The University of Alabama in Huntsville

Center for Environmental and Energy Studies

P. O. Box 1247

Huntsville, Alabama 35807

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Quarterly Progress Report

for

September 11 - December 10, 1975

INTEGRATED REAL TIME CONTAMINATION MONITOR

IRTCM

NAS8-31174

W. E. Luttges
Principal Investigator

Prepared for:

National Aeronautics and Space Administration

George C. Marshall Space Flight Center

Marshall Space Flight Center, Alabama 35812

SUMMARY

The preparations for a sampling of the ozone layer on a balloon flight are continued. Technical difficulties arose with the valving of the evacuated sampling flask. Considerable time was spent to re-design valve seat and seal to make the valve perform at a vacuum of 10^{-7} Torr.

Design Changes, Package

Several changes in the package design of IRTCM were made involving electronics, Dust-Fall, Humidity monitor and the mass spectrograph location. Two sets of package drawings and artwork were fabricated. The location of the above components was rearranged. A different system of humidity monitor was used which required also a re-orientation of its location. The drawing originals and the subsequent artwork are at present at NASA.

Balloon Flight Sampling System

Valve

The absorber system was manufactured and equipped with solenoid valves obtained by purchase. These valves were found to be inadequate for holding the high vacuum (10^{-7} Torr) required by the sampling bottle. The valve poppet, in all experiments, never gave a seal for a vacuum better than 10^{-4} Torr and modifications in seat poppet material and design, as well as use of a variety of o-ring materials (Teflon, Viton, Silicone, Rubber), did not improve the leak conditions beyond 10^{-5} Torr. A vacuum condition of tight seal is required for the sampling bottle in the order of 10^{-7} Torr to cope with the system and the use of gas chromatograph/mass spectrometer combination for analysis of the collected gases. This can only be achieved by increasing the pressure onto an o-ring seal into the order of 16-18 pounds. Under these conditions, the present design of the valve is inadequate as the solenoid will not have the power to overcome this pressure. A re-design using either a geared-down motor drive or using a pneumatic operation of the valve is, therefore, indicated. This is the present state of our approach and the modifications involved.

Septum

The lower end of the sampling bottle, when baked out and ready for sampling, consists of a septum array holding a silicone rubber septum similar to those used in a gas chromatograph. This permits access to the sampled gases upon return from flight and when the sampling vial is baked out and flushed out of its gaseous contents. From this septum, the gases are introduced into either a cryogenic gas trap or into the GC-MS septum directly. A gas-trap system is favorable as it permits a specific release (and thus an even better classification according to boiling points of the gases) than can be obtained by shear gas-chromatic separation in an absorber column. A septum holder was designed for this purpose and machined out of Kel-F.

Ethylene Bottle

For the ozone determination, the reaction of O_3 with Ethylene is used and the amount of Ethylene oxide obtained is then a direct means of measuring the concentration of ozone available at the sampling point. For this purpose, only a small amount of Ethylene is needed, and for high altitude sampling the amount of Ethylene is then in the order of a few milliliters at standard ground (sea level) pressure. In the original design, a solenoid valve identical to the main inlet valve to the sampling vial was used. This particular valve, strangely enough, did perform properly as no trace of leakage was detected from this assembly into the sampling vial. This apparent inconsistency has not been explained as yet; and in view of the time frame involved to get the sampling array ready for a balloon flight, emphasis was put on the main valve and its leak problems rather than to explain why something does function well under the circumstances.

Valve Design Changes

General

The sampling bottle with the valves was cleaned very carefully before filling with the absorber material using a multiple rinse with pesticide grade Acetone (Acetone of spectrographic purity with a zero level of halogenated compounds). Then, the system was baked out for 24 hours at 200°C with noble gas flushing (He) for 2 hours. After cool-off, the system was packed with the absorber material (PORAPAK-Q for the center absorber tube of 100-120 mesh, molecular sieve 5A of 6-8 mesh for the main bottle). The filled tube was again degased at 200°C and He-back-flushed similar to the original cleaning operation. With this system, leak tests were then performed which showed the main valve to malfunction.

Design changes on the main valve and attempted cures by manufacturing new parts were performed in the following manner described. Reference is made to the attached drawings in their numerical order.

1. Layout of Kel-F valve bodies, redesigned

2. Kel-F body drawing

3. Original TFE stem drawing showing the change to Kel-F material in design sub 3A

4. Original Kel-F solenoid valve body design. This design did not show any improvements with several different poppet designs used. The function, in all cases, was limited to a vacuum of 10^{-5} for maximum, even with increased spring tension on the poppet.

5. First redesign of poppet and seat

   The original seal was made with a tapered teflon poppet on Kel-F hoping that the cold flow property of the Teflon would permit sealing. This expectation did not realize. Then, the o-ring design as shown in Figure 5 was tried, but again no improvement was seen.

6. Kel-F poppet, using different o-ring configuration

7. Same as 6, using a flat seat configuration

8. Same as 6, but with tapered groove for o-ring

For all these designs above, leak tests were performed at building 4481 NASA Redstone with Ron Eakes and G. Detco attending and performing, respectively.

These results led to a design change incorporating a pneumatic activated cylinder operating the valve, inasmuch this permits a higher spring load on the o-rings. The pressure on the ring can now be increased to be in excess of 35 pounds, which was a pressure level recommended by the o-ring manufacturer for the vacuum seal in question. Consequently, the use of a solenoid for valve activation is obsolete and has to be changed to pneumatic activation. In the balloon flight, this approach would be permissible carrying a small lecture bottle with compressed air for this purpose. For flight hardware on the shuttle, a different approach will be taken.

Septum Design

Refer to drawings Figure 9 and 10 attached. These drawings were based on hand sketched information obtained from G. Detco. The parts have been machined but have not been tested as yet. The drawings show:

Figure 9: Septum stem; the septum stem holds the silicone rubber septum in place when screwed into the septum body.

Figure 10: Septum body; the body holds the septum and connects to the base of the sampling bottle.

Ethylene Cylinder

The Ethylene cylinder with its design features is shown in Figure 11. It is made of Kel-F and proved to be leak proof during all tests.

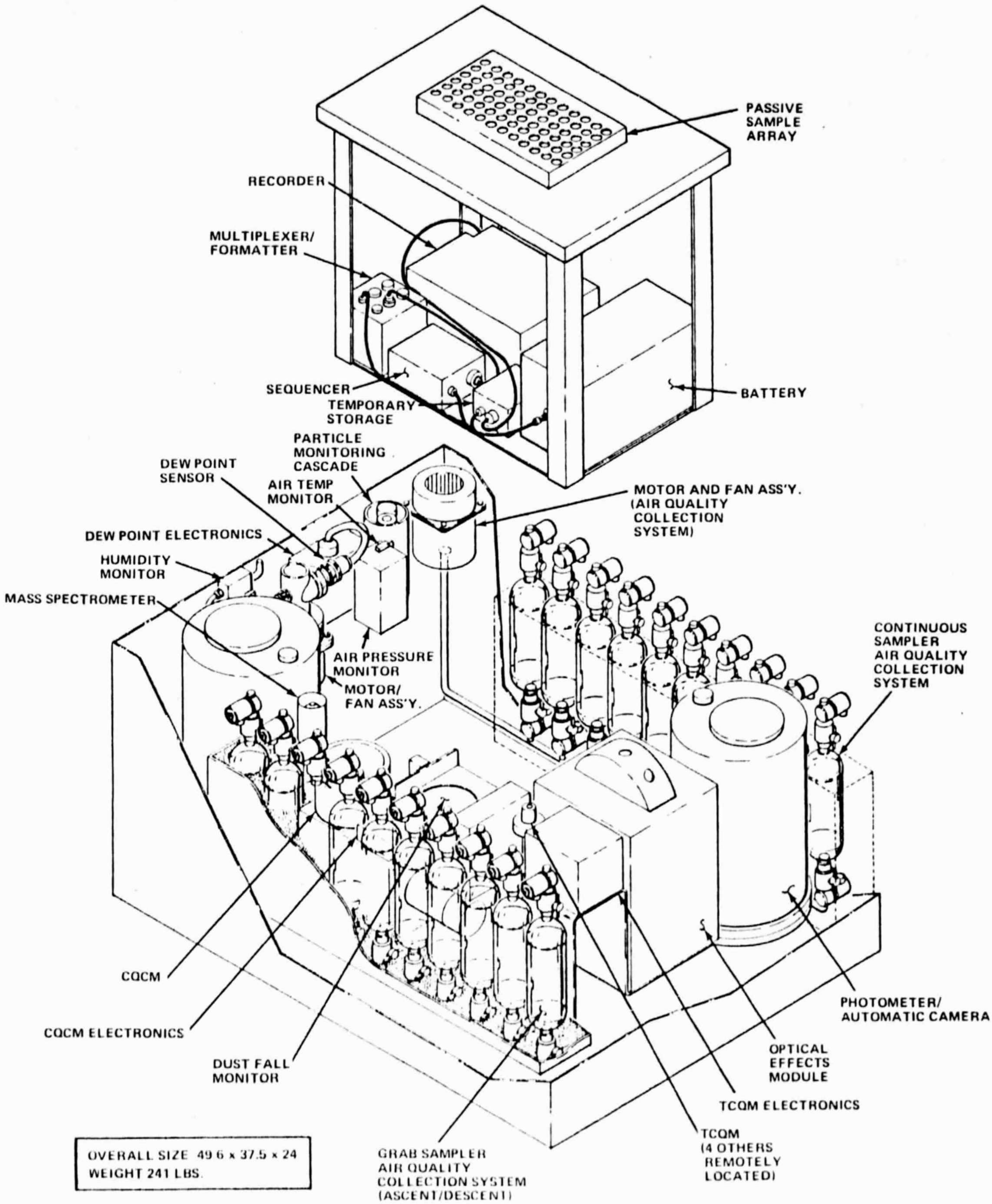
Problem Areas

Problem areas consist of the inadequate sealing of the existing valve design as indicated in the previous sections of this report. We feel confident, however, that with the new pneumatic design, this problem should be solved. If this should not verify, there is still the possible change into a geared, motor- driven approach which has been avoided until now as it opens and closes in a rather slow manner. The advantage of this system is the performance within almost any spring load required against any member of a valve.

FINANCIAL STATUS

1.	Expenditures to date as of November 30, 1975, beginning with UAH fiscal year October 1, 1975 and each previous year, if any.	$9,183.08
2.	Forecast of funds required for completion	3,816.92

(IECM) INTEGRATED ENVIRONMENTAL CONTAMINATION MONITOR

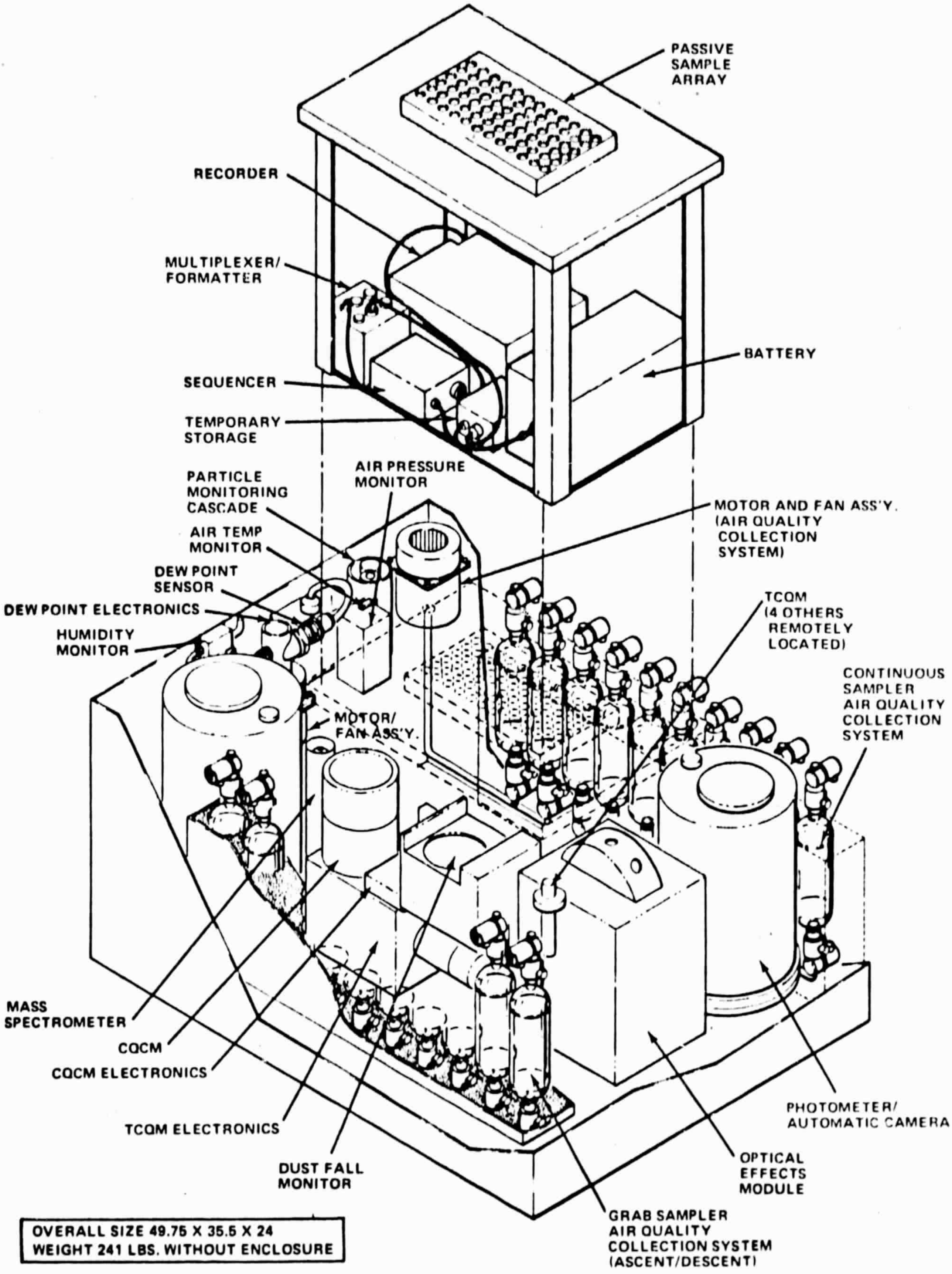


OVERALL SIZE 49.6 x 37.5 x 24
WEIGHT 241 LBS.

SCALE 1/12

FIGURE 1

(IECM) INTEGRATED ENVIRONMENTAL CONTAMINATION MONITOR



OVERALL SIZE 49.75 X 35.5 X 24
WEIGHT 241 LBS. WITHOUT ENCLOSURE

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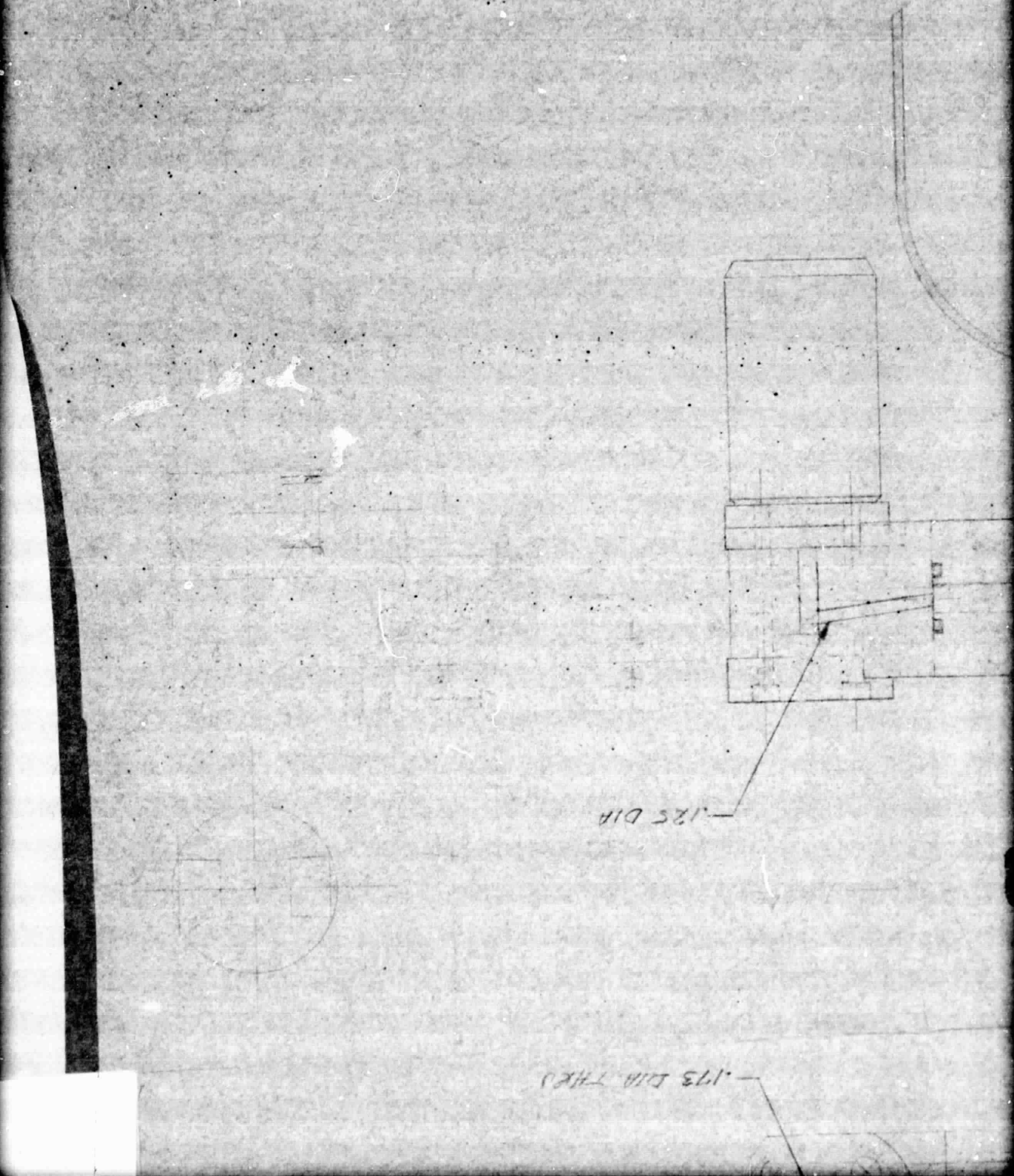

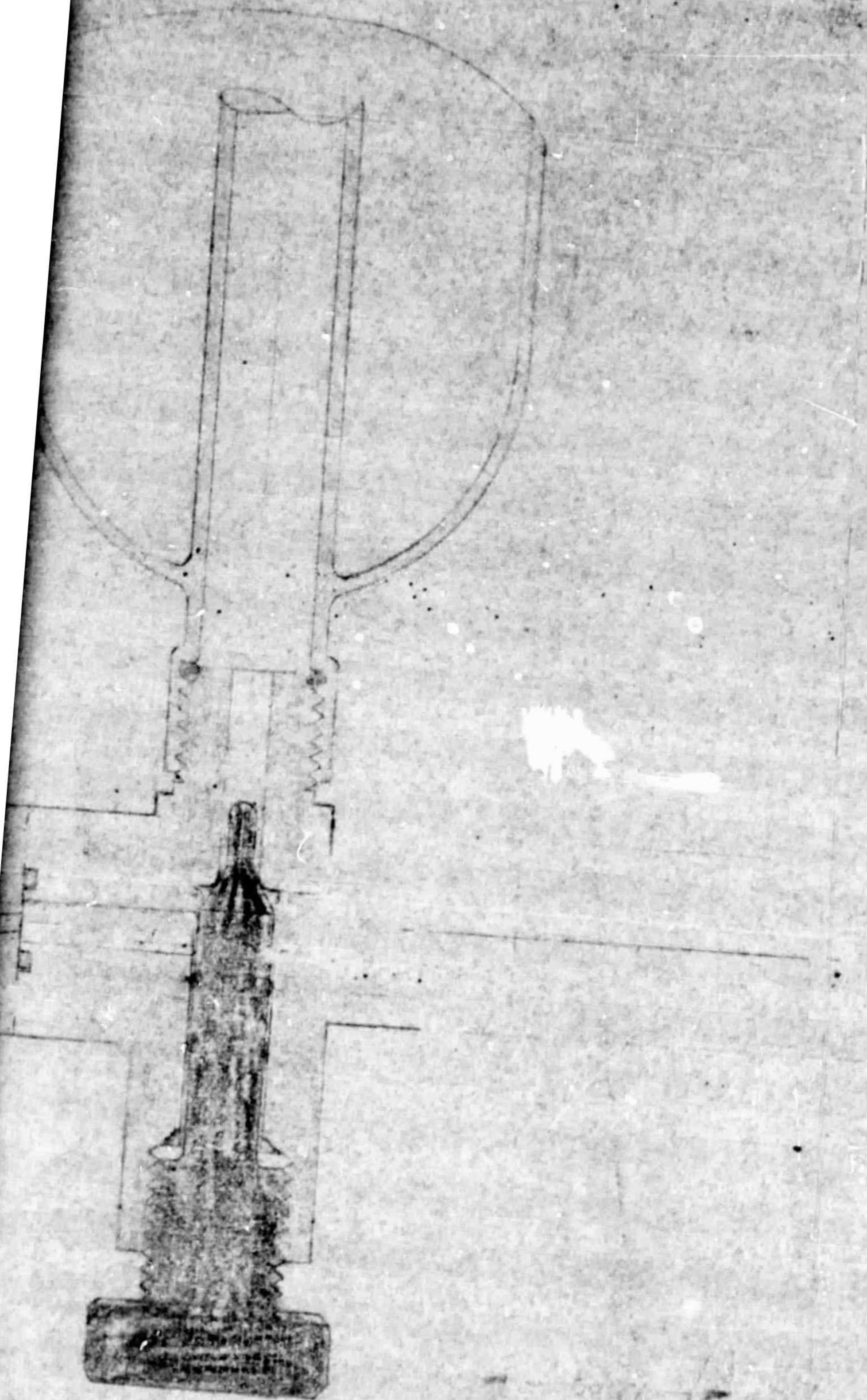

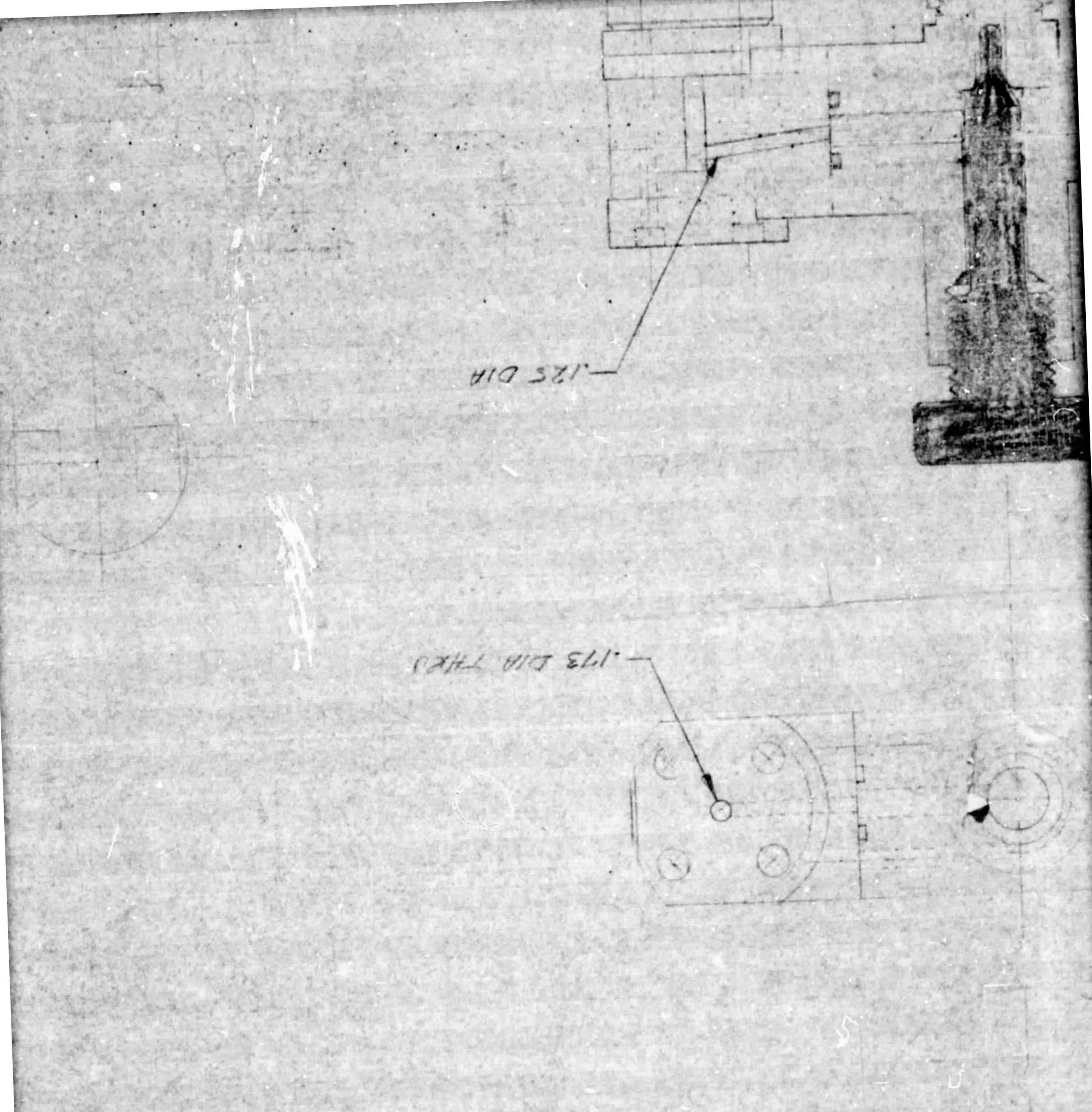

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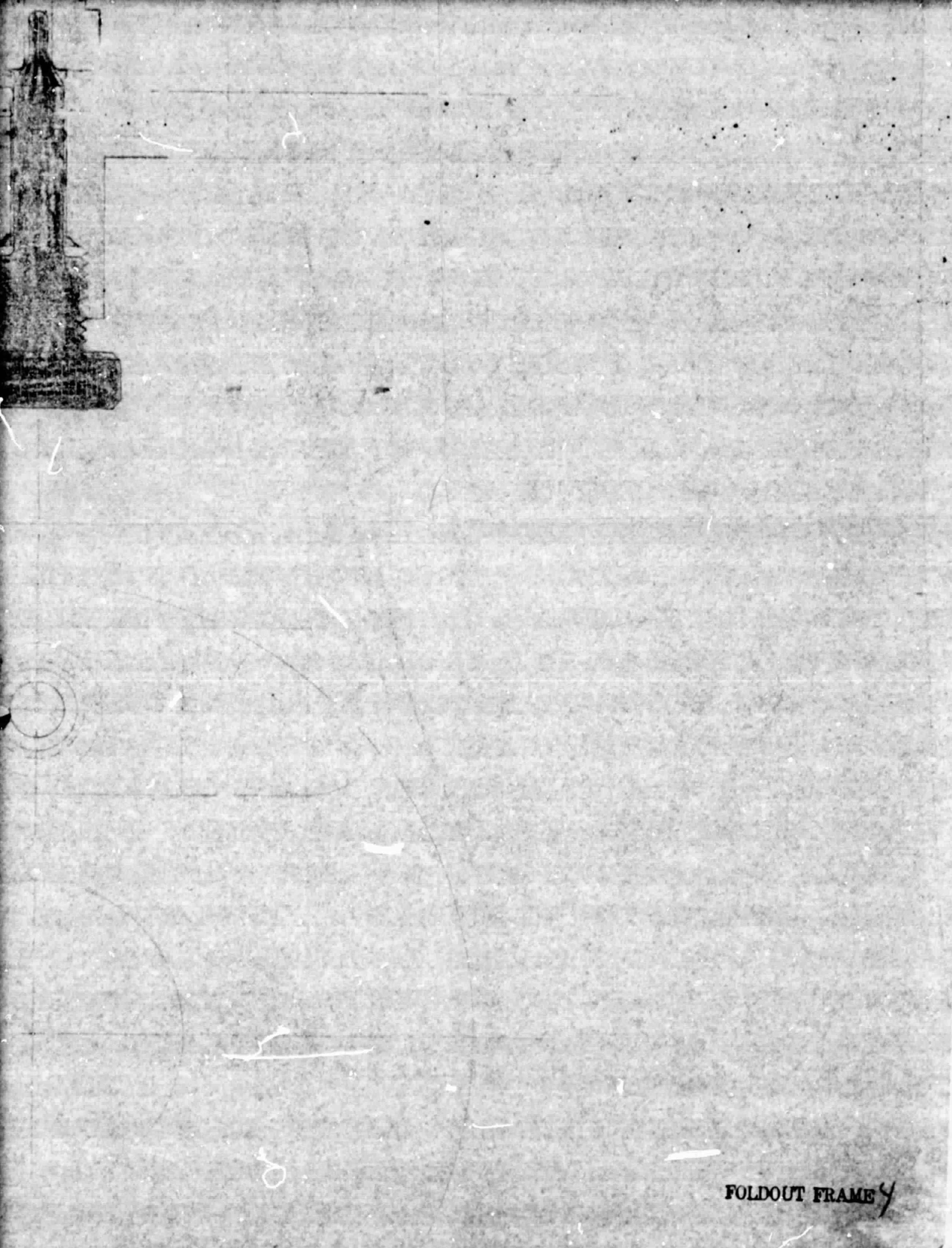

FOLDOUT FRAME 4

FOLDOUT FRAME 1

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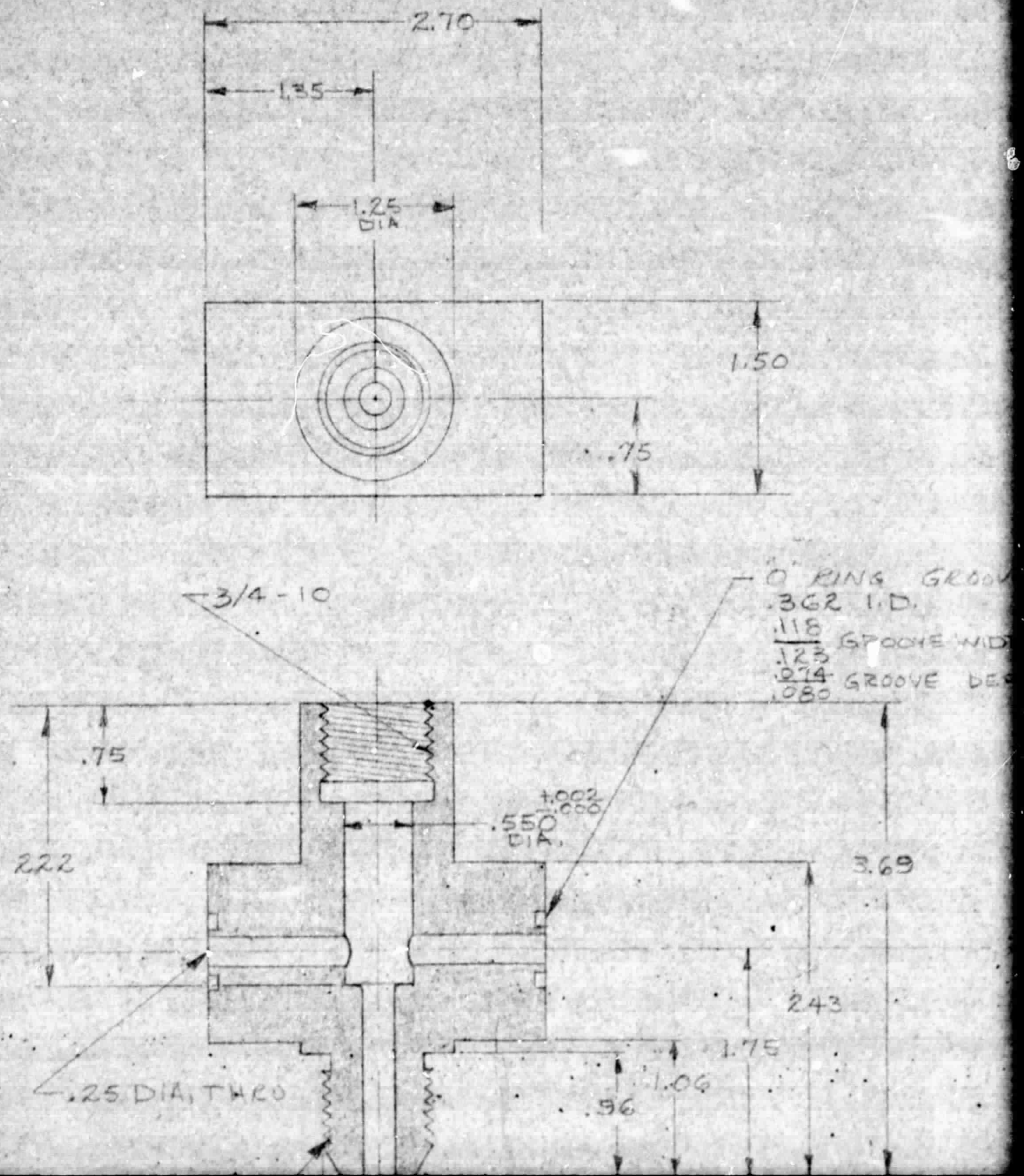

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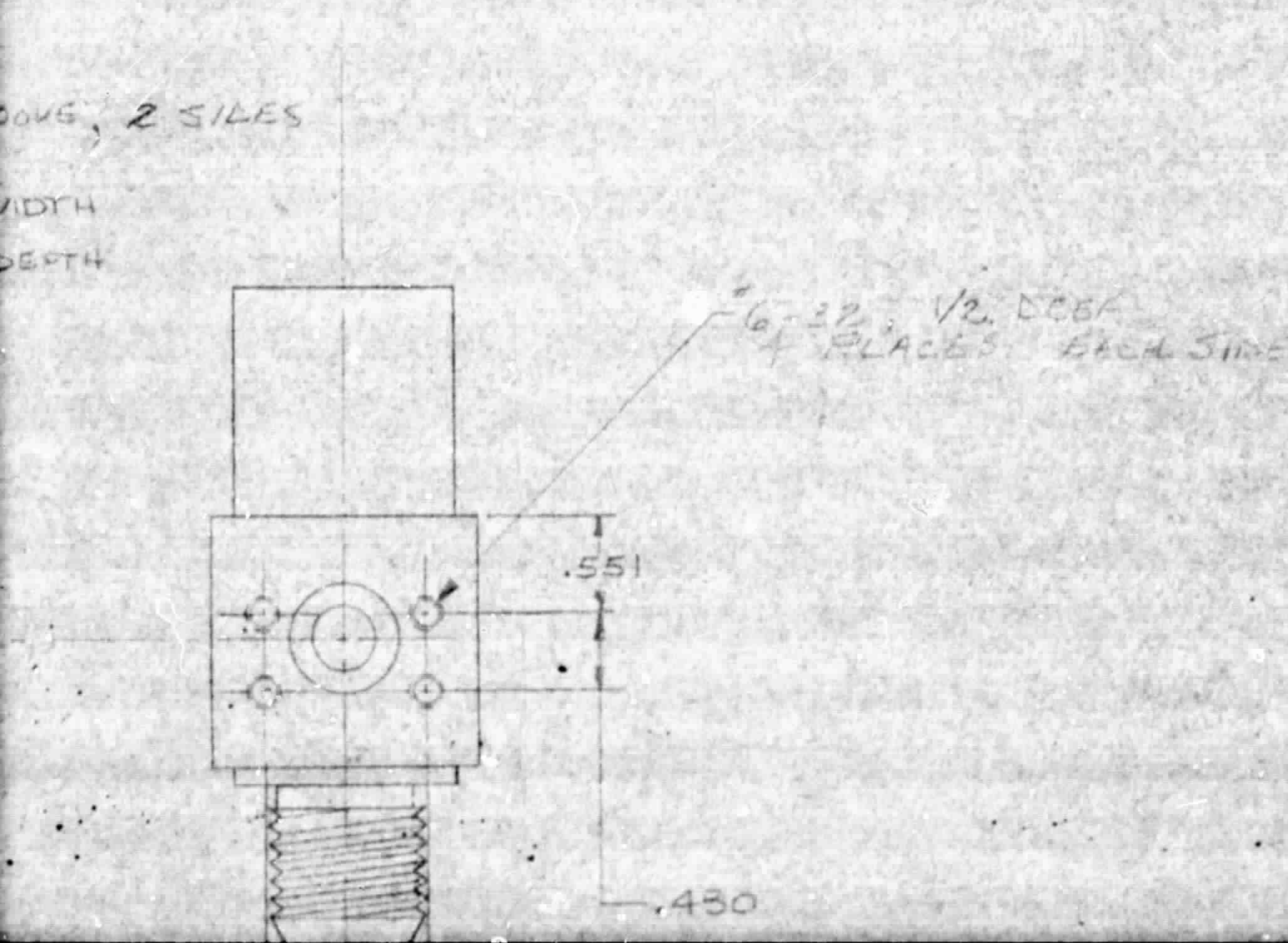

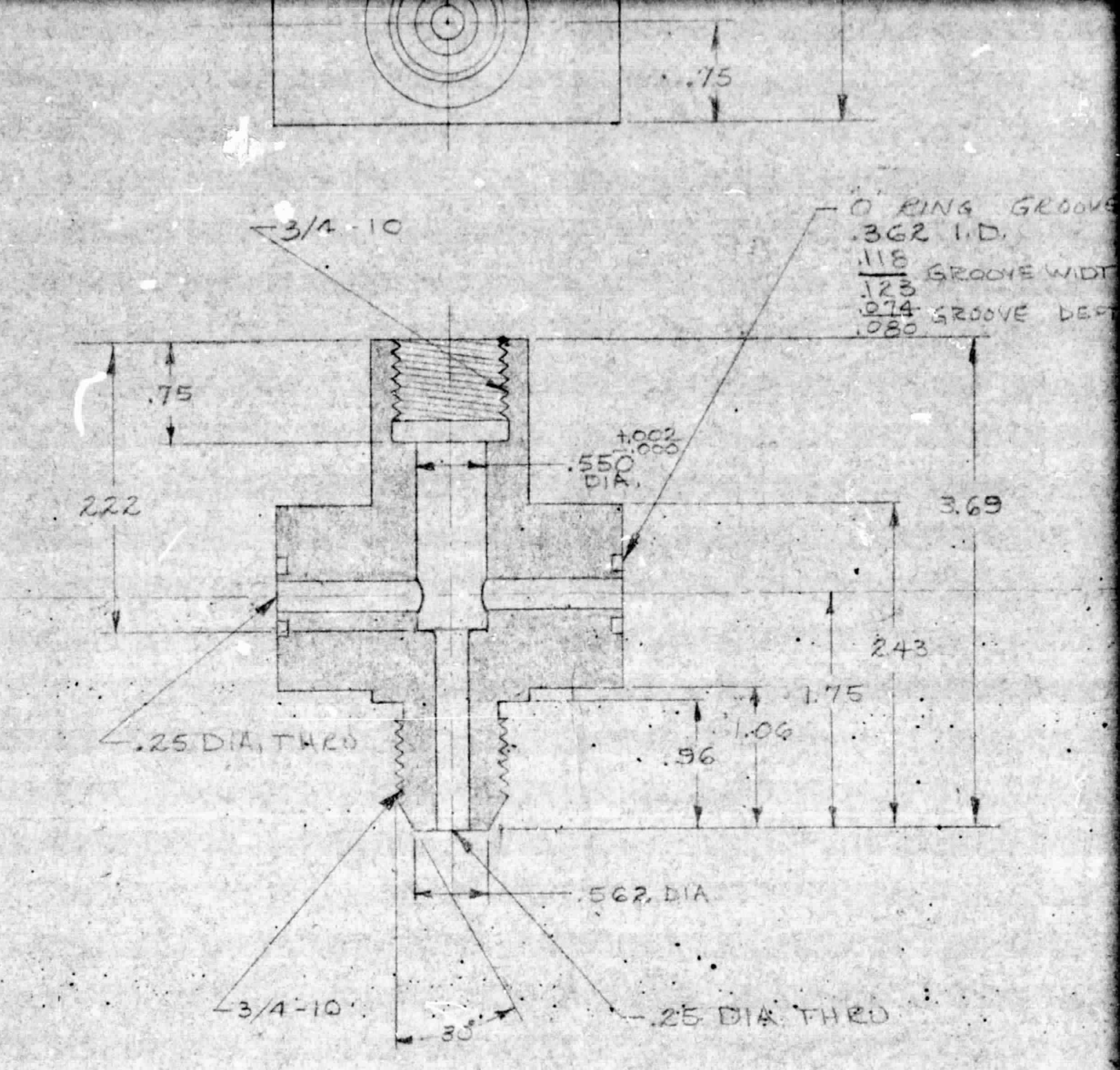

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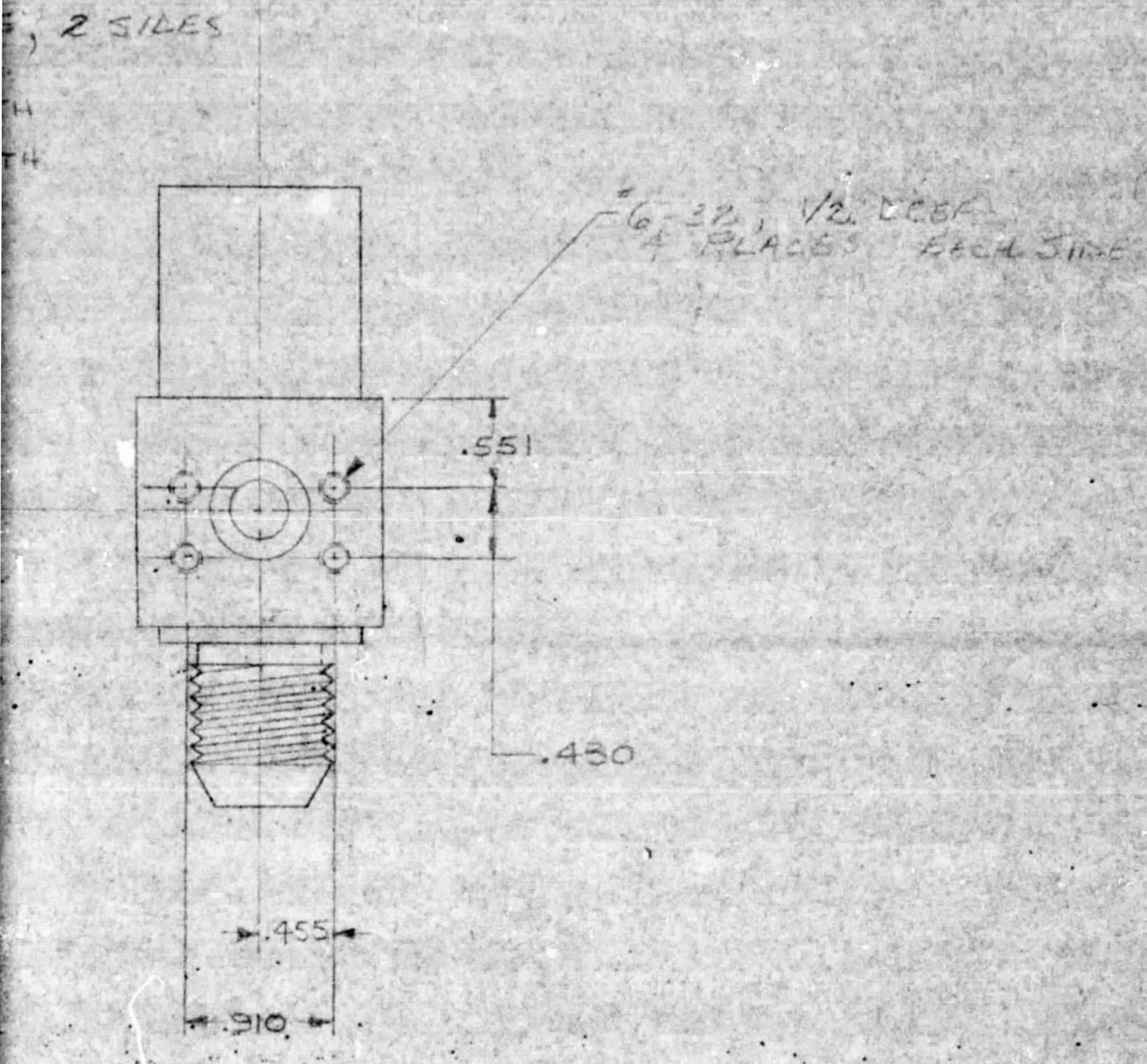

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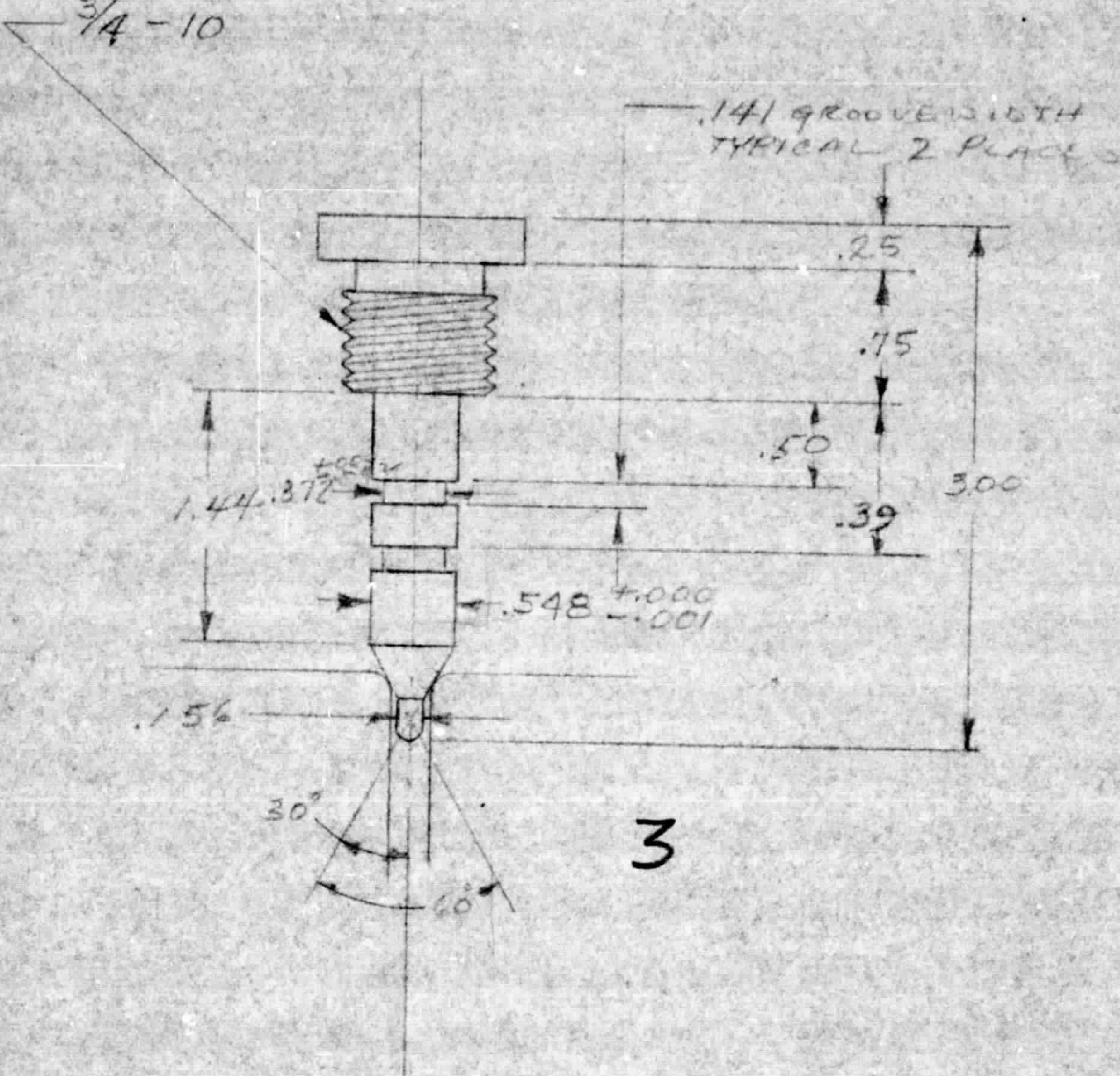
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.141 GROOVE WIDTH
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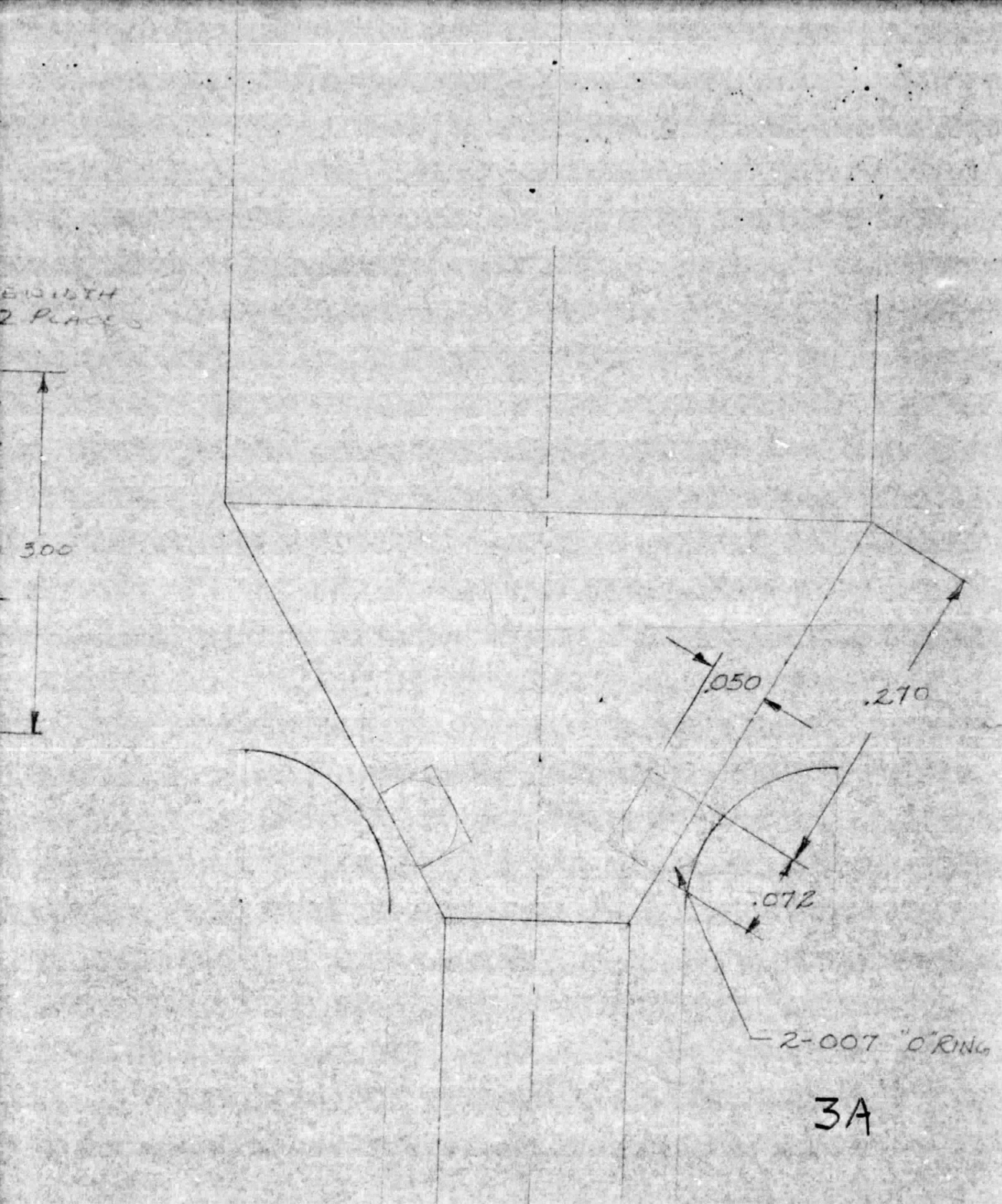
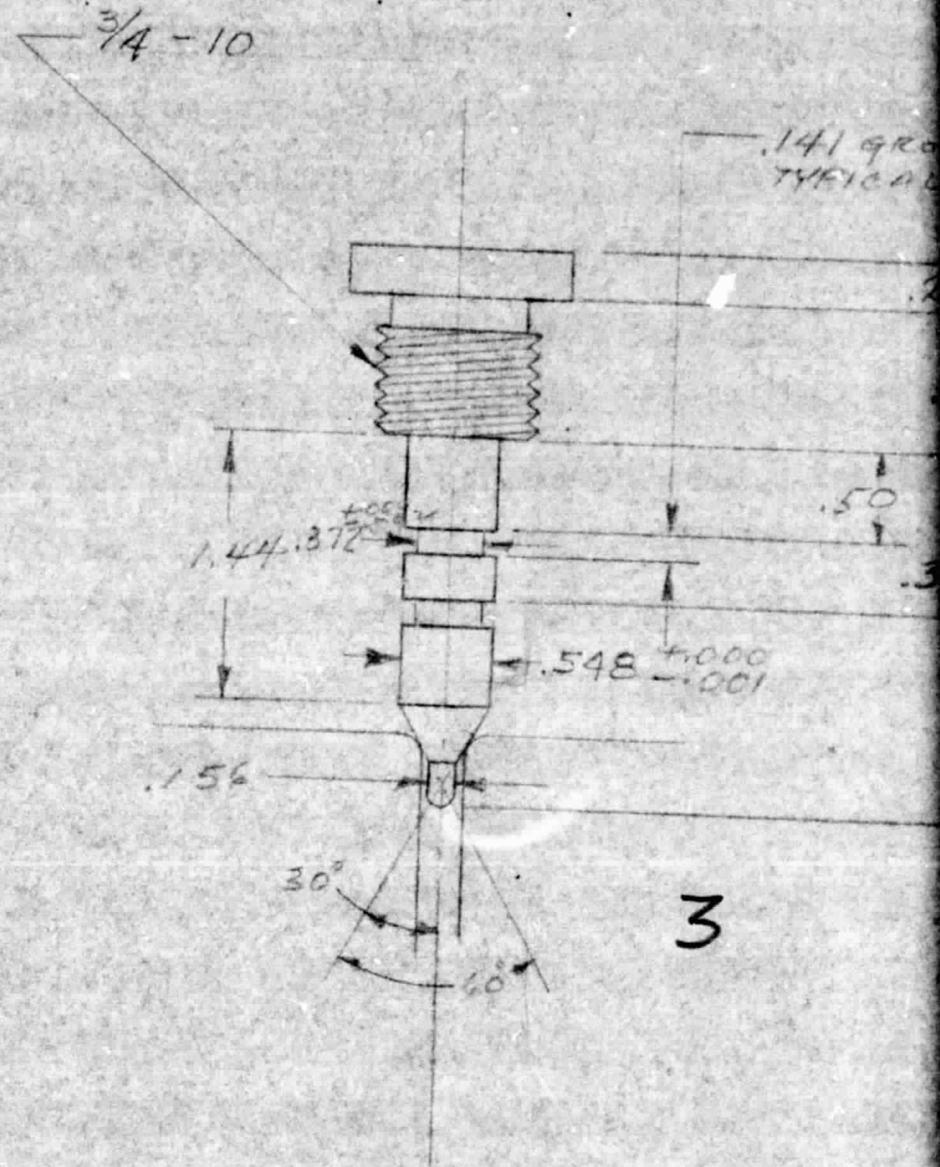
3



3A

FOLDOUT FRAME 4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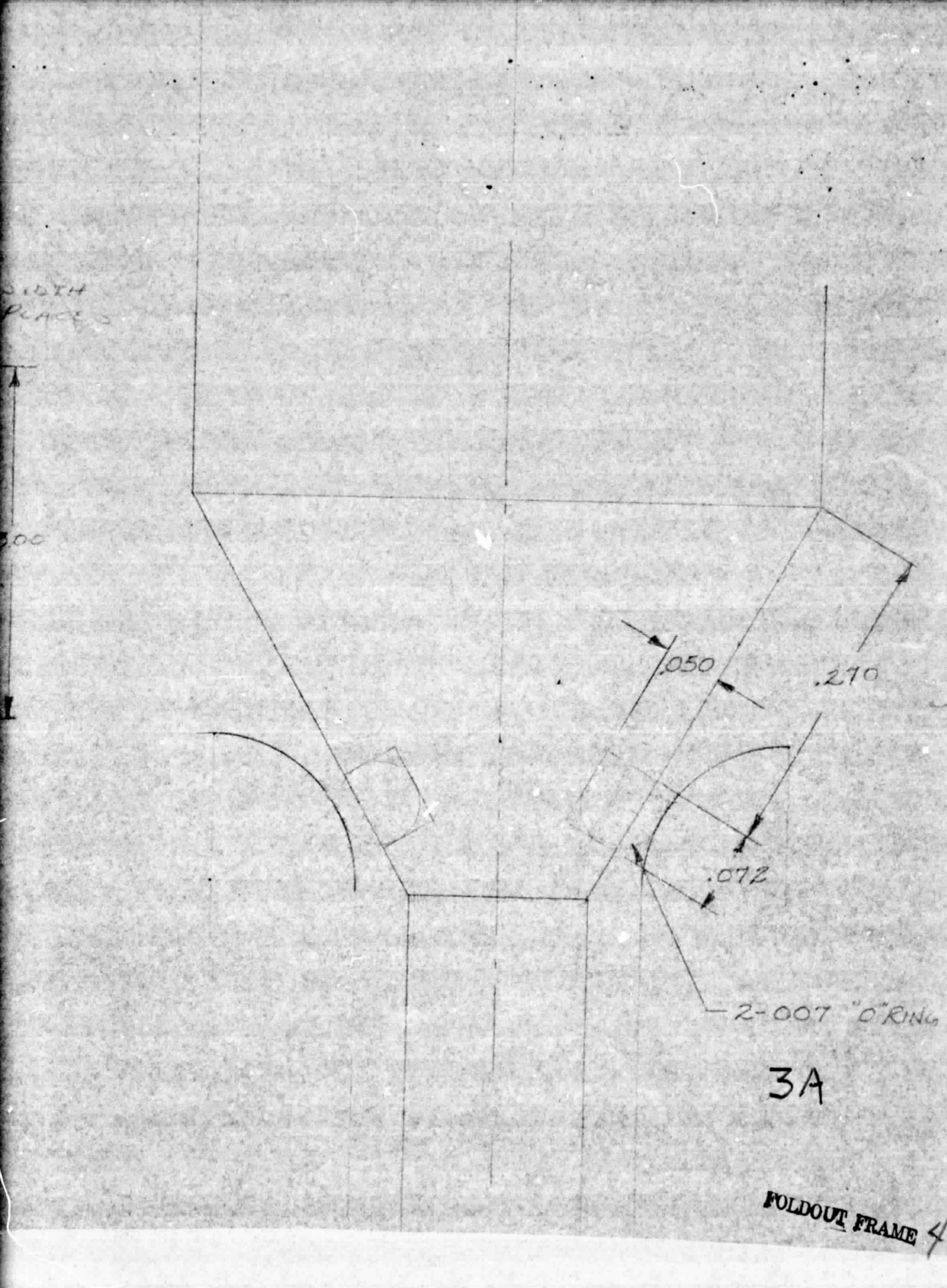

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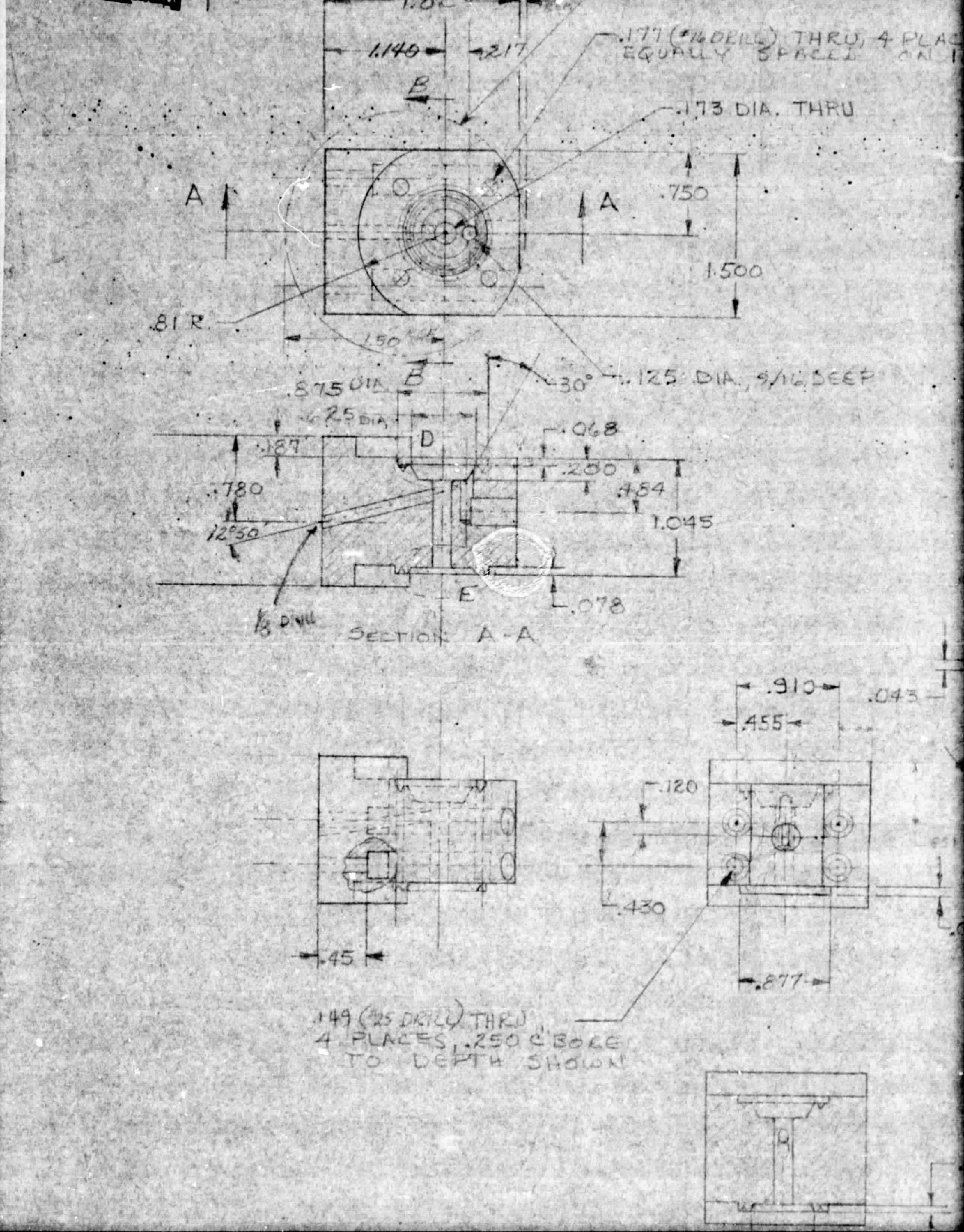

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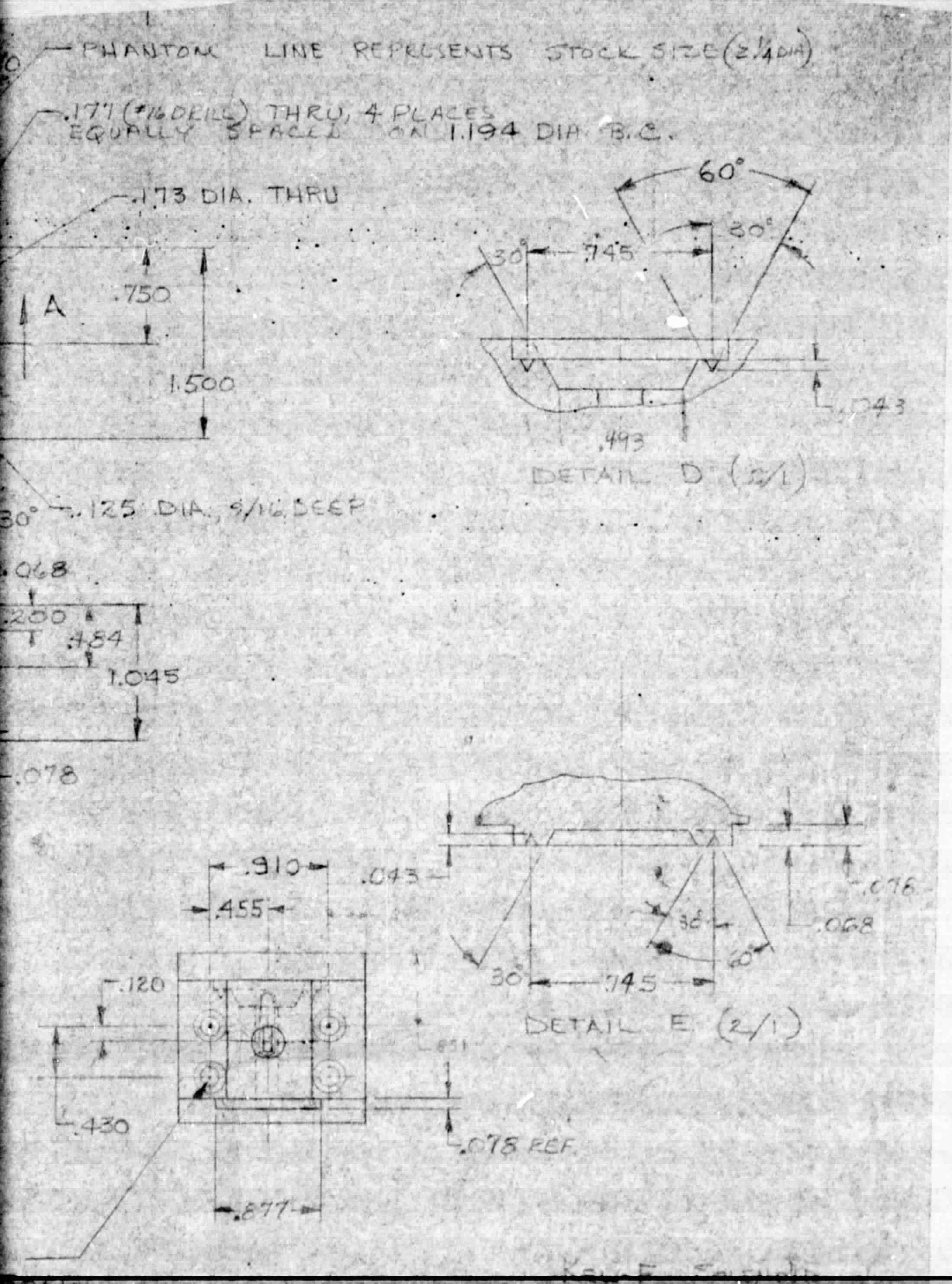

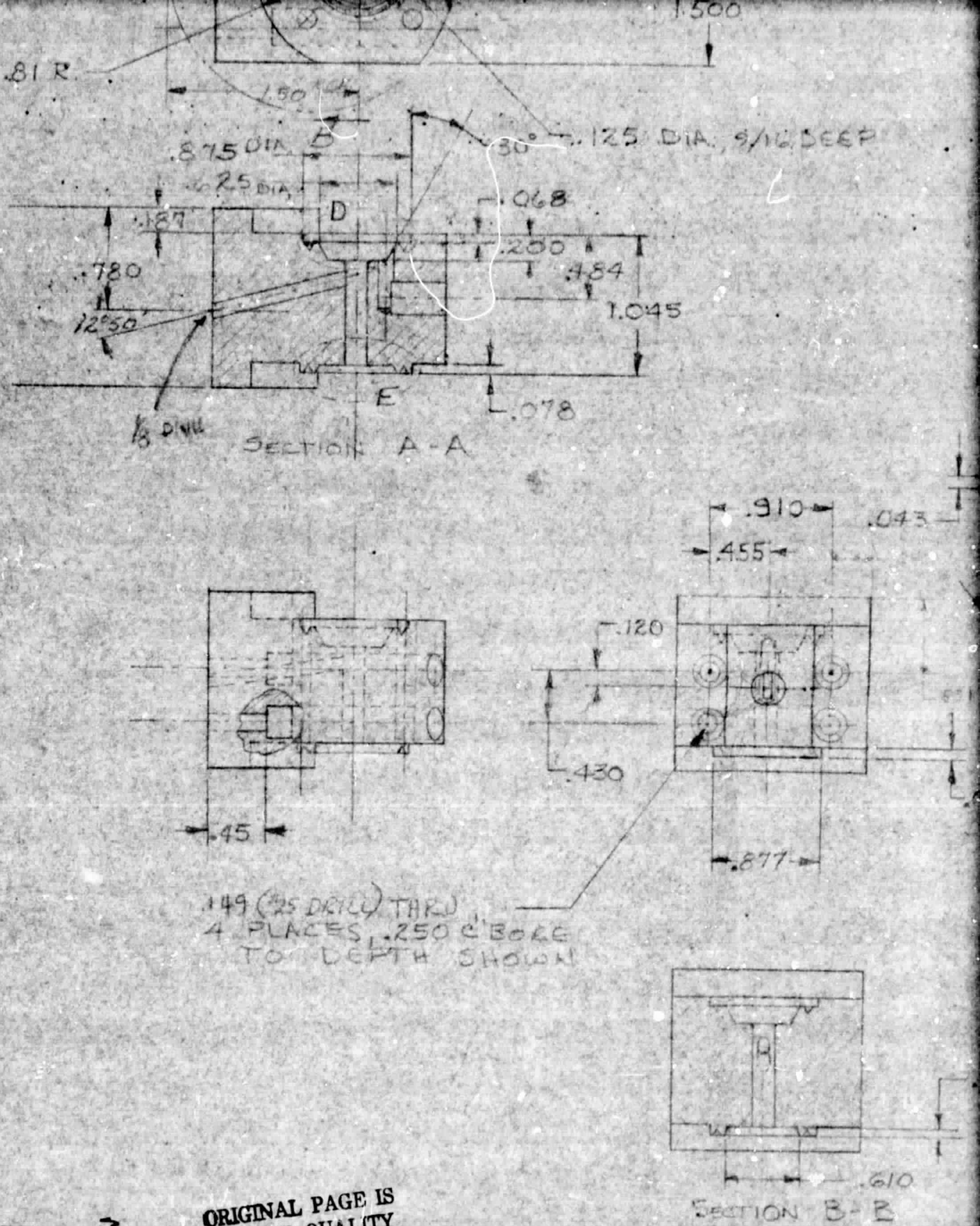

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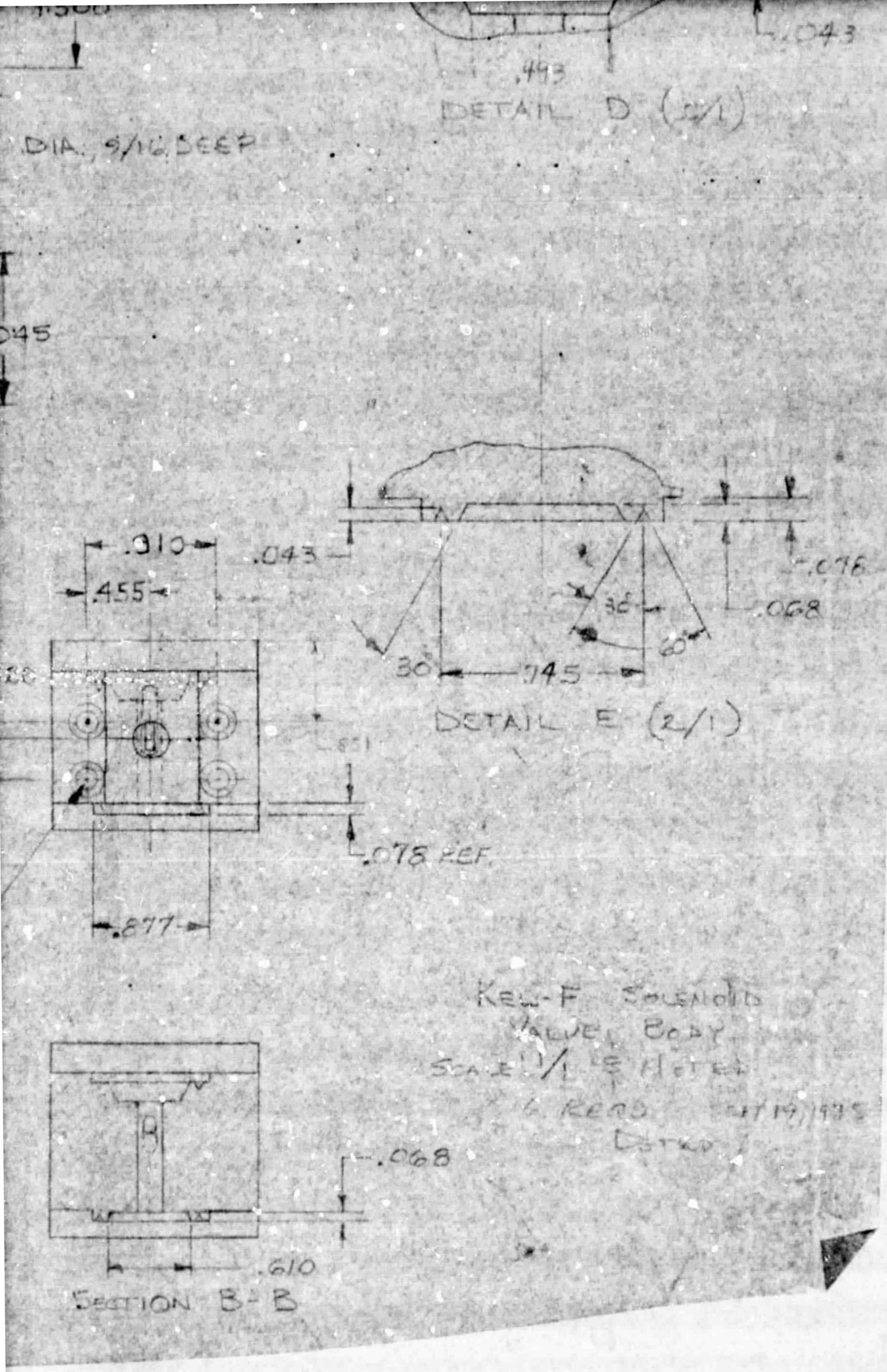

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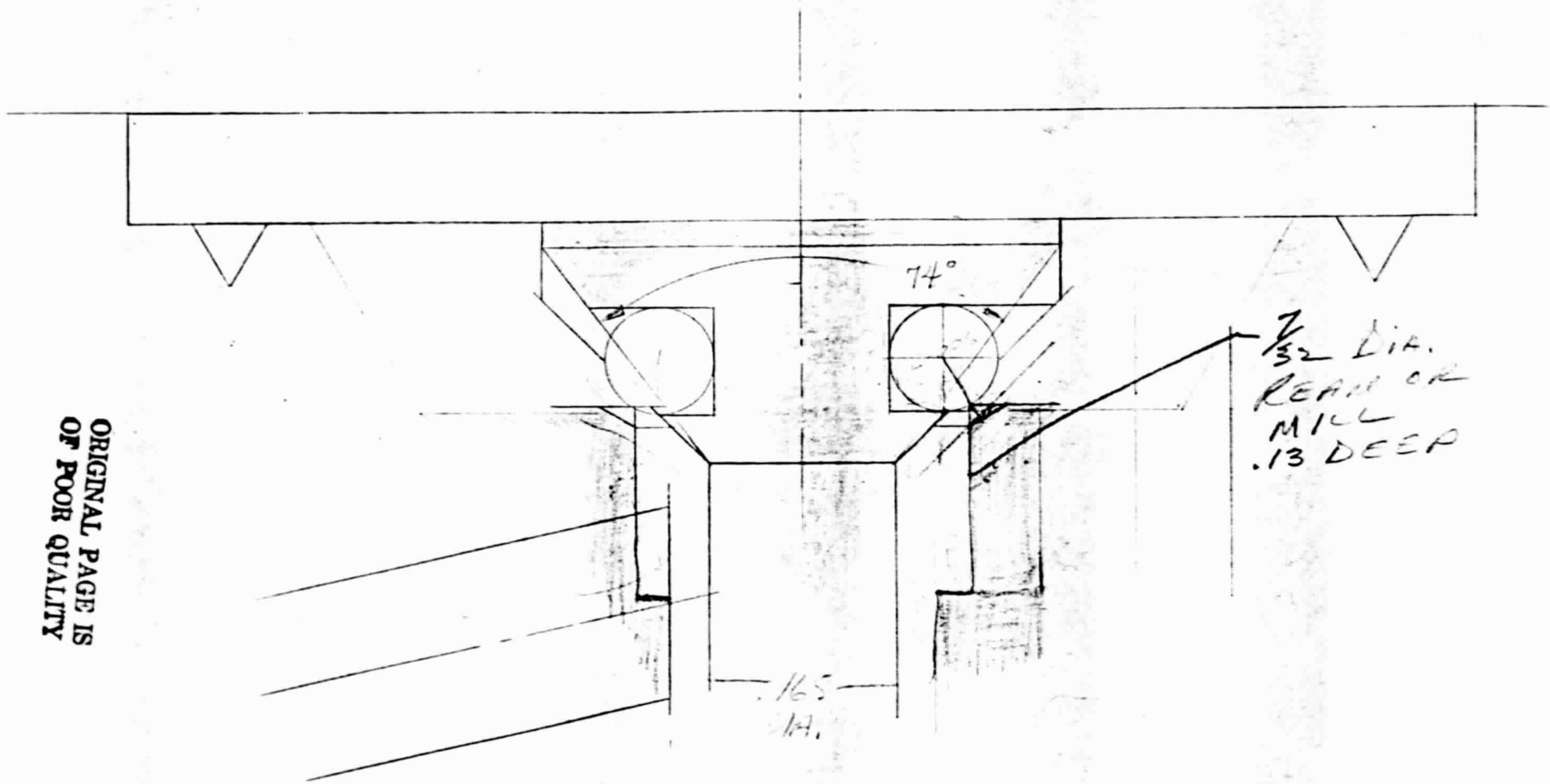
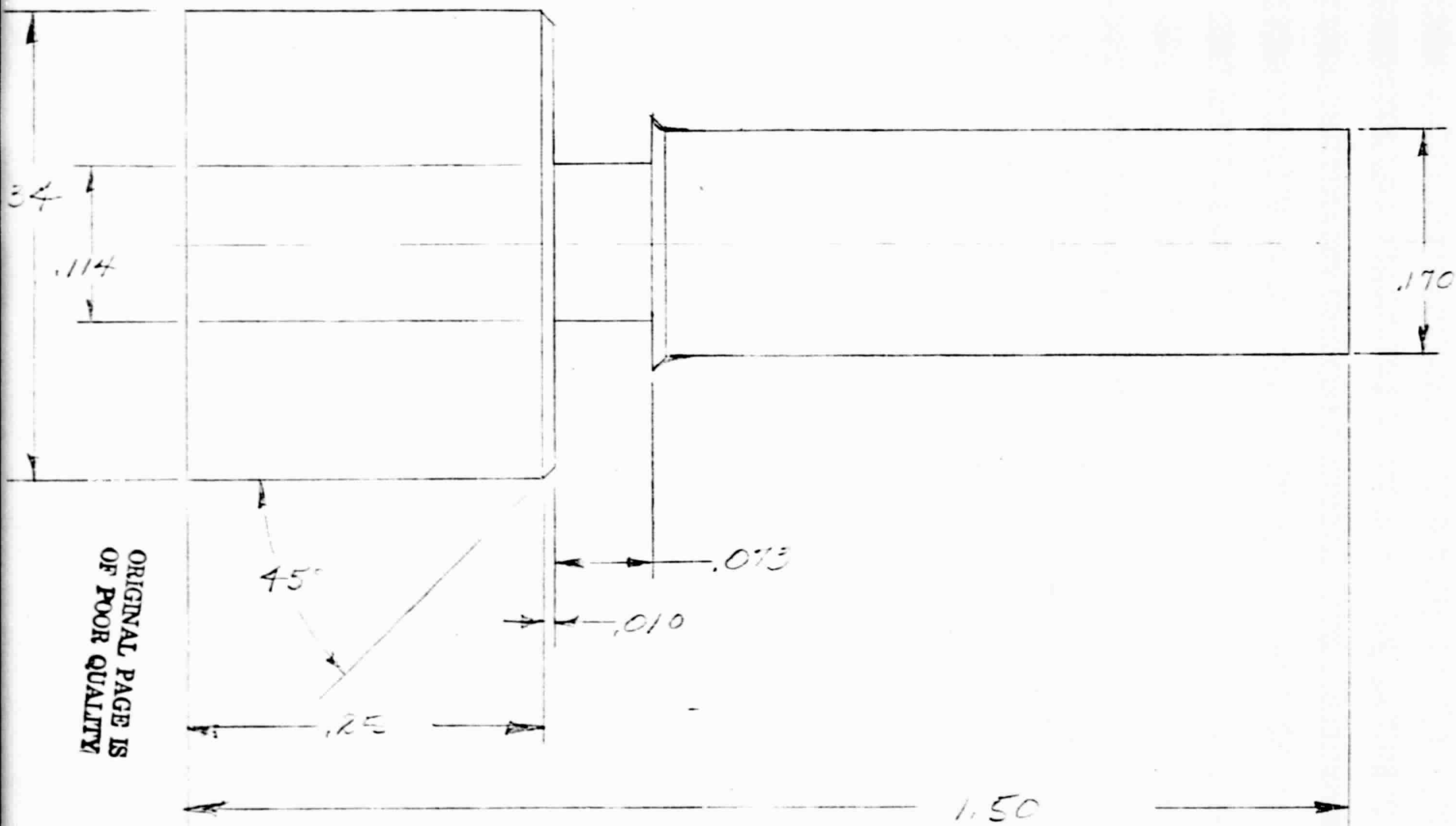


Drawing #5



Finish = 1,015

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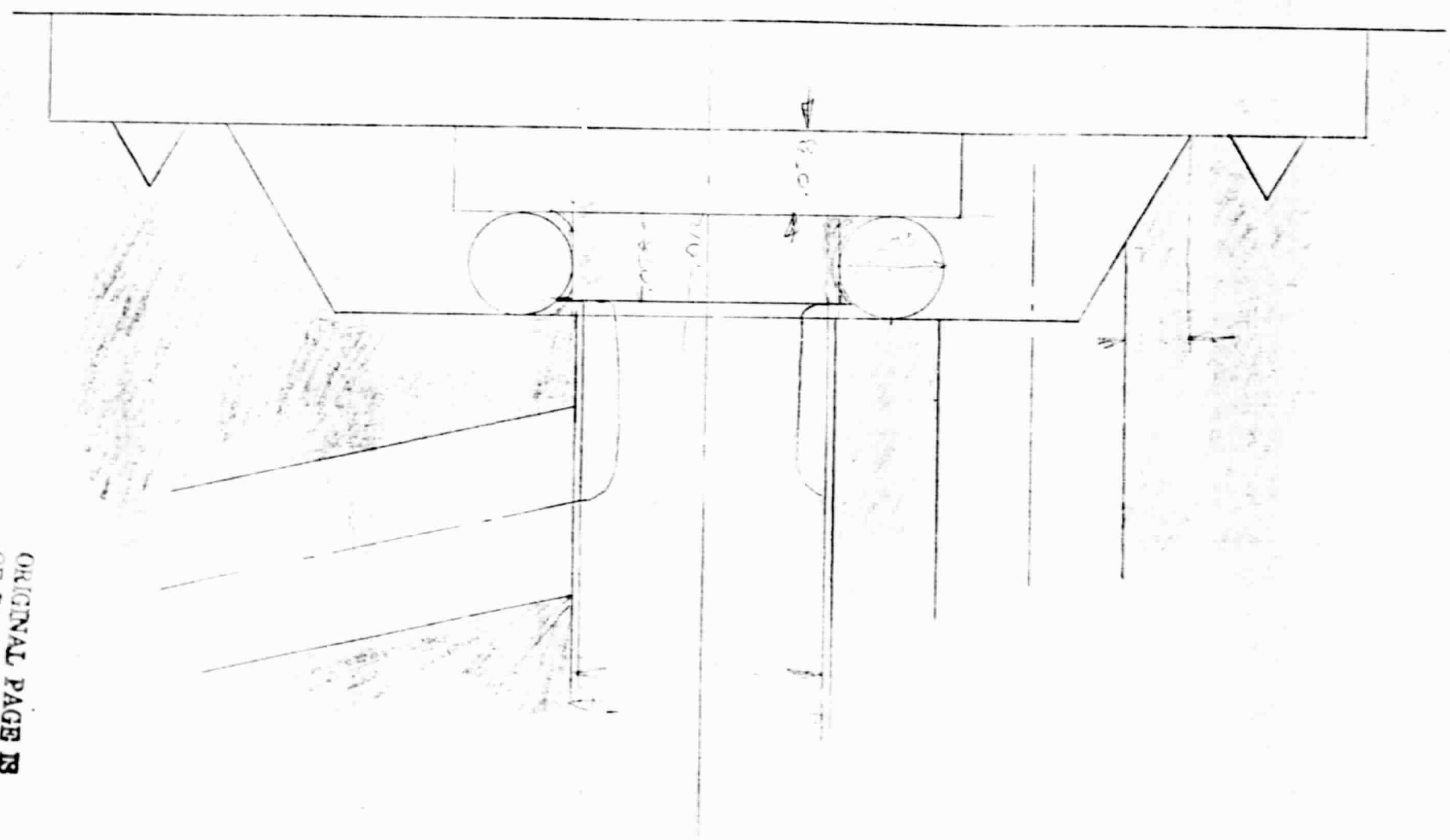
Drawing #6



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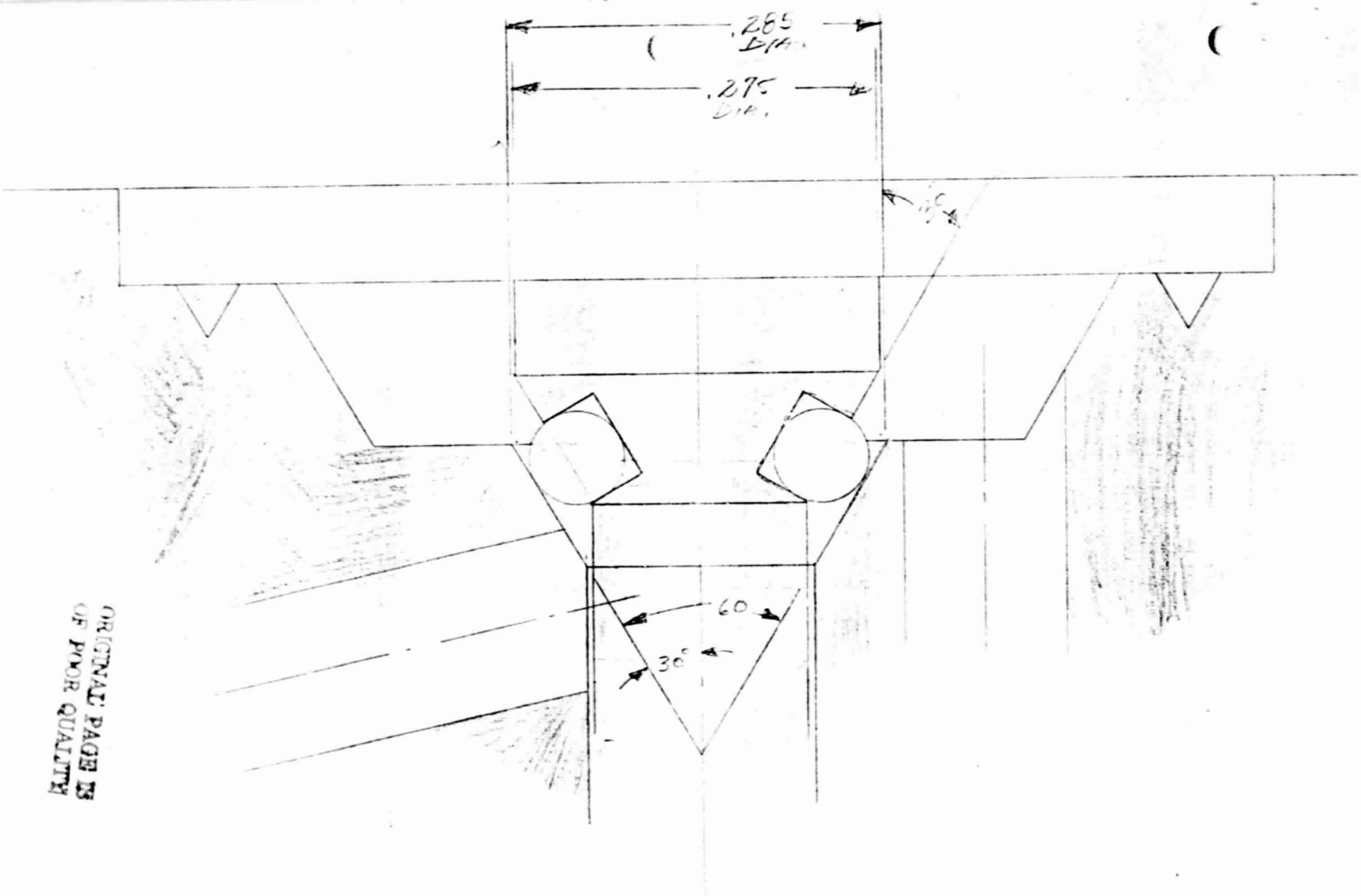
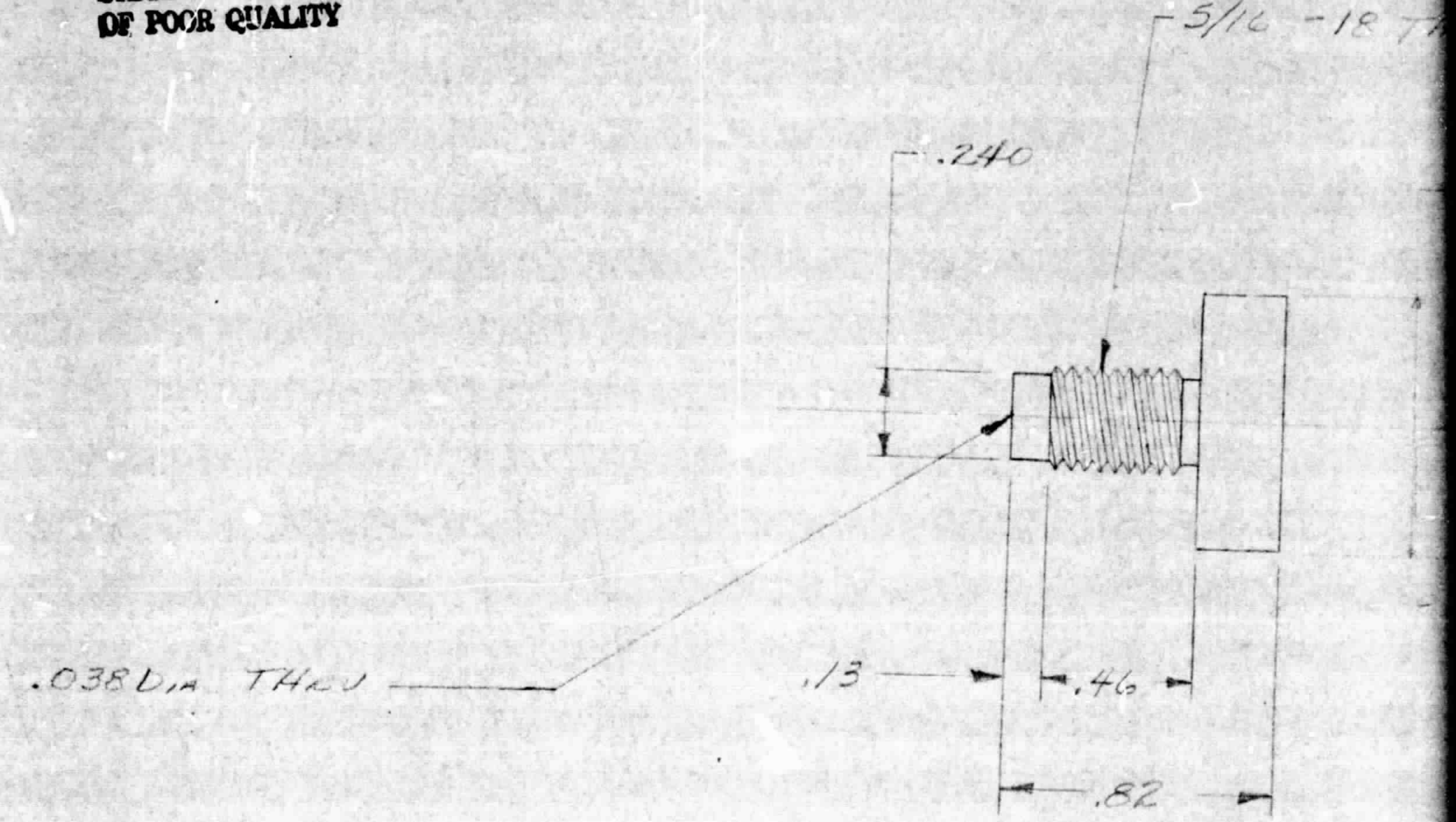


Drawing #8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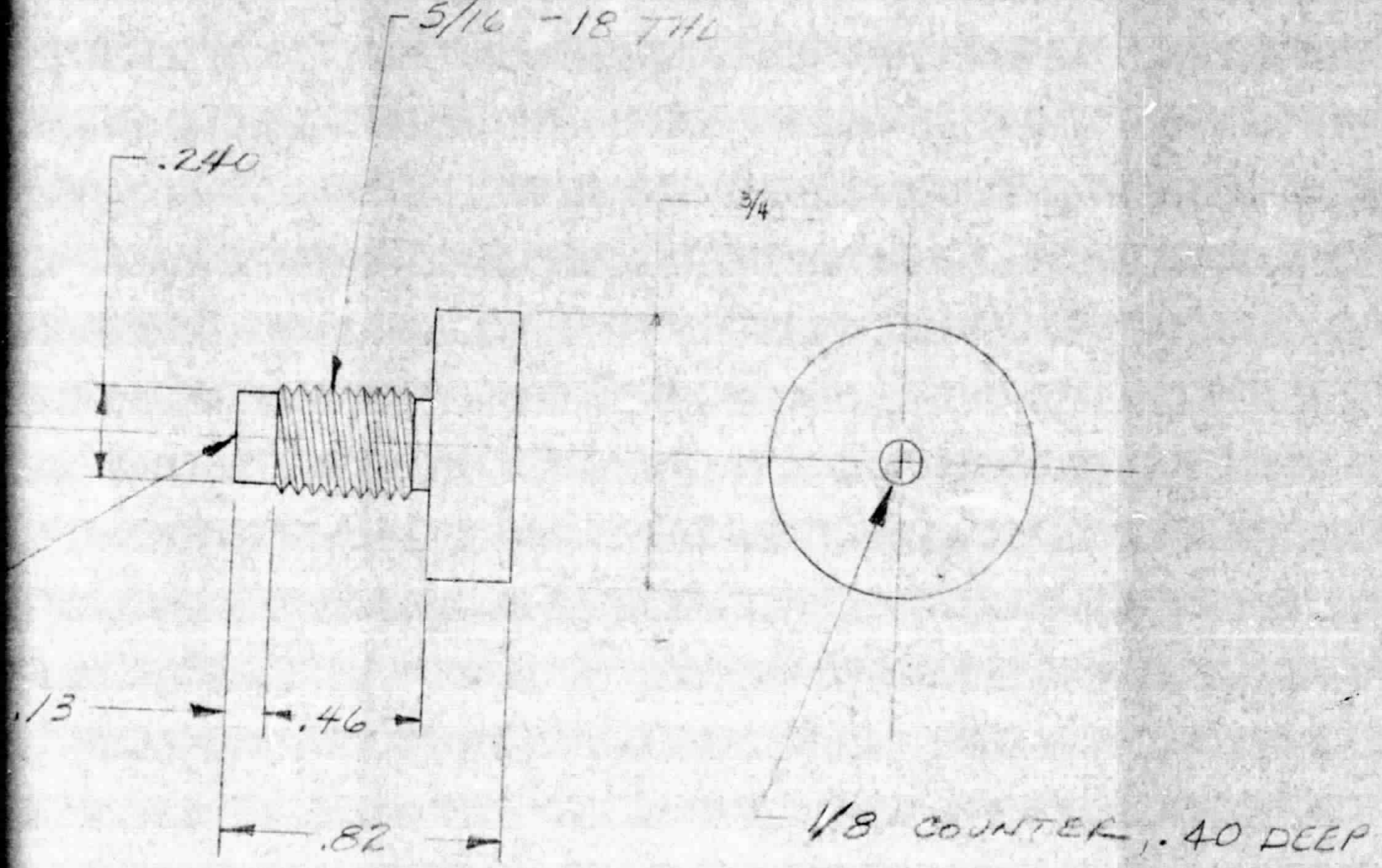

Drawing #9

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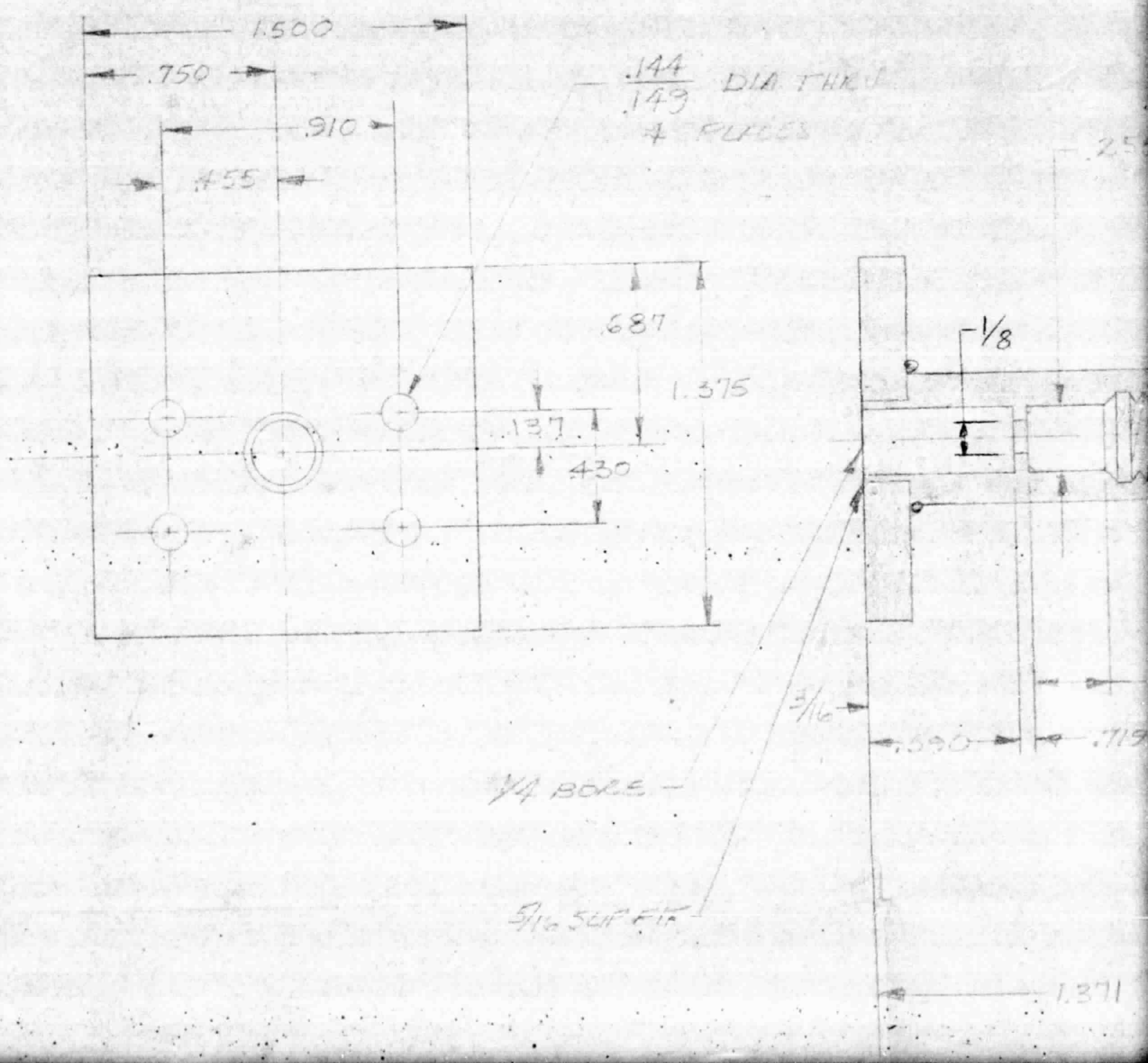

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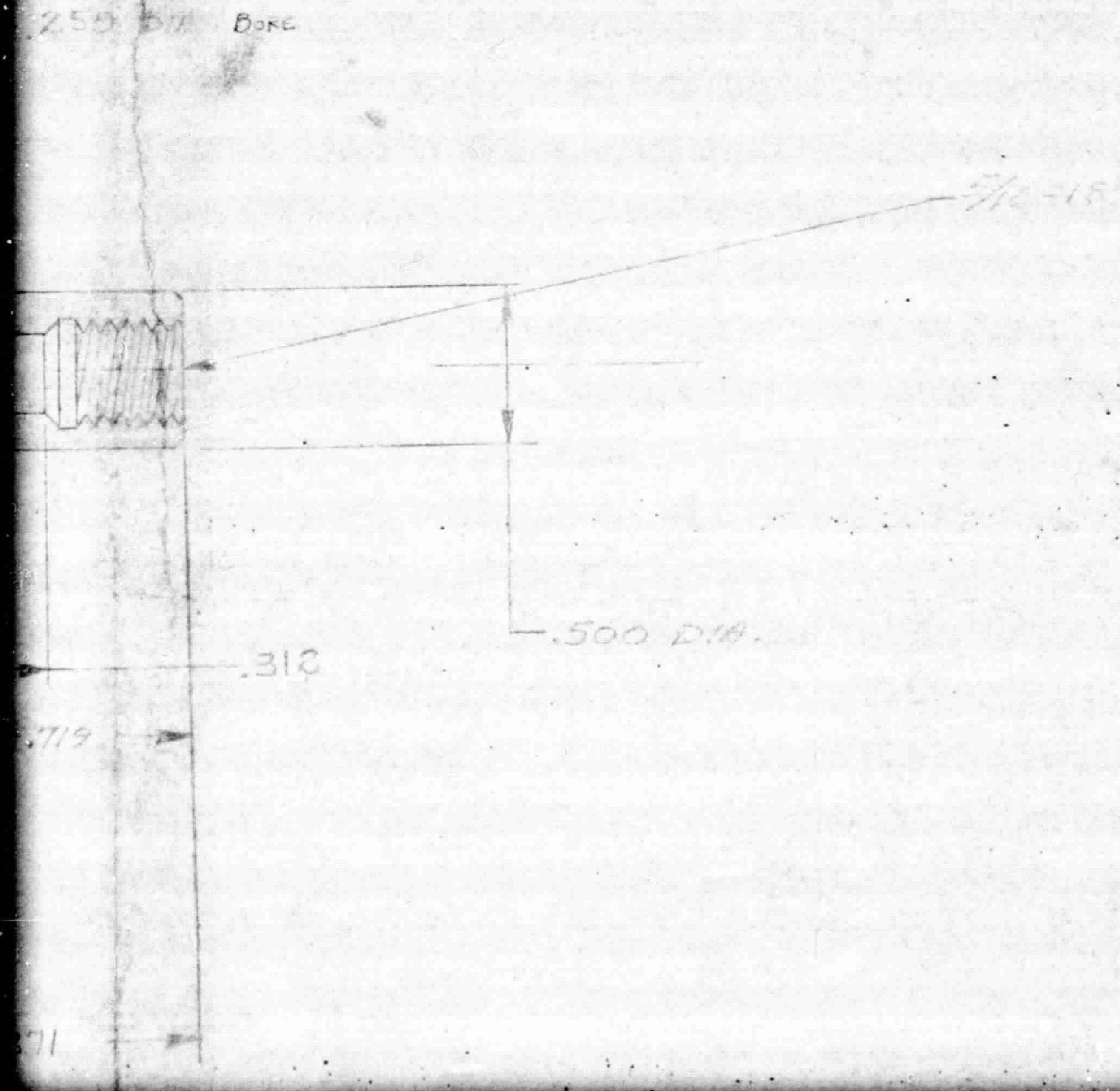

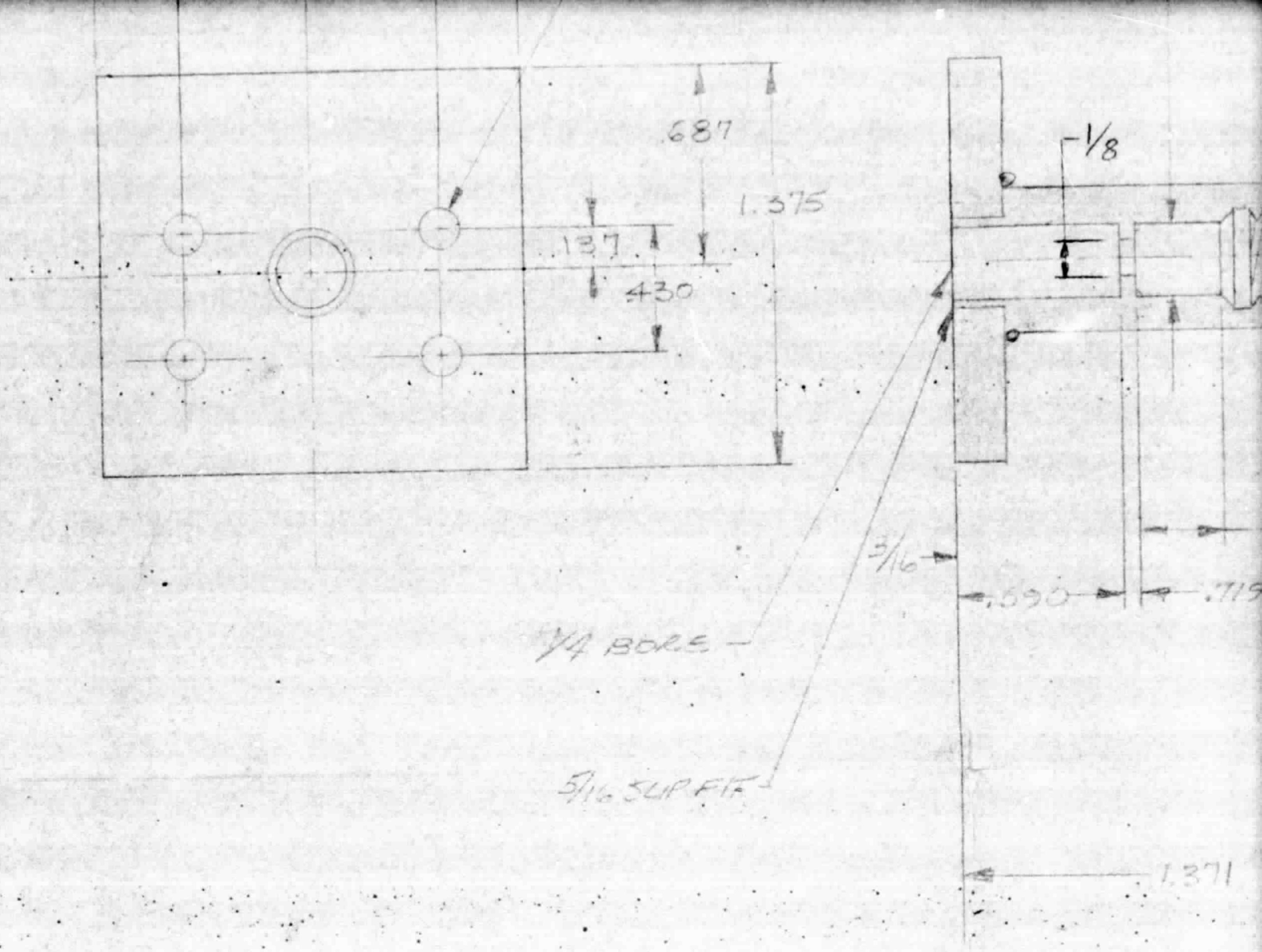
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.590
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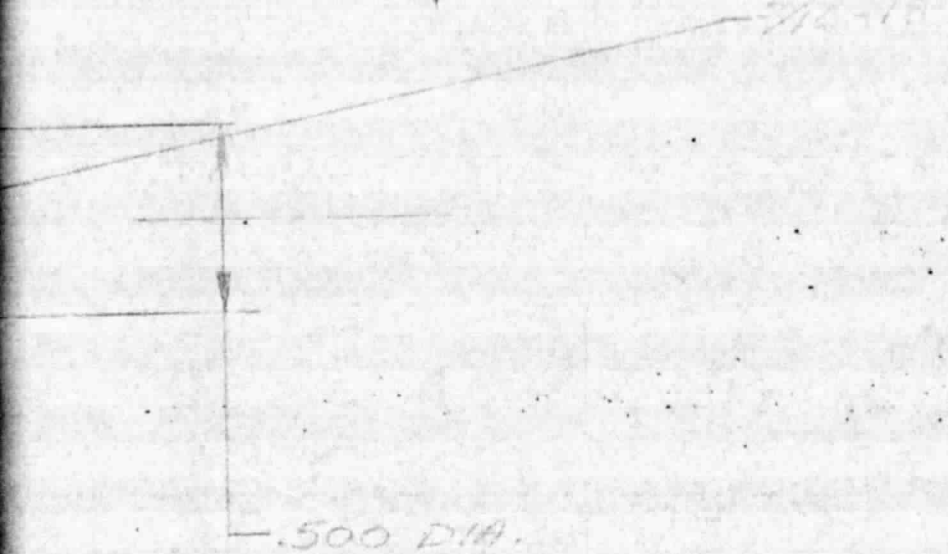
5/16 SLIP FIT
1.371



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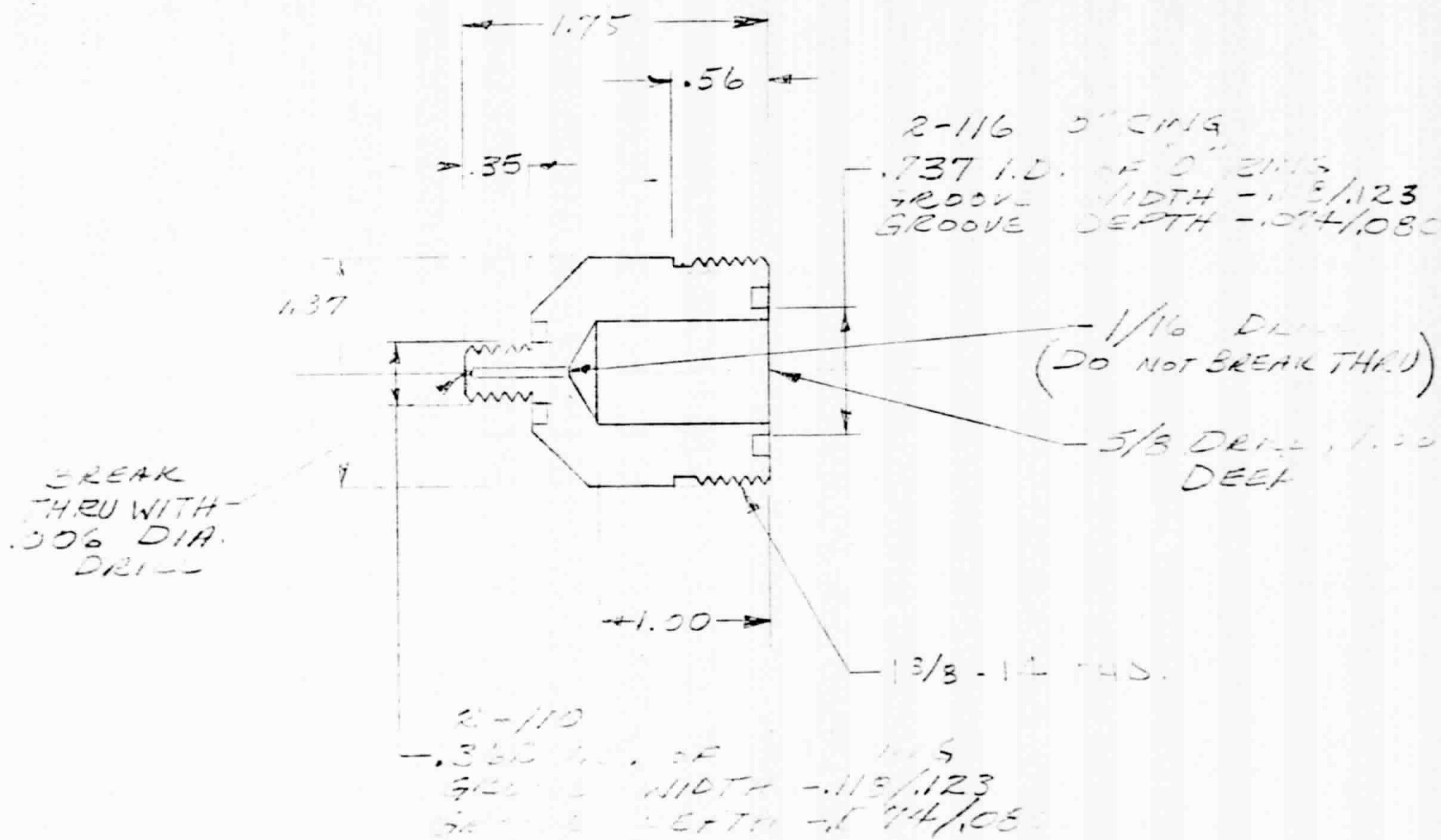
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Drawing #11