UNCLASSIFIED

[redacted]

Classification changed
by authority of

S. L. Marshall

10-22-47

LAMS-153

[redacted]

October 26, 1944

This document contains 13 pages

CONSTRUCTION OF A HAND-CONTAMINATION COUNTER AND RADIATION MONITOR

WORK DONE BY:

Richard J. Watts

WRITTEN BY:

Richard J. Watts

[redacted]

[redacted]

UNCLASSIFIED

[redacted]

UNCLASSIFIED

[redacted]

ABSTRACT

Complete details are given for the construction of an instrument for the detection of α, β, or γ radiation to be used in routine checking of contamination on hands, clothing, etc., and in the monitoring of background radiation.

[redacted]

[redacted]

UNCLASSIFIED

CONSTRUCTION OF A HAND-CONTAMINATION COUNTER AND RADIATION MONITOR

The instrument described in this report is used to detect radioactive contamination of hands, clothing, shoes, etc., through indication of α, β, or γ radiation. It may also be used as a monitor of background radiation.

The apparatus consists essentially of four units: (1) a high-voltage supply (0 to 2000 volts); (2) a low-voltage supply with an amplifier and indicating meter; (3) a Geiger-Mueller tube; and (4) a thin-window counter.

The indicator may be any 0-to 1-ma meter; the Esterline-Angus 0-to 1-ma recording meter is particularly useful when the instrument is used as a monitor. Provisions are also made to operate a loudspeaker as an auditory indicator of counts. On the most sensitive scale an intensity of .0004 R/8hr. will give a deflection of 20% of scale; on the least sensitive scale, .02R/8hr. will give full-scale deflection. For α radiation, intensities of the order of 200 counts per minute may be easily detected.

(1) The High-voltage Supply

A schematic drawing of the high-voltage supply is shown in the upper part of Fig. 1. The supply is of the voltage-regulated type that is commonly used in measuring devices. Attention is called to three points: (a) the low-voltage supply should always be turned on first to permit the heater of the 6J7 to warm up; otherwise, the voltage will surge up well over the plateau of the G-M tube with the consequent possibility of shortening the tube life and changing its characteristics appreciably; (b) a 400K-ohm plate

[redacted]

resistor reduces the plate current of the 6J7 to between .5 and 1 ma; this is done to reduce the drain on the T-17K32 television transformer; and (c) for further reduction of the drain on this transformer the reference voltage is obtained from the VR-105 of the low-voltage supply (usually when drain is unimportant, two 1/25-watt neon lamps with appropriate resistance are placed across the H.V. to obtain this reference voltage). The high-voltage supply will furnish about 2000 volts. If the equipment is to be used with a hand counter about 1800 volts will be needed. It will then be necessary to change the scale of the 0-to-100 microammeter used as a voltmeter from 0 to 1500 volts to 0 to 2000 volts; the resistance in series should be changed appropriately. The 0 to 1500 scale is used with a G-M tube in order that the voltage may be read more accurately.

2. The Amplifier and Meter

The amplifier itself consists of 3 parts: (a) a feedback RC-coupled amplifier of two tubes, a 6J7 and 6SJ7; (b) a univibrator or rectangular-wave generator consisting of a 6SN7; and (c) a tube which gives an output proportional to the number of incoming pulses. The amplifier amplifies the pulses from the G-M tube or hand counter. The size of this output pulse from the amplifier depends upon the size of the input pulse. The amplification may be adjusted by means of the potentiometer on the grid of the 6SJ7. If a G-M tube is being used these output pulses will be uniform in size; if the hand counter is being used the size of the output pulses will vary considerably since it is operated in the proportional range. The pulses are then fed into the univibrator. Because of the manner of coupling the grids in this stage, at some minimum-size pulse the circuit will "flop"; i.e.,

[redacted]

[redacted]

the right-hand tube will become completely conducting and then "flop" back to its original voltage. The output from this stage, which is RC coupled to the output stage, is thus independent of the size of the input pulse. The method of integrating used is quite similar to the basic DC restorer circuits used in television. The diode part of the 6SF7 is shunted by the 1-megohm and 10-megohm resistors. The output stage is coupled to that plate of the tube in the univibrator which will give a positive pulse. This pulse swings the plate of the diode positive and the coupling condenser charges up through the diode. When the pulse disappears, i.e., when the plate voltage of the univibrator returns to 150 volts; the charge on the coupling condenser leaks to ground through the 10-megohm resistor. A large value of resistance is used because it is necessary to add up the effect of the pulses until the leakage current through the 10-megohm resistor is about equal to the charging current through the diode. When this condition is reached, the grid of the 6SF7 will pulsate about an average point. The .05-mf feedback condenser is used as a smoothing filter. It may be considered roughly equivalent to a condenser placed between grid and ground whose value will be given by the value of the feedback condenser multiplied by the gain of the tube. The VR105 tube is used as a reference voltage for the indicating milliammeter. With no incoming pulses the tube is biased by means of the cathode rheostat until the plate voltage is at 105 volts. A 0-to 1-ma METER will then show no deflection if connected between the plate and the VR tube. Incoming pulses, however, change the bias on the grid and cause the plate voltage to rise. There will then be an effective voltage difference across the meter, and the meter reading will be proportional to the number of incoming pulses. The sensitivity of the instrument is changed by varying the size of the coupling

[redacted]

condenser to the last stage. A speaker may be placed in one plate of the univibrator stage if audible monitoring is desired. The speaker circuit has been indicated on the diagram by dotted lines. In an effort to acquire simplicity and reliability in operation the screens of the amplifier tubes and the 6SF7 are biased directly from the VR105 tube. Wave shape and voltages are given on the diagram at various points. Chassis layouts are given in Figs. 2 and 3.

(3) The Geiger-Mueller Tube

The G-M tube is the standard aluminum type commonly used. Since these tubes have a 5-mil wall, β radiation may be detected. Fig. 4 gives details for mounting the tube with a handle so that it may be used for examination of shoes, clothing, etc. A six-foot Amphenol beaded cable may be used to connect the tube to the chassis. A screen is provided to protect the tube from damage, and a lead base is incorporated in the handle so that the tube may be placed in some particular location if background indications are desired over long periods of time.

(4) The Thin-window Counter

Fig. 5 shows the details and methods of assembling the thin-window counter. Since this counter is rather unorthodox in construction the technique of assembling it will be given in detail.

It was thought desirable to use a one-mil tungsten wire for the center wire since the voltage then required would be considerably reduced. To facilitate ease of assembly the two ends of the counter are made of Amphenol discs. These make a press fit into the ends of the brass tube; part five (see Fig. 5) is removed and the Amphenol disc tapped into place.

[redacted]

A piece of buss wire about five inches long, small enough to go through the male Amphenol connector, is scored on the end with a knife and one end of a piece of 1-mil wire is wrapped around it several times. This joint is soldered with an iron (an open flame will burn up the 1-mil wire). Since it is doubtful, under these circumstances, that a good electrical connection has been made, the joint is dipped in aquadag. The other end of the 1-mil wire is then threaded through the disc and is pulled through until the buss wire makes contact with the Amphenol. A hot iron is applied to the buss wire which will melt its way into the Amphenol (this can be helped along by gently pushing it). When the buss wire is halfway through the disc the heat is removed and the disc around the wire will solidify and hold the wire tightly in place. The joint around the disc and the brass tube is then painted with glyptol. The buss wire is threaded through the male Amphenol of part five and part five is screwed into place. The buss wire is soldered to the Amphenol connector and the excess wire is clipped off. This completes the assembly of this end of the counter. On the other end, the one-mil wire is slipped through the hole in the center of the Amphenol disc and the disc tapped into place. The wire is pulled taut and bent so that it rests flush on the disc. A hot soldering iron is used to press the wire into the disc and to push the soft Amphenol into the hole and close it up. When the Amphenol solidifies it will hold the wire firmly. The end is painted with glyptol and the excess wire is clipped off. A cap may be used to shield the end although it has not been found necessary. The counter is now ready for the thin window.

The thin window is made from a half-and-half mixture of collodion of amyl acetate. On the bottom of a flat bowl filled with distilled water is placed a mask somewhat larger than the window opening. About seventy drops

[redacted] [redacted]

of the mixture from an eye-dropper is dropped on the water; in a few minutes a thin film will appear on the surface. The thickness of this film may be varied by varying the mixture or the number of drops. When the film has solidified sufficiently and interference colors are plainly visible the film is carefully lifted from the water by means of the mask. The plate of the counter is coated with glyptol and when it is tacky the window is lowered into place and pressed into the glyptol with the ball of the finger. The mask is freed by cutting around the film with a razor blade. The protective screen is screwed into place and the counter is ready for operation.

Either argon or methane gas may be used in the counter. Argon has the advantage of using a much lower voltage (around 1300 volts in this case) but methane, since it is much cheaper, is preferable. The counter voltage needed for methane is about 1800 volts. The methane is run through the counter at slightly above atmospheric pressure; the pressure is controlled by means of a Victor Welding Equipment Company oxygen reducing valve #24471, which is used to reduce the pressure from the tank to about ten pounds. The gas at this pressure is fed through a Hooke needle valve so that a very fine flow is obtained. After the gas comes from the counter it is burned. The burner is a piece of tubing attached to the rubber hose, drawn down to a fine point with a shield around it to keep the flame from blowing out. The gas flow is measured by the size of the flame; a flame about one-half inch long is used.

No attempt to evacuate the counter is made. After the gas has flown through for a half hour or so the counter will begin to count; after two hours or so the counting rate becomes constant. Although the amplifier has not a large gain it will be found that by turning the gain up alphas may be counted in the presence of gammas. No trouble has been encountered with microphonics with this counter and with no alpha contamination present the background count is close to zero.

[redacted]

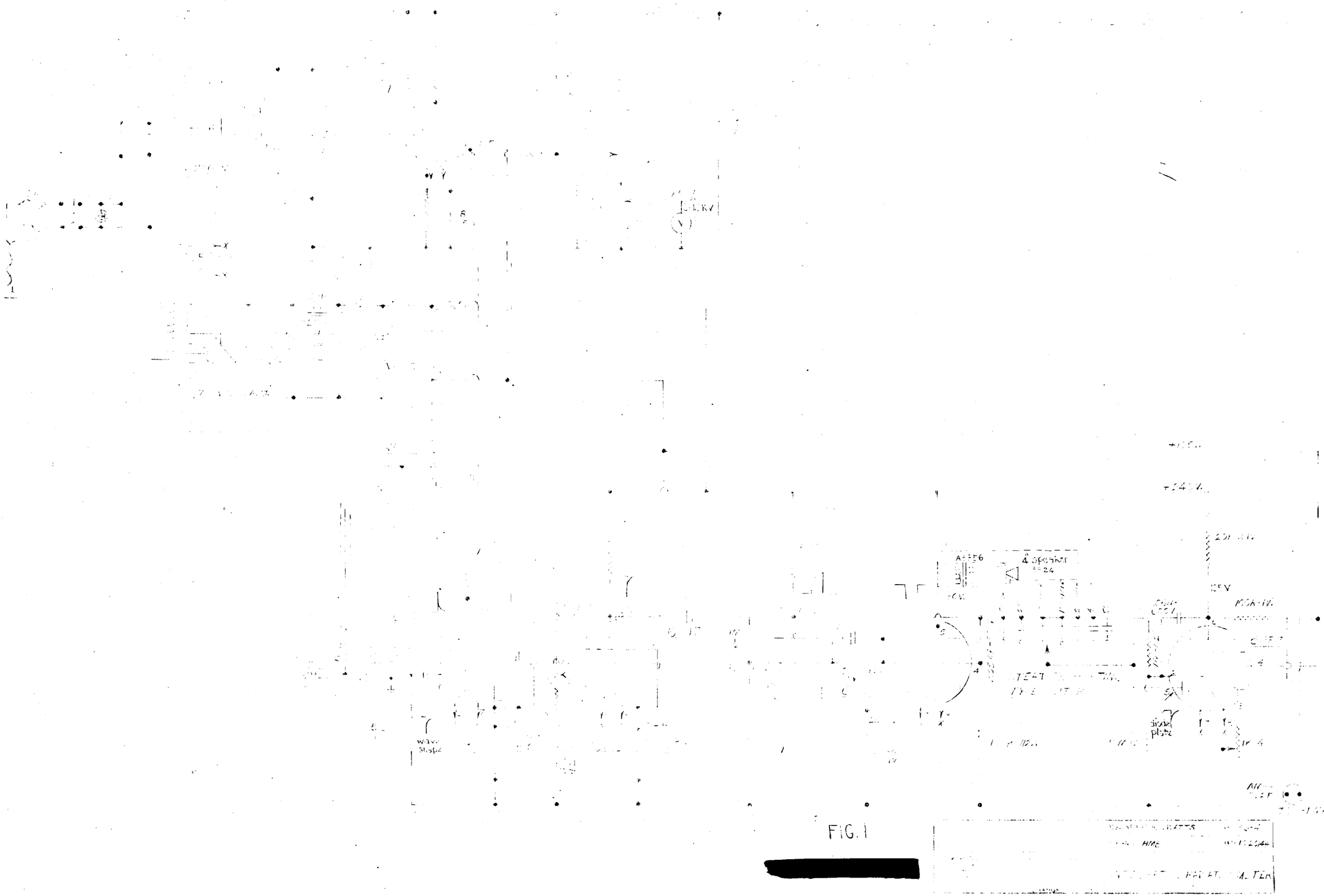


FIG. 1

[redacted]

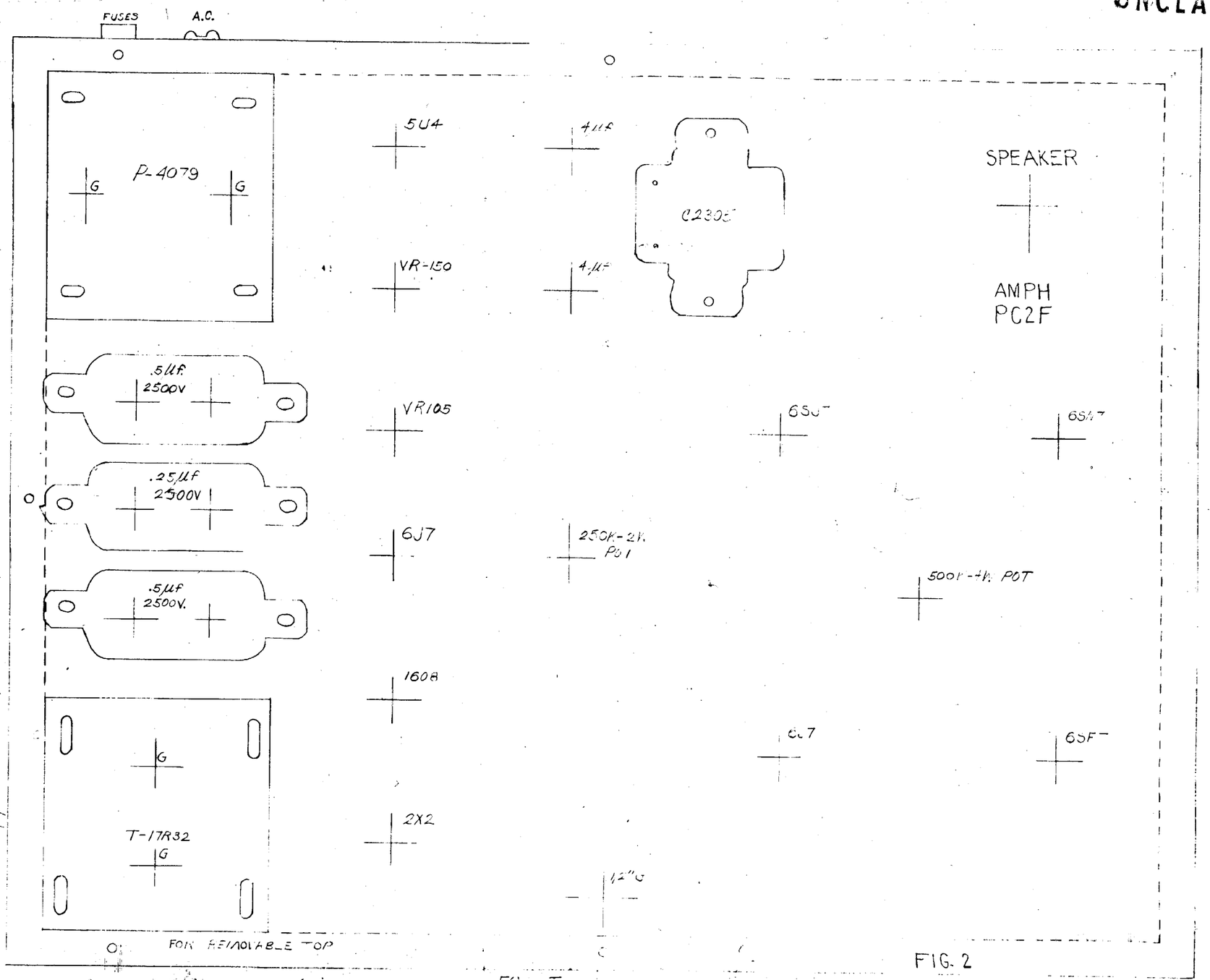
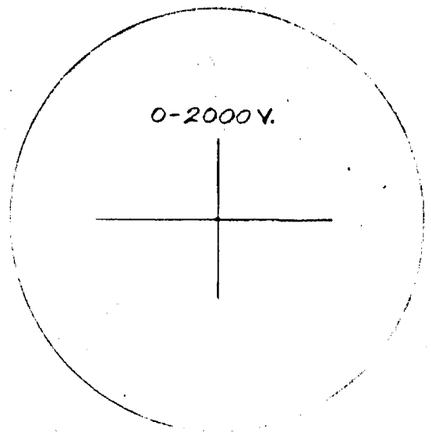


FIG. 2

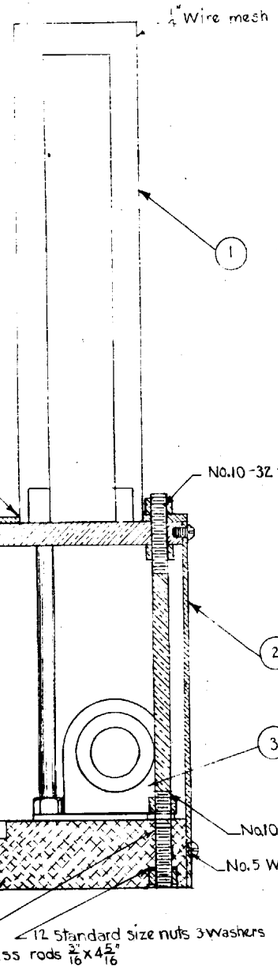
DESIGNED BY J. WATT GROUP 4
DRAWN BY H. LEE DATE 9-44
DRAWING NO. 1
INTEGRATING WATTMETER
(CHASSIS LAYOUT)
CHANGE DATE



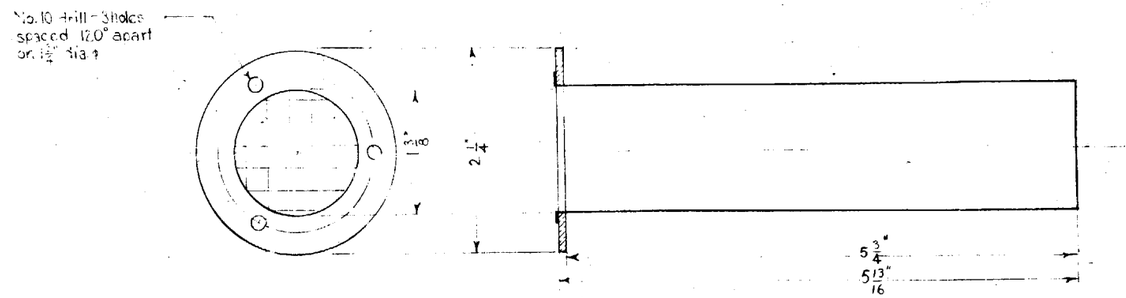
FRONT PANEL

FIG. 3

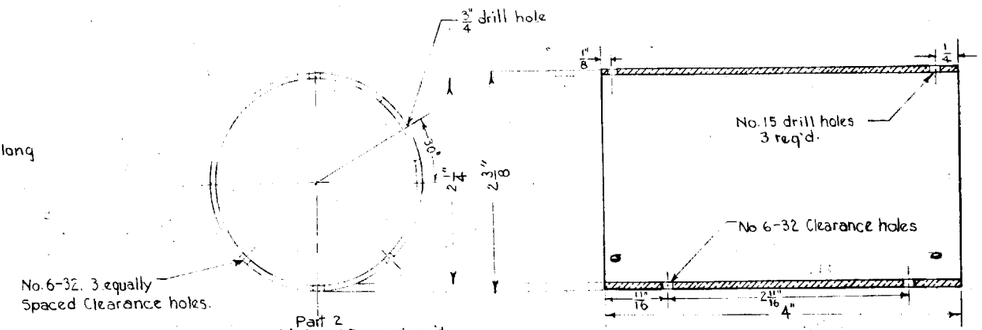
	DESIGNED BY R.J. WATTS	GROUP G-4
	DRAWN BY HMB	DATE 10/19/44
DRAWING NO. 421-B	CHANGE / DATE	TITLE: INTEGRATING RADIATION METER (PANEL LAYOUT)



SECTIONAL ASSEMBLY

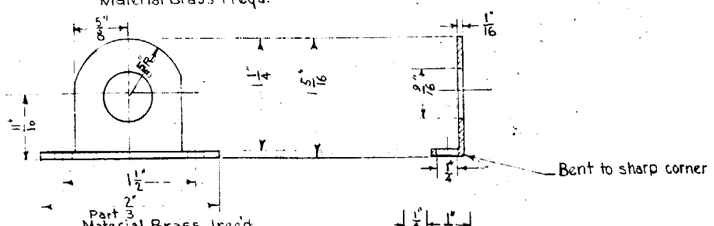


Part 1
Material Brass 1 req'd.

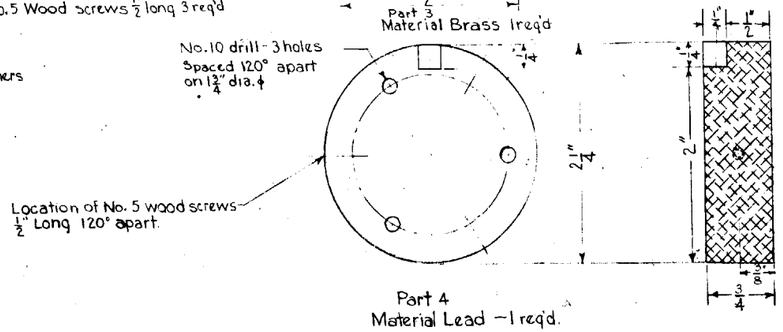


No.6-32. 3 equally Spaced Clearance holes.

Part 2
Material Brass 1 req'd.



Part 3
Material Brass 1 req'd



Location of No. 5 wood screws 1/2" Long 120° apart.

Part 4
Material Lead — 1 req'd.

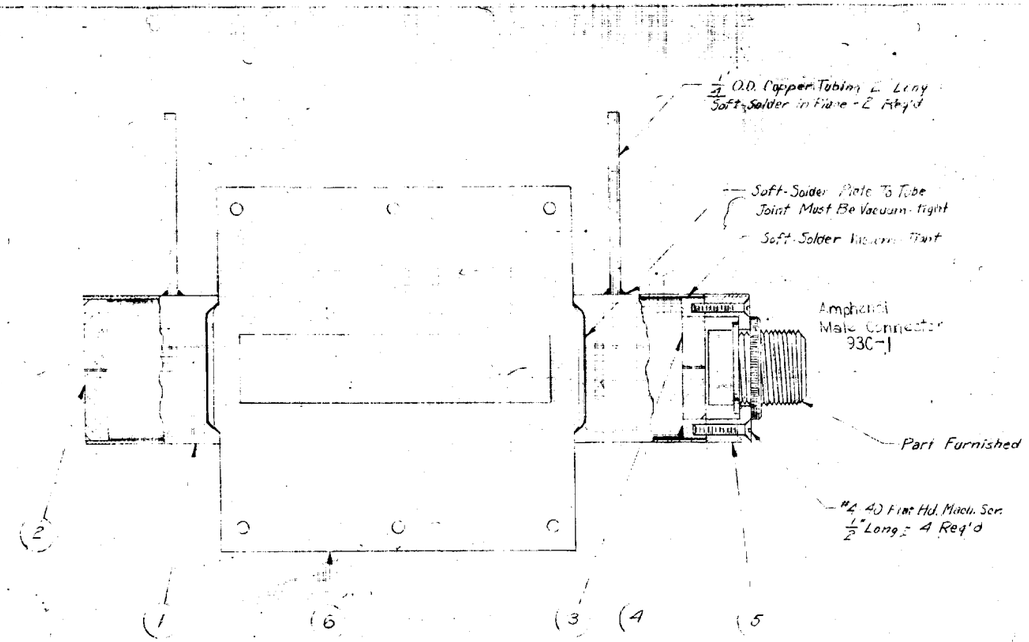
FIG. 4

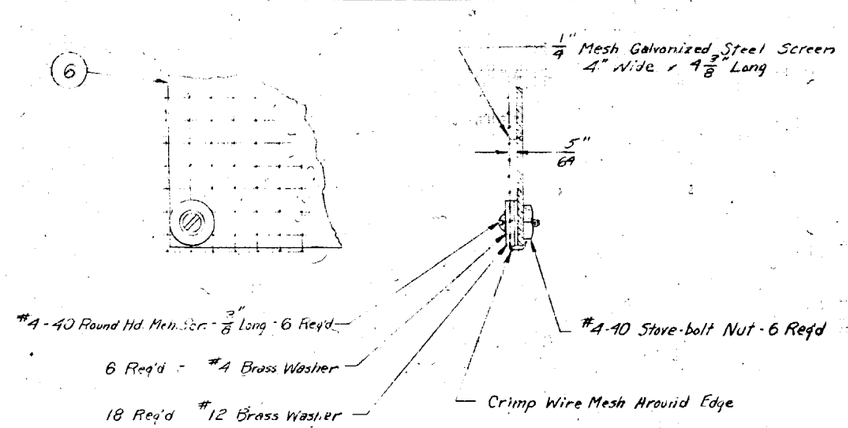
[redacted]

UNCLASSIFIED

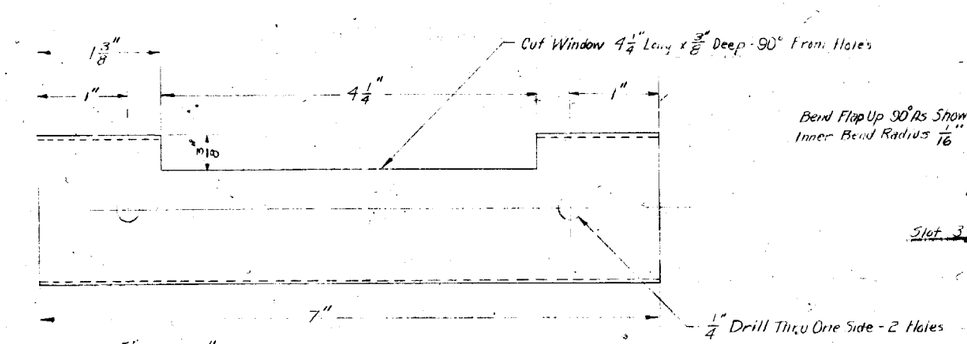
SCALE 1=1

WATTS	DRAWING NUMBER	
G.M. BASE	G-4 — 22663 . 0	

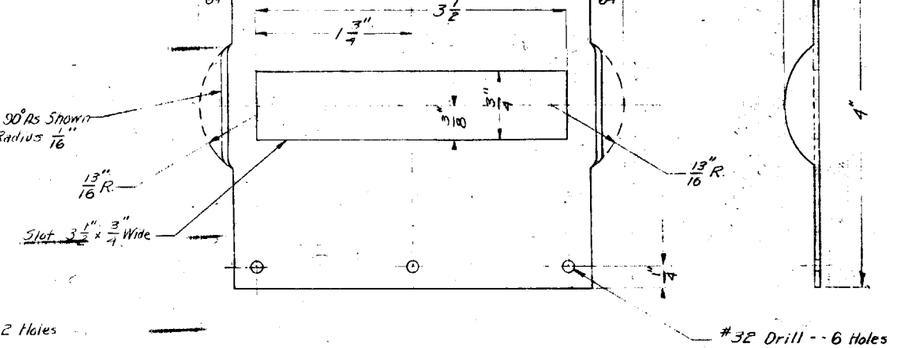




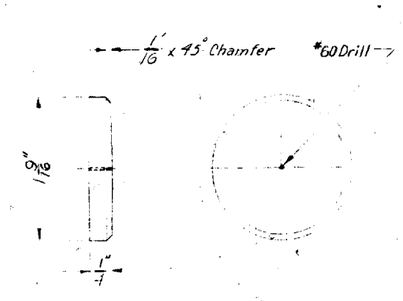
PROTECTIVE SCREEN ASSEMBLY



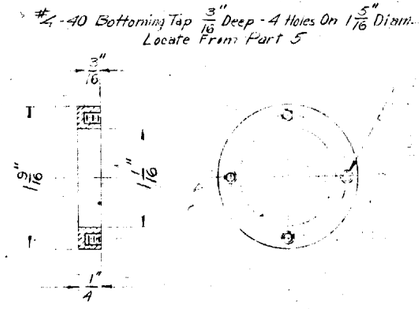
1 5/8" O.D. x 1/32" WALL BRASS TUBING - PART #1 - MAKE ONE



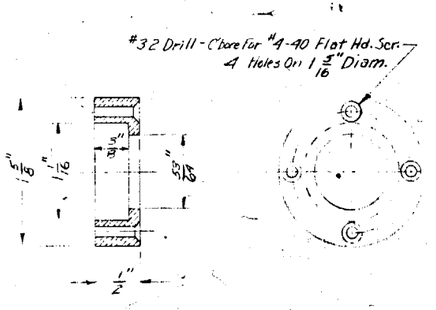
PART #6 - BRASS 1/16" SHEET - MAKE ONE



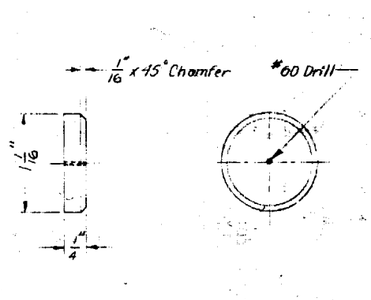
PART #2 AMPHENOL - MAKE ONE - P.FIT IN PART #1



PART #4 - BRASS - MAKE ONE
PRESS FIT IN PART #1



PART #5 BRASS - MAKE ONE



PART #3 - AMPHENOL - MAKE ONE - P.FIT IN PART #4

[redacted] FIG. 5

SCALE - FULL SIZE

WATTS COUNTER	9-21-44	DRAWING NUMBER G-4 19926	DRN. BY RAMARC