

# Lawrence Berkeley National Laboratory

## Recent Work

**Title**

Method of Operation of the Permeameter

**Permalink**

<https://escholarship.org/uc/item/8c63h93s>

**Author**

Richardson, R.E.

**Publication Date**

1949-01-21

UNIVERSITY OF  
CALIFORNIA

*Radiation  
Laboratory*

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy  
which may be borrowed for two weeks.  
For a personal retention copy, call  
Tech. Info. Division, Ext. 5545*

BERKELEY, CALIFORNIA

## **DISCLAIMER**

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

## METHOD OF OPERATION OF THE PERMEAMETER

R. E. Richardson

Copy 2

## PRELIMINARY:

Turn on the blower. Switch is situated on the blower motor under the permeameter table. Make certain that the lead from switch A (marked Selector Lead) is connected to terminal on top of Low-field Rheostat which is located on end of table. Move contact of the low-field Rheostat to the bottom, which is the position for minimum current. Open both switches and connect ammeter leads to  $\frac{1}{2}$  ampere shunt. NEVER CHANGE AMMETER CONNECTIONS UNLESS BOTH SWITCH A AND SWITCH B ARE OPEN.

## INSERTION OF SAMPLE:

The permeameter will handle samples up to  $7/8$ " by  $1\ 7/8$ " in cross-section. Minimum length of sample which may be measured is fifteen inches. Most convenient length is approximately thirty inches. To insert sample, release Knu-Vise clamps and roll moveable yoke outward until it hits stops. Slide sample into gap. The B-measuring coils are exposed, so care must be used in order that they will not be damaged. The coils are visible as a rectangular <sup>opening</sup> in the bakelite collar midway between the pole pieces, in the gap. Sample should be centered vertically for best results. This positioning is not critical. Adjusting screws are provided at the ends of the pole pieces. Sample should be clamped firmly in place by setting the Knu-Vise clamps. Adjusting screws are provided on the clamps. They should be adjusted so that the sample is held firmly in position, but is not subjected to excessive stress.

## MAKING H MEASUREMENTS:

Connect fluxmeter leads to coil H-1. It is not necessary to observe any polarity convention for H coils. Close switch B in the up position. Close switch A and adjust to proper value of current by using the low-field rheostat. The high-field rheostat may be used for fine adjustment. When proper current is obtained reverse switch A several times, allowing at least ten seconds after each reversal for field to reach equilibrium. When current stays steady for several reversals, fluxmeter should be read at each reversal and the best value of deflection recorded. Repeat this process for each desired current. When the range of one shunt has been completed the corresponding B measurements should be made before changing shunts. When it is desired to make measurements at a lower field than any which has been previously reached, it is necessary to demagnetize the sample by successive reversals of gradually decreasing currents. This is necessary when the B measurements are made over a current range already covered in H measurement or vice-versa, or when the previous history of the sample is not known.

## MAKING B MEASUREMENTS:

Connect fluxmeter leads to a B coil and its corresponding bucking coil. Polarity must be observed. The two coils are placed in series opposing. This is accomplished by connecting the coils so that the lead which joins one coil to the other is connected to the left hand terminal of the B coil and the right hand terminal of the bucking coil, as shown in figure 4. Readings are made in the same manner as for H measurements.

CHOICE OF COILS:

Coil H-1 should be used for half ampere and five ampere ranges. Coil H-3 should be used for fifty ampere range. If higher currents are to be used, coil H-2 may be used.

Coil B-6 has been found satisfactory for all measurements on samples of dimensions approximating 1/2" x 1". For different size samples different B coils may be used.

MAKING HIGH CURRENT MEASUREMENTS:

The Selector Lead is moved to the shunt on the welding generator terminal for currents exceeding ten amperes. Generator is turned on and off with buttons provided on the end of its case. Current is adjusted by use of a screw-operated field rheostat controlled by a brass handle at the top of the end of the case. The current-selector handle should be in the extreme right-hand position. This is located immediately below the current control handle. Measurements are made in the same manner as the low-current measurements for fields up to forty amperes. For currents higher than this, generator should be turned off before switch A is reversed. This is necessary to prevent excessive arcing.

REMANANCE TESTS:

During B measurements the fluxmeter does not return to zero-flux position when switch A is opened. This is a measure of the remanance of the sample. In measuring remanance, the readings when the switch is opened in first one direction and then the other determine the deflection to be used in the computations.

INTERPRETATION OF DATA:

In H measurements, the measured flux-linkage change represents twice the value of H to be plotted (since current is reversed). In B measurements the bucking coil links flux equal to the air-flux in the B-measuring coils. The measured flux change therefore corresponds to twice the flux of intrinsic magnetization in the sample. The area to be used in the calculation of B is the area of cross-section of the sample multiplied by the number of turns of the B coil. When B is measured in gauss and H is measured in oersteds, the value of  $\mu$  is determined by

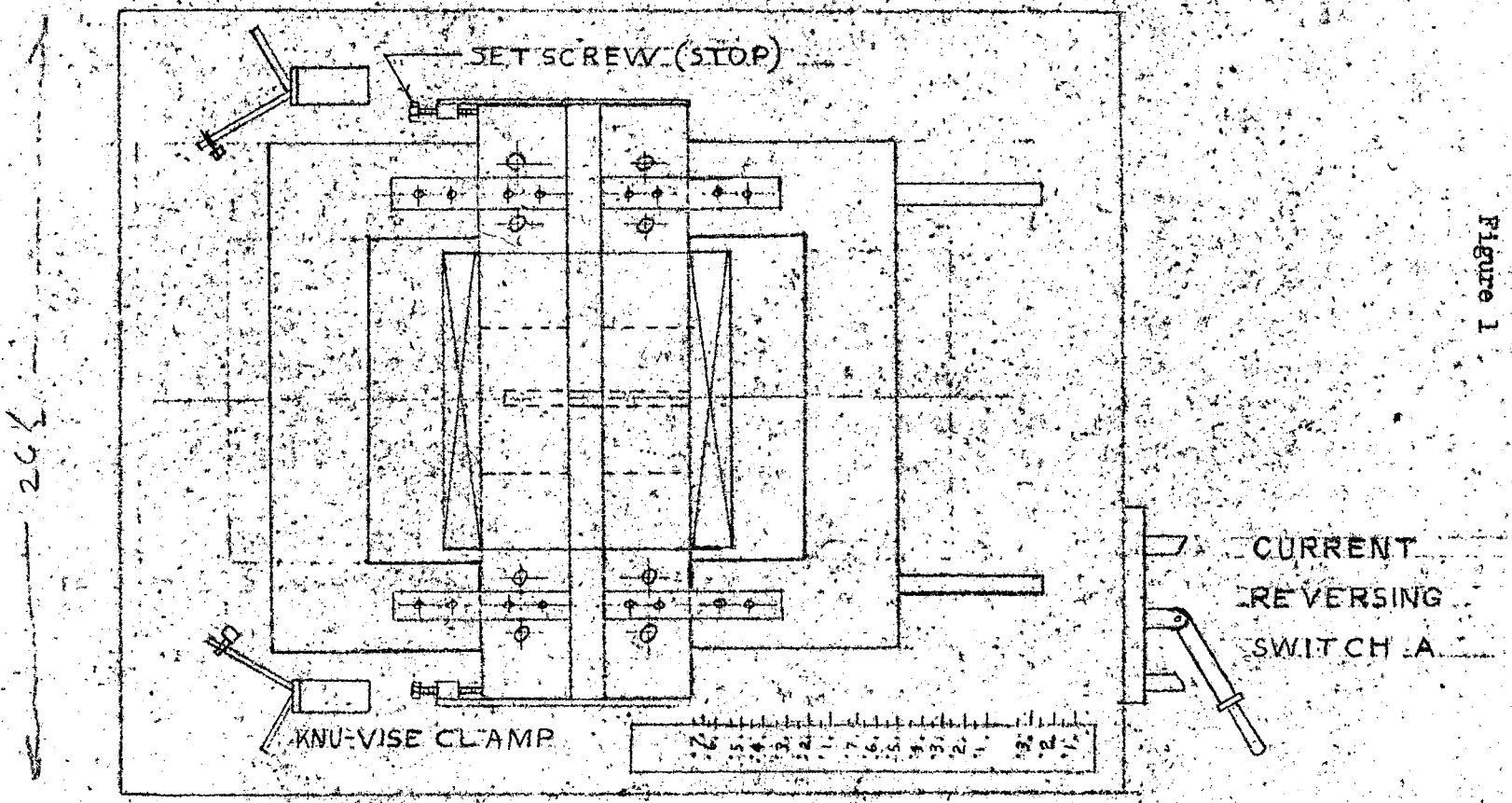
$$(\mu - 1) = \frac{B - H}{H} = \frac{4\pi I}{H}$$

Where B is intrinsic magnetization and H is magnetizing force.

Coil	Area	Coil	Turns
H-1	7275 cm <sup>2</sup>	B-1	200
H-2	14771	B-2	100
H-3	2837	B-3	50
		B-4	24
		B-5	15
		B-6	10
		B-7	6

R. E. Richardson,  
January 21, 1949

SHOWN ON					FIRST USED ON	RADIATION LABORATORY	DRG. NO. 408
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO. 77	DATE REQ'D	MAKE		UNIVERSITY OF CALIFORNIA-BERKELEY
ROUGH $\phi$ FINISH      FINE $f$ FINISH GOOD $\gamma$ FINISH      GRIND $G$ FINISH						DRAWN BY Richardson	CHECK BY
MACHINED DIMENSIONS $\pm$ .010 UNLESS OTHERWISE SPECIFIED						APPROVED BY	DATE 23 July 1948.
							SCALE $\frac{1}{6} = 1"$
PERMEAMETER							
ASSEMBLY DRAWING							

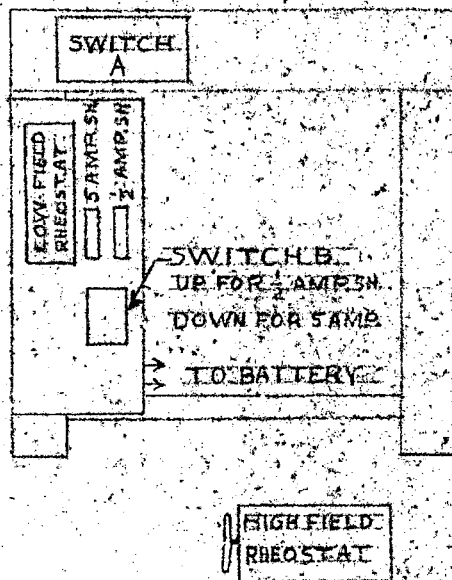


408791

MATERIAL	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
----------	---------------	----------	----------	------	--------

408791

SHOWN ON						FIRST USED ON	RADIATION LABORATORY		DRG. NO.
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE	UNIVERSITY OF CALIFORNIA-BERKELEY			
ROUGH $\phi$ FINISH      FINE $f$ FINISH GOOD $f$ FINISH      GRIND $G$ FINISH						DRAWN BY R. Richardson	CHECK BY	DATE	
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED						APPROVED BY	SCALE		
						PERMEAMETER			
						CURRENT CONTROL			



BOTH SWITCHES SHOULD BE OPEN WHEN CHANGING METER LEADS, FOR PROTECTION OF THE METER.

FOR HIGH FIELDS, REMOVE WELDING CABLE FROM TOP OF LOW-FIELD RHEOSTAT. CONNECT THIS CABLE TO END OF 50 AMP. SHUNT ON GENERATOR TERMINAL.

Figure 2

MATERIAL

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
---------------	----------	----------	------	--------

K1128

SHOWN ON					FIRST USED ON
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE

**RADIATION LABORATORY** DRG. NO.

UNIVERSITY OF CALIFORNIA-BERKELEY

ROUGH $\phi$	FINISH	FINE <i>ff</i>	FINISH
GOOD <i>f</i>	FINISH	GRIND <i>G</i>	FINISH
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED.			

DRAWN BY *R. Richardson* CHECK BY DATE

APPROVED BY SCALE

PERMEAMETER

ENERGIZING CIRCUIT

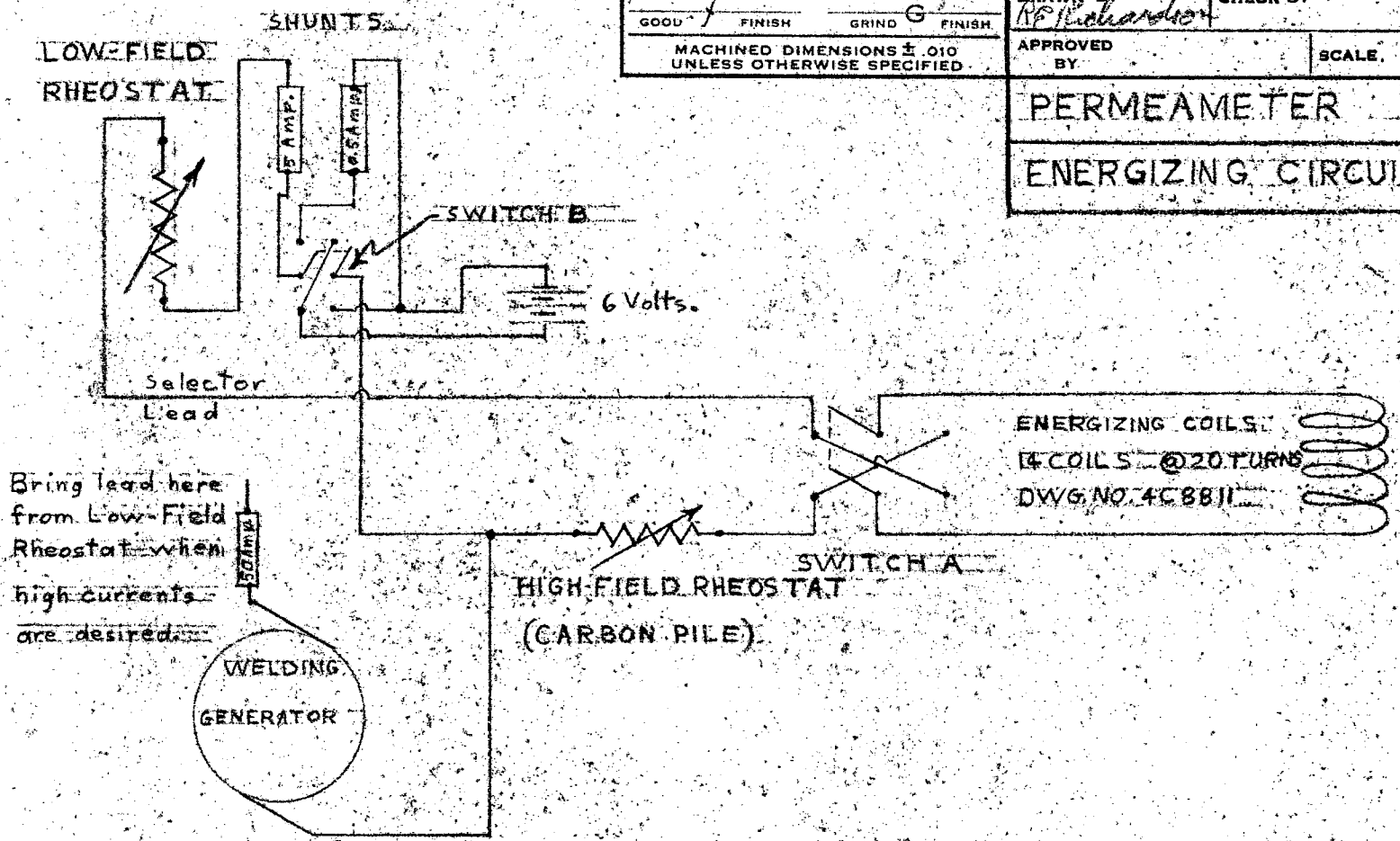


Figure 3

*15-2-2*

MATERIAL	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
----------	---------------	----------	----------	------	--------



SHOWN ON					FIRST USED ON	RADIATION LABORATORY		DRG. NO.
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE	UNIVERSITY OF CALIFORNIA-BERKELEY		
						DRAWN BY	CHECK BY	DATE
						<i>RE Richardson</i>		
						APPROVED BY	SCALE	
						PERMEAMETER		
						MEASURING CIRCUITS		

ROUGH	FINISH	FINE	FINISH
GOOD	FINISH	GRIND	FINISH

MACHINED DIMENSIONS  $\pm .010$   
UNLESS OTHERWISE SPECIFIED

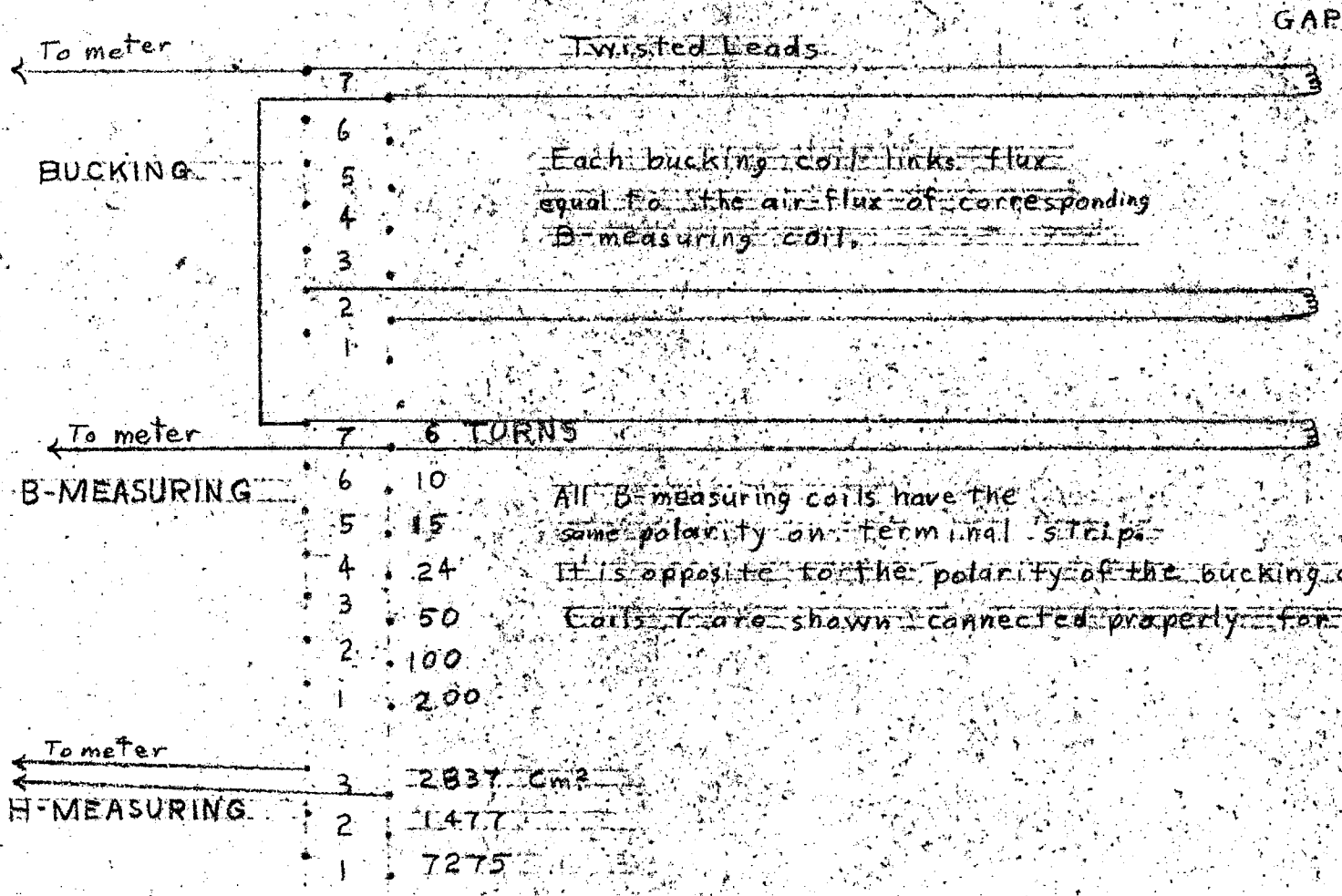
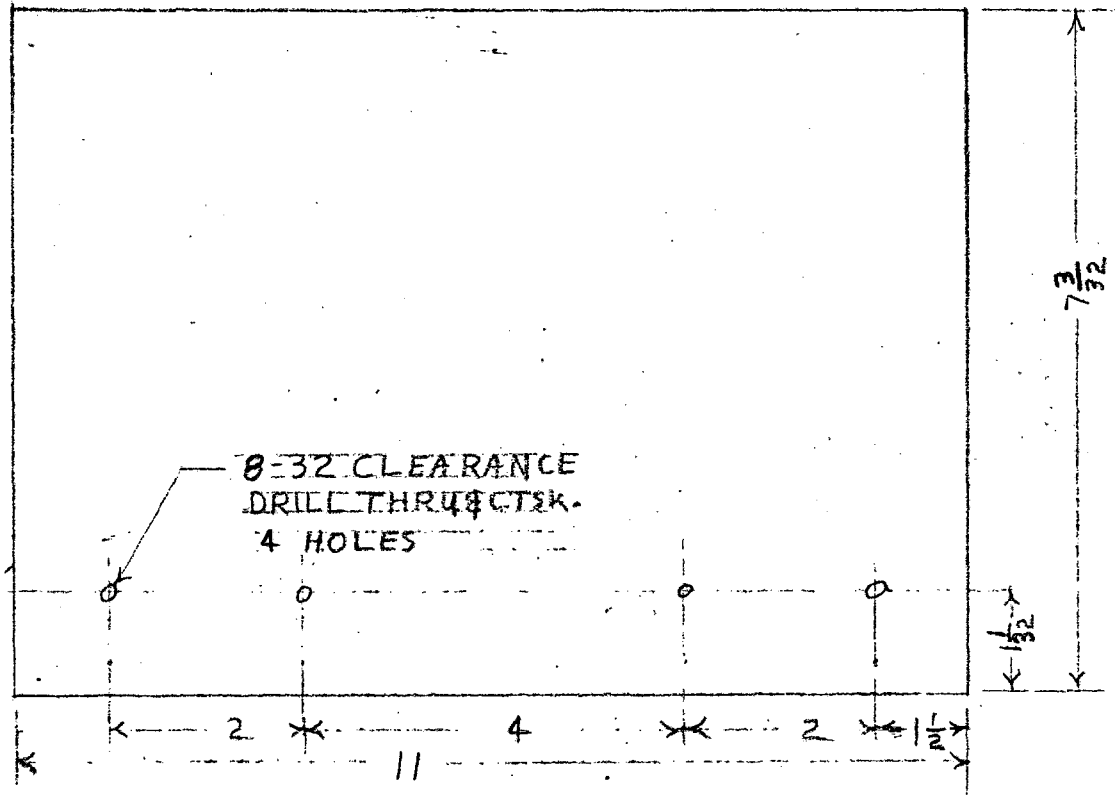


Figure 4

K128

MATERIAL	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
----------	---------------	----------	----------	------	--------

SHOWN ON						FIRST USED ON	RADIATION LABORATORY		DRG. NO. 4C8801
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE	UNIVERSITY OF CALIFORNIA-BERKELEY			
ROUGH $\phi$ FINISH      FINE $f$ FINISH GOOD $f$ FINISH      GRIND $G$ FINISH						DRAWN BY <i>Richardson</i>	CHECK BY	DATE 23 JULY 1948	
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED						APPROVED BY	SCALE $\frac{1}{2}'' = 1''$		
PERMEAMETER									
MAGNETIZING COIL SUPPORT									



MATERIAL	$\frac{1}{4}''$ CANVAS BAKELITE	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
----------	---------------------------------	---------------	----------	----------	------	--------

"ALBANENE" 195L K. & E. CO., N. Y.  
REG. U. S. PAT. OFF.

25 June 52

For H. Keller

MISSING:

4C 8811 - already

in your possession

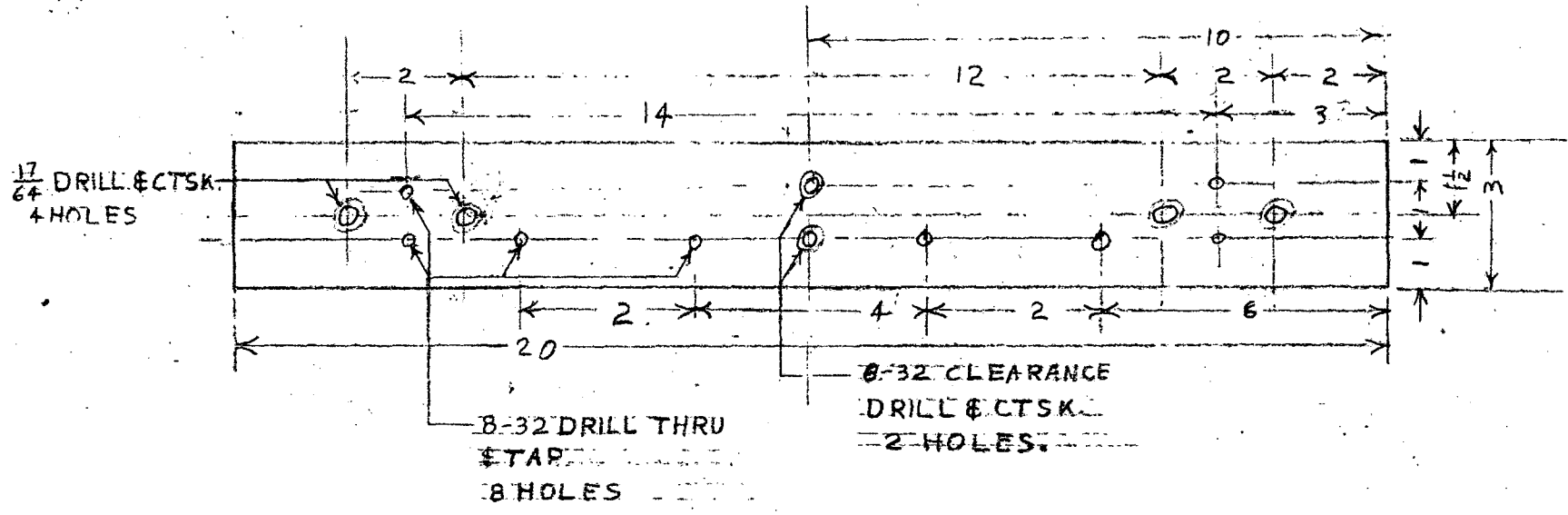
MISSING FROM PRINT ROOM

4C 8791 ASSEMBLY

4C 8881 TEST COIL SUPPORT

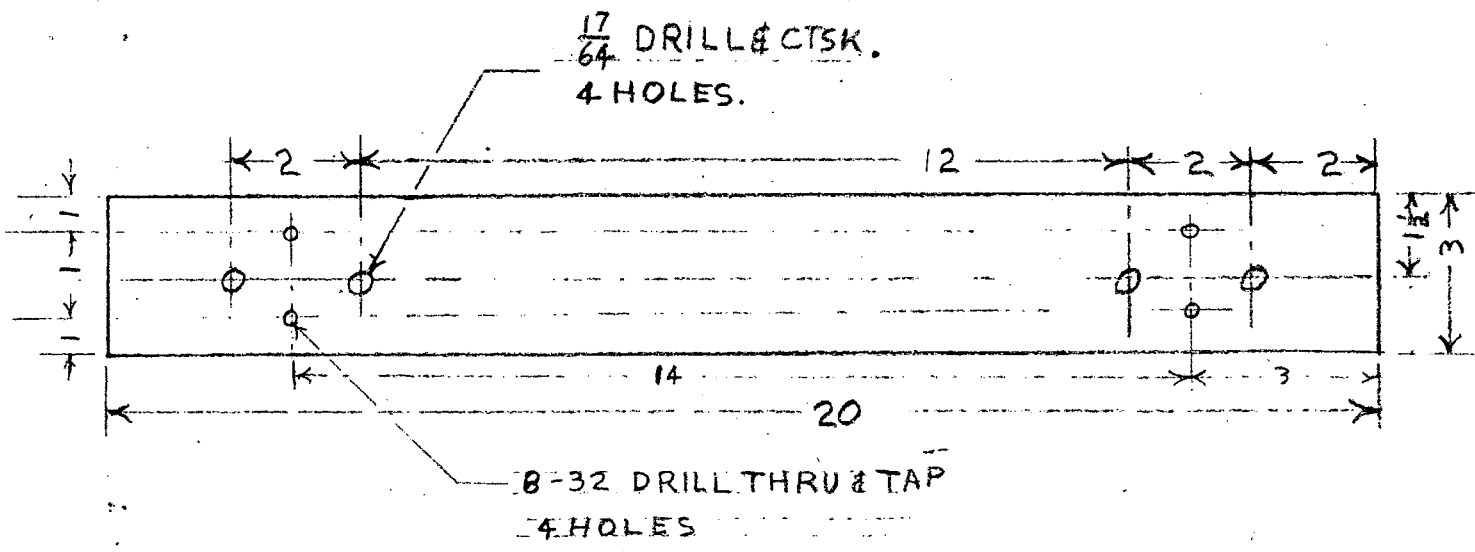
W E Humphrey

SHOWN ON					FIRST USED ON	RADIATION LABORATORY		DRG. NO. 4C8821
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO. 3-1	DATE REQ'D	MAKE	UNIVERSITY OF CALIFORNIA-BERKELEY		
					ROUGH $\phi$ FINISH	FINE $ff$ FINISH	DRAWN BY Richardson	
					GOOD $\gamma$ FINISH	GRIND $G$ FINISH	CHECK BY	
					MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED		DATE 23 JULY 1948	
							APPROVED BY	
							SCALE N.T.S	
							PERMEAMETER	
							POLE SPACER - A	



MATERIAL - $\frac{1}{4}$ " BRASS	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
----------------------------------	---------------	----------	----------	------	--------

SHOWN ON					FIRST USED ON	RADIATION LABORATORY		DRG. NO. 408831	
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO. 77	DATE REQ'D	MAKE 2	UNIVERSITY OF CALIFORNIA-BERKELEY			
					ROUGH $\phi$ FINISH	FINE $ff$ FINISH	DRAWN BY <i>Richardson</i>	CHECK BY	DATE 23 JULY 1949
					GOOD $f$ FINISH	GRIND $G$ FINISH	APPROVED BY		SCALE $\frac{1}{2}'' = 1''$
					MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED				
					PERMEAMETER				
					POLE SPACER-B				



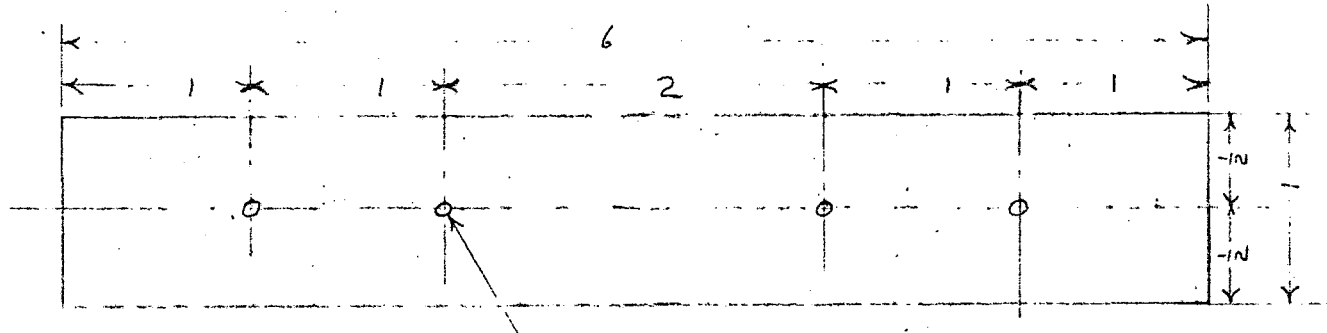
MATERIAL $\frac{1}{4}$ BRASS	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
------------------------------	---------------	----------	----------	------	--------

SHOWN ON						FIRST USED ON	RADIATION LABORATORY	DRG. NO. 4C 8841
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE			UNIVERSITY OF CALIFORNIA-BERKELEY

ROUGH $\phi$	FINISH	FINE $ff$	FINISH
GOOD $f$	FINISH	GRIND $G$	FINISH
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED			

DRAWN BY <i>Richardson</i>	CHECK BY	DATE 26 JULY 1948
APPROVED BY	SCALE 1"=1"	

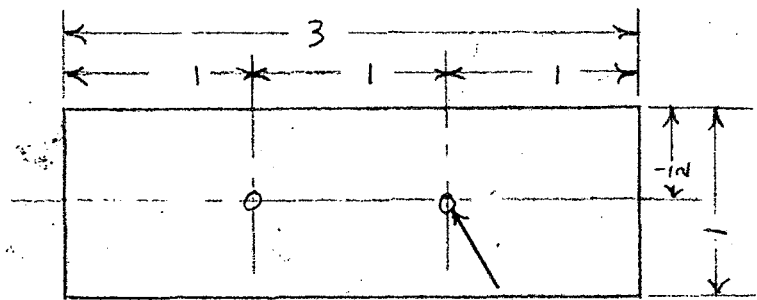
<input type="checkbox"/> PERMEAMETER
<input type="checkbox"/> POLE TIE STRAP



8-32 CLEARANCE  
HOLES DRILL THRU.

MATERIAL $\frac{1}{4}$ " BRASS	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
--------------------------------	---------------	----------	----------	------	--------

SHOWN ON						FIRST USED ON	RADIATION LABORATORY		DRG. NO. 4C8851								
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE	UNIVERSITY OF CALIFORNIA-BERKELEY											
<table border="1"> <tr> <td>ROUGH <math>\phi</math></td> <td>FINISH</td> <td>FINE <i>ff</i></td> <td>FINISH</td> </tr> <tr> <td>GOOD <i>y</i></td> <td>FINISH</td> <td>GRIND <i>G</i></td> <td>FINISH</td> </tr> </table>						ROUGH $\phi$	FINISH	FINE <i>ff</i>	FINISH	GOOD <i>y</i>	FINISH	GRIND <i>G</i>	FINISH	DRAWN BY <i>Richardson</i>		CHECK BY	DATE 26 JULY 1948
ROUGH $\phi$	FINISH	FINE <i>ff</i>	FINISH														
GOOD <i>y</i>	FINISH	GRIND <i>G</i>	FINISH														
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED						APPROVED BY	SCALE 1" = 1"										
PERMEAMETER																	
POLE TIE STRAP SPACER																	

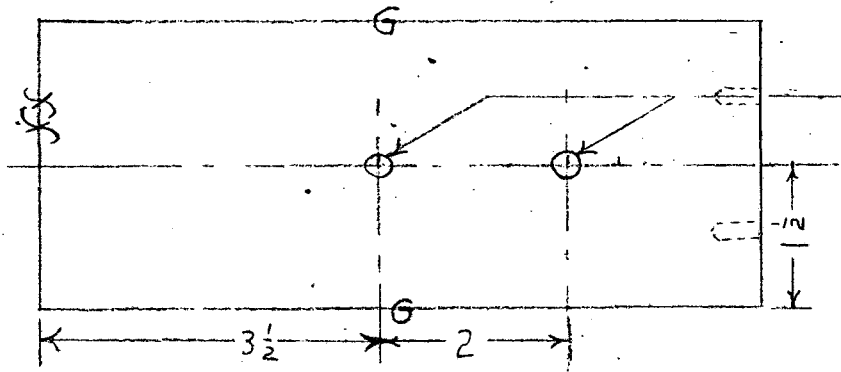


8-32 CLEARANCE  
2 HOLES DRILL THRU.

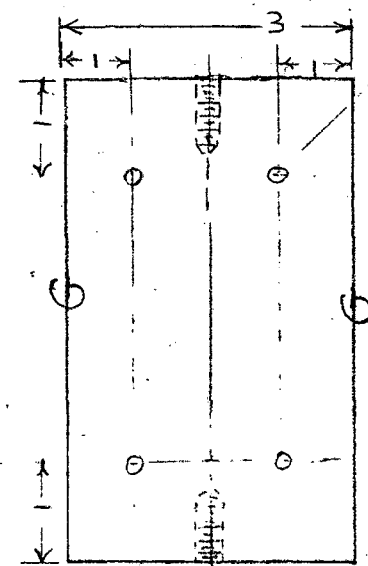
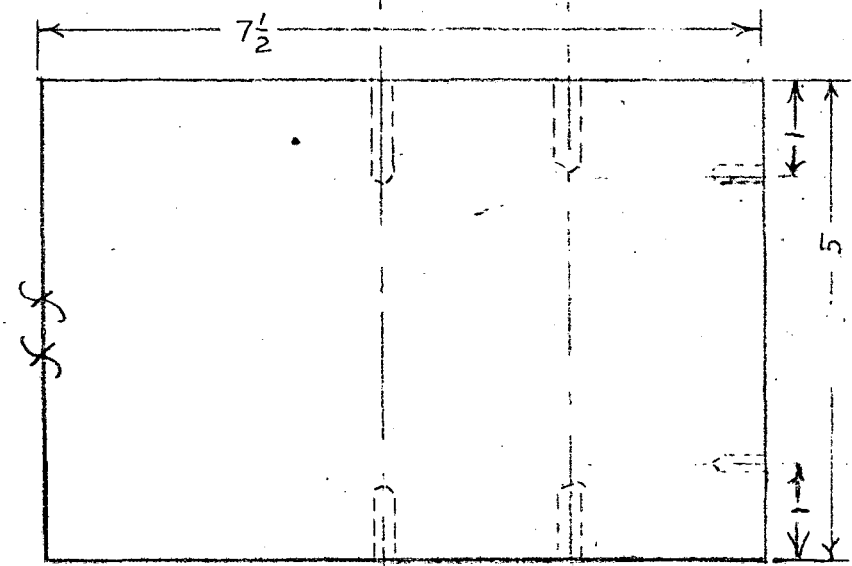
MATERIAL  $\frac{1}{4}$ " BRASS

CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
---------------	----------	----------	------	--------

SHOWN ON					FIRST USED ON	<b>RADIATION LABORATORY</b>		DRG. NO. 4C 8861																		
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE	UNIVERSITY OF CALIFORNIA-BERKELEY																				
<table border="1"> <tr> <td>ROUGH</td> <td>FINISH</td> <td>FINE</td> <td>FINISH</td> </tr> <tr> <td>GOOD</td> <td>FINISH</td> <td>GRIND</td> <td>FINISH</td> </tr> </table>					ROUGH	FINISH	FINE	FINISH	GOOD	FINISH	GRIND	FINISH	<table border="1"> <tr> <td>DRAWN BY</td> <td>CHECK BY</td> <td>DATE</td> </tr> <tr> <td>RICHARDSON</td> <td></td> <td>23 JULY 1948</td> </tr> </table>		DRAWN BY	CHECK BY	DATE	RICHARDSON		23 JULY 1948	<table border="1"> <tr> <td>APPROVED BY</td> <td>SCALE - <math>\frac{1}{2}'' = 1''</math></td> </tr> <tr> <td></td> <td></td> </tr> </table>		APPROVED BY	SCALE - $\frac{1}{2}'' = 1''$		
ROUGH	FINISH	FINE	FINISH																							
GOOD	FINISH	GRIND	FINISH																							
DRAWN BY	CHECK BY	DATE																								
RICHARDSON		23 JULY 1948																								
APPROVED BY	SCALE - $\frac{1}{2}'' = 1''$																									
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED						PERMEAMETER																				
						POLE PIECE																				



$\frac{1}{4}$ -20 DRILL AND TAP  
4 HOLES  $\frac{3}{4}$  DEEP.

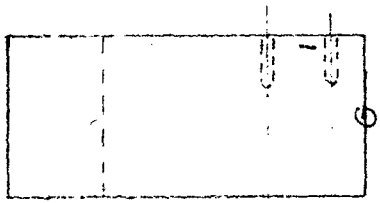


8-32 DRILL & TAP  
4 HOLES  $\frac{3}{4}$  DEEP.

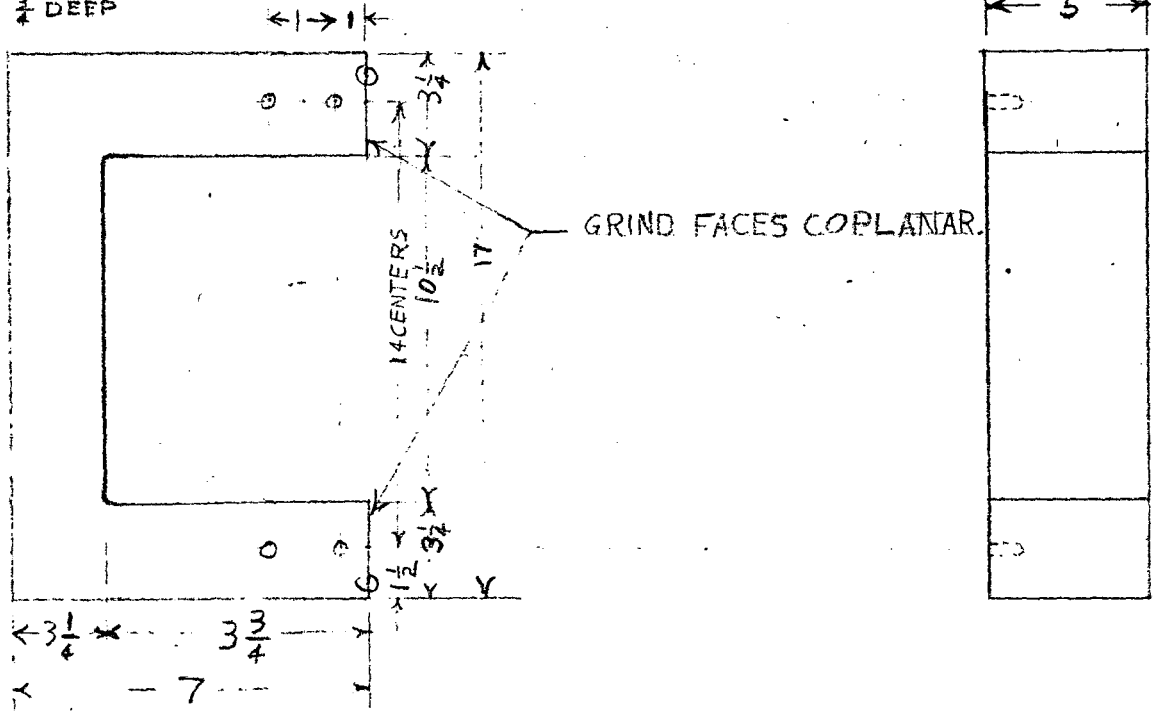
MATERIAL MILD STEEL					CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
---------------------	--	--	--	--	---------------	----------	----------	------	--------



SHOWN 03						FIRST USED ON	RADIATION LABORATORY	DRG. NO. 408871										
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO.	DATE REQ'D	MAKE	UNIVERSITY OF CALIFORNIA-BERKELEY		DRAWN BY Richardson	CHECK BY	DATE 21 JULY 1948								
<table border="1"> <tr> <td>ROUGH <math>\phi</math></td> <td>FINISH</td> <td>FINE <i>ff</i></td> <td>FINISH</td> </tr> <tr> <td>GOOD <i>f</i></td> <td>FINISH</td> <td>GRIND <i>G</i></td> <td>FINISH</td> </tr> </table>							ROUGH $\phi$	FINISH	FINE <i>ff</i>	FINISH	GOOD <i>f</i>	FINISH	GRIND <i>G</i>	FINISH	APPROVED BY		SCALE N.T.S.	
ROUGH $\phi$	FINISH	FINE <i>ff</i>	FINISH															
GOOD <i>f</i>	FINISH	GRIND <i>G</i>	FINISH															
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED							PERMEAMETER											
							YOKE											



8-32 DRILL & TAP  
4 HOLES  $\frac{3}{4}$  DEEP



MATERIAL	MILD STEEL	CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
----------	------------	------------------	-------------	-------------	------	--------

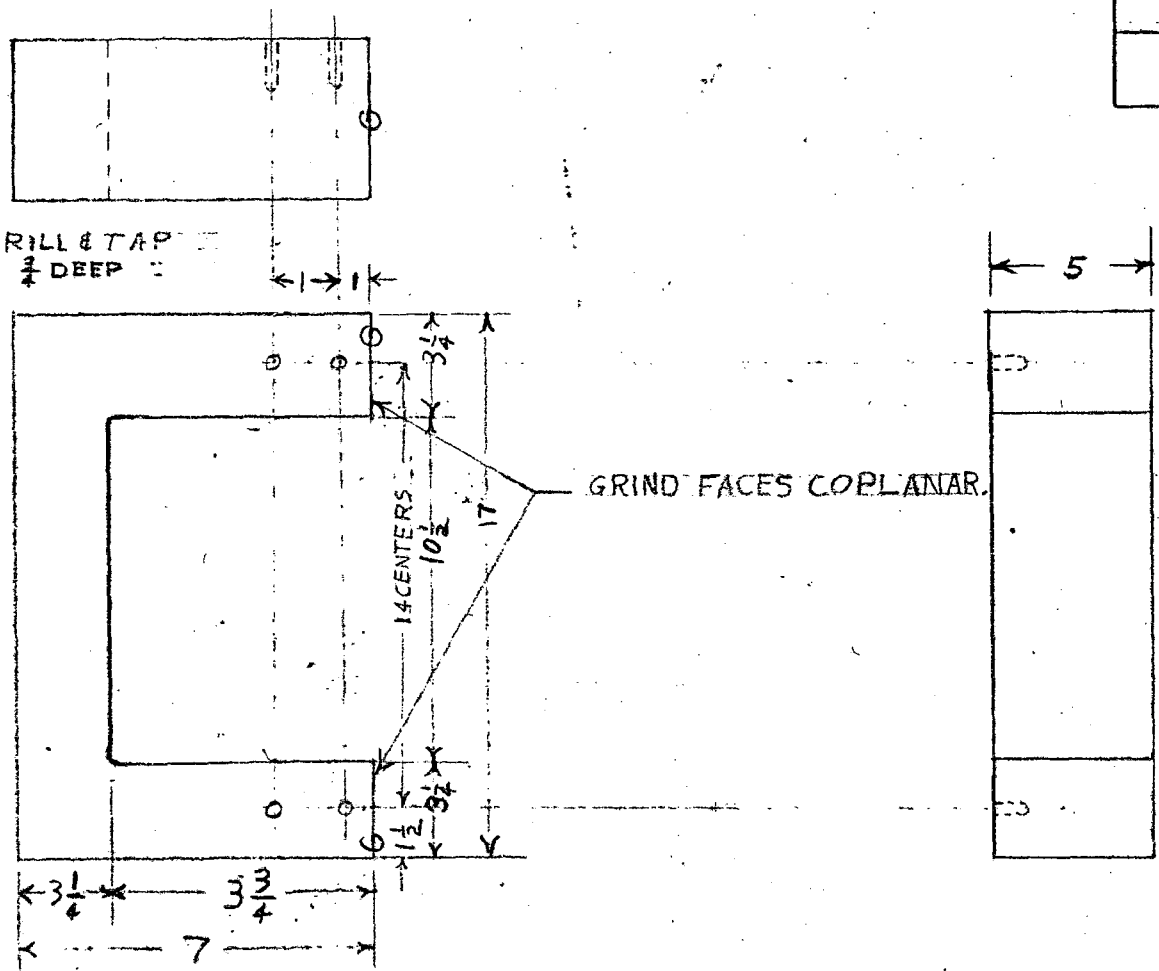
SHOWN ON					FIRST USED ON	RADIATION LABORATORY	DRG. NO. 4C8871
ISSUED TO	DATE ISSUED	DELIVER TO	JOB NO. 7	DATE REQ'D	MAKE		UNIVERSITY OF CALIFORNIA-BERKELEY

ROUGH $\phi$	FINISH	FINE <i>ff</i>	FINISH
GOOD <i>f</i>	FINISH	GRIND $\phi$	FINISH
MACHINED DIMENSIONS $\pm .010$ UNLESS OTHERWISE SPECIFIED			

DRAWN BY <i>Richardson</i>	CHECK BY	DATE 23 JULY 1948
APPROVED BY	SCALE N.T.S.	

PERMEAMETER  
YOKE

8-32 DRILL & TAP  
4 HOLES  $\frac{3}{4}$  DEEP



MATERIAL	MILD STEEL				CHANGE LETTER	DRAWN BY	CHECK BY	DATE	CHANGE
----------	------------	--	--	--	---------------	----------	----------	------	--------