Memo Report C-54-161

CHEMISTRY RESEARCH DEPARTMENT

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HIGH-PRESSURE, HIGH-TEMPERATURE APPARATUS: THE 15° "BELT"

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Abstract: The 15° "Belt" was designed to give greater support to the most highly stressed components than that afforded by the previous 6.9° design. Features of the new design and its pressure calibration are give.

The 15° "Belt" (See Figs. 1, 2, 3 and 4) was designed to give more support to the carboloy chamber than that given by the 6.9° design.[1] This was done to obtain great life at 100,000 atmospheres and offer the possibility of pushing beyond this pressure. The greater angle permits the use of a greater mass of steel close to the chamber where it is most effective in giving support. It also allows increasing the surface area of the chamber where it is supported by binding rings by 20% without increasing the chamber diameter. Compare the drawings of Ref. 1 with those of this report to see the difference in design. Note the increase in the diameter of the Binding rings in the 15° design. This was done to further increase chamber support. A higher alloy steel, SAE 4340, has been used for the 15° design.

To avoid crumbling of the carboloy chamber A (see Fig. 4), the various rings must be assembled as follows: (1) push C in D, (2) place B in C as far as it will go with its own weight, (3) place support under B and push A all the way into B, (4) support C and push B (together with A) into C. By utilizing this procedure, ring C offers safety protection against the bursting of ring B and the force required to push A into B has been materially reduced over that required to push A into B with B pushed all the way into C.

A slight change in conical piston design has also been made. The piston has been shortened 0.050 inch (10% of the length protruding from the binding rings). At the same time, the radius on the piston shoulder has been reduced from 0.50 inch to 0.350 inch. This makes the shoulder contour of the piston fit the contour of the chamber instead of "breaking away" from it. These changes were made in a move to increase piston life at 100,000 atmospheres. Shortening the piston, shortens the "ties" into the carboloy mass at the base of the cone and should give increased strength. Making piston shoulder contour fit the chamber contour was intended to increase the load on the gasket at greater radial distances from the centerline of the system. More load at greater radial distances should increase the support to the piston and chamber, giving increased life to these components. It was anticipated that the 15° "Belt" would require about 20% more press load to obtain the same pressure as that in the 6.9° "Belt". In practice, the calibration plot of the new system was found to be identical with that obtained for the 6.9° "Belt". Experience with the 15° apparatus is too limited at present to determine if expected increased life will be obtained.

A new water cooling arrangement has been designed and is presently being used with all "Belt" equipment. A spray of water is directed in the vicinity of the conical pistons on each side of the chamber by a water spray ring (see Fig. 5). The overflow is collected in an "O" ring gasketed catch pan that slips over the lower piston assembly. To prevent short circuiting, the faces of the piston assemblies, the chamber assembly and the water spray ring have been given a coat of insulating varnish.

Current conducting rings surrounding the piston assemblies have been eliminated. Current leads are now attached to the hardened steel bosses which back up the piston assemblies. Current passes from the bosses to the pistons through the base of the piston. The top piston assembly is held in place by a split ring. The lower piston is held in place by gravity. Elimination of the current rings makes piston removal rapid when equipment changes are desired.

The 15° design, in increasing the support provided the chamber, of course reduced the lateral support provided to the conical pistons. Ring B (Fig. 3) of the piston assembly when made of SAE 4140 steel hardened to Rc 48 will usually break in use if the inside dimensions are made 0.002 inch smaller than those given. The support given by the dimensions given, however, seems to be entirely adequate.

The apparatus was calibrated using transitions in bismuth, thallium, cesium and barium as previously described. A calibration plat is shown in Fig. 6 where points are compared with the previous calibration for the 6.9° apparatus. Individual transitions are shown in Figs. 7, 8, 9 and 10. Transitions are for the second cycle; the first cycle being a compacting cycle (see Ref. 1).

Dimensional details of the apparatus are given in Figs. 1, 2, 3 and 4. The stone and metal chamber components are the same as given in reference 1.

H. Tracy Hall

[1] H. Tracy Hall, The "Belt": Ultra-high-pressure, High Temperature Apparatus, RL-1064, March, 1954.

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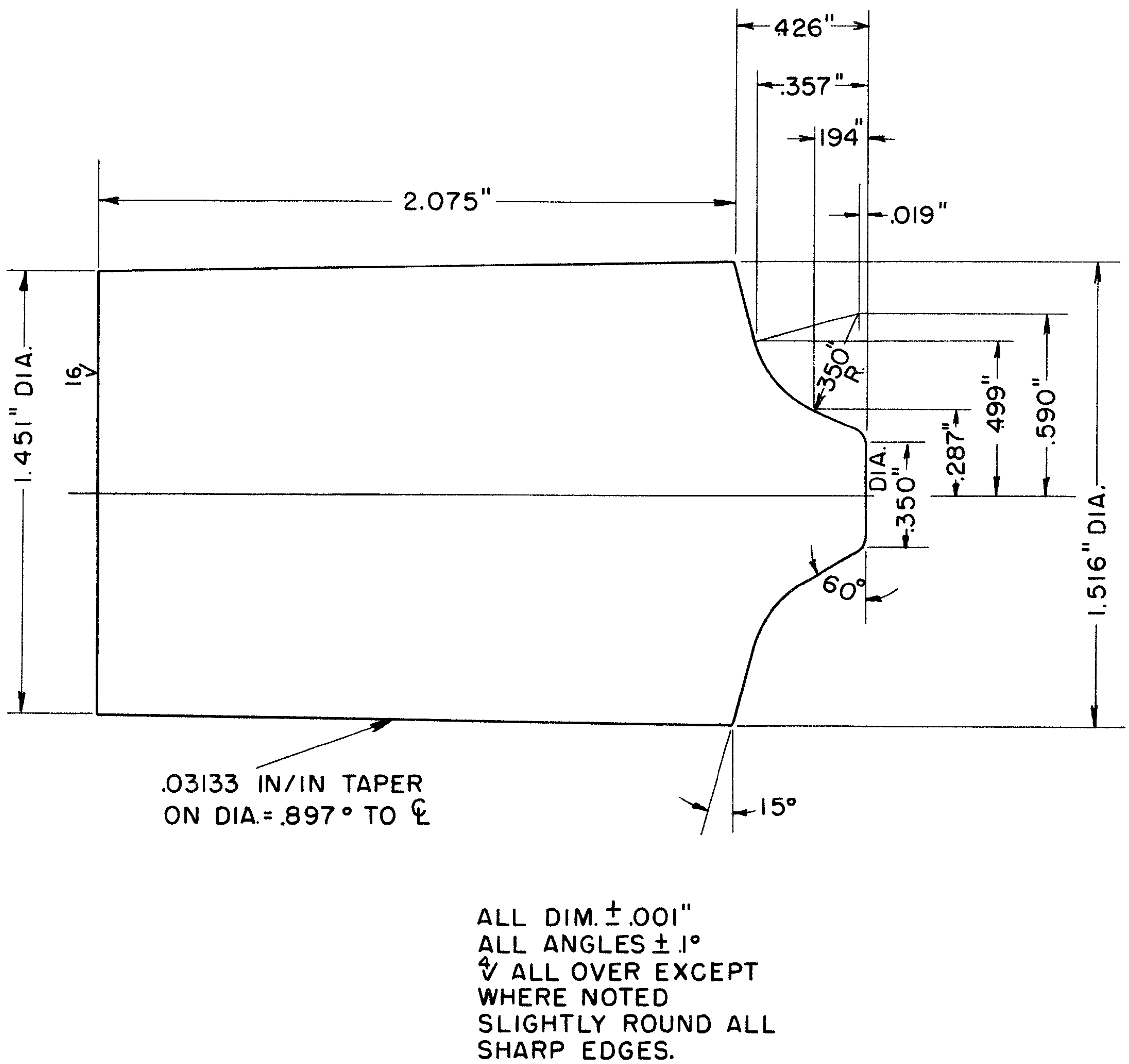
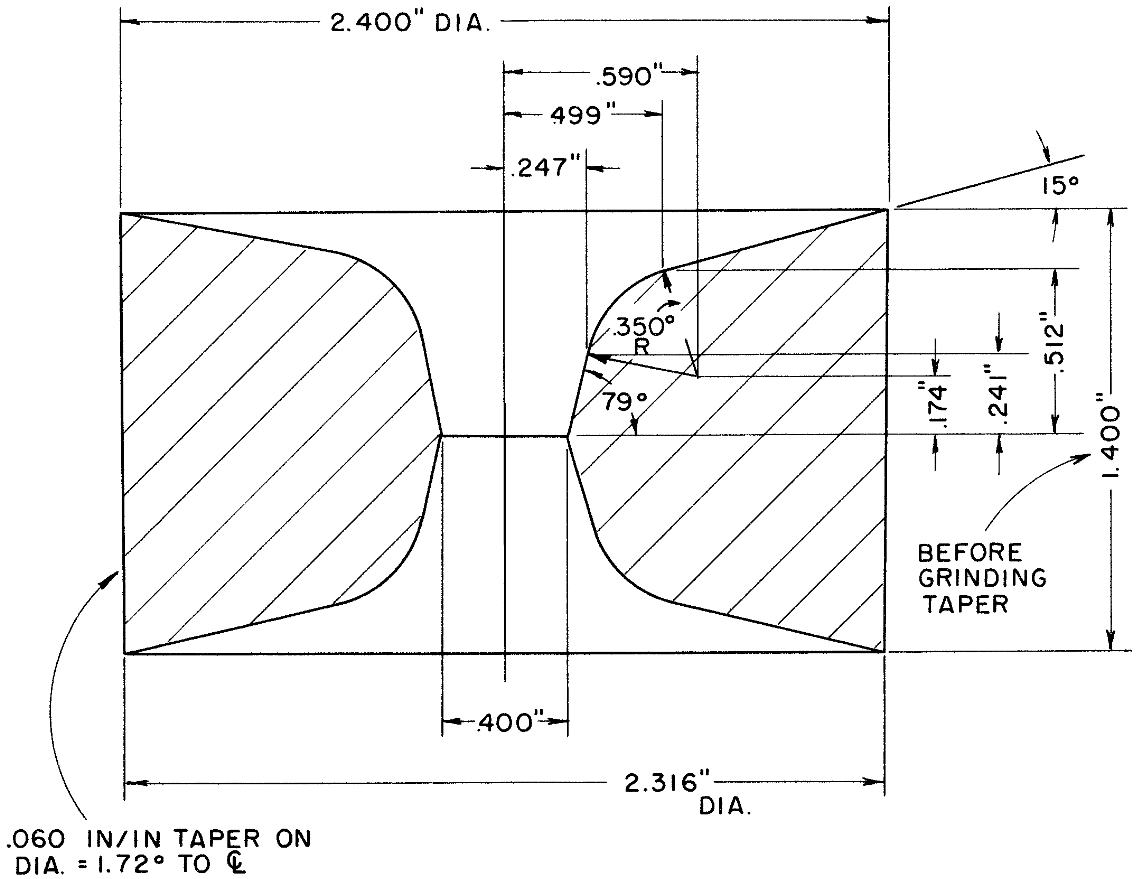


FIG. I PISTON 15° BELT



ALL DIM. ± .001
ALL ANGLES ± .1°
4 FINISH EVERYWHERE
SLIGHTLY ROUND ALL
SHARP EDGES

FIG. 2 CHAMBER 15° BELT

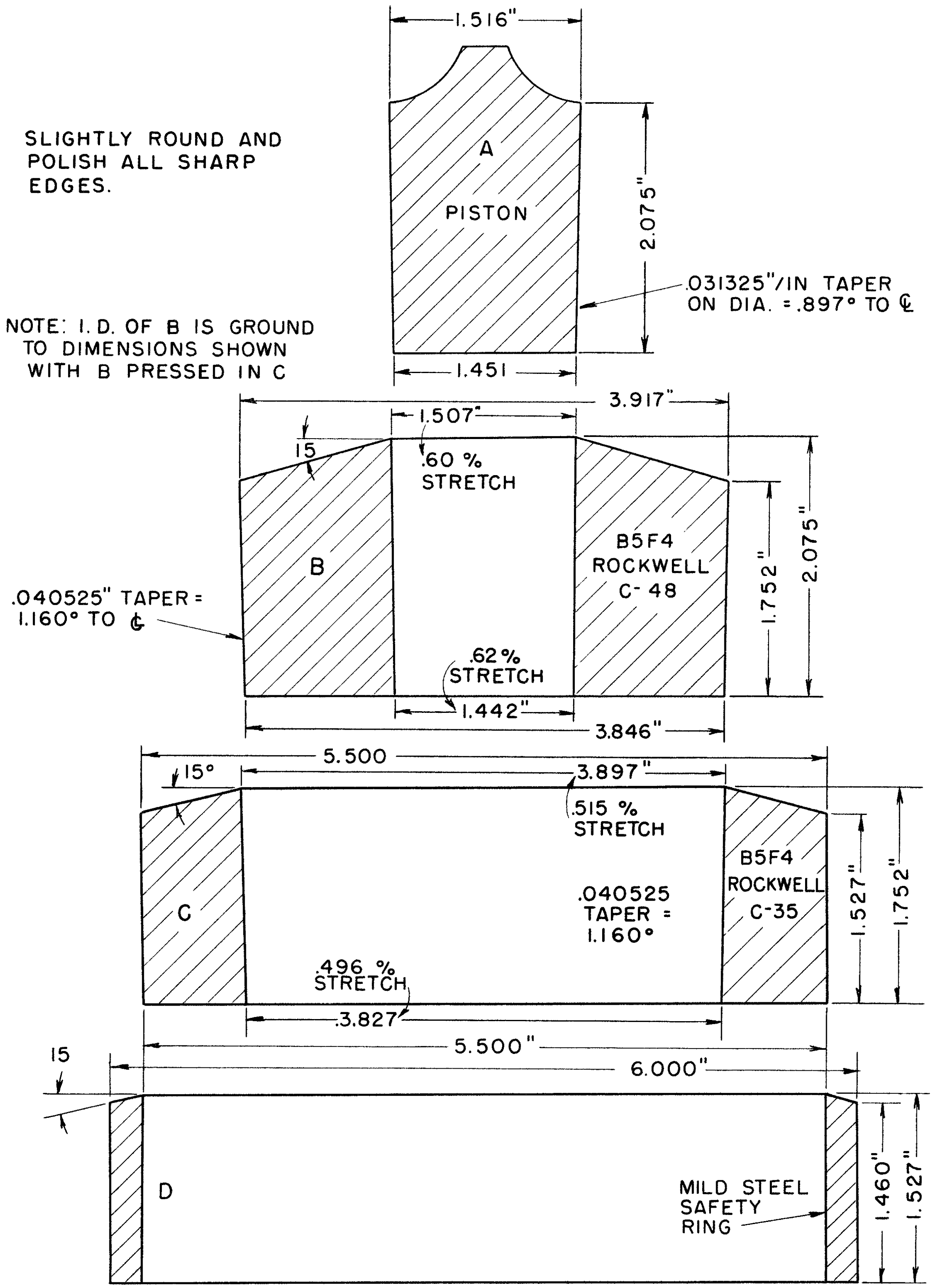


FIG. 3 PISTON ASSEMBLY 15° BELT

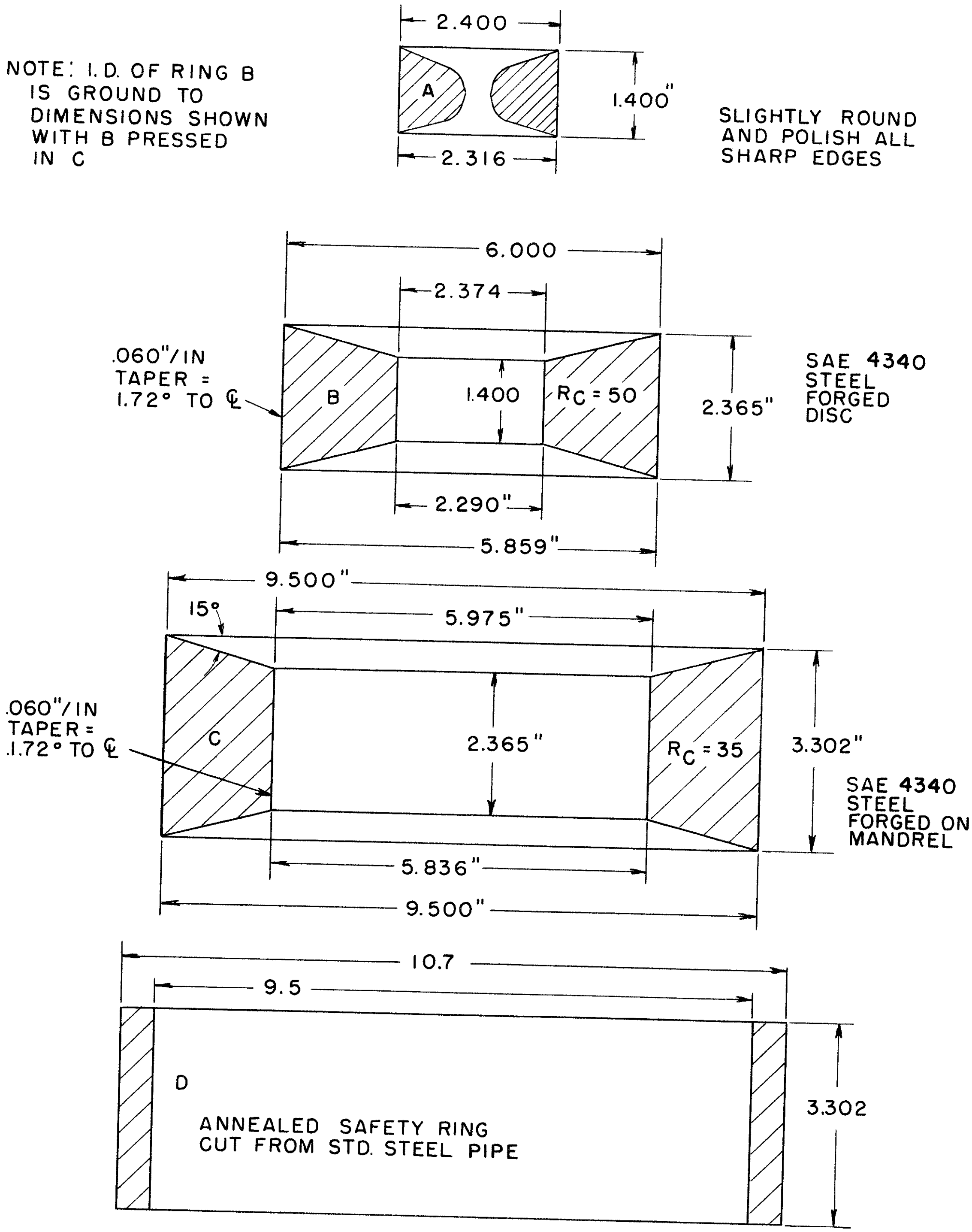


FIG. 4 CHAMBER ASSEMBLY 15° BELT

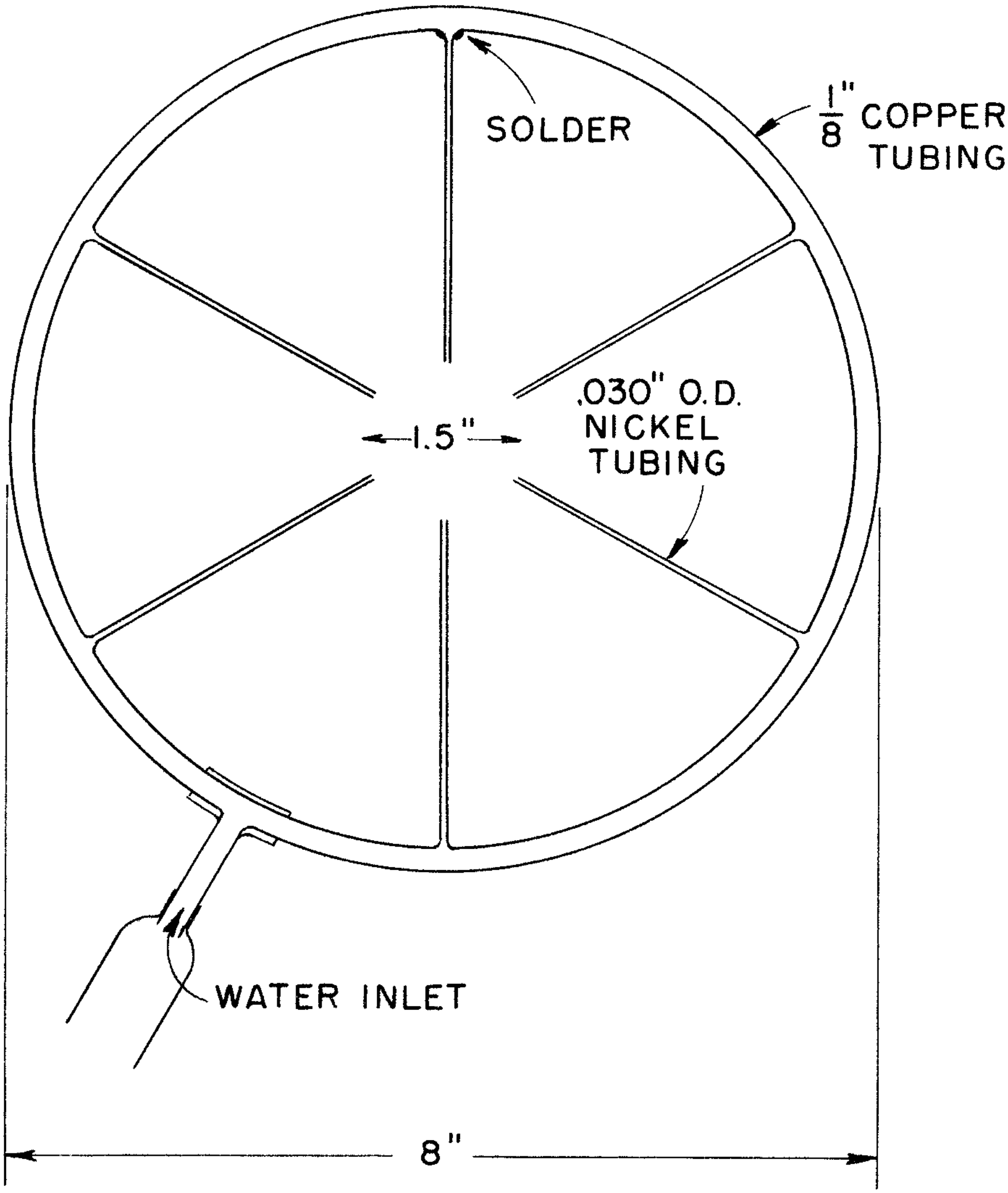


FIG. 5 WATER SPRAY RING

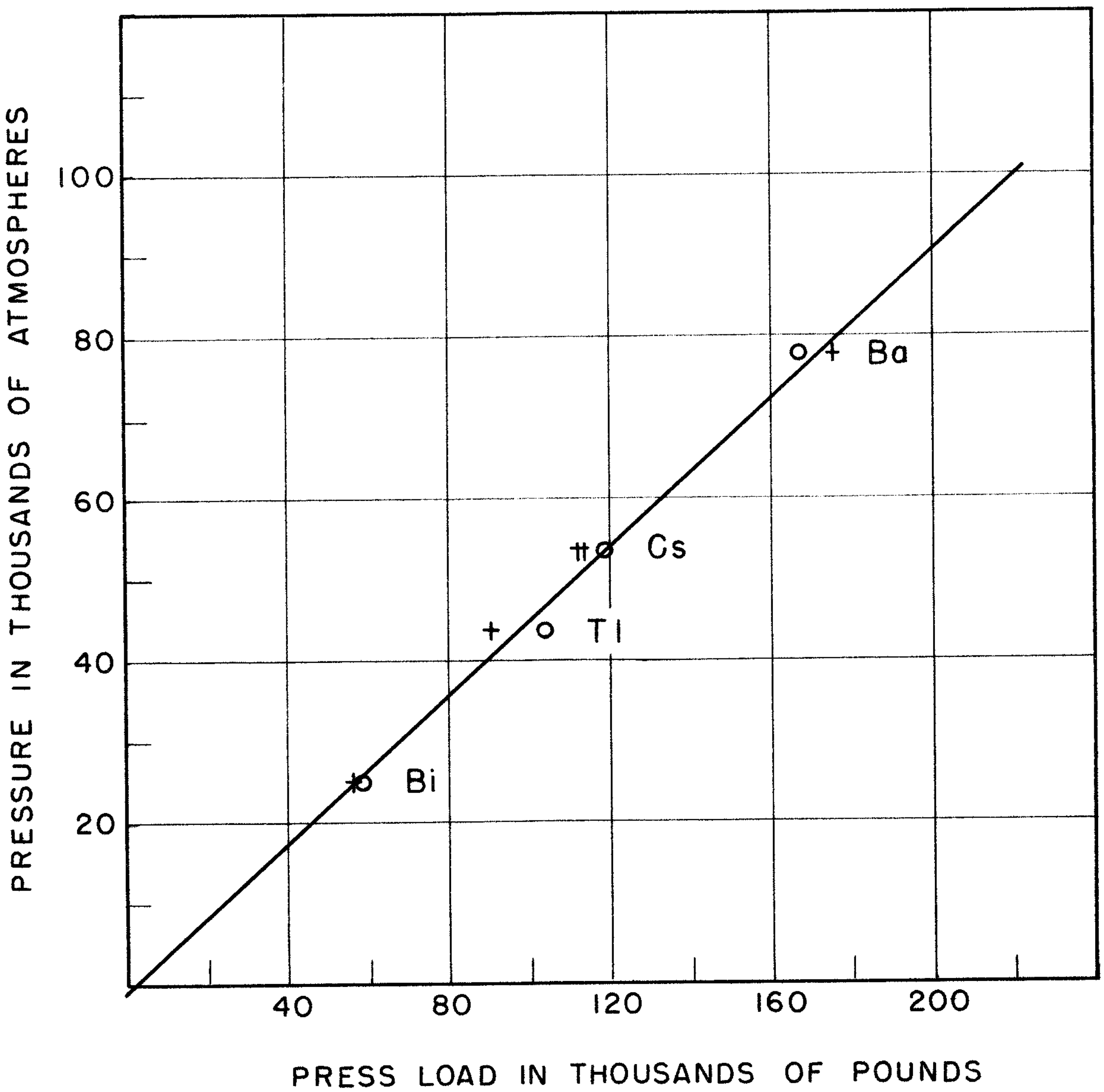


FIG. 6 PRESSURE CALIBRATION
o = 15° BELT, + = 6.9° BELT

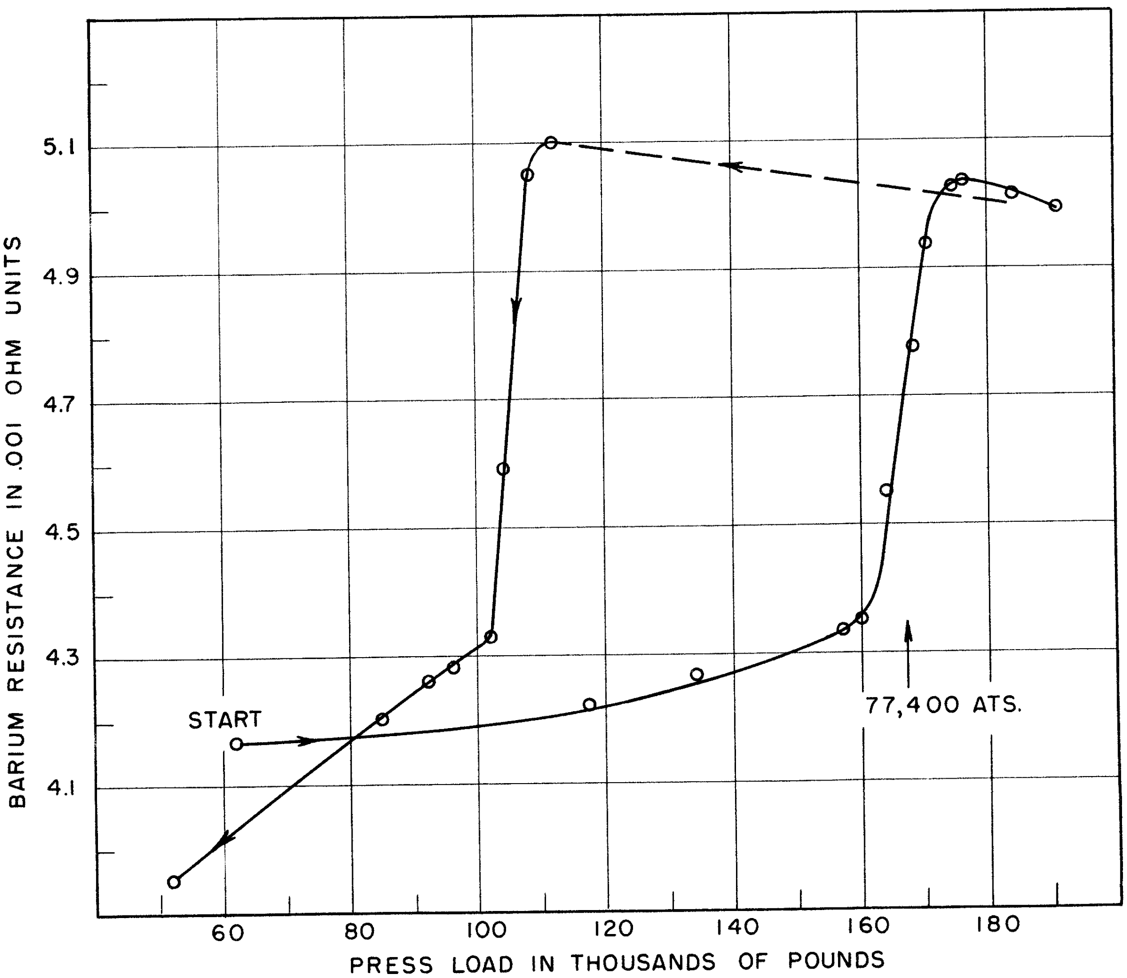


FIG. 7 BARIUM TRANSITION 15° BELT

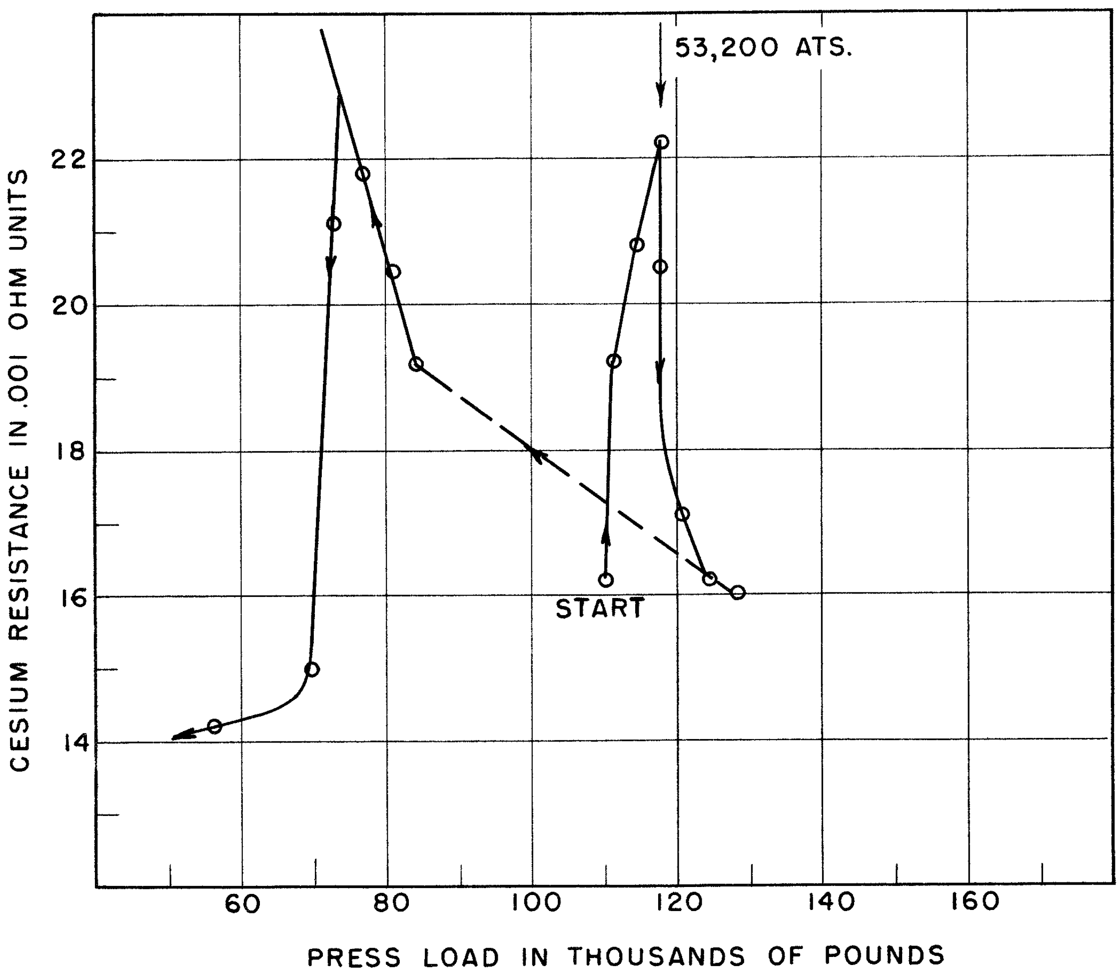


FIG. 8 CESIUM TRANSITION 15° BELT

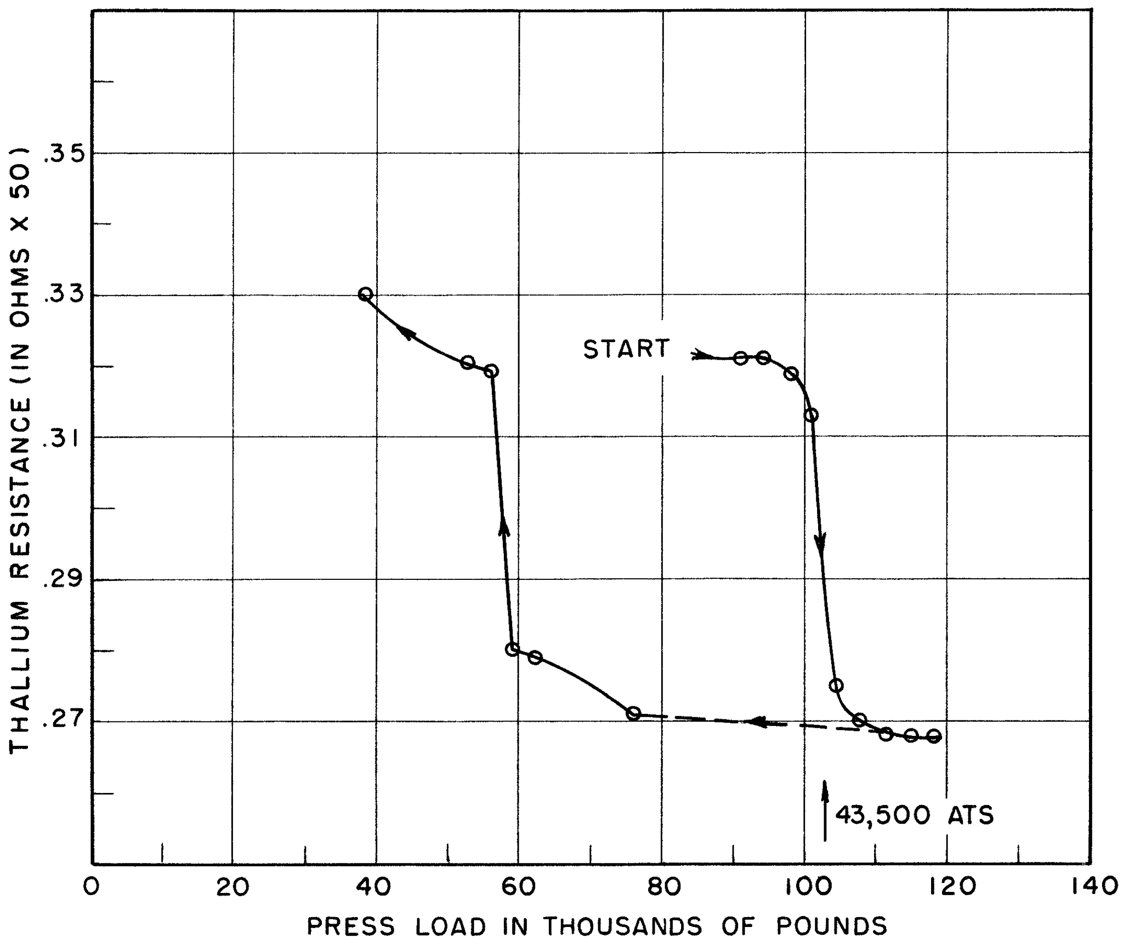


FIG. 9 THALLIUM TRANSITION 15° BELT

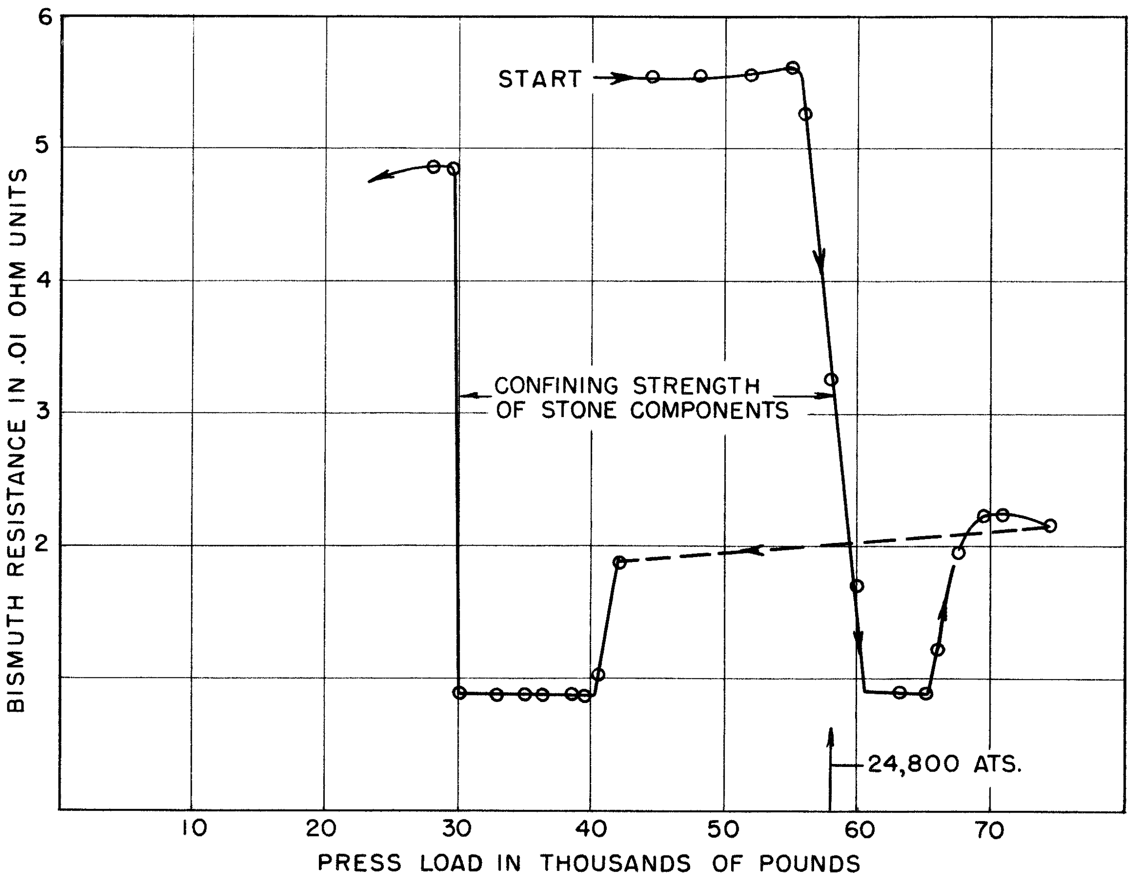


FIG. 10 BISMUTH TRANSITION 15° BELT