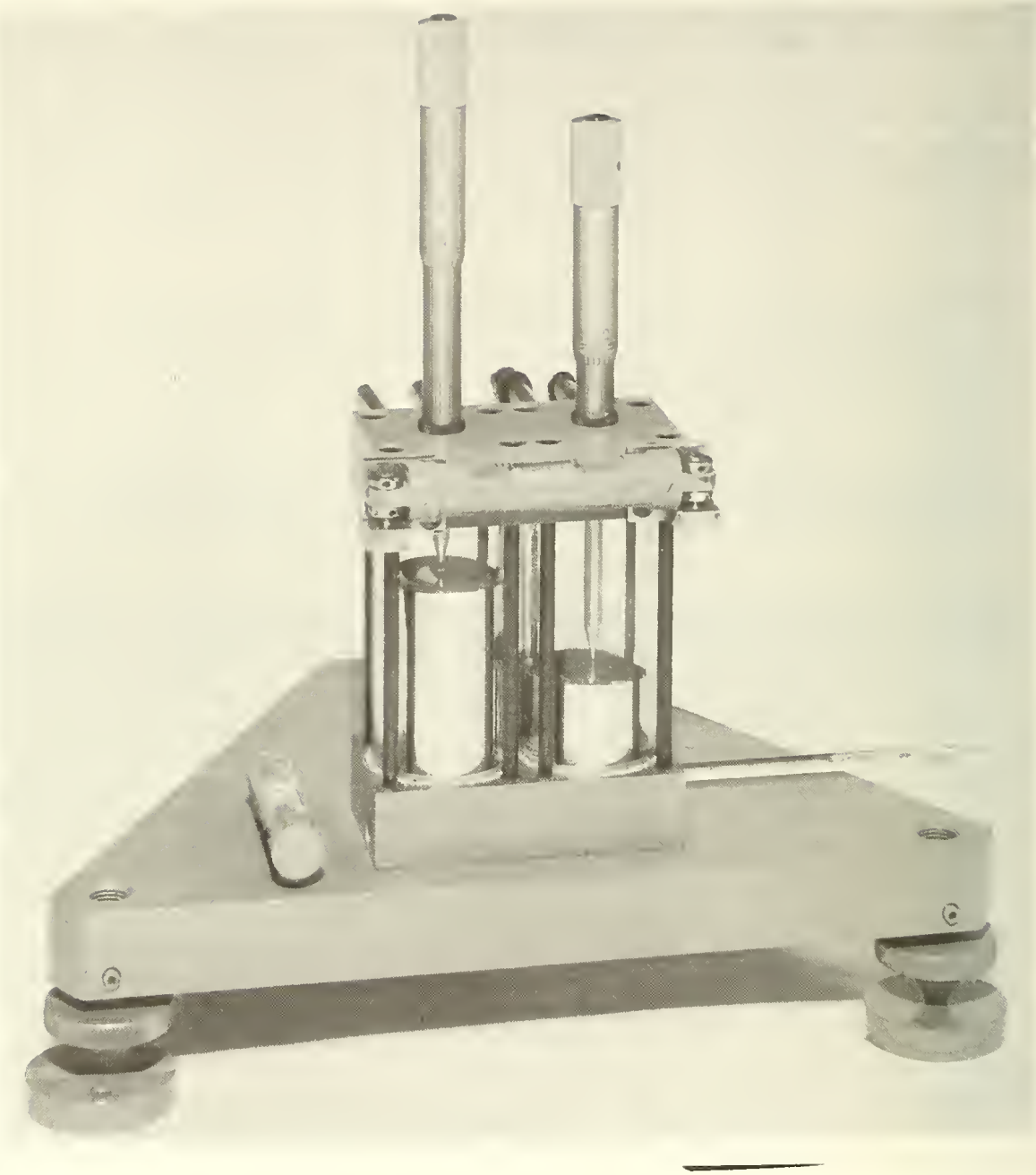


Figure 1. Mercury Manometer showing four pressure connections from rear of top plate.

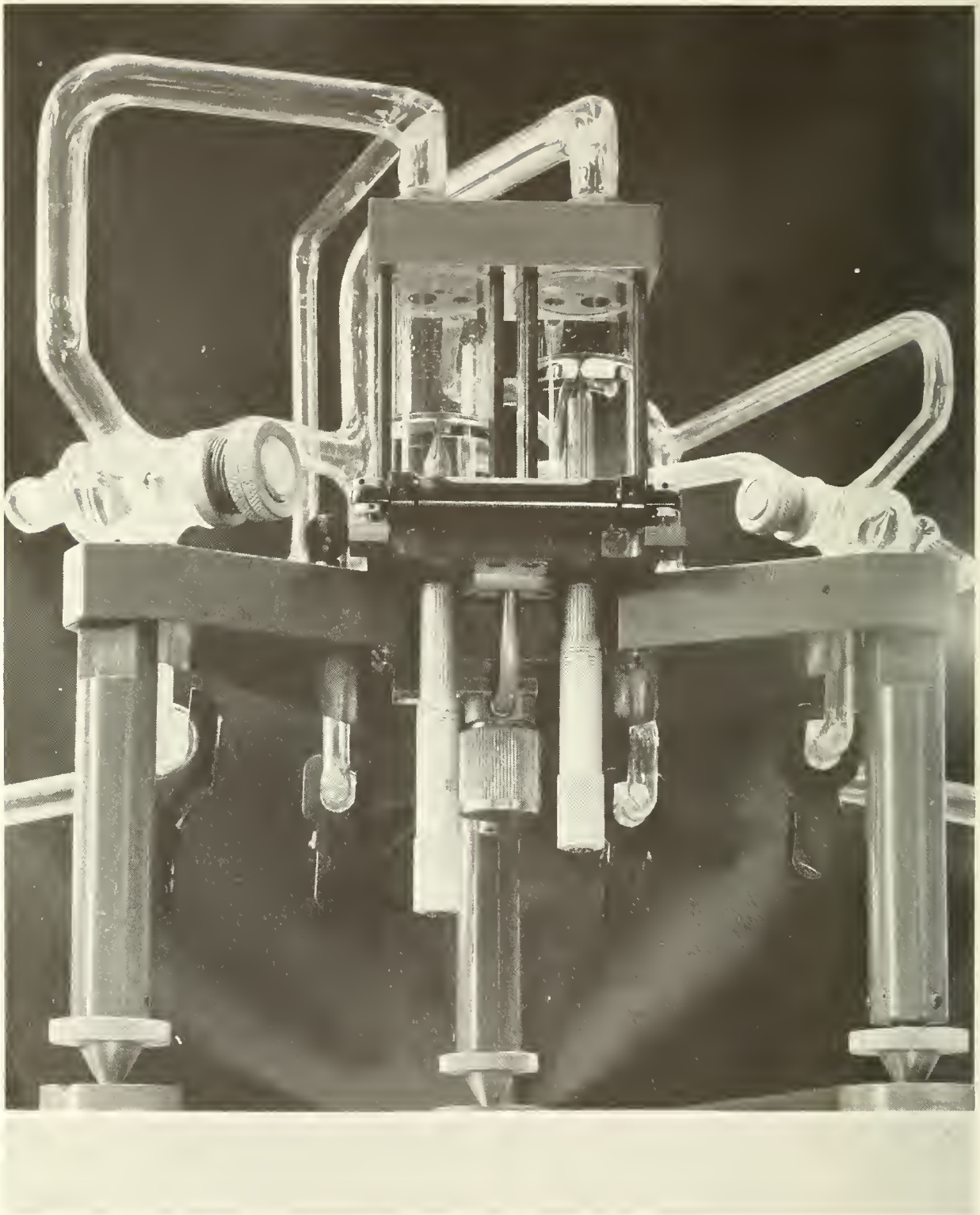


Figure 2. Oil Manometer with index points approaching the liquid surface from below.

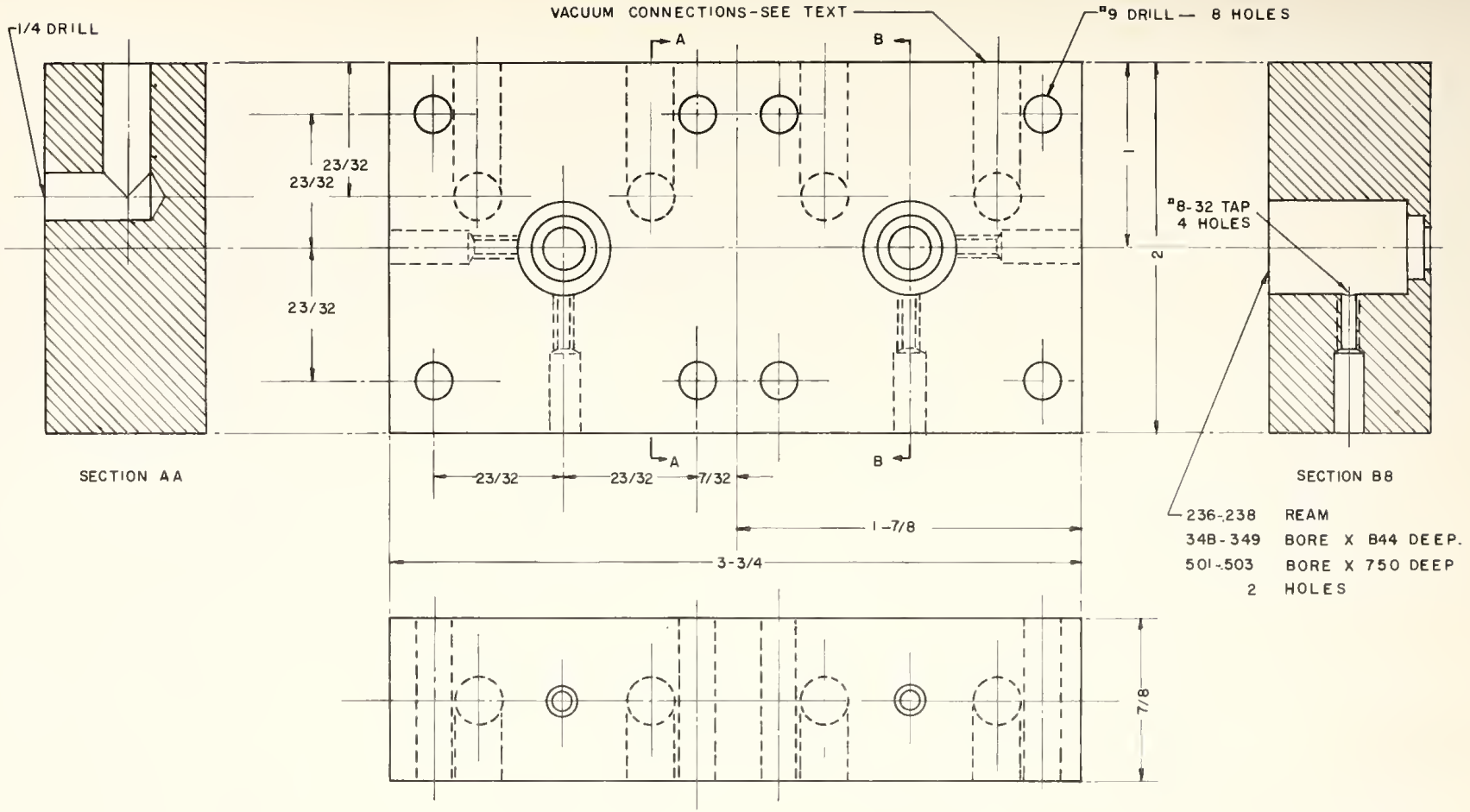


Figure 3. Top Plate - Mercury Manometer.

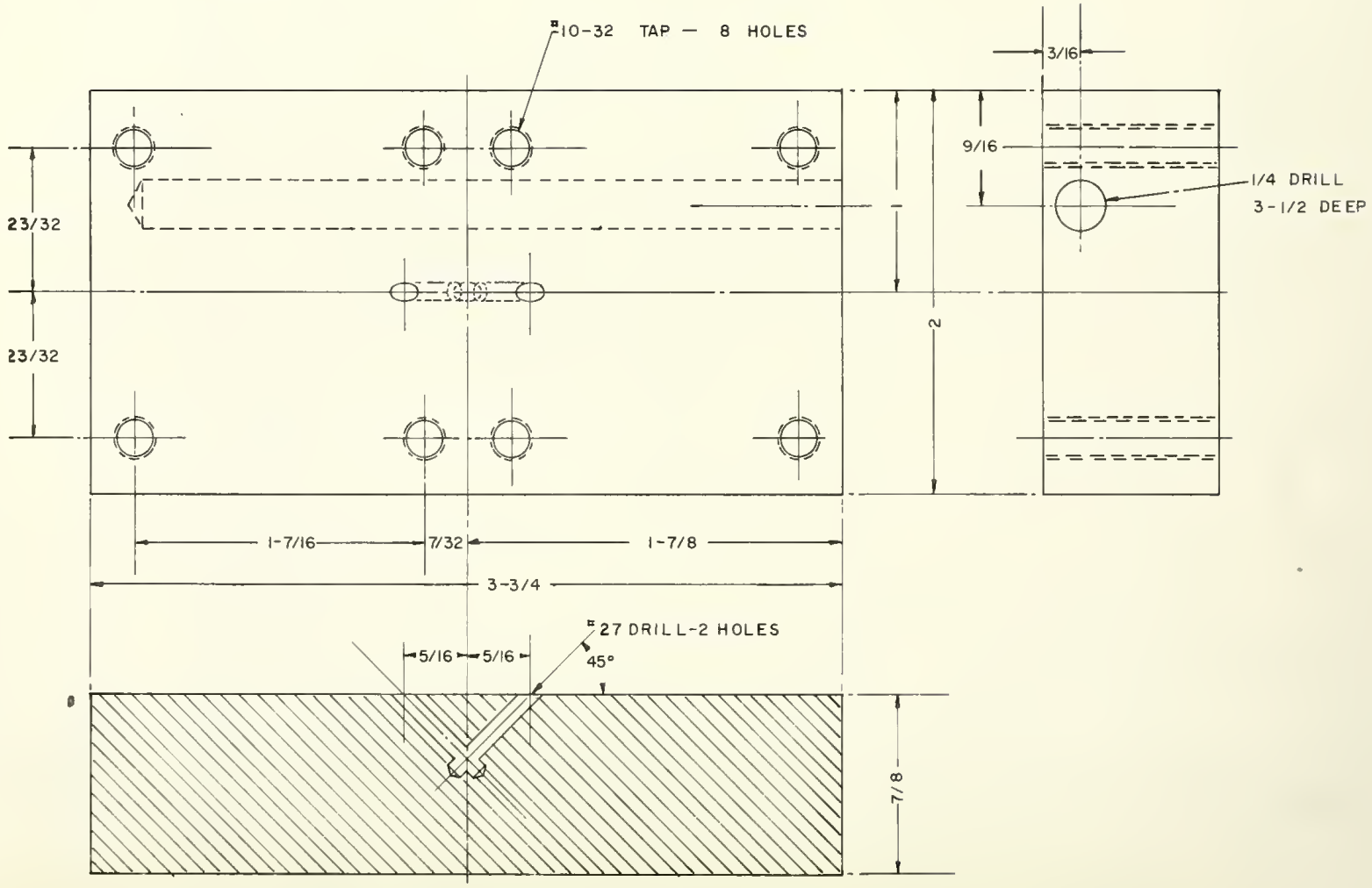


Figure 4. Bottom Plate - Mercury Manometer.

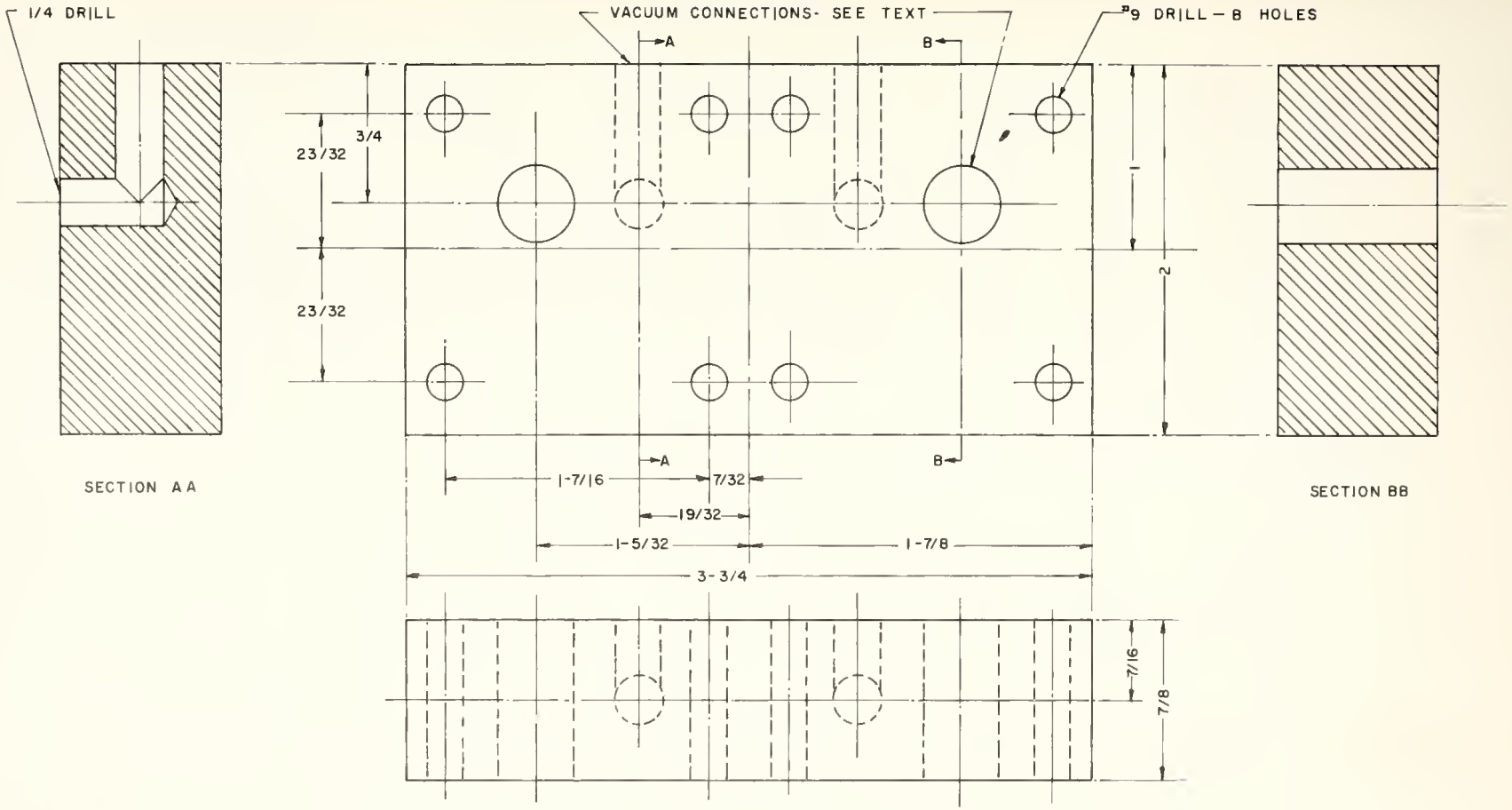
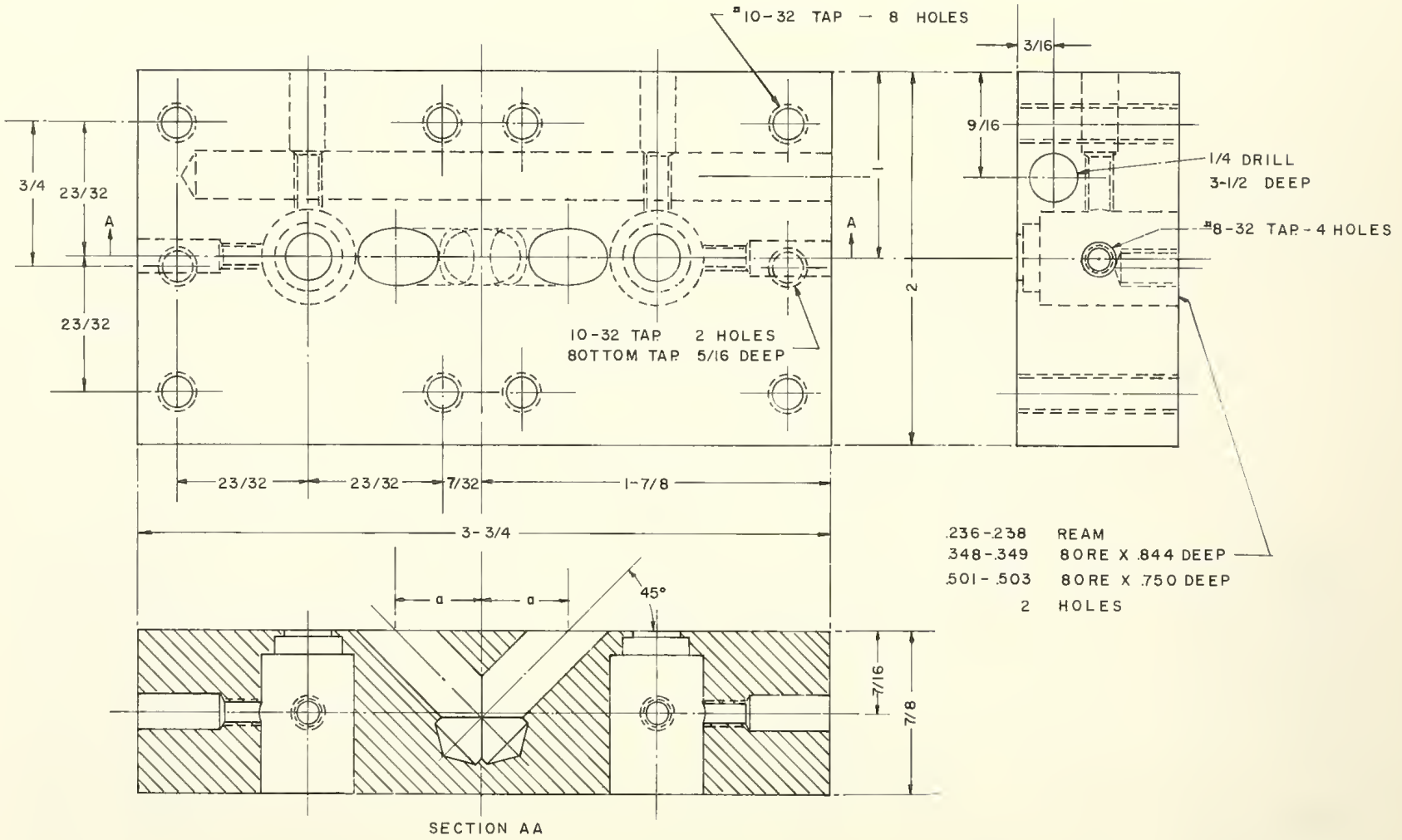


Figure 5. Top Plate - Oil Model.



	DIM. a	HOLE SIZE
OIL MANOMETER	15/32	.316 DRILL 7/8 DEEP
H_2O MANOMETER	9/32	.1065 DRILL 9/16 DEEP

Figure 6. Bottom Plate - Oil and Water.

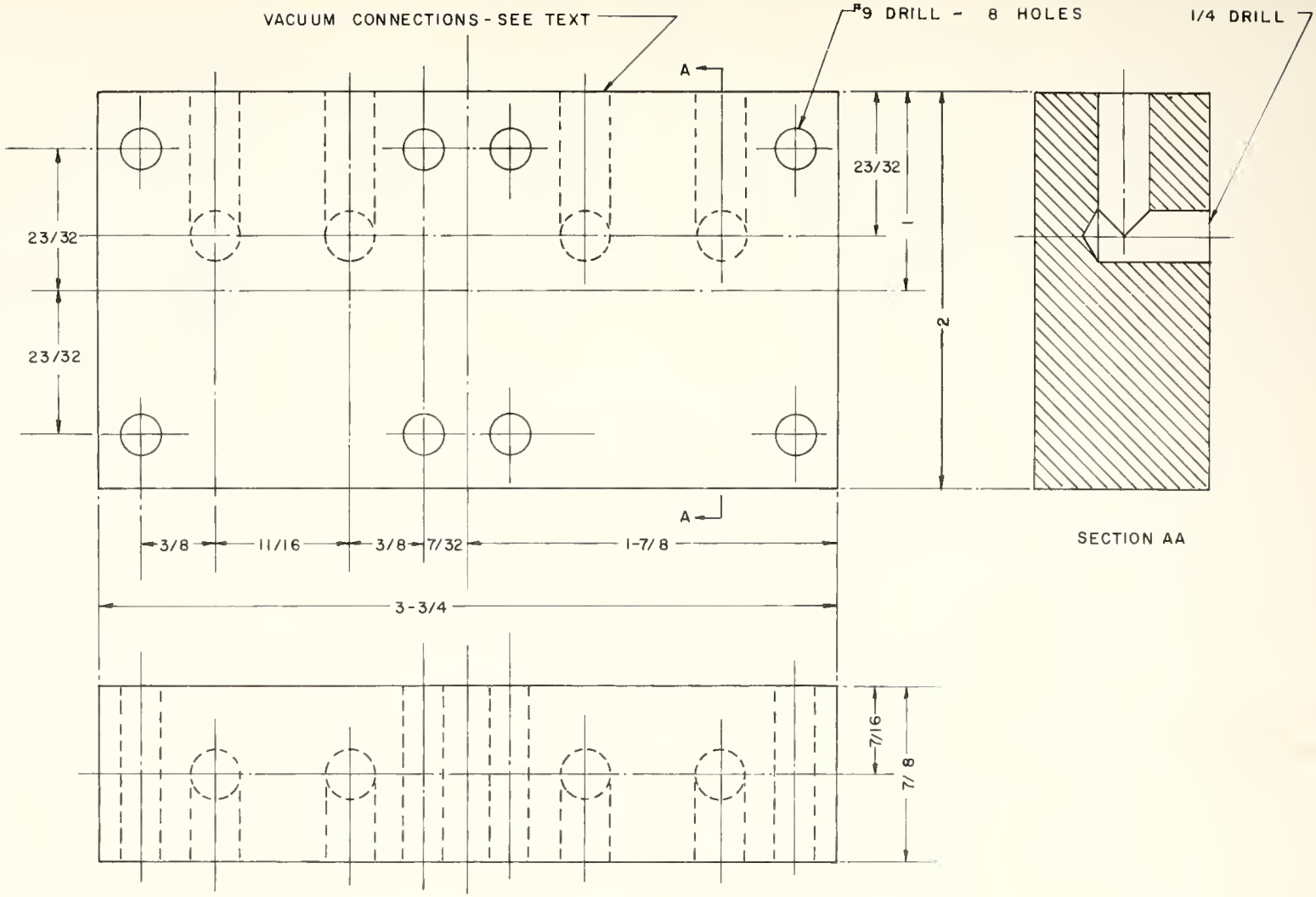


Figure 7. Top Plate - Water Model.

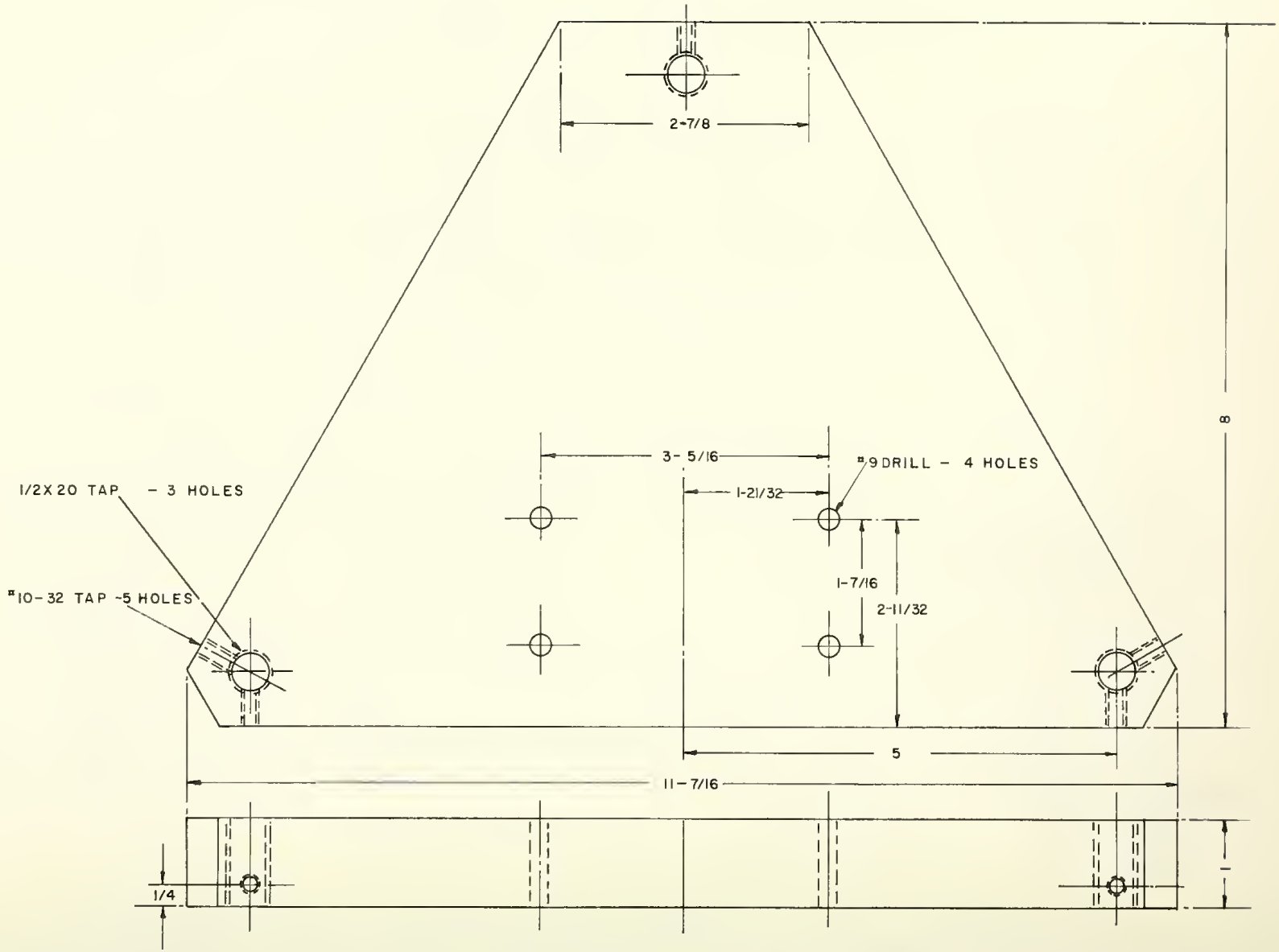


Figure 8. Base Plate - Mercury Model.

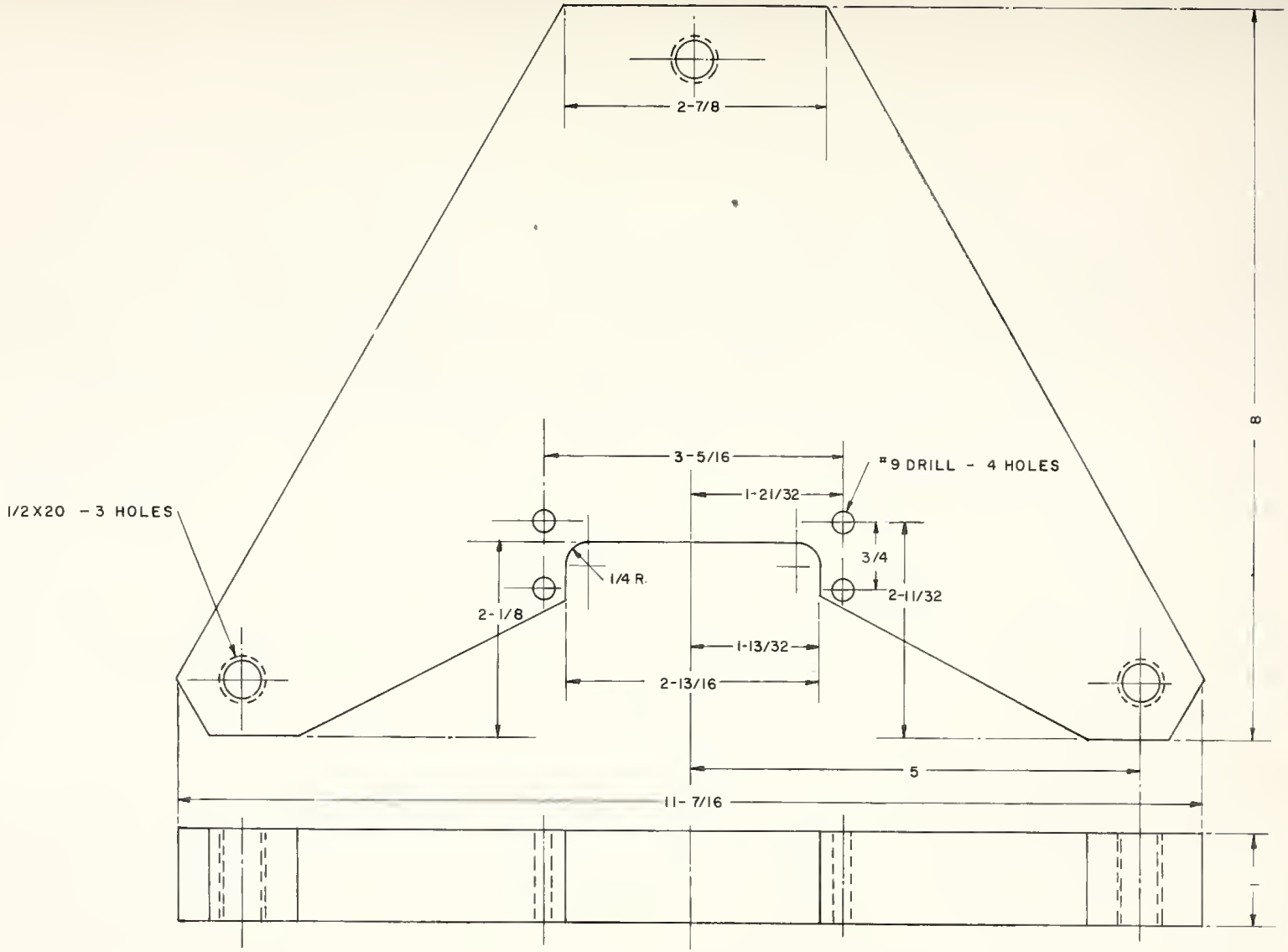
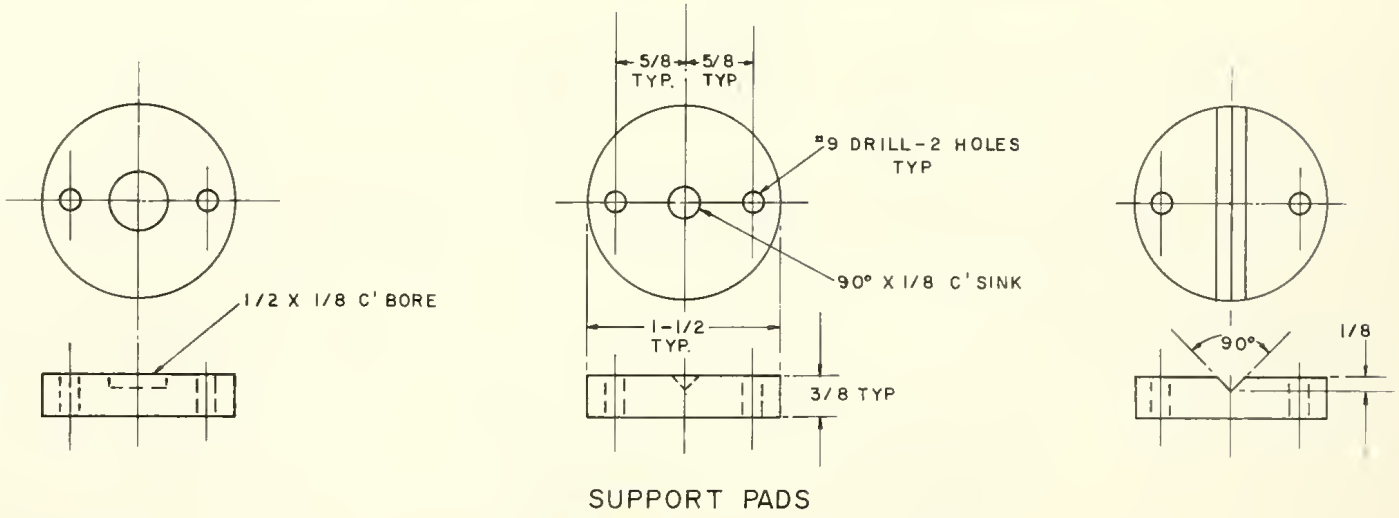


Figure 9. Base Plate - Oil and Water.



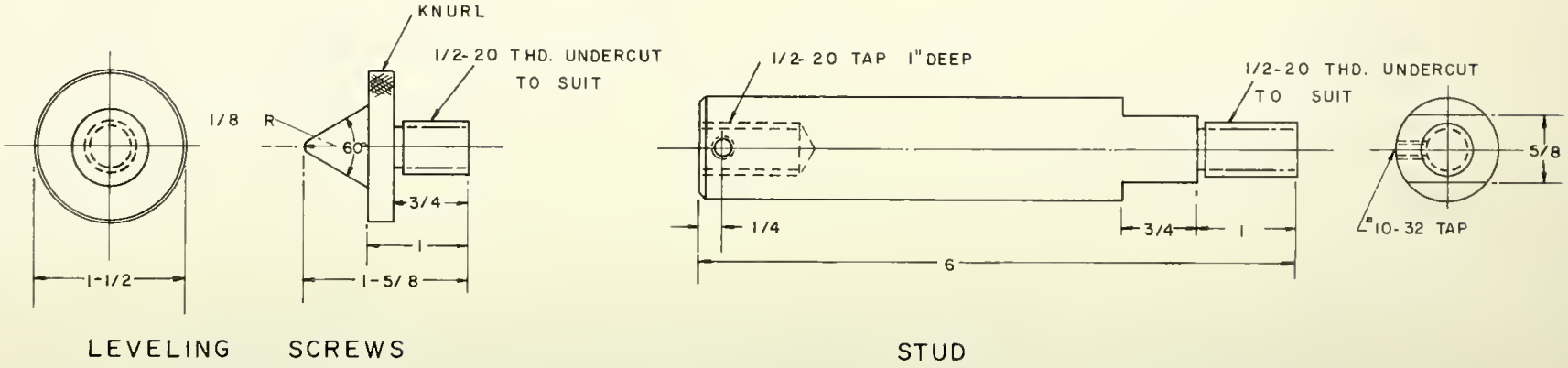


Figure 10. Miscellaneous Parts.

* U.S. GOVERNMENT PRINTING OFFICE: 1967—301-018/12

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