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HEALTH DIVISION

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Health-Physics Section

K. Z. Morgan, Section Chief

THE CLINTON WALKIE-TALKIE AND SCALE OF TWO

8/1/46

Report Prepared by: W. H. Ray

Received: 8/7/46 Issued: 8/14/46

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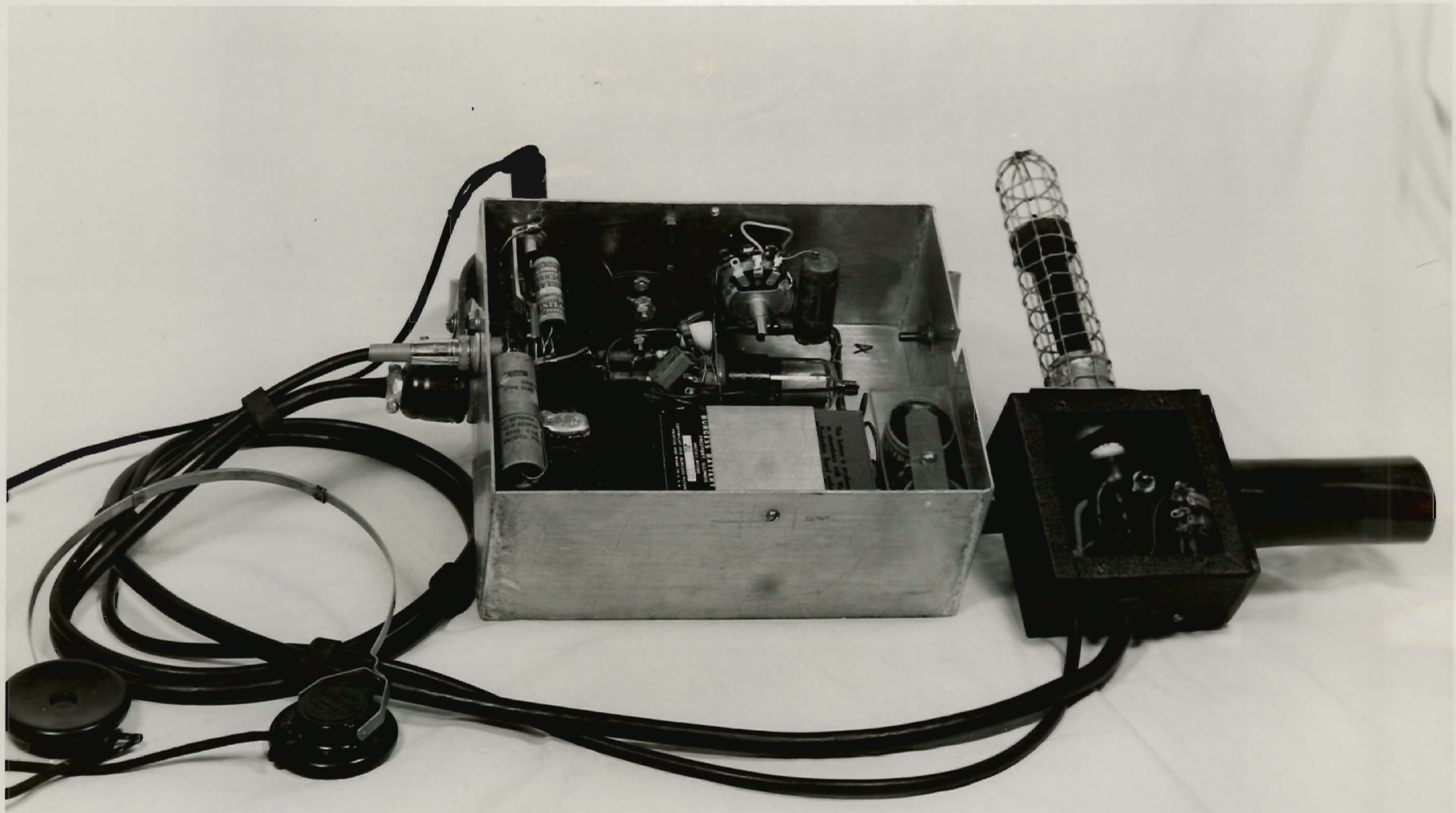

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I. SUMMARY

The Walkie-Talkie received its name from the fact that the operator wears head phones and carries the major part of the instrument from a shoulder strap. The aluminum instrument case is 9 3/16" long, 7" high, and 3 7/8" thick. It contains the batteries and the choke coil-multivibrator high voltage supply. The Eck and Krebs thin wall G.M. tube filled with 85% neon, 15% ethyl ether accompanies a 1 N 5 G T vacuum tube in a probe connected to the power supply by a 3' cable. The convenience of this probe, protected by large mesh wire cloth, is the outstanding feature of this mobile Geiger-Muller detector. The over all weight of about 10 pounds makes this instrument acceptable for survey work. The major service requirement of this rugged instrument with few controls, is the replacement of the filament supply batteries. The aural detection provided by this instrument makes it extremely useful as a scanner to locate sources of beta or gamma radiation.

II. USES FOR SUB-TOLERANCE RADIATION SURVEY METERS

While some have questioned the need of sub-tolerance radiation instruments for Health Physics work, much effort has been expended by instrument personnel endeavoring to perfect sensitive radiation instruments. Some uses for instruments capable of measuring sub-tolerances levels of radiation are obvious.

Contamination of wastes or anything else that is likely to accumulate should be detectable when the levels of activity are near background. This is equally true in studying the housekeeping in a laboratory which, if not immaculate, will permit the accumulation of activity to a point where a genuine hazard results.

Studies at low levels of activity are essential also to permit extrapolation to operation levels of activity of higher magnitude. Some cases are encountered where the growth of activity with time is a consequence of radio active decay, and here also sub-tolerance measurements are needed for predicting conditions for the future.

It is convenient to study absorption, distribution, and other properties of radiations without using intensities that approach tolerance levels.

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III. NEED FOR WALKIE-TALKIE

At the time the first Walkie-Talkie appeared, no satisfactory sensitive direct reading survey meter had been developed. Ion chamber instruments could be made and calibrated to represent the ionizing effects in tissue of the radiation they detected. However, sensitivites in the neighborhood of 12½ mr/hr or less are attainable only by using large ion chambers, pressurized chambers, or amplifiers capable of building up very small currents to levels that would operate a direct reading meter. Even when such amplifiers were built it became apparent that the time constant in the RC circuit of the ion chamber delayed the direct reading of the meter to such an extent that the competition of electroscopes was keenly manifest in the field of low radiation measurements.

Although a counter may be calibrated in terms of mr/hr for only one specific quality of radiation its size is much in favor of its use as a survey instrument. The electrical circuits used to operate a Geiger-Muller counter are not as critical in their requirements as those of amplifiers of very small currents. So we find that early in the project (during 1943) portable Geiger-Muller counters were considered for Health Physics survey work, and a few units were constructed in Chicago and sent to Clinton Laboratories.

Attempts to use these instruments on surveys proved futile. The electrical curcuits were relatively complex and had many adjustments requiring time and attention of a skilled instrument man. As many as five knobs appeared on the control panel of the instrument, and five or six additional adjustments needing frequent attention were accessible inside. Some models provided openings so that a screw-driver could be inserted to make these adjustments. With all these variables the circuits were unstable and the instrument would not hold operating adjustment from one survey until the next.

These early G.M. survey instruments were equipped with rate meters but calibration found them to be far from linear, and this condition was aggravated by switching mechanisms to change ranges of sensitivity. The response of a well damped rate meter was slow. Some of the instruments were equipped with small neon bulbs on the panel which flashed with each pulse from the G.M. tube. This proved to be a more valuable indicator than the slow acting rate meter.

These first portable G.M. survey meters were mounted in a single box 9" by 12", by about 2½". They were equipped with a leather strap handle, but they were heavy and awkward to carry. With the Geiger-Muller tube encased in the box, beta detection was not provided.

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IV. DEVELOPMENT OF WALKIE-TALKIE

From this predecessor the Walkie-Talkie was developed by trial and error. It acquired its present form in March 1944. In developing such an instrument at that time the supply of material and man power to do the work was limited to that available at the local instrument shop whose primary function was maintaining operational instruments.

The initial design consideration was to overcome the known faults of the pioneer models. To facilitate survey work the G.M. tube was mounted in a probe and the rest of the instrument, connected by cable, was supported from the shoulder of the surveyor by a leather strap. An Eck and Krebs thin wall G.M. tube was used in the probe protected only by a wire screen of large mesh. This permitted the detection of beta radiation except the extremely soft. The use of head phones for the indicator became so popular that the rate meter was abandoned. Elimination of the rate meter resulted in a more stable circuit with fewer adjustments necessary. A meter was left on the panel qualitatively indicating the operating voltage of the G.M. tube. However, the number of controls was reduced to two, a G.M. tube adjustment, and an Off-On switch.

V. FAULTS ELIMINATED

With the obvious faults corrected instruments were produced which worked well enough to determine some other defects which were subsequently overcome. It was found that the Eck and Kreb tubes were quite photosensitive; this was partially eliminated by painting the tubes black. In bright light, however, it has been found advisable to wrap the probe with opaque paper. Keeping the probe wrapped with paper also overcomes another difficulty, that of contamination of the wire screen protecting the G.M. tube. It has been found impractical to attempt decontamination of this wire cloth cage and hence it has been found advisable to have a stock of spares available.

Another defect of the G.M. tube was also observed. With a mobile instrument it became quickly apparent that the tubes in use were temperature sensitive. Experimentation showed that a mixture of 85% neon, 15% ethyl ether made a self quenching G.M. tube that showed no appreciable temperature effects from sub-freezing to 130 degrees F. While the quenching of such a mixture may not be the best for high speed and coincidence work it is highly satisfactory for the Walkie-Talkie, where a shift of plateau with temperature change renders the instrument almost valueless.

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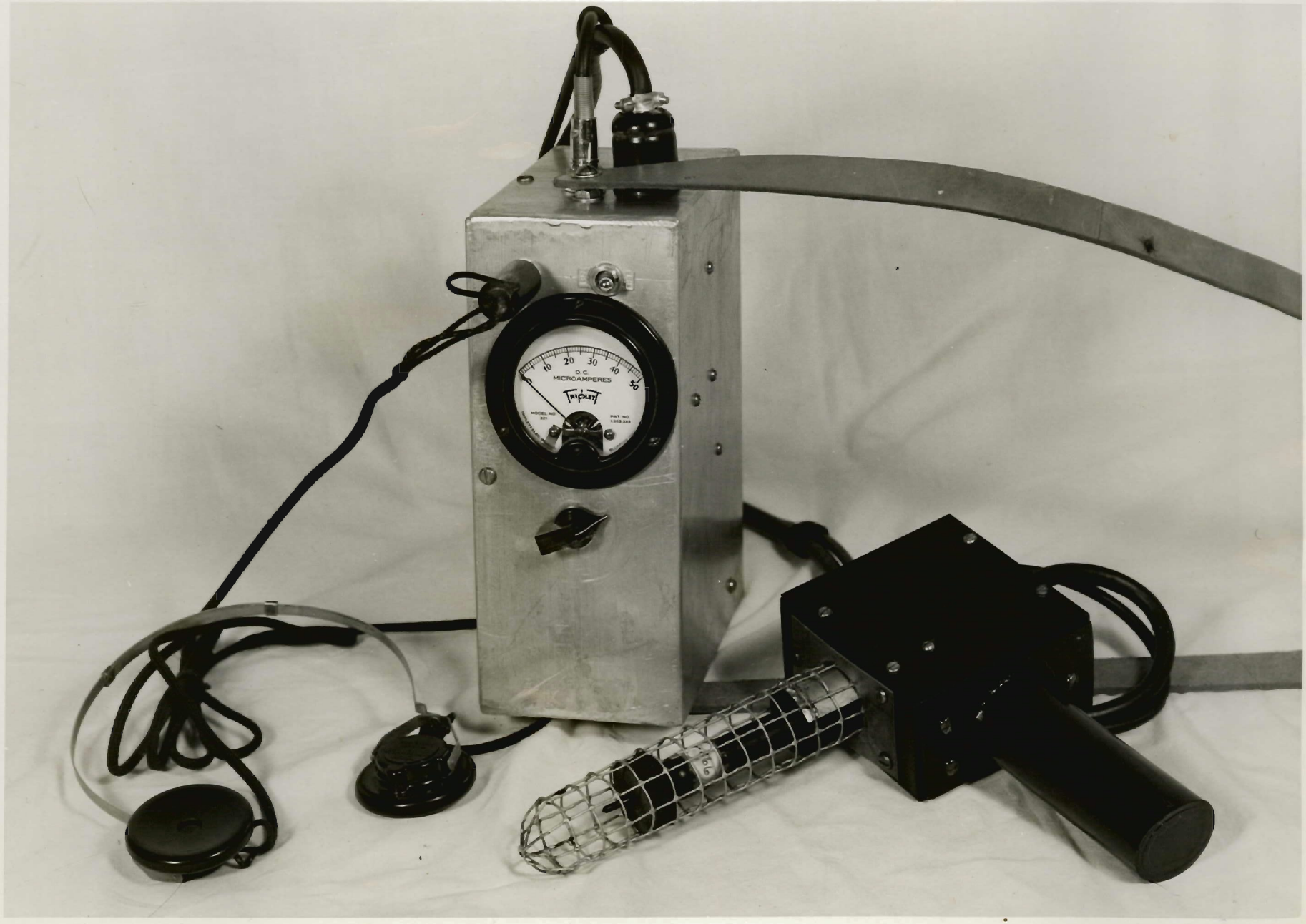
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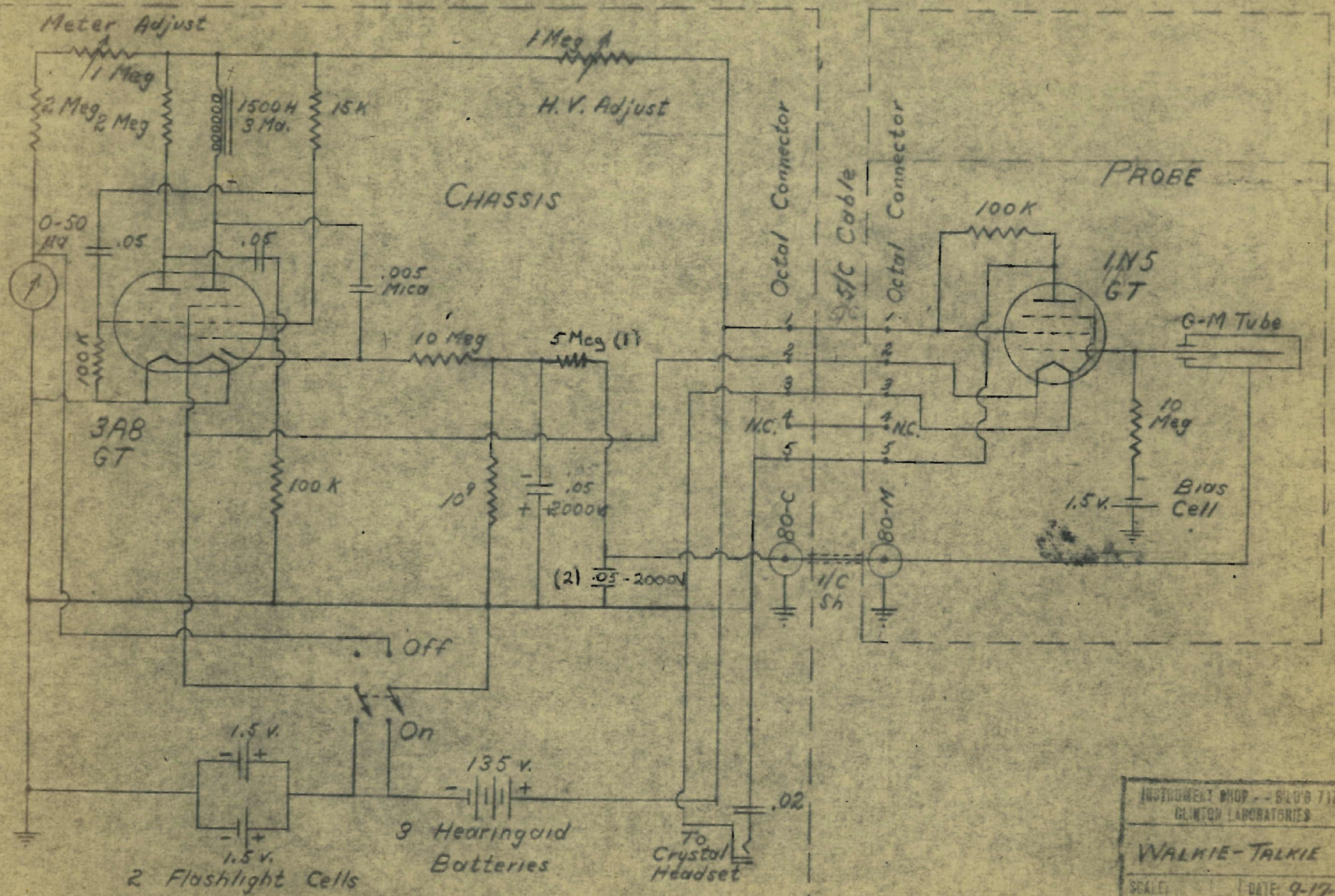

INSTRUMENT SHOP - - BLDG 7178 CLINTON LABORATORIES			
WALKIE-TALKIE			
SCALE:		DATE: 9-17-45	
DWN: JRB	CK'D	APP'D	
SKETCH NO. Q-38-G	BLDG. NO.		

REVISION -- APPROVAL -- DATE

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A defect which serves a good purpose in protecting the G.M. tube is the limit to the current that can be provided at high voltage by the multivibrator power supply. When not using a rate meter this defect is only of significance in an extremely high radiation field. Under such conditions the G.M. tubesbleeds off current faster than the multivibrator can provide it, with the subsequent voltage dropping below threshold. This blocking out of the signal when high intensity radiation levels are experienced could be misleading, but in the hands of a careful surveyor it merely limits the intensities of radiation for which a Walkie-Talkie may be used. This intensity varies from instrument to instrument but is usually somewhere between 40 and 80 mr/hr.

An additional misleading attribute results from the use of Eck and Kreb G.M. tubes, which have the sensitive region around the middle of the cylinder about half way from each end. A novice would be tempted to point the Walkie-Talkie at a suspected source for maximum geometry whereas the correct position would be with the side of the probe directed toward the source. Use of G.M. tubes with thin windows in the end would obviate this problem. Smaller difficulties are also encountered from an occasional "motorboat" background noise in the head phones. Surveyors soon learn, however, that this motorboating is usually a symptom of run down batteries and warns him to get them replaced before the instrument ceases working entirely. The head phones and probe on a cable makes the Walkie-Talkie very useful in the field, but the fact that the instrument is in three parts connected by cables (even though they do unplug) makes laying down or picking up the instrument quite awkward. A rack with pegs on which to hang respective units facilitates its storage.

VI. VIRTUES DISCOVERED

Along with the problems encountered several qualities have been discovered making the Walkie-Talkie a valuable popular instrument.

The aural indication of pulses from the G.M. tube makes rapid scanning possible. This high speed indication of low intensity radiation is the most valuable feature of the Walkie-Talkie. In spite of its sensitivity being capable of measuring cosmic backgrounds the Walkie-Talkie can be used for locating sources over a wide range of radiation flux. The instrument has proved to be reasonably rugged in service and stands up well under the abuse survey work imposes upon it. Its weight is moderate. Maintenance of the batteries is the chief service required in addition to the occasional repair necessitated by breakage. The life of the two flash-light cells in parallel, used to heat the filaments of the two tubes in the instrument, is a function

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of the length of time it is turned on. It is in keeping with other instruments used for survey work where weight and battery life make opposite demands. The parts in the Walkie-Talkie are standard and readily available. No special machine shop work is required for the instrument's construction. The high voltage supply is remarkably stable and seldom needs adjustment while on a survey. The indicating meter makes the need for compensation for battery aging apparent and quickly achievable.

VII. ATTACHMENTS

The versatility of the Walkie-Talkie has been enhanced by the use of various attachments. A submarine probe can be substitued for the usual survey probe. This probe consists of a G.M. tube enclosed in a three foot length of pipe which may be suspended in the water from a life preserver and towed behind a boat for surveying lake and river contamination with radioactive materials.

A mobile scale of two and register has been made to plug in the output jack of the Walkie-Talkie in place of the head phones. This scale of two is built into an aluminum case the same size as that housing the Walkie-Talkie. It also is equipped with a shoulder strap. The weight of 8 3/4 pounds is largely contributed by the batteries and built in Cycltron Specialties Company register which is readable through a lucite window in the top of the case. The glow of the two cold cathode thyratrons used in the scale of two can be observed from peep holes in the top which permit visual indication of the individual pulses received. Since no warm up time is required the single off-on switch satisfactorily stops and starts the count. There is considerable drain on the batteries resulting from the use of thyratrons in the scale of two, but continuous use for several hours has shown the instrument to be satisfactory for survey work. Experiments with different units indicate that very few counts are missed when counting at random up to rates of 750 counts per minute. By using an empirical graph, corrections can be made to make the instrument usuable up to counting rates of 1500 counts per minute. Since equivalent results were also obtained using a thyratron trigger without scaling, it is believed the counting rates are limited by the electrical circuit rather than the performance characteristics of the mechanical register. Experiments at five, twenty, and thirty-five degrees C. have shown that the scale of two is not affected by temperature changes in this range.

VIII. THE WALKIE-TALKIE IN USE

In use the Walkie-Talkie has proved itself to be a basic survey instrument used in all areas. Perhaps the largest portion of a surveyor's time expended in instrumentation is consumed in locating sources. As a source locator

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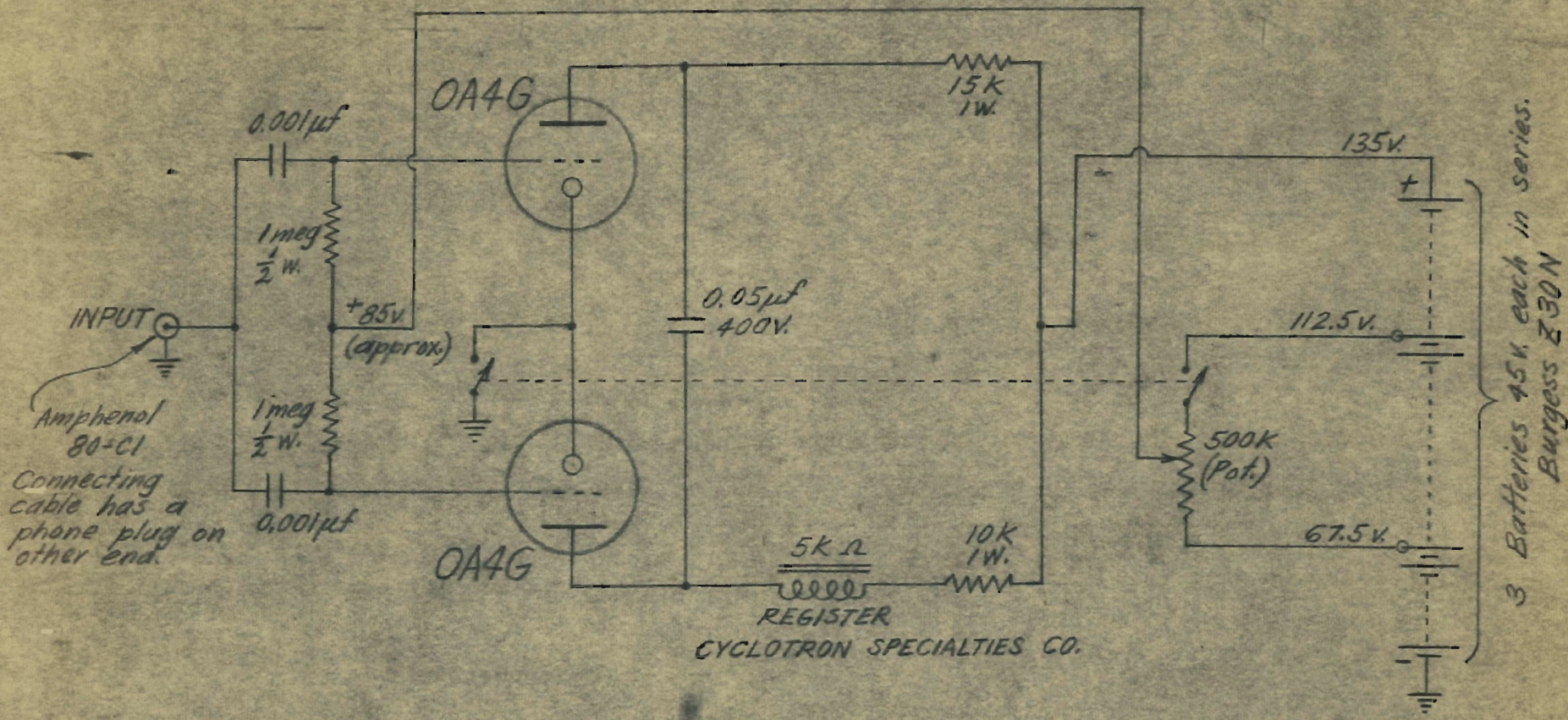

REFERENCE DWG. Q-38, 38A, 38B

INSTRUMENT SHOP — BUILDING 717-B
CLINTON LABORATORIES

PORTABLE SCALER FOR PORTABLE RADIATION METER

REV. No.	REVISIONS	REV. DATE	DATE 12-14-44
			SCALE
			DRAWN BY M. Falls
			APPROVED BY M. Falls

BLDG. No.

SKETCH Q-254

or scanner the aural detection provided by the Walkie-Talkie makes it supreme in the field of beta-gamma survey work. The speed with which one can pass through a laboratory waving the magic wand (probe) of the Walkie-Talkie making sure no significant sources have been missed saves many man hours. From a legal point of view knowing that sources are absent is as important as measuring the values of large sources.

The range of intensities in which a Walkie-Talkie may be used is wide enough to make it suitable in all normally habitable areas. Its upper range approaches that where direct reading ion chambers can be made with modest response time. Although the health hazard encountered cannot be precisely determined with a Walkie-Talkie, an experienced user can estimate by the sound in the head phones within about 10 mr/hr the value of radiation he is encountering, and can thus establish the need for measurements in the places located.

The Walkie-Talkie has also proved valuable for making measurements at locations remote from the electric mains. Measurements of atmospheric radiation or water contamination can be made in temporary set ups by counting the clicks in the head phones and timing them with a stop watch; or the scale of two and register attachment may be used. A word of caution, however, should be emphasized in regard to using the Walkie-Talkie for quantitative measurements. Its design was intended to make it exclusively a qualitative detector for locating sources. While its stability is good, if the need arises for accurate measurements of low activity over extended periods where specific rather than relative information is sought, a power supply more stable than the battery powered multivibrator should be incorporated. High voltage batteries are now available which make rather satisfactory G.M. voltage supplies for this purpose. The user should also be cautioned about efforts to interpret Walkie-Talkie readings in terms of roentgens rather than counts.

IX. THE WALKIE-TALKIE OF THE FURURE

As long as it will be necessary to locate active material it would seem that the Walkie-Talkie will continue to be a popular instrument. The Walkie-Talkie of the future will be even more convenient than the model now so widely used. It will be compact, light weight, have no cords, will be rugged, and have a long battery life. The development of a Geiger-Muller tube to operate on voltages as low as 45 volts will make this possible. Models prepared by the Metallurgical Laboratories of the University of Chicago have been seen which forecast the trend. The instrument is about an inch thick,

three inches wide and ten inches long. It weighs 1½ pounds, hence no probe is needed and the G.M. tube can be housed within the case. Head phones are used with the present model but a built in miniature speaker would eliminate all cords and the two piece nuisance. An opening in the case is also needed to detect beta radiation. It seems that the one piece instrument of greatly improved design should be available as soon as the low voltage G.M. tubes can be produced in quantity.

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