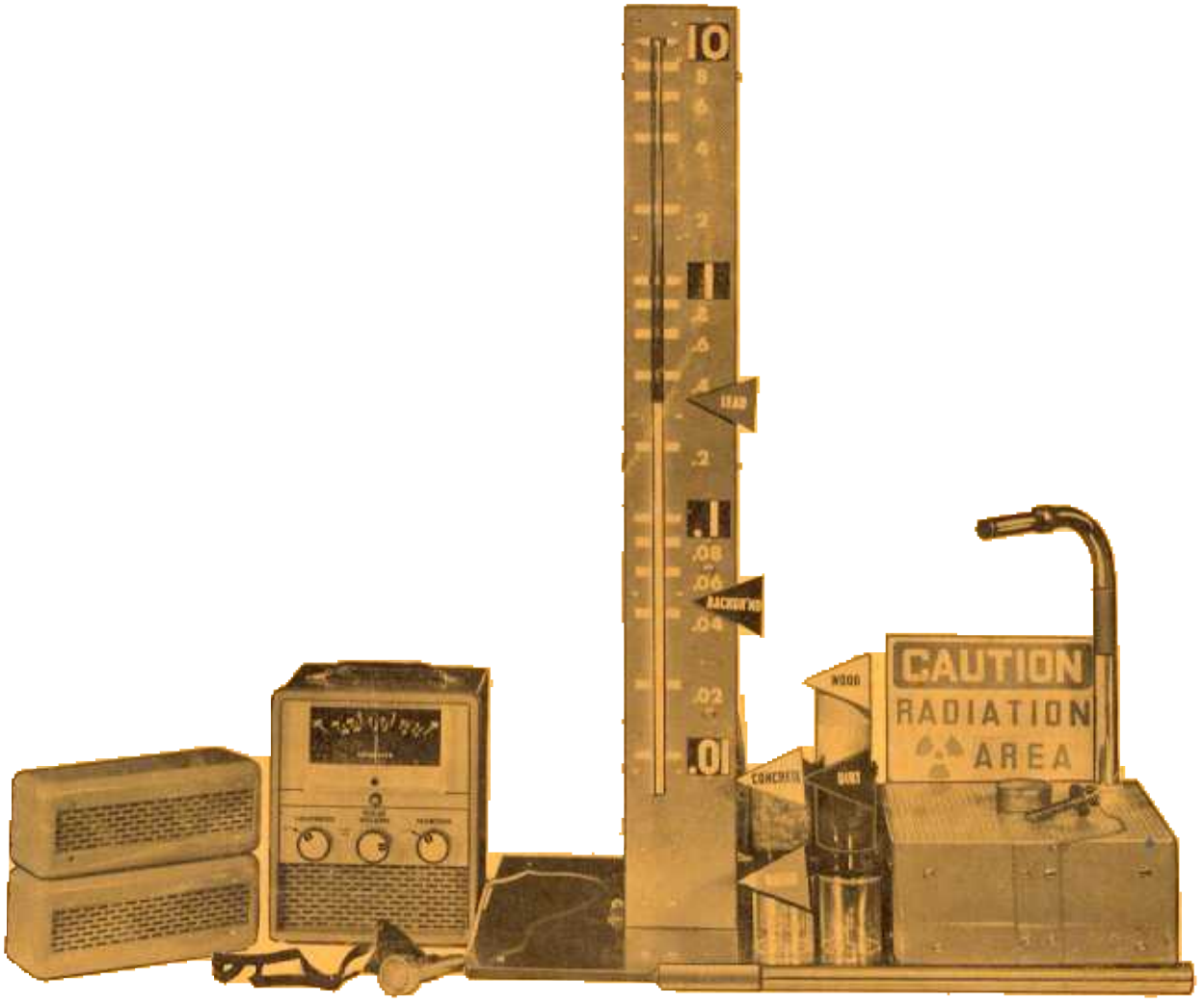
BARRIER SHIELDING DEMONSTRATOR SET

OCD Item No. CD V-757, Model 1



THE VICTOREEN INSTRUMENT COMPANY
10101 WOODLAND AVENUE · CLEVELAND, OHIO 44104

VICTOREEN

INSTRUCTION AND MAINTENANCE MANUAL

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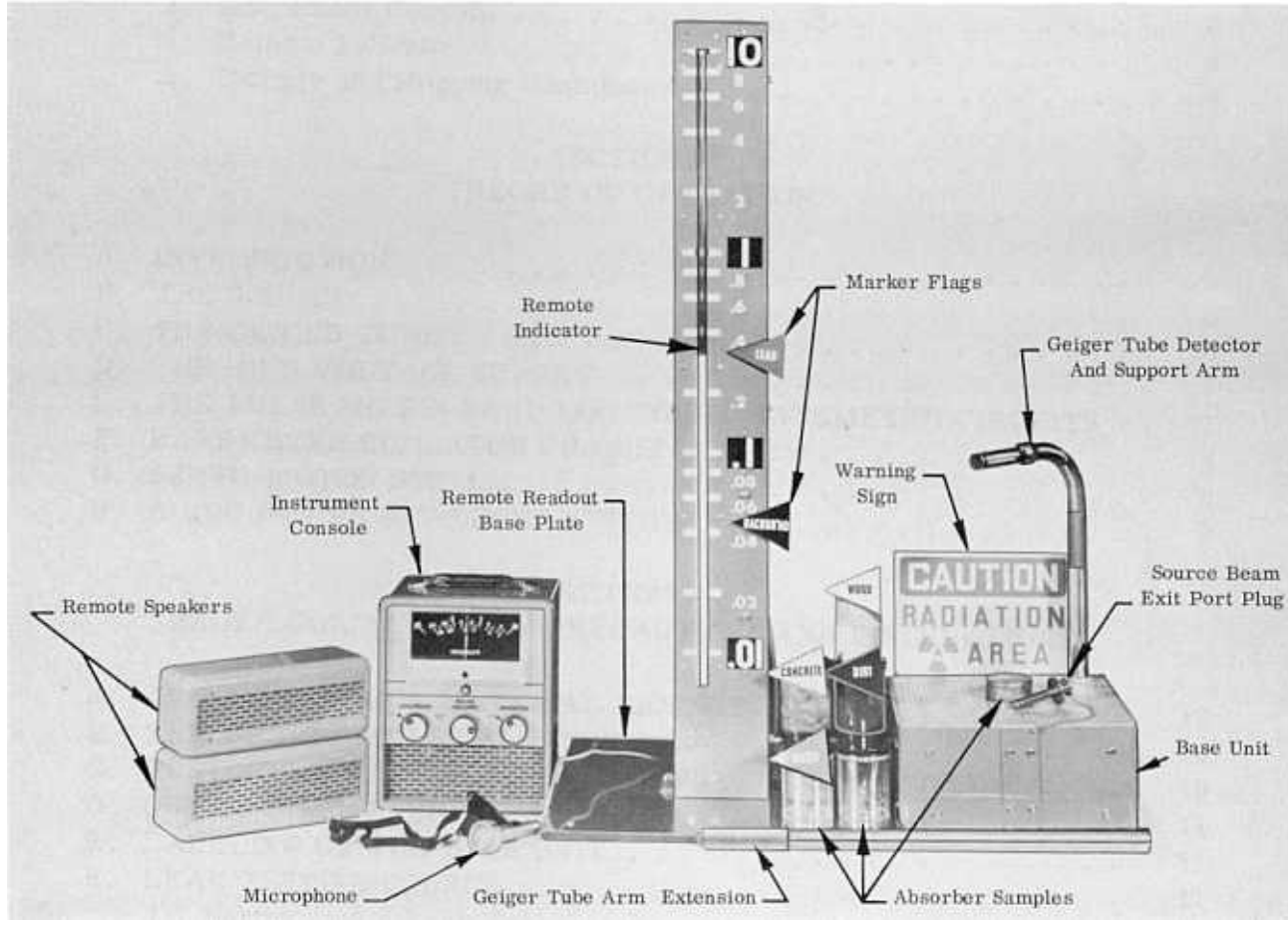

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PRECAUTIONS

1. The CD V-757, Model 1, Barrier Shielding Demonstrator Set, is supplied with a 1 mc Cs^{137} source mounted in a lead shield housed in the base unit. With the gamma beam exit port closed with the provided plug, radiation levels at the surfaces of the base unit are negligible for all practical purposes. With the gamma beam exit port open, the dose rate one-half inch above the open port is approximately 35 mR/hr. decreasing to approximately 1.5 mR/hr. at a height of one foot. This is a collimated conical beam with fairly sharp limits, and outside of this cone the dose rate remains low except for a slight increase due to air scattering. The operator should be careful to avoid exposing his hands or head to this cone of radiation, and it will be found that with a little planning almost all exposure to the direct beam can be avoided.

2. High voltage (725 V DC) is present in the geiger tube input circuit, the power supply, and cable to the geiger tube. Although the current capability of the high voltage supply is very low, thus reducing the hazard, only qualified personnel should attempt to disassemble or repair the instrument.

3. The instrument is designed to operate from 105 - 125 volts, 50 - 60 cycle AC power. Connecting the instrument to any other source of power will result in faulty operation or permanent damage.

1. GENERAL DESCRIPTION

A PURPOSE

The CD V-757 Model 1, Barrier Shielding Demonstrator Set, is designed to provide the materials and equipment required to present a short lecture and demonstration on the use of common materials as barrier shielding against fallout radiation. The set provides a gamma radiation source with holding fixture, a radiation detector with a conventional output meter plus an auditorium-size indicator, samples of barrier shielding materials, a complete public address system, and a prepared text for the lecture-demonstration. All component parts are stored for transportation in two shipping containers, each of which can be easily handled by one person.

B. ELECTRICAL SYSTEM COMPONENTS.

The electrical system of the Barrier Shielding Demonstrator Set consists of the radiation detector and output indicator system, a public address system, and the servo-drive system for the remote radiation indicator.

The radiation detector system uses a geiger tube detector feeding into a pulse amplifier and shaper and finally to a three-decade log count ratemeter output circuit. This permits operation over a 1000:1 intensity ratio without having to resort to range switching on the instrument.

The log count ratemeter output is continuously monitored by a large six-inch panel meter mounted on the front of the instrument console. For use with large audiences, the giant remote indicator is plugged into the instrument console and will show the radiation intensity on a large illuminated vertical scale. A small built-in speaker on the instrument console front panel allows audible presentation of the geiger tube pulses to a small group, and by connecting the two remote speaker units, ample sound volume is provided for larger groups.

The self-contained public address amplifier is also housed in the instrument console. A laveliere type microphone is furnished for use with this sound system. Connectors are provided at the rear of the instrument for microphone input and the remote speaker cables. Controls on the front panel provide for separate gain control of speech volume and geiger tube pulse volume. The local speaker may be switched in or out of the system at will without disturbing gain settings. The remote speakers are operated in a series circuit and both must be connected in order to function.

The remote indicator is slaved to the panel meter in the instrument console, and is operated by a DC servo-motor drive system. The indicator scale is illuminated by a 30 watt green fluorescent lamp. The brilliant green color of the light is very close to the peak of the response curve of the human eye, and thus commands attention when viewed in high ambient light levels. An effective viewing angle of 180^{o} is obtained through the use of a special plastic prism with the remote indicator scale.

C. MECHANICAL COMPONENTS

1. Base Unit and Source Shield Assembly

The base unit is a heavy gauge aluminum box, 12" x 12" x 5-1/2" high with the bottom open. The 12" x 12" closed side forms the work deck of the demonstrator and is

covered with a heavy ribbed vinyl rubber mat to protect the metal surface. The under side of the deck is heavily reinforced for rigidity, and also serves as a mounting support for the heavy source shield. One corner of the deck has a grommeted, indexed hole which receives the pointed end of the geiger tube support arm, and correctly orients the detector with respect to the radiation beam exit port, located in the center of the deck. A second grommet on a bracket below the deck prevents the detector arm from wobbling. Hand cut-outs are provided on two sides for ease in lifting and carrying the base unit.

The Cs^{137} gamma ray source shield is a steel-jacketed lead sphere which was designed to give maximum shielding with minimum weight. A rectangular steel plate is welded to the equator of the sphere, and this plate is bolted to the deck reinforcing members, aligning the beam exit port in the shield with the beam exit port in the center of the deck.

The sealed one millicurie Cs^{137} source is threaded into the small end of a flanged, lead-filled, nickel plated brass plug. This plug is inserted into a snug-fitting hole which positions the source at the center of the spherical shield and aligned opposite the beam exit port. The flange on the source holder is secured to the bottom of the steel shell of the shield with screws and the screw heads are then concealed by an adhesive backed aluminum disc.

The beam exit port is kept closed at all times when the source is not in use by means of a plated brass and tungsten plug inserted from the top of the deck. The plug is retained in place for storage or shipment by means of a spring-loaded slide, equipped with a locking hasp. The source exit port plug release handle and locking means is located on the side of the base unit over the hand cut-out nearest to the detector arm grommet. A slight sideways pull is sufficient to release the latch after the lock is removed. When the exit port plug is removed from the exit port, and the latch released, the plug retainer advances and covers the exit port in the source shield with a thin aluminum slide. This serves to prevent dirt and bits of crumbling sample material from falling into the exit port and interfering with the fit of the exit port plug. The exit port plug is secured to the base unit by means of a length of chain to ensure that it is not inadvertently misplaced when removed to allow use of the Cs^{137} source. A padlock for the exit port plug latch is included as part of this unit.

2. Geiger Tube Mounting Arm and Detector Assembly

The geiger tube mounting arm supports the geiger tube radiation detector in a fixed horizontal position centered over the radiation beam exit port. The upper end carries the geiger tube, tube socket and protective housing, including a beta shutter which may be opened if desired. The beta shutter should be kept in the closed position, except for certain special tests.

The cable from the detector head to the instrument console is brought out through the wall of the support arm. The lower end of the support arm is a sliding fit in the grommeted hole in the deck and the back-up grommet located below the deck. The tip of the support arm is fitted with a tapered wooden plug designed to pilot the tube into the lower grommet with a minimum of fumbling. A radial slot in the upper grommet rim and a mating pin in the support arm line up to orient the detector at the proper angular position to place the geiger tube in the center of the beam of radiation from the source exit port. A straight length of extension tube is provided for use with

the detector mounting arm when it is desired to show the effect of increasing the source-detector spacing upon the indicated dose-rate. The extension tube effectively doubles the source-detector separation, facilitating illustration of the inverse square law.

3. Instrument Console (Figure 7)

The instrument console houses the electronic circuitry for all of the various subsystems comprising the Barrier Shielding Demonstrator. This includes the log count ratemeter, the remote indicator servo-amplifier, the audio sound system amplifier, and the necessary regulated power supply circuits. The front panel of the console mounts the local meter for radiation intensity and a small speaker for aural presentation of the geiger tube pulses.

The instrument "on-off" power switch is combined with the microphone channel gain control (marked LOUDNESS) for the audio system. A red jeweled pilot light indicates when the power is "on". The geiger tube pulse input channel to the audio system has a separate gain control (marked PULSE VOLUME) combined with a push-pull type switch. This allows one to set the sound level of the geiger tube pulse signals and then switch the channel off and on without disturbing the pulse volume level. The local monitor speaker has a separate rotary type on-off switch (marked MONITOR) mounted on the console panel. The rear of the instrument console is recessed and all connectors for the various inputs and outputs are mounted here. The power input line fuse, remote speaker line fuse, and servo-motor line fuse are also here, as well as spare fuse holders.

The cabinet stands approximately 11-1/2" high, is 9" wide, and 6-1/2" deep. The console weight is approximately 18 pounds. The instrument console is finished in a blue lacquer.

4. Remote Indicator

The remote indicator is a servo-operated, giant-size indicator which utilizes a brightly illuminated vertical column of variable height to indicate the relative radiation intensity seen by the detector. The entire assembly is housed in a blue lacquered steel case approximately 42" long, 5" wide, and 4" deep. The indicator mounts on a base plate which supports the unit in a vertical position and minimizes the possibility of tipping. The corners of the base plate have rubber feet to prevent scratching polished surfaces. A strut mounted between the rear of the upright column and the base plate helps provide a rigid assembly.

The indicator mechanism is a DC self-balancing feedback servo-motor operated system. The servo-motor drives a multi-turn precision potentiometer which is geared and synchronized to an endless loop of 35 mm mylar film. The film is clear for one-half of its length, and black for the other half. The position of the black to clear junction along the indicator scale shows the signal amplitude. A green fluorescent lamp directly behind the film loop causes the clear portion of the film to show from the front of the indicator as a brilliant green bar which increases or decreases in length according to the control signal from the log count ratemeter. The servo-motor operates until the position feedback signal from the precision potentiometer balances against the input signal and the motor then stops - until the input signal changes, when the cycle repeats. The potentiometer and the indicator tape are geared together mechanically, so the tape position continuously indicates the amplitude of the input signal.

All of the operating parts of the indicator are mounted on the front panel member. The cover box serves as a protective housing and mount for the base plate

The servo-motor, precision potentiometer, gear train, one lamp socket, and the tape drive sprocket assembly are located at the lower end of the scale. The upper end mounts the tape idler rollers and the other lamp socket. The fluorescent lamp ballast and starter are located along the bottom half of the back side of the front panel. At the rear are the line fuse holder, spare fuse, and the cable connector to the instrument console. A two ampere fuse is connected in the power line to the fluorescent lamp circuit. The indicator scale is notched at each decade point, with intermediate scale points indicated by backlighted, translucent dots and stenciled contrasting lines. The major decade marks are also indicated by backlighted numbers, while the intermediate divisions are identified by smaller stenciled numbers. The small numbers are intended for the convenience of the lecturer and small groups. The lighted dots are easily discerned at 100 feet, and the indicator bar can be seen from well beyond that. A plastic prism permits uninterrupted viewing of the lighted indicator bar over a full 180^{o} scan.

5. Storage and Shipping Containers

The Barrier Shielding Demonstrator Set comes packed in two laminated fiber shipping/storage containers, each of which is "one-man" portable. Figure 1 shows the location and orientation of the various components when properly packed in the shipping containers.

The instrument console, base unit, microphone, detector arm and cable, and the remote indicator cable are housed in the cubical box. Also included is the maintenance and instruction manual, a copy of the text for the lecture-demonstration, and a 25 foot extension power cord. The second case contains the remote indicator, remote speakers, barrier shielding material samples, indicator-base strut, and detector arm extension tube, plus a set of magnetic marker buttons for use with the remote indicator.

Each shipping case is fitted with a padlock hasp to permit locking to prevent tampering. Since the base unit contains a radioactive isotope subject to AEC and/or state regulations, it must be inaccessible to unauthorized personnel and the case should be locked as soon as the base unit is returned to it. Each case is provided with its own padlock.

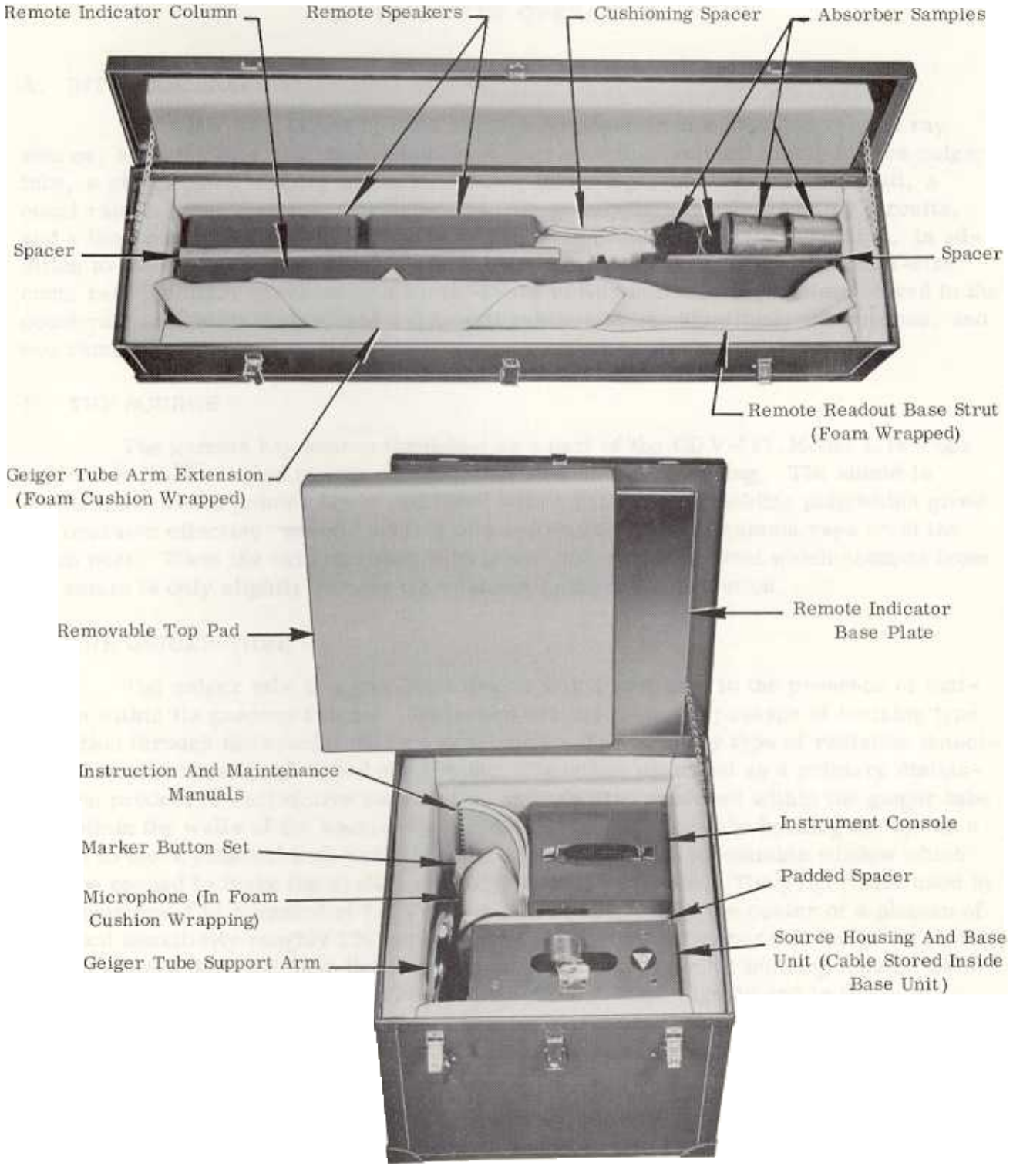


Figure 1. Shipping Cases Opened Showing Placement Of Barrier Shielding Demonstrator Components.

2 THEORY OF OPERATION

A INTRODUCTION

The CD V-757, Model 1, basic instrument consists of a shielded gamma ray source, a geiger tube radiation detector, a regulated high voltage supply for the geiger tube, a signal pulse shaping amplifier feeding into a log count ratemeter circuit, a count rate indicating meter, regulated low voltage supplies for the counting circuits, and a loudspeaker system for simultaneous audible counting activity indication. In addition to the basic components, the instrument also includes a giant auditorium-size count rate indicator operated by a servo-motor driven null-seeking system slaved to the count rate indicating meter, and a five watt public address amplifier, microphone, and two remote speakers.

B THE SOURCE

The gamma ray source furnished as a part of the CD V-757, Model 1, is a one millicurie Cs^{137} sealed source mounted in a lead shielded housing. The shield is constructed with a gamma beam exit fitted with a removable shielding plug which gives the operator effective "on-off" control of a collimated beam of gamma rays from the beam port. When the exit port plug is in place, the radiation level which escapes from the shield is only slightly greater than natural background radiation.

C. THE GEIGER TUBE

The geiger tube is a gas filled device which responds to the presence of ionization within its gaseous volume. Ionization results from the passage of ionizing type radiation through the special filling gas mixture. The primary type of radiation detected is beta radiation (high speed electrons). These are produced as a primary disintegration product of radioactive substances, and are also produced within the geiger tube and within the walls of the housing by gamma radiation. The tube housing serves as a shield to block external beta radiation, but is provided with a rotatable window which may be opened to make the system sensitive to beta radiation. The geiger tube used in this instrument is operated at 725 V DC, which is essentially the center of a plateau of constant sensitivity roughly 100 volts in width. A geiger tube operated below its plateau region voltage does not have the same signal pulse output for all ionizing inputs, while a tube operated above its plateau region will produce false signals and is likely to go into a continuous discharge condition. The latter situation not only provides no useful information concerning the radiation situation, but is very likely to cause permanent damage to the tube if allowed to persist.

In normal operation the geiger tube produces one pulse per ionizing event, but the maximum counting rate at which the tube can operate is limited by the duration of the recovery period following each pulse. In order to make sure that the tube recovers, or quenches, after each pulse, a small amount of a halogen gas is added to the inert filling gas. The action of the quenching gas is not completely understood, but its effect is to suppress any internal effects which might trigger another electron avalanche before the recovery period ends. After the internal field conditions at the tube anode have been re-established, the geiger tube is ready to respond to another ionizing event. The maximum counting rate for the 75NB3 geiger tube is over 100,000 counts per minute, which is considerably greater than the count rate which can be realized from the source

as mounted.

D. THE HIGH VOLTAGE SUPPLY

The regulated high voltage necessary for the operation of the geiger tube is obtained directly from a separate high voltage winding on the power transformer. The AC voltage is rectified by a silicon diode, filtered by a simple pi type RC network, and regulated at 725 volts by a Victoreen corona type gaseous regulator.

E THE PULSE SHAPING AND LOG COUNT RATEMETER CIRCUITS

The negative signal pulse from the geiger tube is applied to the emitter of an npn silicon transistor amplifier stage, producing an amplified, non-inverted output signal. This signal is fed via steering diodes to the conducting transistor in a dual transistor binary stage, causing the binary to reverse its state. The binary stage delivers its output signal to a buffer amplifier which drives the log count ratemeter circuit. An auxiliary emitter follower stage feeds a signal to the audio amplifier for aural counting indication.

The log count ratemeter covers the decade count range from 10 through 10,000 counts per minute. The decades below 10 are suppressed because the natural radiation background that exists everywhere is - unless special shielding precautions are taken- almost always greater than 10 counts per minute for this system. In addition, the geiger tube itself has a certain counting rate minimum below which it is not possible to go, due to traces of radioactive materials in the components from which the tube is constructed. This constitutes a built-in background count which is in addition to the local environmental background count.

The principle of the log count ratemeter is that of the diode pump circuit developed by Cooke-Yarborough. Most linear counting ratemeters are arranged so that each input pulse feeds a known charge into a tank capacitor which is shunted by a load resistor. The voltage across the tank capacitor builds up to an equilibrium value at which the rate of loss of charge through the load resistor equals the rate of input of the charge by the pulses being counted. If the charge per pulse is constant, the equilibrium value of the voltage V is

$$V = rqR$$

where r is the average number of pulses per second, q is the charge per pulse, and R is the load resistance. The equilibrium voltage across the tank capacitor is thus seen to be independent of the size of the capacitor. However, the capacity does affect the time required to reach equilibrium, and hence the statistical accuracy.

The diode pump is a satisfactory method of feeding the charge into the tank capacitor and is essentially the same circuit used as a voltage doubling rectifier in many other applications. The input capacitor is alternately charged from the source and discharged into the storage capacitor. The equilibrium output voltage for a fixed input thus depends mainly on the load current drawn.

As used in the Cooke-Yarborough count ratemeter, the input voltage goes to zero but does not reverse polarity as in the case of a conventional voltage doubler circuit, so the maximum output voltage can only approach the input voltage, rather than twice the input voltage. If a number of restrictions are met, the output of the count

ratemeter can be a linear function of the average frequency of the input pulses. If the restriction that the output voltage be very much smaller than the input voltage is not met, the charge transferred per pulse is no longer constant and becomes

$$q = (V-v)\,C_c$$

where V and v are input and output voltages and C_c is the charging capacitor The variable charge transfer q causes the output voltage to become

$$v = \frac{VrC_cR_1}{1+r\,C_c\,R_1}$$

This equation shows that by a proper choice of circuit values, a tailored non-linear relationship between voltage and counting rate can be obtained. A very good approximation to a logarithmic function of the counting rate is obtained by adding the outputs of a number of diode pumps, each of which has a response of the type given by the above formula. If all of the diode pumps are driven in parallel, and the time constant of the R_1C storage of each one is shorter than the previous one by a factor of 10, the sum of the outputs of the diode pumps very closely approximates a logarithmic function to the base 10 of the input counting rate.

In the log count ratemeter used in this instrument, four decaded diode pump stages are used to cover the three-decade range of interest. The fourth stage extends the counting capability beyond the range required in the instrument, and increases the linearity and accuracy of the output indication. In the count range of interest, the accuracy of the indication is essentially that of the meter.

The use of the log count ratemeter circuit rather than a linear count ratemeter eliminates the need for multiscale ranges on the indicators and range switching in the instrument circuitry. The intended use of this instrument is such that range-changing and keeping track of the range in use would occupy the lecturer's attention to a burdensome degree if the log count ratemeter scheme were not employed.

F RATEMETER INDICATOR CIRCUIT

The output signal from the log count ratemeter is amplified in a three-stage silicon transistor direct coupled amplifier. The gain of the amplifier is stabilized by overall feedback. The output signal of the LCRM DC amplifier drives one-half of an emitter-follower differential mixer stage which directly actuates the panel radiation intensity meter. The other half of the mixer circuit is driven from the servo-motor position feedback potentiometer in the remote indicator. The differential mixer stage has double-ended input with single-ended output, necessary to provide a drive signal compatible with the input circuit of the servo-motor power amplifier.

G. SERVO-MOTOR SYSTEM

The servo-motor remote indicator drive system is a null-balance type where the servo-motor moves the position feedback potentiometer wiper in such a direction as to cancel out the LCRM input signal to the differential mixer with a matching input to the other half. The resulting zero-or nearly zero-output from the mixer circuit produces the same zero output at the servo-motor and stops it. When the LCRM output changes enough to produce a drive signal to the servo-motor, the motor runs to seek a new null. With the statistical variations which normally occur in radiation

counting systems, the null-seeking action becomes an almost continuous process. With a fixed input signal, the null position is rock-steady.

The servo-motor amplifier is supplied current from regulated positive and negative 15 V DC supplies. The servo-motor is rated at a nominal 12 V DC, so the amplifier is capable of overdriving the motor in response to a signal from the LCRM calling for a large change in rate indication. This gives the remote indicator a fast response capability, as well as the ability to follow very small signal changes with very little residual error.

H AUDIO POWER AMPLIFIER SYSTEM

The remaining system in the CDV-757, Model 1, is a builit-in five watt public address system (ten watt on peaks). The power amplifier portion is essentially identical with the power amplifier driving the servo-motor system.

Output pulses from the LCRM driver may be injected into the input of the power amplifier to give an audio presentation of the counting rate. A separate gain control is provided to permit setting the pulse sound level independently of the microphone input channel. The gain control is combined with a push-pull switch on the same shaft, so that the pulse sound level may be set and then switched on and off without changing the preset level.

The sound system includes a microphone and mike preamplifier stages to bring the level up to that necessary to drive the power amplifier input. The sound level of the amplified speech output when fed to the two remote speakers, also supplied, is sufficient for the usual "little" auditorium or lecture hall.

The power supplies required to operate the speech amplifier are similar to those used with the servo-amplifier, but are not as highly regulated, as the audio system is not as critical in its supply voltage requirements.

All of the power supplies in the instrument receive their input voltage from separate windings on the same transformer. No problems have occurred due to interaction between the windings.

3. RADIOLOGICAL SAFETY PRECAUTIONS AND INSTRUCTIONS

A. AEC BY-PRODUCT MATERIAL LICENSE

The one millicurie of Cs^{137} used as a gamma ray source with this instrument requires a specific AEC By-product Material License for possession and use. Use of the instrument is governed by the conditions set forth in the license which will require adherence to the instructions and procedures outlined in this manual, as well as those AEC Regulations specified in Title 10, Chapter 1 of the Code of Federal Regulations, Part 20 "Standards for Protection Against Radiation (10CFR20) and Part 30 "Licensing of By-product Material" (10CFR30). In some states this licensing authority is handled by a state agency which also has appropriate regulations. To determine if your state handles this authority, contact your OCD Regional Radef Officer for further information.

B. THE SOURCE AND SHIELD

The one millicurie Cs^{137} source is supplied by the Nuclear Products Department of the Minnesota Mining and Manufacturing Company. The source material consists of 3M brand Radiating Microspheres incorporating Cs^{137} oxide as the radioactive material. The Radiating Microspheres are tiny spheres of insoluble, high temperature ceramic, which are also shock and abrasion resistant, and whose softening point is over 1500°C. These radioactive particles are sealed into the bore of a threaded stainless steel capsule with a press fitted stainless steel plug. The plug is then silver brazed in place to hermetically seal the source. The combination of the 3M Radiating Microspheres plus the hermetic encapsulation produces a compact source with an excellent seal. Figure 2 shows the source configuration.

The hermetic source capsule is threaded into the end of a lead-filled brass holder, which positions the source at the center of a lead-filled steel walled sphere. The sphere is mounted beneath the deck of the base unit by means of a steel plate welded to the equator of the sphere. The spherical shield is constructed with a gamma beam exit port positioned opposite the end of the source holder. A removable brass and tungsten plug, which also passes through the deck of the base unit, gives the operator effective "on-off" control of a narrow conical beam of gamma rays from the beam port. With the exit port plug in place, the radiation level around the shield housing is only slightly greater than natural background radiation.

With the gamma beam exit port plug removed, the exposure rates in the vicinity of the source housing are as indicated in Figure 3. A cutaway drawing of the source capsule, shield and base unit with all important parts labeled is shown in Figure 4.

C POSTING RADIATION SIGNS AND IDENTIFICATION OF AREA

Requirements for posting radiation areas are governed by Part 20 of the AEC Regulations. As the surface dose rate with the beam port closed does not exceed 2 mR/hr., the area around the instrument need not be posted as a restricted radiation area. However, when the instrument is in use with the gamma beam port open, there exists a sharply defined inverted cone of radiation above the base unit deck wherein exposure rates exceed those permitted in unrestricted areas. It therefore becomes the

duty of the operator, when using the source, to post the area above the instrument by attaching a radiation sign to the geiger tube mounting arm behind the detector assembly as shown in Figure 5. Access to the base unit should be denied to all unauthorized personnel. The restricted spread of the emerging gamma beam plus the rapidity with which the dose rate falls as the distance above the base unit increases eliminates the necessity for posting other areas.

In addition any room or area where the CD V-757 unit is stored must be posted with a "Caution, Radioactive Materials" sign provided. The dimensions of the radiation beam plus its location under typical use conditions make it difficult to expose any major portion of the body, other than the head, to the higher dose rates. The operator should exercise care to avoid needless exposure of the head and hands when using the source for its intended purpose.

D. USE OF DOSIMETER

Part 20 of the AEC Regulations also requires that appropriate personnel monitoring equipment be used by each individual entering a restricted radiation area under such circumstances that he is likely to receive a dose in any calender quarter in excess of 25% of the applicable value specified. The allowable quarterly dose for exposure of the hands and forearms; feet and ankles, is 18-3/4 rems. For exposure of the whole body; head and trunk; blood forming organs; lens of the eyes; or gonads, the permissible dose is 1-1/4 rems per quarter.

It is possible that poor operating techniques could cause an operator to accumulate a total quarterly dose greater than the minimum allowable. For this reason, the operator should use a CD V-138 dosimeter when operating the equipment. A cumulative record should be kept of the total dose received by all personnel using the equipment as indicated by the dosimeter readings in accordance with paragraph 20.102 of Title 10, Chapter 1, Part 20 of the Code of Federal Regulations (10CFR20). A pocket dosimeter worn in a shirt or coat pocket will give very little information about the dose the hands are experiencing, and with a discontinuous radiation field such as is present in this case, the same can be said for the head. Simple precautions can be taken to protect the head, i.e., refrain from leaning over the gamma port of the base unit. The hand most often used by the operator to place materials in the gamma beam should be monitored by strapping an additional CD V-138 dosimeter to the back of the hand with tape or by clipping the dosimeter on his shirt cuff.

E. LABELING OF THE BASE UNIT

The outside of the base unit is labeled to show that it contains radioactive material. The label displays the magenta and yellow radiation symbol with the legend "Caution, Radioactive Material", followed by the isotope (Cs^{137}), the activity (1 mc), the date of measurement, chemical form, and the radiation level outside the container (<0.1 mR/hr. at one foot). The same information is also marked on the outer surface of the source shield mounted inside the base unit. When the source is in use, the area immediately above the source shall be posted "Caution, Radiation Area", using the sign provided. (See Figure 8).

F. LEAK TESTING SOURCE

The AEC requires that most sealed sources or devices with a permanently or

semi-permanently secured source be tested for leakage of radioactivity at intervals not to exceed six months. The source shield of the CDV-757 is not exempted from this requirement because it falls into the category of a device with a semi-permanently mounted source as it is not handled in normal operation.

1. Performing a Leak Test

To perform a leak test, use a cotton-tipped wooden swab at least six inches long or a piece of hard filter paper (Wattman No. 50) attached to a pair of long handled forceps, at least six inches in length. Moisten the cotton or filter paper with several drops of diluted detergent solution and insert the swab into the bore of the gamma beam port, thrusting it all the way to the bottom of the hole. Using moderate pressure, swab the bottom of the bore with wiping or twirling movements. It will be necessary to hold the protective source cover slide open while performing the wipe test. Use a second dry swab, or filter paper, to remove any excess moisture left in the bore.

Check the swab for gross activity with a CDV-700 geiger tube type radiological survey instrument, if available, or use the geiger tube detector which is part of the CDV-757 Barrier Shielding Demonstrator.

To use the CDV-757 detector, remove it from the base unit, and move the base unit far enough away so that stray radiation from the source cannot affect the detector. Open the beta window in the geiger tube housing and bring the test swab up to the tube wall, not quite touching it, and check for obvious activity.

If the test shows little or no increase over the background level, there is no great amount of leakage, if any, present. Dry the sample swab and check it with a sensitive radiation detection system capable of detecting 0.005 μc of radioactive Cs^{137}. A lead shielded (at least one inch of lead), mica end-window geiger tube working into a numerical readout scaler is recommended for this purpose. The combination should be calibrated for Cs^{137} using a known calibration source. Cs^{137} emits beta radiation which is normally suppressed by the stainless steel capsule which contains the source material in the CDV-757. The only positive way to calibrate a particular instrument configuration for response to the unfiltered beta-gamma radiation is by using a standard source which allows the beta ray components to escape. The sensitivity of any detector counting arrangement is very dependent upon the geometry of the tube, shield, and sample positions, and all efforts should be made to maintain the same geometry when counting the wipe test sample as was used with the calibrating source. If the sensitive radiation counter shows less than 0.005 μc present on the swab, the leak test is considered negative.

2. Procedure in Case of Source Leakage

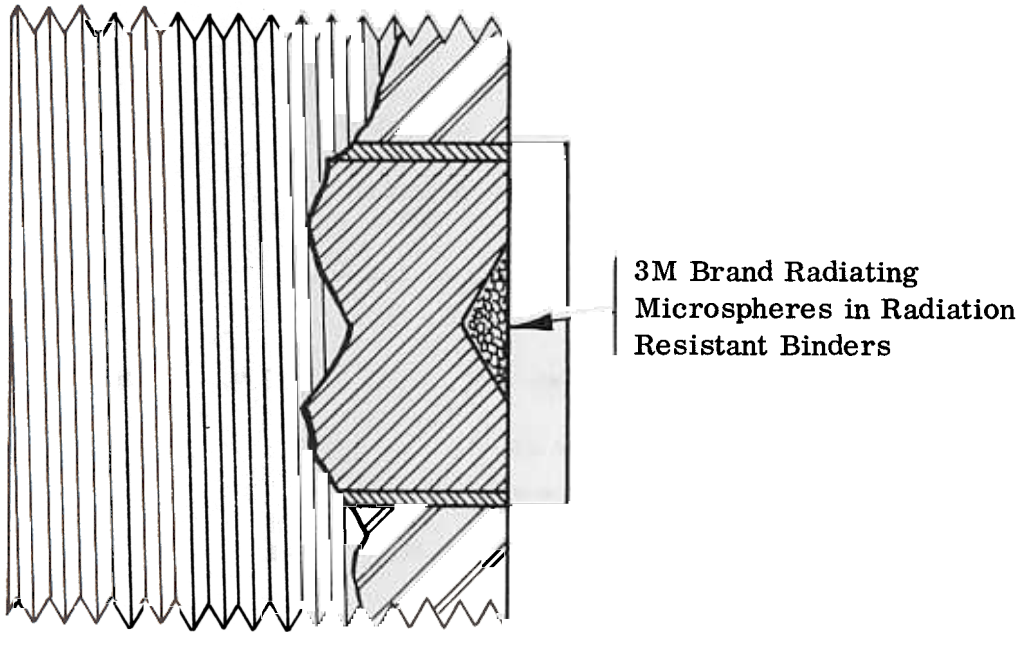
If the leak test is positive, lock the source and remove the base unit from service. Notify the Radiological Defense Staff, Technical Services, the Pentagon, Washington, D.C., 20310 (Phone: (202) OX5-2519) the appropriate OCD Regional Radef Officer and the AEC or the appropriate state authorities in accordance with 20.403 of 10CFR20 as required. Also, a written report on the results of a leak test indicating 0.005 μc or more of activity must be made to the Division of Materials Licensing, USAEC, with a copy to the director of the appropriate AEC Regional Compliance Office or reported to the State Licensing Authority as required. The unit should be taken out of service, locked, wrapped in heavy plastic or paper sealed with tape and stored in a location away from personnel access until health physics assistance is obtained.

Disposition of the leaking source cannot be made without the approval of the Radiological Protection Officer of the Office of Civil Defense.

G. ACCIDENTS, CATASTROPHIES (FIRE, FLOOD, EXPLOSION, ETC.), THEFT OR LOSS

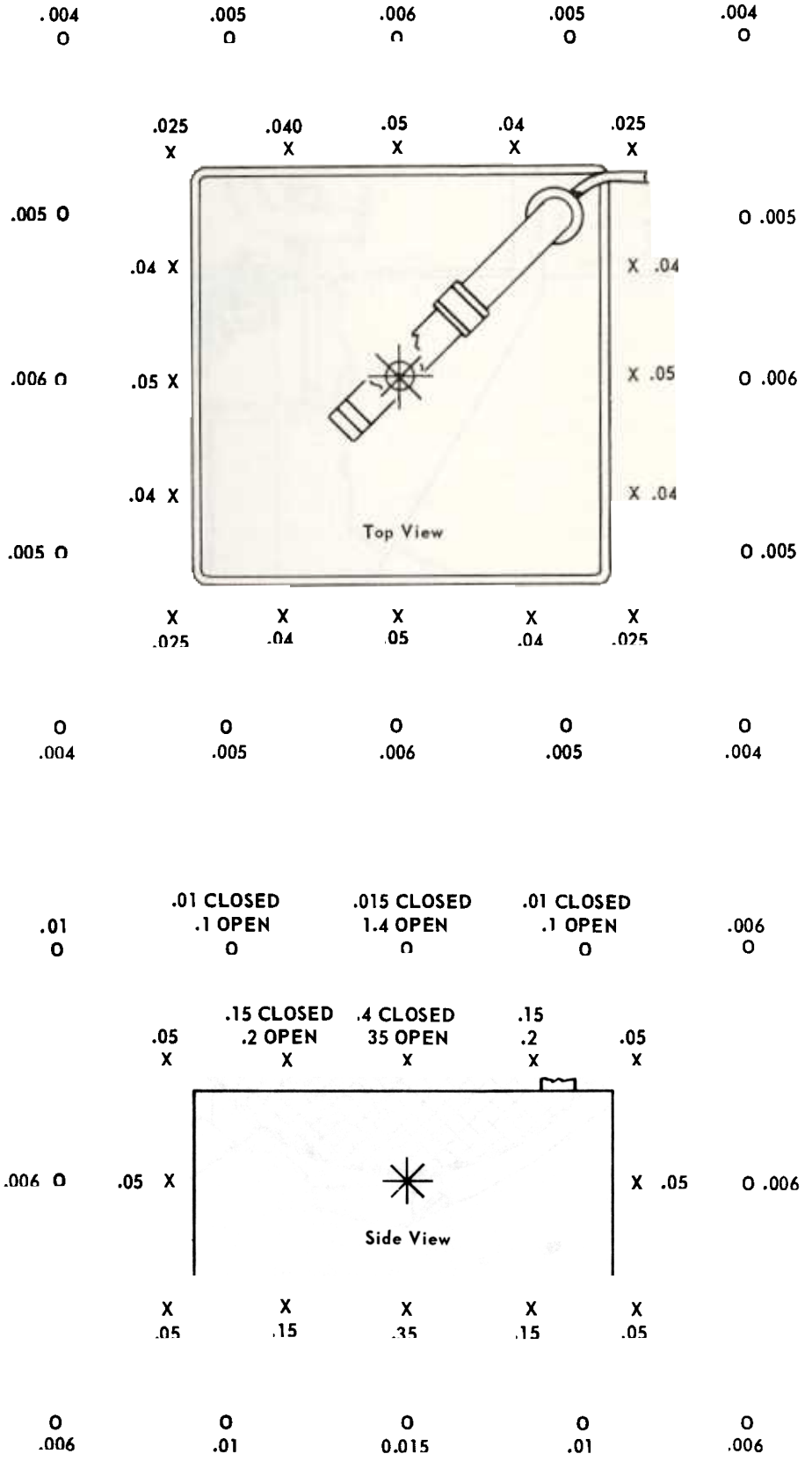
In the event that the base unit of the CDV-757 is involved in any natural or man-made accident, it is unlikely that the integrity of the source and shield would be affected. The unit might be lost or buried under mud, rubble, or other debris, and could be difficult to locate due to the low level of radiation escaping through the shield. A sensitive low-range survey instrument would be required to pinpoint the location of a buried unit. The person responsible for the unit should make a preliminary evaluation of the situation and if possible determine the extent of damage or radiation hazard which exists without disassembly of the unit. He should then contact the AEC in accordance with 10CFR20 or the appropriate state regulatory agency, The Radiological Defense Staff, Technical Services, Office of Civil Defense, the Pentagon, Washington, D.C., 20310 (Phone: (202) OX5-2519) and the appropriate OCD Regional Radef Officer. In the event, the unit is lost or stolen, the OCD individuals and organizations given above must be contacted. In addition, the appropriate state agency or the AEC must be contacted in accordance with paragraph 20.402 of 10CFR20.

The repair or recovery of the base unit as the result of catastropic conditions must be carried out under the supervision of a qualified health physicist and must be approved by OCD.



Minnesota Mining & Mfg. Co.
Model No. 4D6E
Activity 1 Millicurie Cs^{137}

Figure 2. Cs^{137} Sealed Source Capsule Configuration



MAX. INTENSITY AT SURFACE:
.4 MR/HR AT MIDDLE OF PLATFORM
.35 MR/HR AT BOTTOM OF PLATFORM

X = 1/2" FROM SURFACE
O = 1FT. FROM SURFACE
ALL FIGURES IN MR/HR

Figure 3 Radiation Levels Around Base Unit

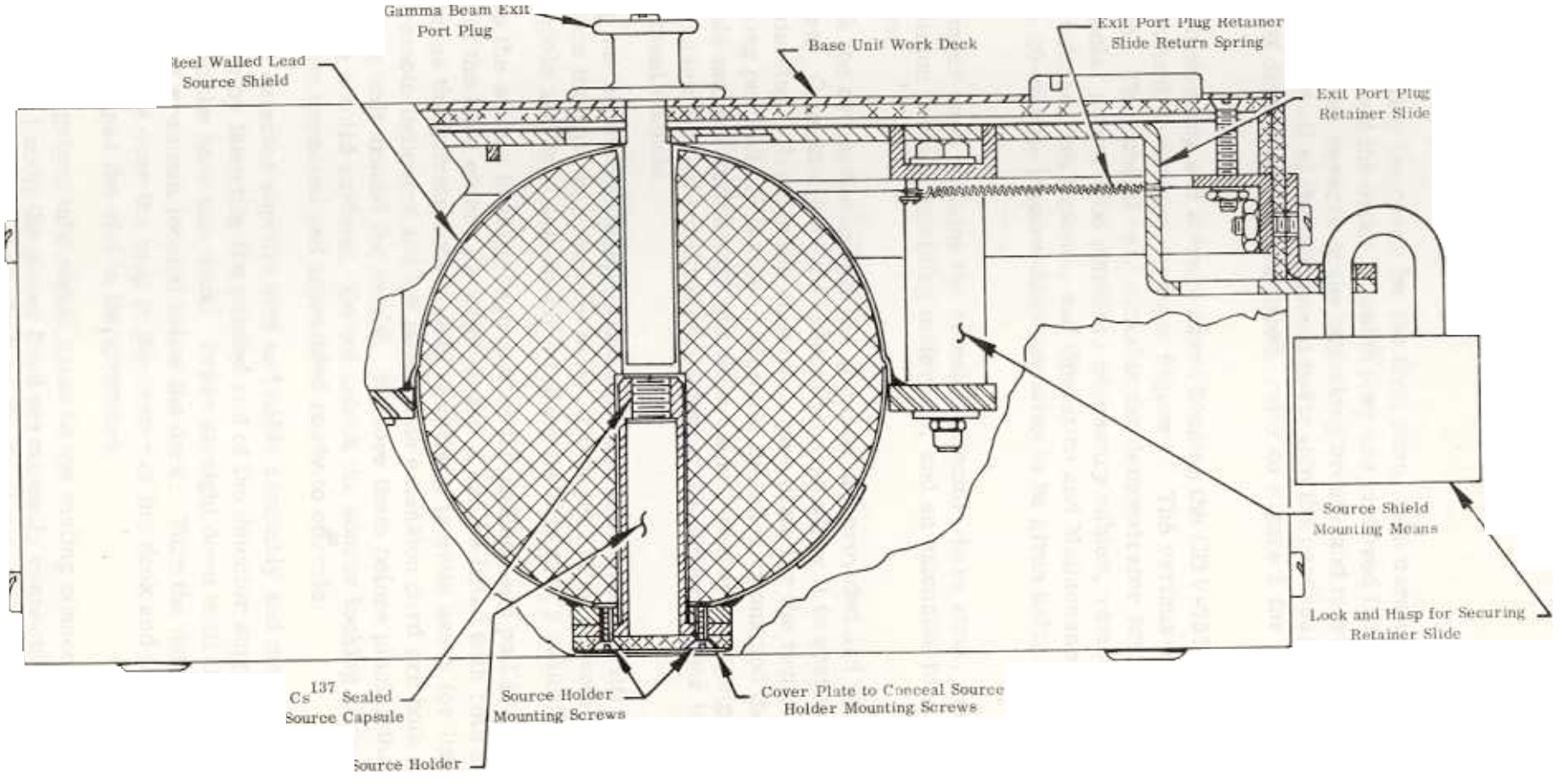


Figure 4. Base Unit Source and Shield

4. INSTALLATION

A UNPACKING THE EQUIPMENT

When unpacking the cases for the first time, take careful note of the position of the various items and the order in which they are removed from the cases. Repacking the cases is the reverse of the unpacking order, and must be adhered to in order to be able to fit all of the component parts into the necessarily limited volume of the two cases. If difficulty is encountered, refer to Figure 1 for proper component locations.

The two shipping and storage cases housing the CDV-757, Model 1, Barrier Shielding Demonstration Set are shown in Figure 1. The various components are packed as shown. The cubical case contains the demonstrator source shield housing, instrument console, geiger tube detector, necessary cables, remote indicator base plate, marker buttons, microphone, and Operation and Maintenance Manual, as well as the script for a 20-minute lecture-demonstration to be given using the CDV-757, Model 1.

The longer case contains the remote indicator, base strut, remote speakers, samples of common barrier shielding materials, and an extension tube for the geiger tube support arm.

Unlock the two padlocks with the common key provided and release the catches on the two cases. Open the lid of the cubical box and allow it to rest in the open position against the chain stop. Remove the aluminum base plate for the remote readout. Remove the top cushioning pad and lay it aside. Remove the microphone and the package of magnetic sample marker buttons and put them aside. Remove the geiger tube support arm and cable assembly and put it aside. Remove the padded spacer between the base unit and instrument console.

Grasp the handle on the top of the instrument console and lift it out of the shipping case. Place the unit on a suitable table or counter. For convenient operation, the instrument console and base unit should be placed within arm's reach of each other.

Grasp the source housing base unit by the padlock and pull it straight up until the open edge of the base clears the padding and it can be lifted with both hands. The base unit contains the gamma source lead shield and is quite heavy for its size. The cable for the remote indicator and the power line extension cord are both stored coiled up inside the base unit around the shield. Remove them before placing the base unit on its rubber feet on a solid surface. Do not unlock the source locking slide until the rest of the unit has been unpacked and assembled ready to operate.

Take the detector support arm and cable assembly and mount it on the base unit. This is done by inserting the pointed end of the detector support arm into the grommeted hole in the base unit deck. Press straight down until the lower end engages the second support grommet located below the deck. Turn the detector arm so that the geiger tube housing is over the plug in the center of the deck and the polarizing pin in the support arm engages the slot in the grommet.

Connect the geiger tube signal cable to the mating connector on the rear of the instrument console. Uncoil the power cord permanently connected to the instrument console. Check the rotary power switch on the front panel to see that it is in the "off"

position. This is the left-hand knob on the panel and the "off" position is marked. Plug the power cord into a 115V, 60 cycle, AC (only) line outlet. A 25-foot, 3-wire extension cord with dual outlets is supplied with the instrument for use where the AC power outlet is inconveniently located. A 3-wire to 2-wire adapter is supplied for use with older type 2-wire power outlets.

The CDV-757 is now set up for use before a small group. If the Barrier Shielding Demonstration is to be given before a large group, the remote indicator should be set up as well. The remote indicator may also be used before small groups to capture audience interest and attention.

Open the second case and remove the geiger tube support arm extension tube and the base plate bracing strut. Take out the group of barrier shielding samples and place them near the base unit along with the extension tube. Take out the two remote speaker cases. Lift out the remote indicator unit and fit it over the two snapslide studs near the center of the support base plate which was the first item to come out of the other case. Figure 6. Be sure that the third snapslide stud on the base provided to secure the base to indicator brace is to the rear of the indicator. Lock the indicator column to the base plate with the snapslides mounted on the column foot. Mount the indicator brace on the rear of the indicator and to the base plate and lock it in place with the snapslides provided.

Place the assembled remote indicator and base plate on a suitable table, or the top of the instrument carrying case may be used. Take the interconnecting cable provided and connect it from the rear of the remote indicator to the rear of the instrument console.

If the built-in public address system is to be used, pull open the back of each speaker case and unwind sufficient cable to allow the two speakers to be spaced far enough apart to give good audience coverage. The back cover is held by two spring clips; to remove it, insert the fingers in the holes provided and pull straight out. Plug the two speaker cable connectors into the jacks provided on the rear of the instrument console. Both speakers must be used as they are connected in a series circuit and will not operate independently. Remove the microphone from its carrying case and plug it into the mating jack on the rear of the instrument console. The instrument is now ready for its operational check.

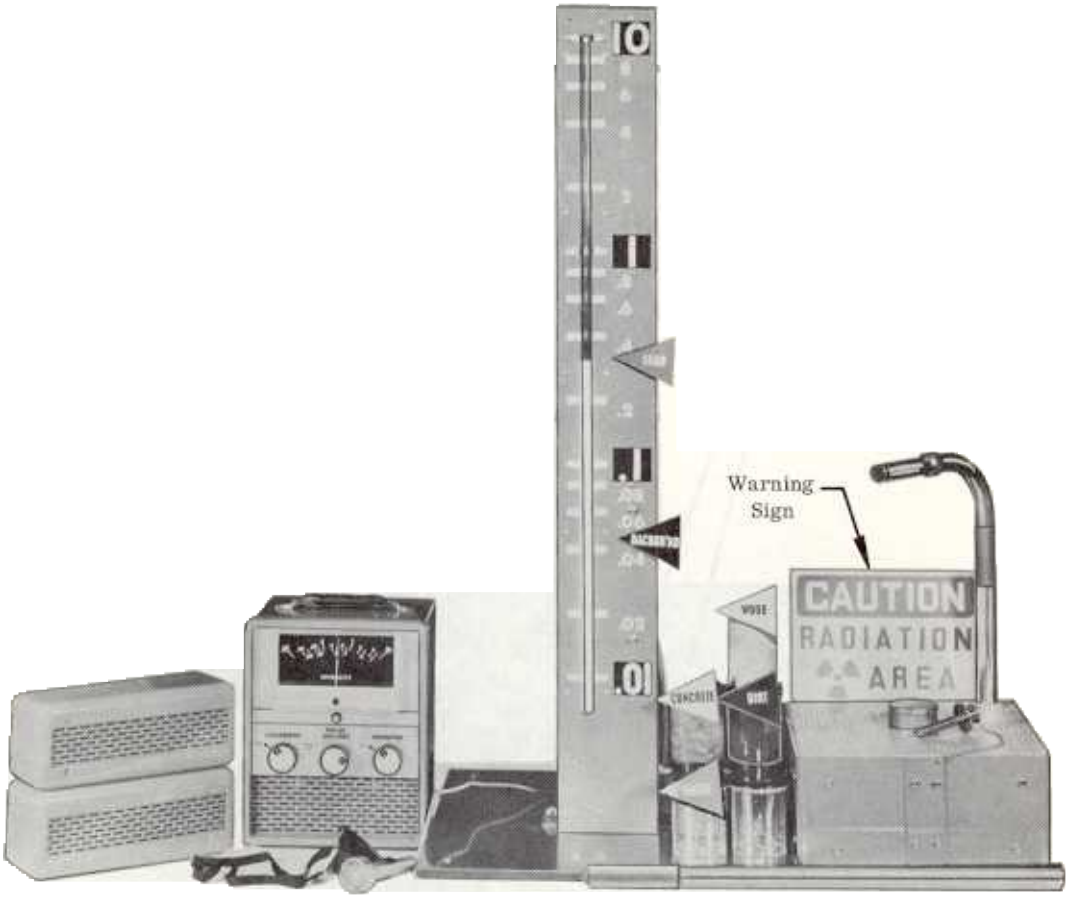


Figure 5. Barrier Shielding Demonstrator In Operational Form Showing Use Of Radiation Warning Sign.

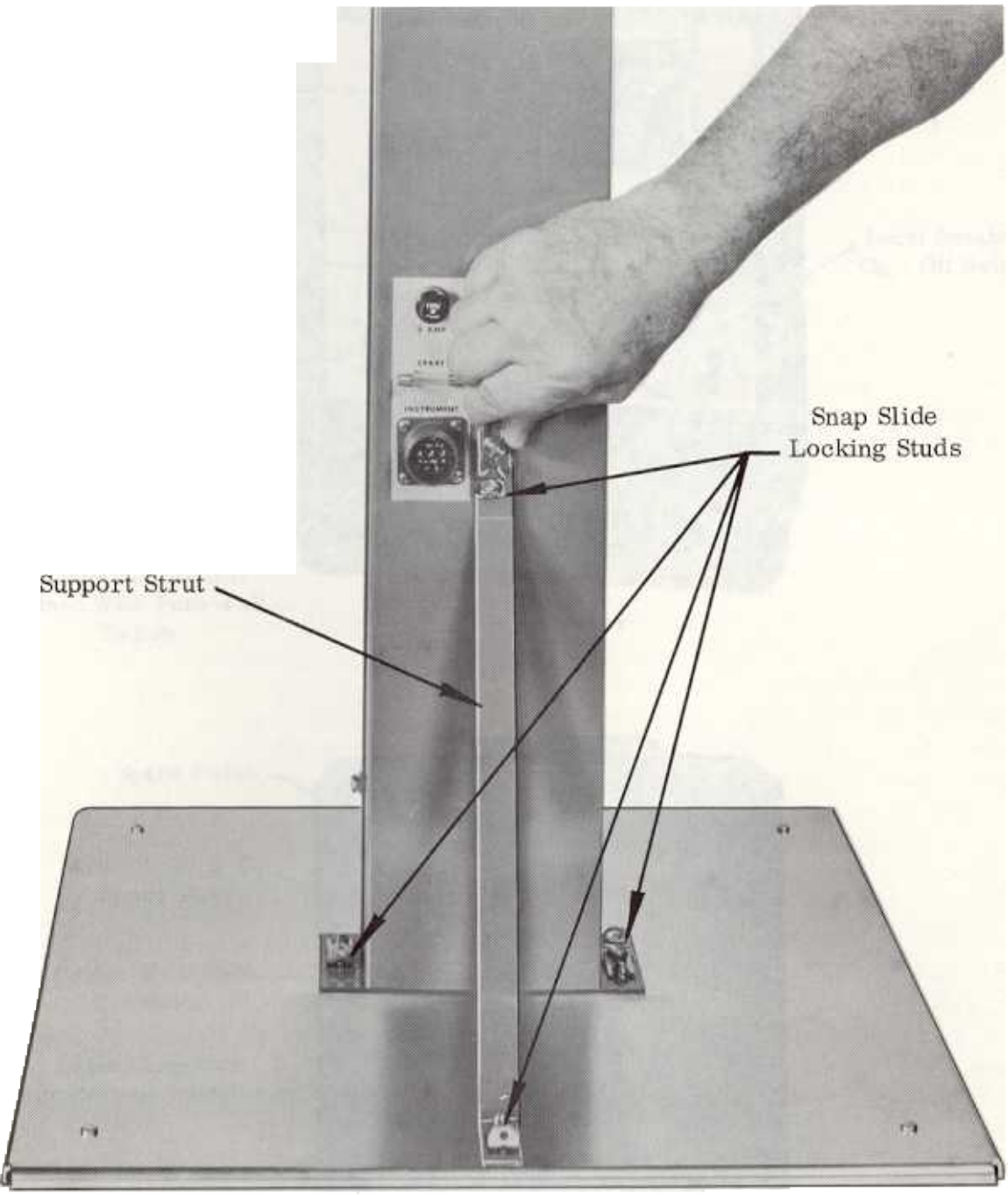
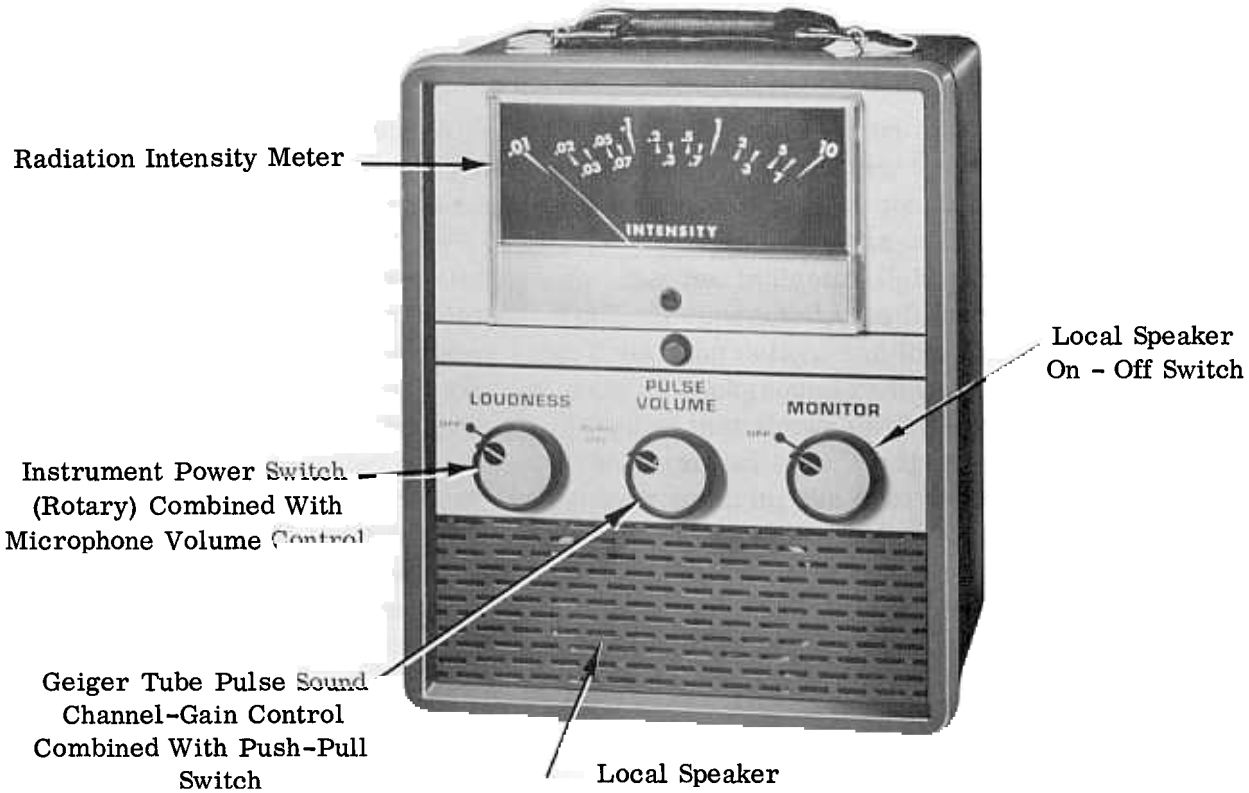
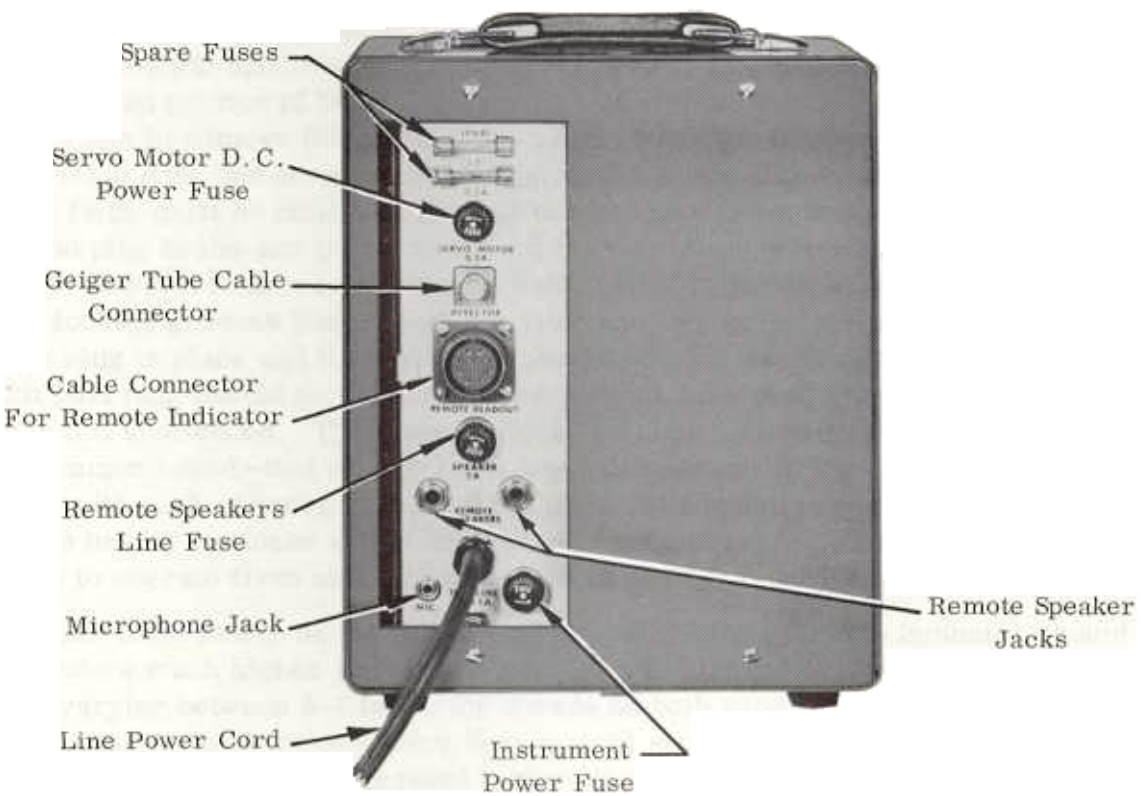


Figure 6. Detail Showing Mounting Means and Bracing Strut - Remote Indicator Column To Base Plate.



Front View



Rear View

Figure 7. Instrument Console

5. OPERATION

Refer to the section on Installation for instructions on setting up the instrument. On completing this procedure, plug in the power cord and turn on the instrument power, using the left-hand knob on the front panel of the instrument console. This is labeled "Loudness", and is a rotary type switch incorporated with the microphone channel gain control. The "Off" position is indicated. The red indicator light directly below the meter should light when the switch is "On". If connected, the fluorescent lamp in the remote indicator should light after a brief starting delay, and the radiation detector circuit should start to indicate the presence of background radiation. The remote indicator should indicate the same activity level as that shown on the console meter. To check for proper operation of the overall system and synchronization of the two indicators over the full range, unlock the padlock securing the source locking slide and remove the lock. Pull out on the slide until it stops and then lift the beam exit port plug clear of the hole and lay it aside on the deck. The captive chain will prevent it from straying. Release the slide and it will spring back to cover the beam exit port with a thin aluminum shield. This is intended to keep foreign objects out of the radiation beam port, while the aluminum section covering the port is not thick enough to cause any noticeable beam attenuation.

The demonstrator base unit houses the Cs^{137} gamma ray source in its lead shield. During the course of the lecture-demonstration, the speaker will be required to operate the sliding latch each time he opens or closes the beam exit port. The base unit should be set up on the work table with the latch facing the operator for ease of operation The sliding latch is spring loaded, and is operated by placing the left forefinger behind the bend in the slide handle and pulling outwards until it strikes its stop. This disengages the elongated portion of the opening in the slide from the mating groove on the plug and allows one to remove (or replace) the plug. When the latch is released, the spring pulls the slide back and covers the beam port with a thin aluminum cover to keep dirt out. The latch must be pulled all the way out in order to replace the plug. When replacing the plug in the exit port, push it all the way down and release the latch. Test the plug to see if it is free to turn in the hole, and if it should be, continue to turn it until the locking grooves line up with the slide and the spring pulls the slide home. This locks the plug in place and it cannot be removed without operating the slide once more. The exit port plug should be locked with the padlock furnished whenever it is not in active use or is left unattended. The three padlocks furnished as part of each CD V-757, Model 1, are common keyed - that is, the same key will open any of the three locks. One lock is furnished with each shipping case, and the third is provided to secure the source. In addition to having the locks within any one set common keyed, all of the locks in all sets are keyed to operate from master keys retained at OCD Headquarters.

The local meter on the instrument console and the remote indicator should both indicate a much higher radiation intensity, with the radiation beam port open, typically varying between 5-7 in the top decade on both readout scales. The remote indicator, since it is a motor-driven device, will show a longer time delay in reaching its maximum indication than the panel meter, but it should not exceed 6-8 seconds to reach equilibrium. Tracking between the two indicators should be very close, allowance being made for the unequal response times.

Check the geiger tube pulse sound channel in the following manner: (1) Rotate

the right hand knob (marked MONITOR) on the instrument console clockwise until the stop is felt. Pull out on the center knob (marked PULSE VOLUME) until it clicks, and turn it clockwise to increase the geiger tube pulse sound level. The pulse sounds with the source beam port open will be a veritable roar, both in the local monitor speaker and the remote speakers, if connected.

Close the beam exit port with the exit port plug by pulling all the way out on the plug latch and replacing the plug in the exit port while holding the latch fully open. Release the latch and rotate the plug in the hole to make sure the plug is latched in place. The geiger tube pulse sounds should decrease abruptly to a low level as soon as the beam port is closed, and the two radiation level indicators should promptly start back down toward the background level region. The recovery time of the Log Count Ratemeter circuit is slow enough so that both indicators should be tracking again before the readings have dropped below .1 - .2 in the middle decade on the readout scales. The eventual low end reading will depend upon local radiation levels. If the instrument has performed as described during the above test, all systems may be considered as operating correctly.

The microphone is a close-talking dynamic type with a laveliere mount so as to free the operator's hands. The microphone gain control is the same knob which operates the instrument power switch. If any acoustic feedback is encountered, turn off the local monitor speaker in the instrument console. If this does not eliminate the problem, try to reposition the remote speakers so as to get the lecturer's area out of the high sound field which obviously exists. If this fails, the only alternative is to operate the sound system at a reduced level which will not support feedback. In a small hard-surfaced room this will often be the only solution.

In use, the barrier shielding demonstrator shows directly the relative stopping power of the shielding materials furnished. The CD V-757 includes two concrete, two earth, and two water specimens contained in clear plastic containers with thin metal screw tops. The containers are identical. Also furnished are four wood samples cut to size such that the stack of four pieces is the same height as two of the other specimens when stacked. Eight 1/8 inch lead discs are also provided. See Figure 8.

In use, one opens the radiation beam exit port and then places the samples in the beam of gamma rays, singly or in combination. The geiger tube radiation detector senses the change in the amount of radiation reaching it and this is indicated on the panel meter and the remote readout. Magnetic button markers are provided to enable the lecturer to mark the intensity level for any given absorber and so be able to compare the effect of one absorber relative to another with ease and accuracy. See Figure 9.

An extension tube is provided for use with the detector mounting arm when it is desired to show the effect of increasing the source to detector distance upon the indicated dose rate. The extension tube effectively doubles the source-detector distance facilitating illustration of the inverse square law. The extension tube has a guide pin near the lower end oriented with a slot at the upper end to maintain the detector position over the beam exit port.

The lecture-script included as a part of the CD V-757 demonstrator is intended to be followed rigorously by those unfamiliar with radiation and barrier shielding, and should be used by qualified personnel until such time as they are prepared to expand or modify the basic lecture to suit their own particular needs.

In using the source in the CD V-757 for its intended purpose, the operator should exercise reasonable care to avoid excessive exposure of the hands, arms, head, etc. to the gamma rays radiating from the beam exit port. When the source is in use, the area immediately above the source shall be posted: "Caution, Radiation Area" using the sign provided. The radiation warning sign is shown in use with the CD V-757 unit setup in Figure 8.

When finished with the demonstration, the operator should replace the beam exit port plug, check to see that the latch is engaged, and then lock it with the padlock provided.

The two plastic containers for the water samples should be filled to the brim in order to equalize the absorption path length for all samples. This means that almost no air space remains in the package, with the possibility that expansion of the contents due to heating or freezing during shipment or storage could damage the container and result in water damage to the instrument.

It is recommended that the water sample containers be stored with the instrument only after being emptied, and that they be emptied after each lecture as a matter of routine preventative maintenance.

Replace the components of the CD V-757 in the shipping containers in the reverse order of unpacking and in the same location and orientation in the proper case. Failure to do so may make complete packing difficult or impossible, and the only recourse will be to start over and do it correctly. Lock both cases after packing is completed.

Figure 8. View of Base Unit With Barrier Shielding Sample In Place Over Source Beam Exit Port - Radiation Sign Displayed.

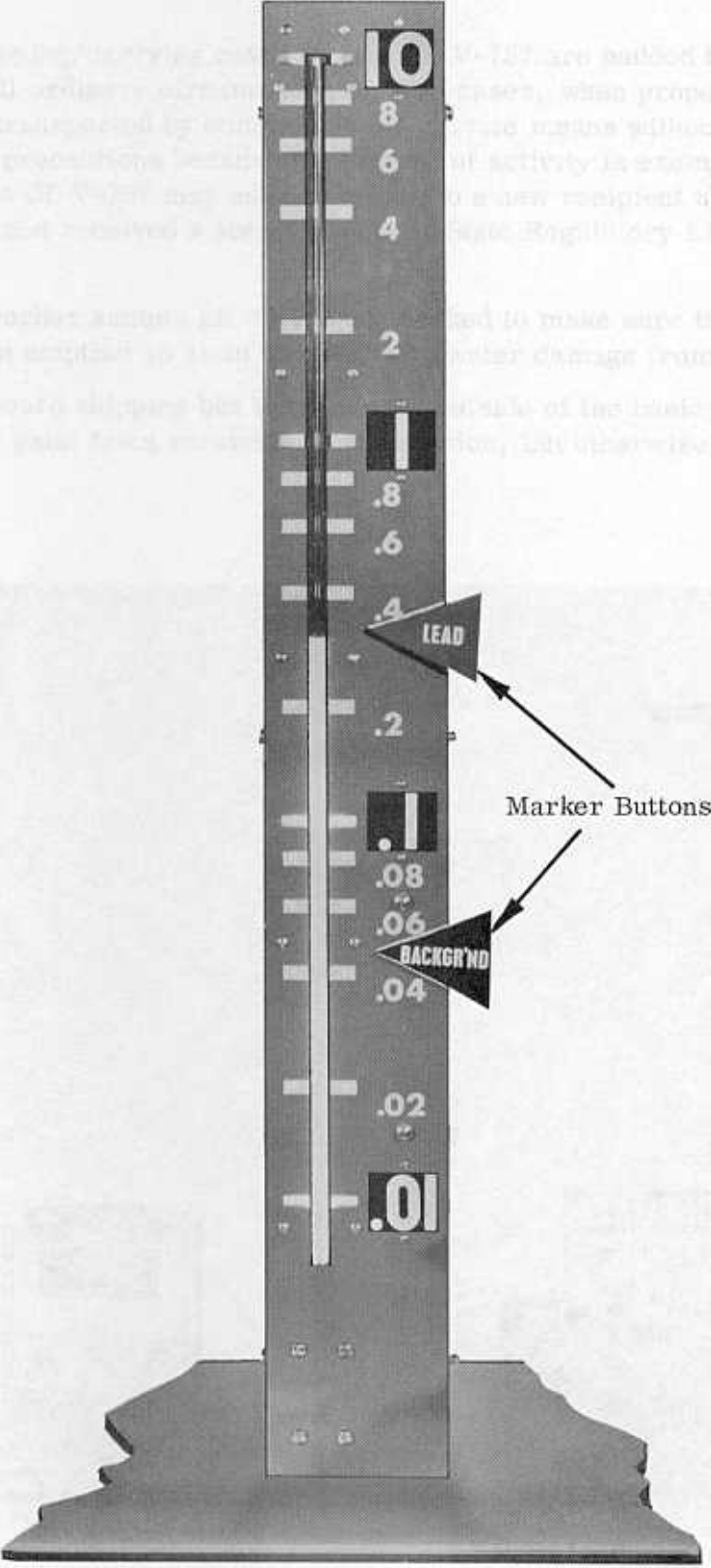


Figure Use Marker Buttons

6. SHIPPING

The shipping/carrying cases for the CD V-757 are padded to protect the contents under all ordinary circumstances. The cases, when properly packed and locked, may be transported by commercial or private means without requiring any special shipping precautions because the amount of activity is exempt from ICC regulations. The CD V-757 may not be shipped to a new recipient unless they have first applied for and received a specific AEC or State Regulatory License to allow possession.

The absorber sample kit should be checked to make sure that the water containers have been emptied so as to forestall any water damage from accidental leakage.

A cardboard shipping box may be used outside of the basic carrying case to protect the outer paint from scratching and abrasion, but otherwise is not required.

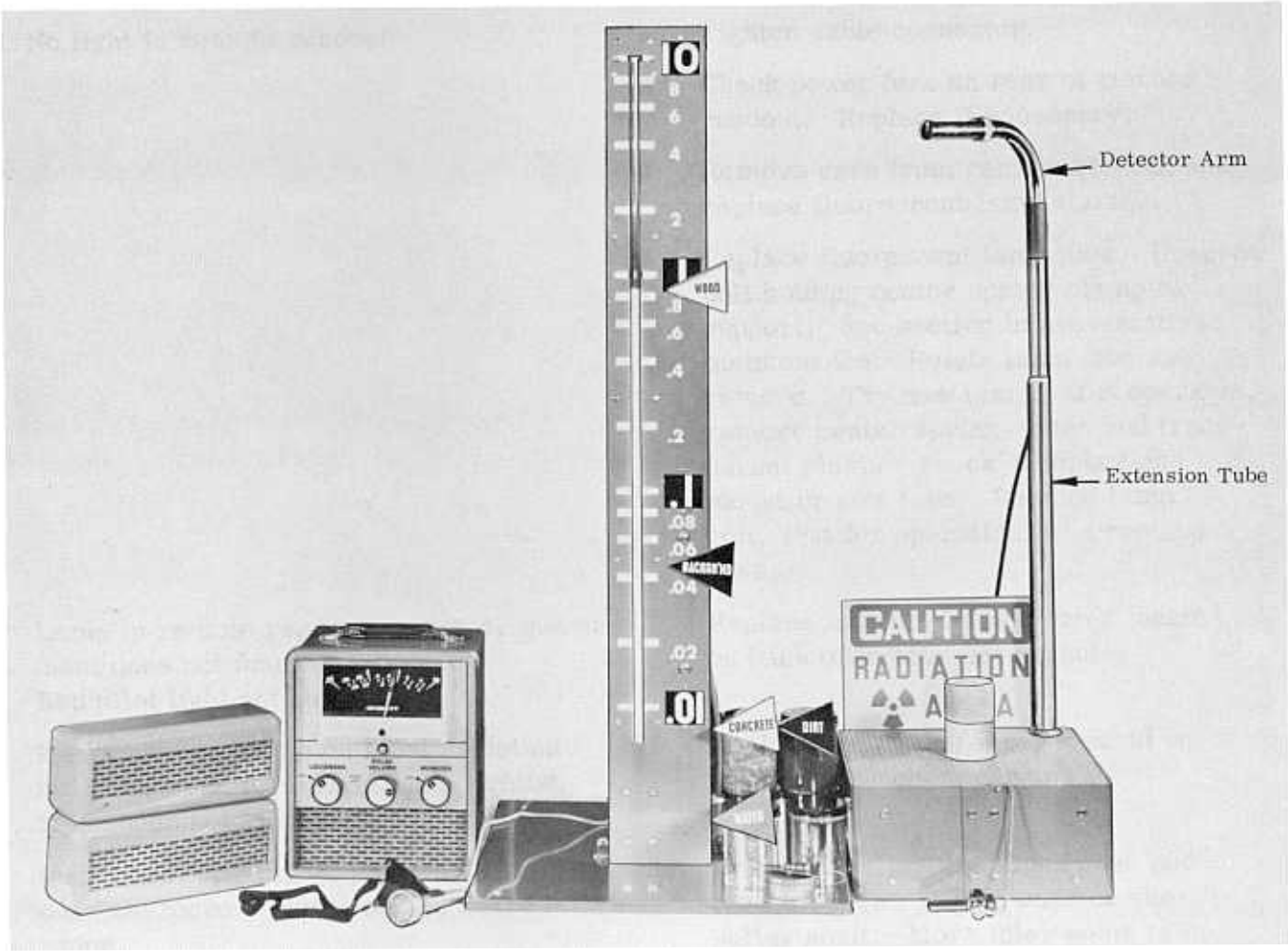


Figure 10. Barrier Shielding Demonstrator Showing Use Of Geiger Tube Arm Extension Tube.

7. OPERATOR'S MAINTENANCE

Maintenance to be performed by operator is limited in scope, of necessity, and by design. The components used in the CDV-757 have been chosen with great care to combine ruggedness, trouble-free operation and economy with long life.

The operator's maintenance duties will be limited to items such as changing fuses, fluorescent lamp starter, installing a new fluorescent tube, checking connections, etc.

Trouble	Remedy
No remote speaker output	1. Check speaker plugs and cables for breaks or poor connections. Make sure both speakers are connected. 2. Check speaker line fuse located on back of instrument console. Replace if necessary.
No light in remote readout	1. Tighten cable connector. 2. Check power fuse on rear of remote readout. Replace if necessary. 3. Remove case from remote readout and replace fluorescent lamp starter. 4. Replace fluorescent lamp tube. Unscrew bolt holding center spring clamp to support. See section in preventative maintenance. Rotate lamp tube and remove. Try new lamp. If it operates, remove center spring clamp and transparent plastic shock absorber and mount on new tube. Replace lamp in unit, test for operation, and replace case.
Lamp in remote readout operates, instrument does not function. Red pilot light not lit.	1. Replace instrument line fuse, located on back of instrument console.
Instrument operates on local radiation monitor, remote readout lamp lighted, tape does not move. No motor sounds.	1. Replace servo line fuse, located on back of instrument console.
Instrument operating, as above, tape does not move - motor can be heard to whine.	1. Drive belt slipping. Open case and loosen screws at both ends of idler pulley shaft. Move idler so as to increase belt tension and tighten screws. Wipe belt and both pulleys clean. Cleaning alone may be sufficient. Figure 11.

Trouble	Remedy
Instrument appears to operate normally, but sensitivity is obviously less than normal. Runup with full beam below 4 in top decade.	1. Weak geiger tube. To replace the geiger tube unscrew the threaded collar (Figure 12) around the detector housing. Lift off the metal shell and unplug the geiger tube from its socket. Replace with new type 75NB3 and reinstall the housing. Power must be off when performing this operation as the tube operates at 725 volts.

Operating problems which do not respond to the previous treatment should be referred to the next echelon maintenance group or returned to the manufacturer for repair.

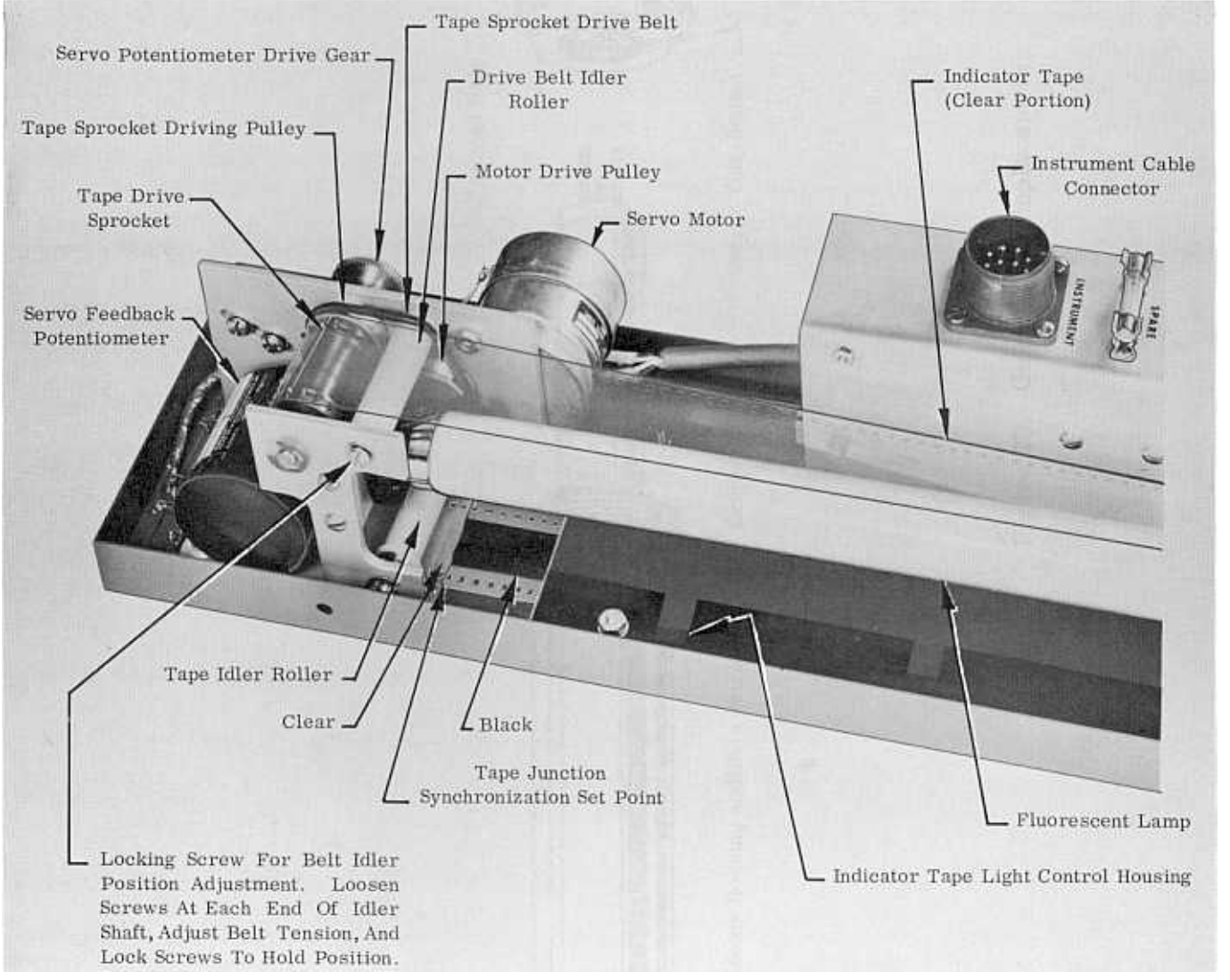
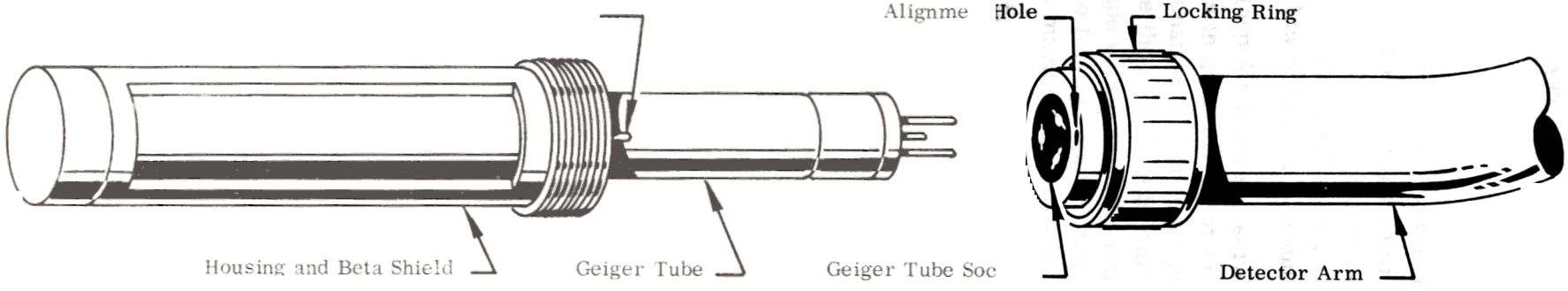


Figure 11. Detail Showing Drive Belt Tension Adjustment



gure ube Replac

8. PREVENTATIVE MAINTENANCE

A. REMOTE READOUT

Servo tape drive. Every six months or oftener if used under dusty conditions the cover should be removed from the remote indicator and the unit carefully cleaned to remove dust, dirt, lint, etc. The cover section may be blown clean with an air hose, but the front portion should be dusted or wiped clean, unless the air line is equipped with a regulator which can be set low enough to prevent any air blast damage.

Inspect the moving tape loop for damage, scratches, excessive looseness, torn sprocket holes, etc. If the tape is in generally poor condition it should be replaced as explained under Corrective Maintenance. Thin spots in the black center strip may be touched up with black paint. Move the tape loop by hand, using the drive sprocket, and carefully wipe both sides of the tape with a suitable anti-static treatment. Chemtronics "Mask-N-Glas" cleaner is suitable for this application. This will help to prevent the electrostatic pickup of dust by the moving tape system.

Lubricate the gear train bearings, sprocket shaft bearings, tape idler shaft, and the belt tension idler shaft using about one drop of General Electric Versilube 305F Silicone Lubricant at each point. Make sure that none spills onto the drive pulleys and be sure that both pulleys and the belt are wiped clean. Lubricate the tape idler pulley shafts at the top of the unit in the same manner. The special O-ring belt material is degraded by mineral oil based lubricants.

B. LAMP SYSTEM

Test the fluorescent lamp system for ease of starting. If the lamp is excessively slow in starting or requires a number of tries before lighting, the starter and/or the lamp may need replacing. The service life of fluorescent lamps is quite long, so replace the starter first to see if operation inproves. If changing the starter does not speed up the starting condition, replace the lamp, using the same type green fluorescent tube as originally supplied. A 30 watt white fluorescent lamp may be substituted if necessary, but the brilliance of the display will be cut by a factor of two or more.

To remove the lamp, the center mounting spring clamp must be released. Remove the machine screw holding the wire spring member to the vertical support. Remove the lamp from its sockets by turning it to bring the spring arm out from the unit to disengage the bipin sockets. Guide the terminal pins down through the slot in each socket and remove it from the side, drive end first. Pinch the spring clamp ends together to release the pressure on the plastic shock absorber and slide the spring off the tube. Remove the split plastic sleeve and mount it on the new tube in the same relative position. Mount the wire spring on the new tube and orient it as before. Replace the tube in its sockets using the reverse order of the steps in the removal procedure. With the tube seated in its sockets, line up the spring clip with its support arm, and bolt it to the support arm as before. Be careful not to exert any undue pressure on the lamp tube and do not use excessive force in moving any parts into position. If the spring clip does not fall into the proper position when the lamp is in place, pinch the spring so as to remove the pressure from the plastic sleeve and reposition the spring. Bolt the spring and its upright support together. See Figure 13.

Check over the wiring harness for loose terminal screws, frayed insulation,

etc Check to ensure that the cable connector to the servo drive unit is properly mated.

C. INSTRUMENT CONSOLE

The instrument console houses the printed circuit boards for the various electronic systems in the CDV-757. With almost 100 per cent solid state circuitry the reliability eliminates the need for routine preventative maintenance. Check the fuse holders on the rear of the instrument to verify that the proper fuses are installed and that spare fuses are installed in the holders provided.

Check the operating knobs on the front panel and tighten any loose setscrews found

D REMOTE SPEAKERS

Remove the back from each speaker and unwind the cable. Inspect the insulation jacket for cuts, nicks and tears, and wipe clean with a damp cloth. If after long use the cable insulation has deteriorated, return the speaker(s) to the nearest maintenance depot for cable replacement. Unscrew the sleeve over the cable end of the cable plug and check the condition of the connections. If the connections show signs of fatigue breaks or loose wire ends due to twisting and pulling on the cable, resolder the connection and then wrap a small piece of insulating tape over each connection to guard against accidental short circuits. Replace the plug cover.

Check the solder joints where the cable is connected to the speaker terminals Resolder if any evidence of cold solder joints, breaks, etc, is noted.

Rewind the cable and replace the rear cover

E CABLES

Inspect all cables for insulation damage, loose connector shells, cable clamps, and other obvious physical defects. Correct any faults found, or replace the entire cable in case of major damage.

F BASE UNIT AND SOURCE HOLDER

Check the operation of the sliding latch for sticking or binding. If necessary work a little Lubriplate or similar grease between the slide and the friction points where the slide passes through the deck reinforcing members. See that the latch engages the exit port plug properly and locks it in place when engaged.

Check all bolts and screws for tightness.

WARNING

The base unit must not be disassembled or the Cs^{137} source removed from its shield unless such operations are performed under the direct supervision of a qualified health physicist.

G. SOURCE WIPE TEST

The sealed Cs^{137} source must be wipe tested every six months. Refer to the section headed Radiological Safety Precautions for instructions on carrying out a wipe test. Record the results of the test and the date. Record this on a card and mount it

on the inside wall of the unit if one is not already mounted.

H. ABSORBER SAMPLES

The absorber materials furnished with the CD V-757 are contained in clear plastic containers with thin metal screw tops. If roughly handled, these can be cracked or broken. Clear plastic pressure sensitive tape may be used to effect an emergency repair, but the container should be replaced at the earliest convenient time. The water containers should always be stored empty so as to eliminate the possibility of accidental water damage due to leakage.

I. CARRYING CASES

With the CD V-757 components removed, inspect the cases for mechanical damage to the hardware and metal structural parts. Straighten any bent parts and check for free operation of lids, hasps, pulldown catches, etc. In case of broken or missing parts, or major structural damage, return the case to the nearest stocking depot for replacement.

Examine the covered foam pads in the cases for tears or loose coverings. A temporary repair to a torn pad cover may be made by using pressure sensitive masking tape to hold the edges of the tear together. A cloth patch may be hand-sewn over the damaged area, or the pad may be removed from the case and a complete cover stapled to the masonite backing piece. The pad is fastened to the case by two or more screws passing through the side of the case and into threaded inserts locked in the masonite backing piece. If badly damaged, the entire pad assembly may be replaced.

J. CASE AND SOURCE LOCKS

Check the locks for ease of operation and oil sparingly if necessary. Check to see if the three locks operate from the same key as intended.

K MICROPHONE, GEIGER TUBE SUPPORT EXTENSION, MISCELLANEOUS ITEMS

Inspect the microphone and its cable for obvious defects. Connect the cable to its socket on the rear of the instrument console and make an audio check. If the microphone is damaged and noisy or inoperative, return it to the maintenance depot for replacement.

Geiger Tube Support Arm Extension Tube. Inspect the open end for dents or nicks which would interfere with the sliding fit required when the tube is in use. If damaged, straighten if possible, otherwise replace the tube.

Marker buttons. Six magnetic scale markers are provided with the CD V-757 for the lecturer's convenience. Replace lost or damaged markers.

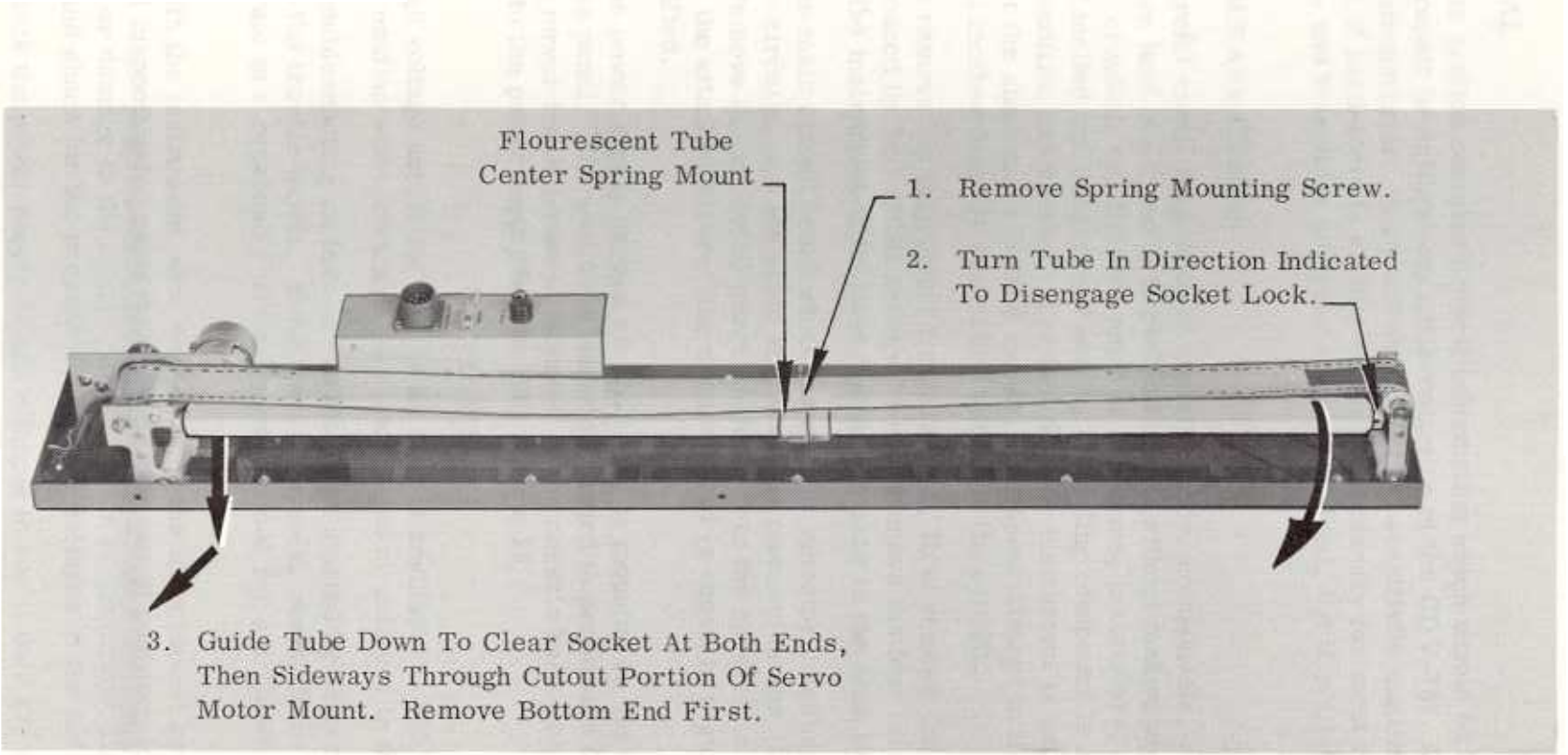


Figure 13. Replacement Of Fluorescent Lamp.

9. CORRECTIVE MAINTENANCE

A. GENERAL

This section contains general information which should be helpful to persons attempting repair or calibration/synchronization of the CDV-757, Model 1, Barrier Shielding Demonstrator. A 20,000 ohms/volt DC sensitivity multimeter and the usual complement of hand-tools is all that should be necessary for most repair problems. An oscilloscope and transistor analyzer are not required, but if available may prove very useful.

B. PRELIMINARY CHECKS

Careful visual inspection of circuit boards, components, soldered connections, etc. can often lead one directly to problem areas without making any electrical tests. Discolored, cracked, or blistered paint on resistors, transistors, or diodes and the presence of melted and rehardened sealing or potting compound is a sure sign that an abnormal condition has existed. The fact that the instrument is out of service should indicate that the abnormal condition caused permanent damage to the discolored component or to another directly associated with it in the circuit.

To remove the instrument from its case, first remove the rear cover plate which is secured by four small screws. Next, remove the four large machine screws which hold the instrument in the case. Slide the case to the rear to remove it.

The main circuit board which mounts the detector counting circuits, the servomotor drive circuits, and the audio amplifier, is mounted on the right-hand side of the chassis. Remove the six small screws holding it to the chassis and swing it out and to the rear on the attached wires. The circuit board is shown in Figure 14 with the major parts identified.

The power supply printed circuit board is mounted on the upper half of the back chassis panel. The wall area behind the board is perforated for additional ventilation. The power transformer is mounted on the chassis base with the output leads running up to the power supply board. See Figure 15.

WARNING

The high voltage supply for the geiger tube is regulated at 725 V DC. Exercise proper caution when working in the instrument circuitry with the power on.

Troubleshooting an instrument should be started by determining the probable area where the trouble exists. If only one subsystem seems to be abnormal while the others operate in a reasonably normal manner, look for a problem in the inoperative system.

With the instrument case removed and the main circuit board swung out, carry out a visual inspection for parts damaged or bent out of position, loose wires, damaged insulation, or damage to the circuit board. Refer to the circuit diagram shown in Figure 16 and check for the presence of normal voltages at the indicated test points.

Check the power supply output voltages to see if they are normal, then start a point to point voltage check in the malfunctioning circuit. If the power supply voltages are obviously low due to an abnormal current drain, it may be safer, in terms of pos-

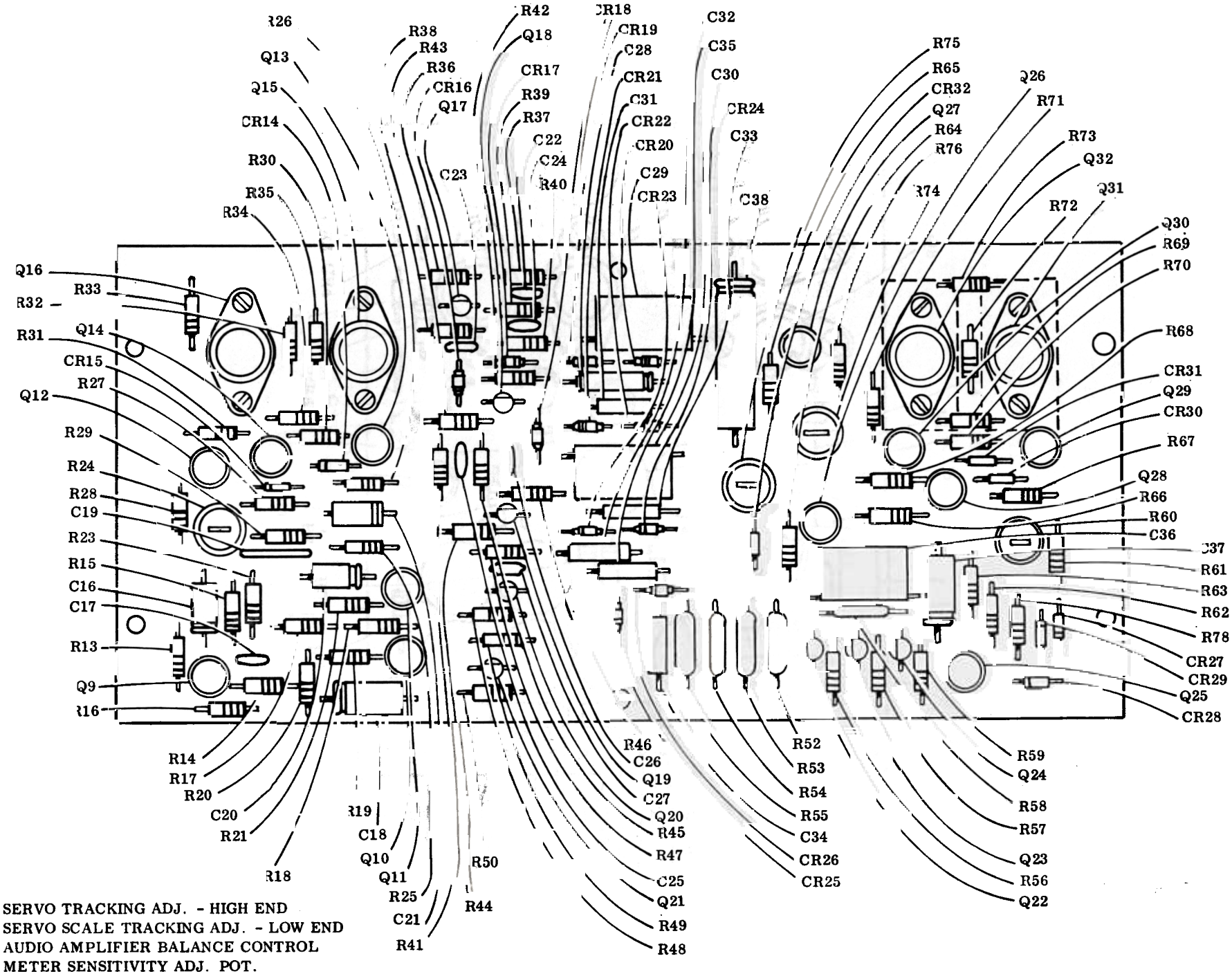


Figure 14. Main Circuit Board With Parts Identified.

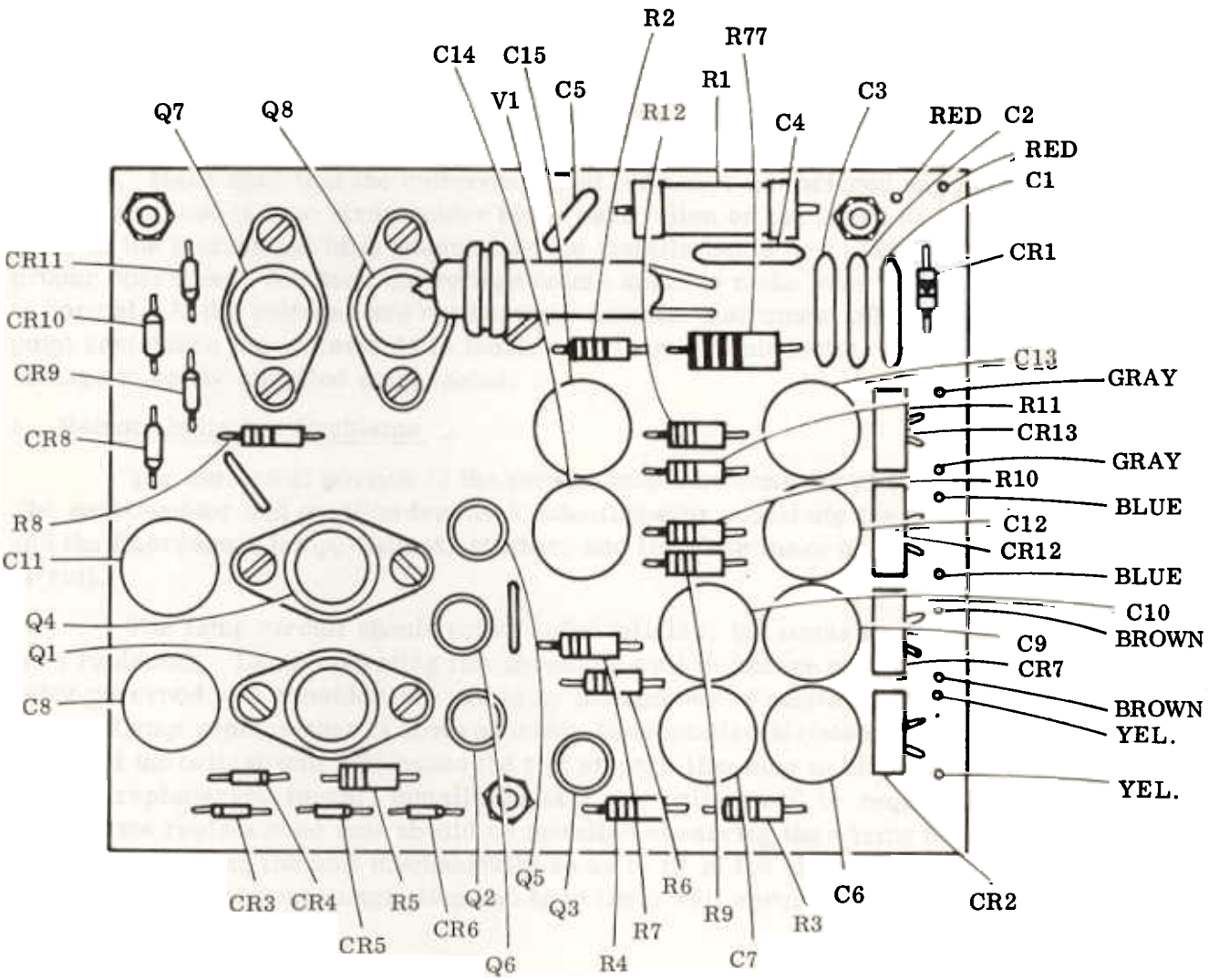


Figure 15. Power Supply Circuit Board With Parts Identified.

sible additional equipment damage, to turn off the input power and use the point to point resistance method of troubleshooting to locate faulty components.

When voltage or resistance measurements indicate a faulty component, it may be cut out with sidecutters, after shutting off the power. The ends of the leads should be removed from the board by heating the solder joint quickly and shaking the board to dislodge the leads. If in doubt about the condition of the suspected part, carefully unsolder and disconnect one lead from the board. The part can then be tested separately to determine its true condition.

Replace any parts removed with new or tested used parts and solder into place quickly to avoid the damaging effects of excessive heat. Make sure diodes, electrolytic capacitors, and transistors are correctly oriented in the circuit before soldering in place. Make sure that the component lead ends have not bridged any printed circuit conductors, and that no stray solder blobs have fallen on the board to cause shorts. Turn on the instrument after completing the installation of new parts and check for proper operation. Recheck the voltage points again to make sure they have returned to normal. If the voltages are not normal, turn the instrument off and use point to point resistance measurements to locate additional circuit faults, and so prevent damage to newly installed components.

1. Remote Indicator Problems

The electrical portion of the remote indicator consists of two separate systems. The servo-motor and position feedback potentiometer constitute the control system, and the fluorescent lamp, ballast, starter, and line fuse make up a separate power circuit.

The lamp circuit should prove quite reliable, but occasionally the starter will need replacing. Lamp operating life should be well in excess of 2,000 hours, this being governed to a considerable extent by the number of starts it is called upon to make. Lamp replacement is covered under Preventative Maintenance. Electrical failure of the ballast unit will cause the two ampere line fuse to blow and it will keep blowing replacement fuses. Installation of a new ballast will be required in this case. A duplicate replacement unit should be installed observing the wiring data on the nameplate and orienting the unit mechanically so as to fit in the allotted space. Dress the leads as in the original installation and keep them well separated from the servo system wiring harness.

2. Servo-Motor Tape Drive System

The servo-motor drives the indicating tape and position feedback potentiometer through a belt-gear system. The motor drives the tape drive sprocket through a belt and pulleys. This portion of the drive system is not required to maintain any fixed relationship between the input and output members. The belt is able to slip under circuit malfunctions which cause the tape to run full up or down scale with the motor continuing to run. The motor current under belt-slip conditions is less than if the motor were stalled, and thus some degree of protection against overheating is realized.

The tape drive sprocket drives the indicator tape directly through the tape sprocket holes, and maintains synchronism with the position feedback potentiometer through a gear drive system. The fixed stops at each end of the potentiometer limit

the travel of the tape system as well.

The drive belt tension should be such that under normal operating conditions the drive pulley does not slip, but when the system is driven to one of the stops, the motor pulley is able to slip. The belt idler pulley has provisions for adjustment to achieve this condition. To adjust belt tension loosen the screw at each end of the idler pulley shaft and move the idler in the proper direction. Retighten the screws. Check for proper operation by operating the complete system. Drive the tape to the upper stop by holding the geiger tube directly over the open gamma beam port. This should provide an offscale signal, and if the belt tension is correct, the tape mechanism should stop just beyond full scale indication and the belt should slip at one of the pulleys. The belt should not be so loose that slippage occurs without hitting the stop.

3. Drive Belt Replacement

If after long usage the belt tension idler adjustment can no longer properly tension the drive belt, the belt must be replaced. Proceed as follows:

a Open the case of the remote readout and place it face down on a cushioning support.

b. Move the tape drive sprocket by hand until the potentiometer hits the bottom stop.

c. Carefully peel off the tape holding the indicator film loop together. Mark the outline of the end of the loop where it overlaps to ensure proper tension when reassembling the loop. If you peel off the binding tape on one-half of each joint and carefully stick it on a small piece of PTFE or Polyethylene, this will keep it clean, neat and sticky, and eliminate the need for new tape. Allow the open ends of the tape to hang out of the way.

d. Remove the two screws securing the belt idler in position and withdraw the idler on its shaft.

e. Loosen the setscrews securing the film drive sprocket and the drive pulley. Note that both of these are positioned on flats cut in the shaft and should be repositioned properly when reassembling the unit.

f. Remove the snap ring on the end of the sprocket drive shaft. Slide the shaft out of the bearing hole, being careful to collect the plastic bearing insert.

g. Remove the old belt and clean the driving pulleys.

h. Mount the new belt in position. It may be necessary to spring apart the sides of the drive housing slightly to get the belt through the opening between the motor pulley and the lamp socket without damaging it. (The idler pulley shaft will re-establish the proper side-to-side spacing when remounted).

i. The rest of the assembly is the reverse of disassembly.

j. Reassembly and synchronization of the indicator tape should be carried out as detailed in the sections on tape replacement and synchronization.

k. Connect the remote readout into the instrument system and check it for proper operation and synchronization with the panel meter. The belt idler should be adjusted to give the proper belt tension so that the belt drives without slipping under

normal operation, but will slip at one of the pulleys when the input signal to the instrument is such as to drive it offscale in either direction. This condition can be created by placing the geiger tube detector close to the open source for offscale at the top, or disconnect it completely for offscale at the low end.

l. Replace the remote readout in its case.

m. Malfunctions in the synchronizing-drive systems can occur if any of the setscrews locking the various pulleys and gears to their respective shafts should loosen. If this should occur, retighten the offending setscrew, and if it secures a gear, recheck the synchronization between the potentiometer and the indicator tape.

4. Synchronizing Indicator Tape and Position Feedback Potentiometer

Synchronization can be checked by turning the tape drive sprocket by hand in the direction of a decreasing reading until the system hits the lower stop. The clear-to-black tape indicator junction should be in line with the upper edge of the servo drive system mounting frame. See Figure 17. If it is not, the system may be easily resynchronized by removing the idler gear to disengage the tape drive sprocket from the potentiometer shaft. The idler gear is held in place on the idler shaft by a snap ring. Pry this off with a small screwdriver or pull off with a pair of needle-nose pliers, and then slide the gear out of mesh with the other two. Check the potentiometer shaft to see that it is still at the lower stop position. Turn the tape drive sprocket to position the tape as shown in the photo, and then replace the idler gear and secure it with the snap ring. See Figure 11.

5. Indicator Tape Replacement

Remove the old tape by peeling back the black pressure sensitive tape which secures the overlapping joint. There is one piece of tape on each surface of the indicator tape. Note the relative positions of the clear and black portions of the tape. Disengage the tape from the drive sprocket and pull it out of the plastic light control housing. Discard the old indicator tape if it is to be replaced.

Feed a new indicator tape into the light control housing (see Figure 18), making sure the tape is oriented the same as the previous one. Loop the tape around all the idlers and overlap the ends, using a spring paper clip for a temporary fastening. Check to make sure the tape is threaded properly over all of the idler pulleys and that the sprocket holes engage the drive sprocket teeth correctly. Carefully align the overlapping portions of the tape so as to have the edges even and parallel. Pull the loop tight and then slack off the tape loop tension by loosening the loop by one sprocket hole space. Carefully apply the black pressure sensitive tape to the joint, first on the outside, and then underneath. Before applying the second piece, make sure the overlap is smooth and even and that no bulging will occur between the two taped joints. Synchronize the indicator tape with the potentiometer by removing the idler gear as detailed in the preceding paragraphs.

6. Maintaining Synchronization Between The Panel Radiation Intensity Meter and The Remote Indicator

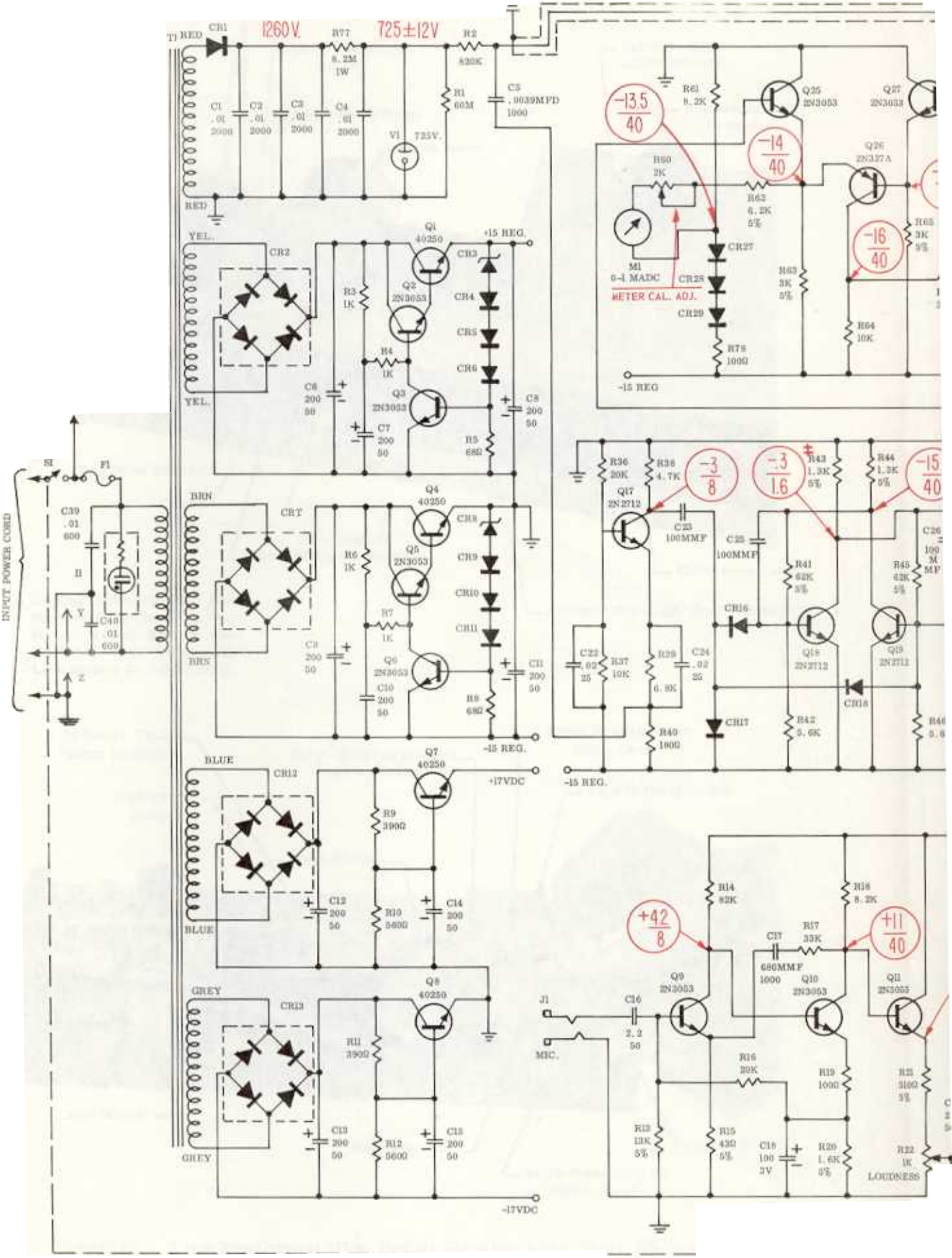
Synchronization between the two indicators is set at the factory and normally does not change. If, however, due to replacement of components or interchanging of whole units, the two indicators do not track, the upper and lower span potentiometers may be adjusted to bring the tracking between the two units up to par. First make sure

that the mechanical synchronization of the remote indicator itself is correct, as detailed in the preceding paragraphs. If this does not prove to be the problem, proceed as follows. Remove the instrument console from its case. Procure a long, thin, small-bladed screwdriver with an insulated shaft which will reach from one side of the instrument to the other. Connect the cable between the instrument console and the remote indicator, and connect the geiger tube to the instrument console. Plug the unit into a power outlet and turn it on.

Refer to the circuit board layout (Figure 14) for the location of the two scale synchronizing adjustment potentiometers, R74 and R75. R74 is the high end tracking adjustment and R75 is the low end tracking adjustment.

Open the source gamma beam exit port on the base unit and check the top readings of the two indicators. Close the exit port and check the low end tracking. If the remote indicator reads high at the low end, turn R75 slightly counter-clockwise to bring the remote indicator into agreement with the panel meter. Recheck the high end and adjust R74 if necessary. Several back and forth checks will probably be necessary before an optimum setting is found. Turn off the power and replace the instrument in its case.

If it should become necessary to calibrate the internal meter in terms of specific radiation units rather than relative intensity as used in normal operation, the meter calibration potentiometer is R60, and it is reached in the same manner as R74 and R75, above. This control can be used to compensate for variations in source strength or geiger tube detector sensitivity and produce a uniform response from all units of the CD V-757 under a given condition.


T1
RED
CR1
1260 V.
R77
8.2M
1W
725±12V
R2
820K
C1
.01
2000
C2
.01
2000
C3
.01
2000
C4
.01
2000
V1
725V.
R1
60M
C5
.0039MFD
1000
RED
YEL.
CR2
Q1
40250
+15 REG.
R3
1K
Q2
2N3053
CR3
CR4
CR5
CR6
R4
1K
C6
200
50
Q3
2N3053
C7
200
50
C8
200
50
R5
68Ω
YEL.
BRN
CRT
Q4
40250
R6
1K
Q5
2N3053
CR8
CR9
CR10
CR11
R7
1K
C9
200
50
Q6
2N3053
C10
200
50
C11
200
50
R8
68Ω
BRN
-15 REG.
BLUE
CR12
Q7
40250
+17VDC
R9
390Ω
C12
200
50
R10
560Ω
C14
200
50
BLUE
GREY
CR13
Q8
40250
R11
390Ω
C13
200
50
R12
560Ω
C15
200
50
GREY
-17VDC
S1
F1
INPUT POWER CORD
C39
.01
600
C40
.01
600
-13.5
40
R61
8.2K
Q25
2N3053
Q27
2N3053
-14
40
Q26
2N3274
R60
2K
R62
6.2K
5%
R65
3K
5%
-16
40
M1
0-1 MADC
METER CAL. ADJ.
CR27
CR28
CR29
R63
3K
5%
R64
10K
R78
100Ω
-15 REG
R36
20K
R38
4.7K
-3
8
Q17
2N2712
C23
100MMF
-3
1.6
R43
1.3K
5%
R44
1.3K
5%
-15
40
C25
100MMF
R41
62K
5%
R45
62K
5%
CR16
C22
.02
25
R37
10K
R39
6.8K
C24
.02
25
Q18
2N2712
Q19
2N2712
CR18
CR17
R42
3.6K
R40
100Ω
-15 REG.
R14
82K
R18
8.2K
+42
8
+11
40
C17
680MMF
1000
R17
33K
Q9
2N3053
Q10
2N3053
Q11
2N3053
J1
MIC.
C16
2.2
50
R16
20K
R19
100Ω
R21
510Ω
5%
R13
13K
5%
R15
430Ω
5%
C18
100
3V
R20
1.6K
5%
R22
1K
LOUDNESS

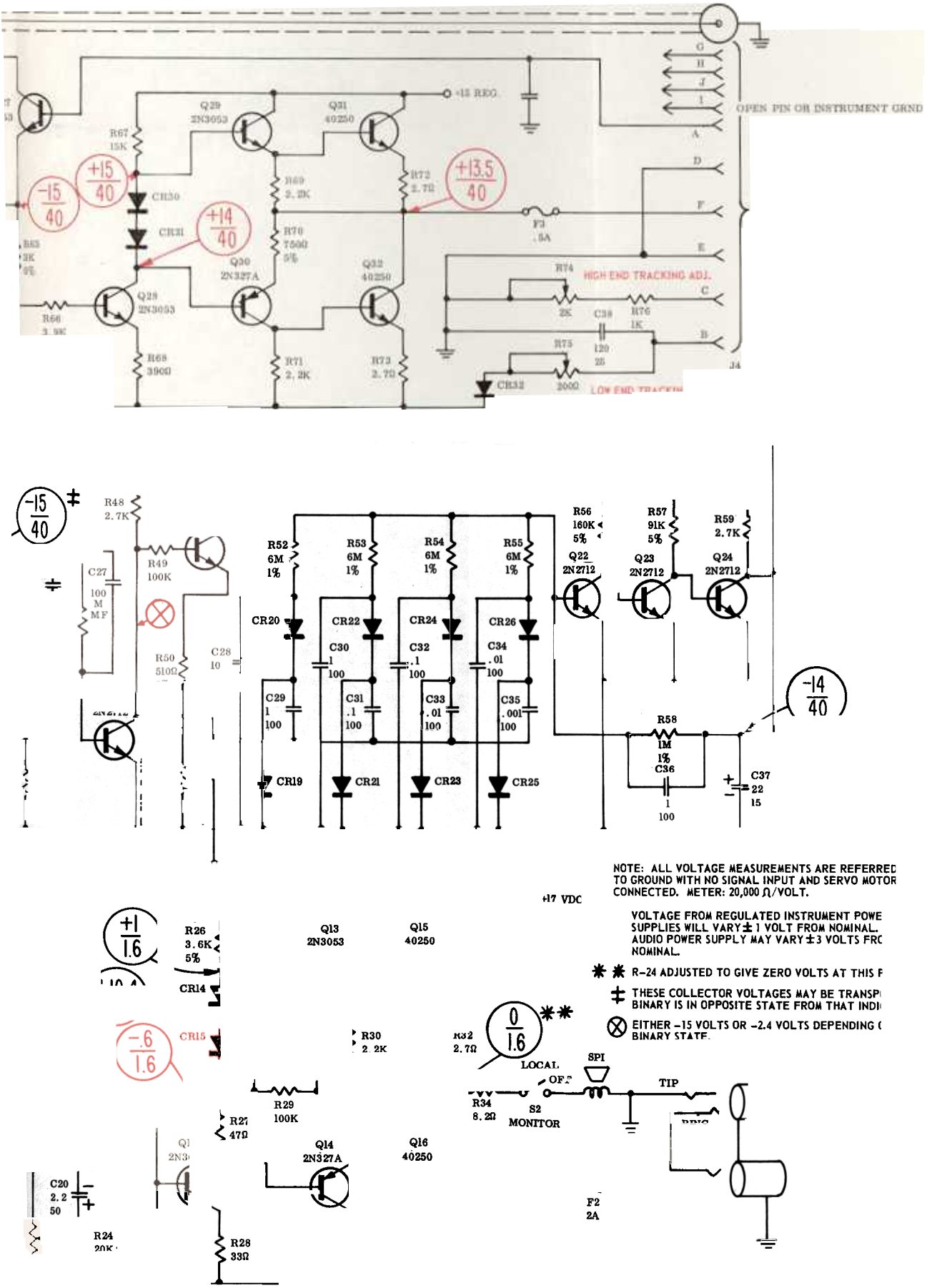
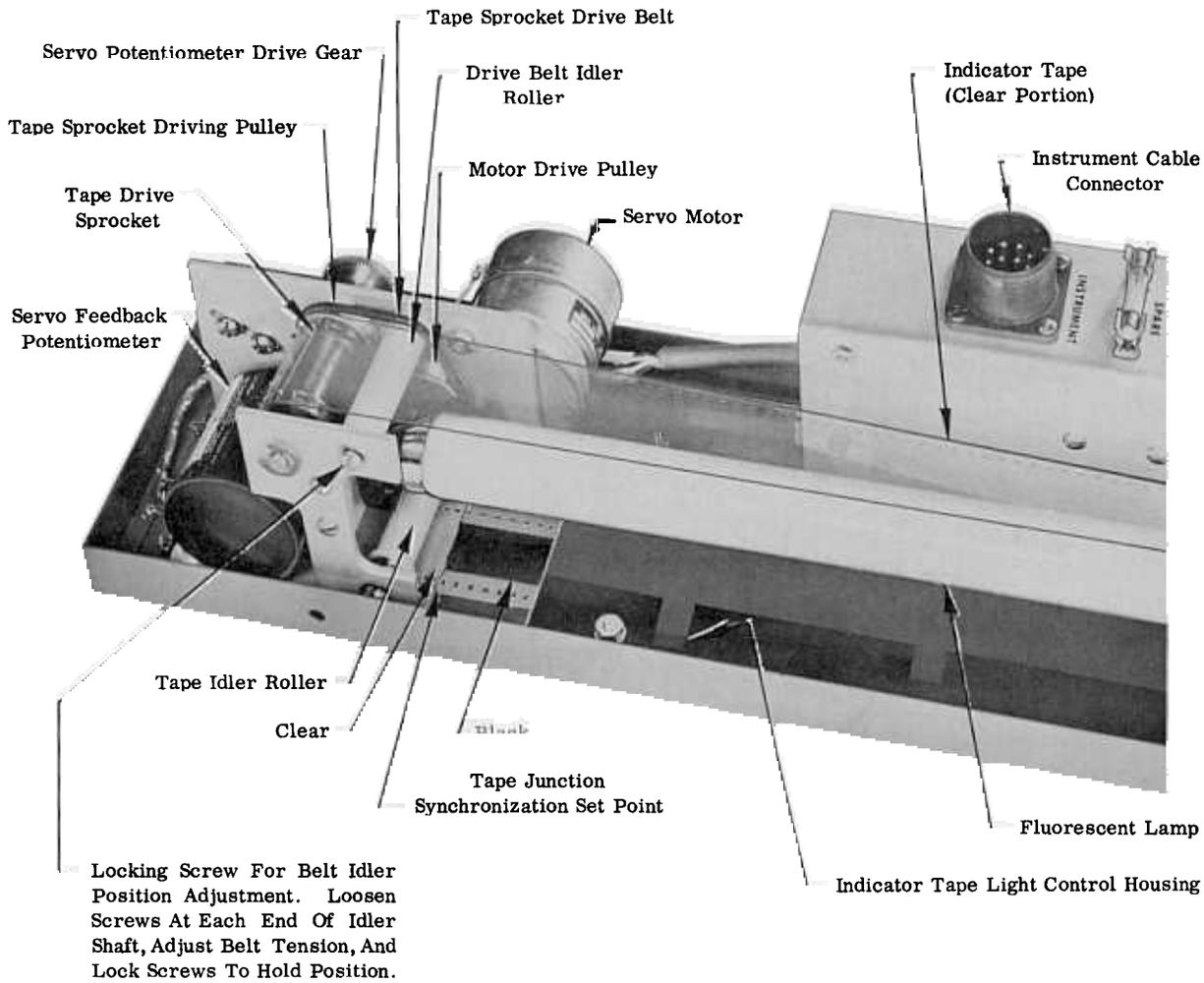


Figure 16. Schematic Circuit Diagram.



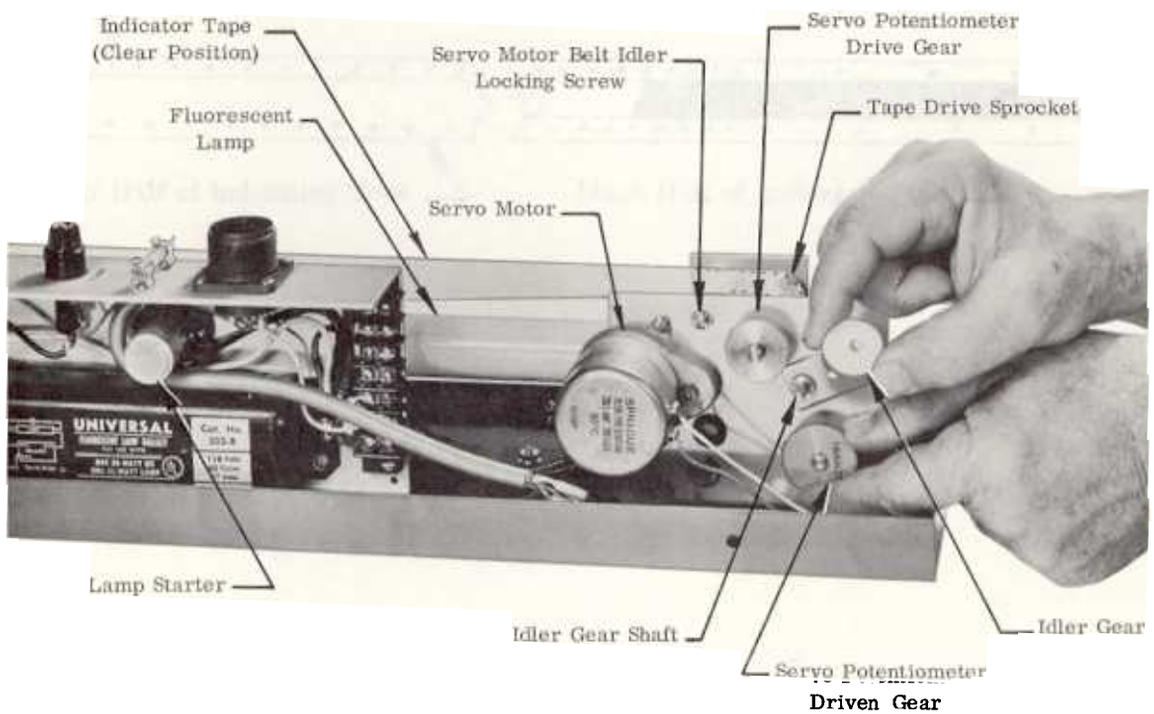


Figure 17. Tape Synchronization Detail Showing Idler Gear Removed

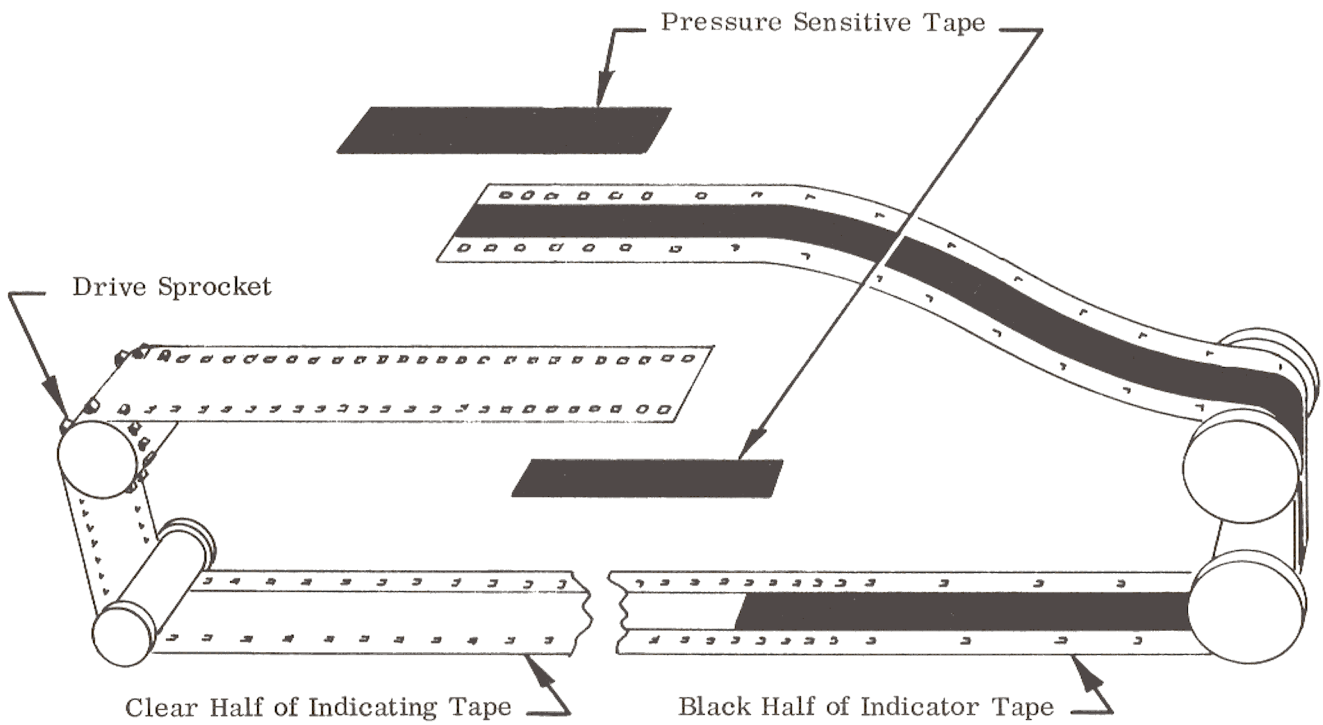


Figure 18. Indicator Tape Replacement

10. LIST OF REPLACEABLE PARTS

A. ELECTRICAL (BSD CONSOLE ASSEMBLY).

Symbol Desig.	Vico Part No.	Description	Manufacturer and Part No.	Qty.
C1 thru C4	21-375	Capacitor: .01 mfd; 2000V	Sprague Electric #BL-S10	4
C5	21-193	Capacitor: .0039 mfd; 1000V	Sprague Electric #5GA-D10	1
C6 thru C15	21-504	Capacitor: 200 mfd; 50V	Nashville Electronics	10
C16, C20, C21	21-606	Capacitor: 2.2 mfd; 50V	General Electric #76F02LC2R2	3
C17	21-389	Capacitor: 680 mmfd; 150V	Erie Resistor Co. #801-000-X5FO-681K	1
C18	21-607	Capacitor: 100 mfd; 3V	General Electric #76F02BG101	1
C19	21-90	Capacitor: 0.1 mfd; 100V	Centralab Div. #DDA-104	1
C22, C24	21-597	Capacitor: .02 mfd; 25V	Erie Resistor Co. #5835-000-Y5U-203Z	2
C23, C25, C26, C27	21-598	Capacitor: 1000 mmfd; 1000V	Erie Resistor Co. #831-000-X5R-101	4
C28	21-599	Capacitor: 10 mfd; 25V	General Electric #29F3515	1
C29, C30	21-601	Capacitor: 1 mfd; 100V; 5%	Goodall Mfg. #X663FR	2
C31, C32	21-602	Capacitor: 0.1 mfd; 100V; 5%	Midwec Sales Co. #7F	2
C33, C34	21-603	Capacitor: .01 mfd; 100V; 5%	Goodall Mfg. #663UW	2
C35	21-604	Capacitor: .001 mfd; 100V; 5%	Midwec Sales Co. #E3F	1
C36	21-380	Capacitor: 1 mfd; 100V; 20%	Goodall Mfg. #X663FR	1
C37	21-600	Capacitor: 22 mfd; 15V	General Electric #76F02FD220	1
C38	21-605	Capacitor: 120 mfd; 25V	General Electric #76F02KN121	1
C39, C40	21-266	Capacitor: .01 mfd; 600V	Sprague Electric #6TM-S10	2
CR1	52-92	Diode	Semtech Corp. #SC-30	1
CR2, CR7, CR12, CR13	52-109	Diode	Diodes, Inc. #5097	4
CR3, CR8	52-110	Diode: IN964B	Motorola Semiconductor Products, Inc.	2
CR4 thru CR6, CR9 thru CR11, CR14, CR15, CR27 thru CR32	52-100	Diode	Raytheon Mfg. Co. #D59039	14
CR16 thru CR26	52-17	Diode: IN457	Texas Instruments Inc.	11
F1, F3	19-15	Fuse: 0.5 amp	Littelfuse, Inc. #313.500	2

A. ELECTRICAL (BSD CONSOLE ASSEMBLY) CONT'D.

Symbol Desig.	Vico Part No.	Description	Manufacturer and Part No.	Qty.
F2	19-12	Fuse: 2 amp	Littelfuse, Inc. #313002	1
F101	19-2	Fuse	Littelfuse, Inc. #312002	1
I1	810-30	Lamp: Indicator	Drake #R115-604	1
J1	810-27	Phono Jack	Switchcraft, Inc. #41	1
J2, J3	810-39	Telephone Jack	Smith #277	2
J4	32-18	Box Receptacle	Amphenol Corp. #3102A-18-1S	1
J5	30-7	Connector: UG93/U	Startronics, Inc.	1
M1	810-18	Meter Assembly	Victoreen Instrument Co.	1
Q1,Q4,Q7,Q8,Q15, Q16,Q31,Q32	23-60	Transistor	RCA #40250	8
Q2,Q3,Q5,Q6, Q9 thru Q13, Q25, Q27 thru Q29	23-48	Transistor: 2N3053	RCA	13
Q14,Q26,Q30	23-59	Transistor: 2N327A	Hughes Electronics Co.	3
Q17 thru Q24	23-49	Transistor: 2N2712	General Electric	8
R1	CP105-18	Resistor: 60 Meg; HVAW; 20%	Victoreen Instrument Co.	1
R2	185-422	Resistor: 820K; .5W; 10%	Allen Bradley Co.	1
R3,R4,R6,R7, R25,R76	185-367	Resistor: 1K; .5W; 10%	Allen Bradley Co.	6
R5,R8	185-416	Resistor: 68Ω; .5W; 10%	Allen Bradley Co.	2
R9, R11, R68	185-585	Resistor: 390Ω; .5W; 10%	Allen Bradley Co.	3
R10,R12	185-601	Resistor: 560Ω; .5W; 10%	Allen Bradley Co.	2
R13	185-339	Resistor: 13K; .5W; 5%	Allen Bradley Co.	1
R14	185-759	Resistor: 82K; .5W; 10%	Allen Bradley Co.	1
R15	185-490	Resistor: 43Ω; .5W; 5%	Allen Bradley Co.	1
R16, R36	185-1113	Resistor: 20K; .5W; 10%	Allen Bradley Co.	2
R17	185-396	Resistor: 33K; .5W; 10%	Allen Bradley Co.	1
R18, R61	185-200	Resistor: 8.2K; .5W; 10%	Allen Bradley Co.	2
R19, R78	185-118	Resistor: 100Ω; .5W; 10%	Allen Bradley Co.	2
R20	185-646	Resistor: 1.6K; .5W; 5%	Allen Bradley Co.	1
R21, R50	185-238	Resistor: 510Ω; .5W; 5%	Allen Bradley Co.	2

A. ELECTRICAL (BSD CONSOLE ASSEMBLY) CONT'D.

Symbol Desig.	Vico Part No.	Description	Manufacturer and Part No.	Qty.
R22, S1	22-216	Potentiometer: 1K With D.P.S.T. Switch	CTS Corp. #WF90 Shaft 11/16 FMS	2
R23	185-633	Resistor: 1.2K; .5W; 10%	Allen Bradley	1
R24	22-215	Potentiometer: 20K	IRC #100-1-PC203	1
R26	185-676	Resistor: 3.6K; .5W; 5%	Allen Bradley	1
R27	185-496	Resistor: 47Ω; .5W; 10%	Allen Bradley	1
R28	185-355	Resistor: 33Ω; .5W; 10%	Allen Bradley	1
R29, R47, R49	185-255	Resistor: 100K; .5W; 10%	Allen Bradley	3
R30, R31	185-657	Resistor: 2.2K; .5W; 10%	Allen Bradley	2
R32, R33, R72, R73	185-1373	Resistor: 2.7Ω; .5W; 10%	Allen Bradley	4
R34	185-1568	Resistor: 8.2Ω; .5W; 10%	Allen Bradley	1
R35	185-1569	Resistor: 3.3Ω; .5W; 10%	Allen Bradley	1
R37, R64	185-253	Resistor: 10K; .5W; 10%	Allen Bradley	2
R38	185-175	Resistor: 4.7K; .5W; 10%	Allen Bradley	1
R39	185-361	Resistor: 6.8K; .5W; 10%	Allen Bradley	1
R40	185-552	Resistor: 180Ω; .5W; 10%	Allen Bradley	1
R41, R45	185-751	Resistor: 62K; .5W; 5%	Allen Bradley	2
R42, R46	185-274	Resistor: 5.6K; .5W; 10%	Allen Bradley	2
R43, R44	185-638	Resistor: 1.3K; .5W; 5%	Allen Bradley	2
R48, R59	185-252	Resistor: 2.7K; .5W; 10%	Allen Bradley	2
R51, S3	22-211	Potentiometer: 2.5K With Push-Pull Switch	Centralab #BPL-702	2
R52 thru R55	185-1566	Resistor: 6 Meg; 1%	IRC Type DCC	4
R56	185-778	Resistor: 160K; .5W; 5%	Allen Bradley	1
R57	185-398	Resistor: 91K; .5W; 5%	Allen Bradley	1
R58	185-1567	Resistor: 1 Meg; 1%	IRC Type DCC	1
R60, R74	22-213	Potentiometer: 2K	Victoreen Instrument Co.	2
R62	185-229	Resistor: 6.2K; .5W; 5%	Allen Bradley	1
R63, R65	185-670	Resistor: 3K; .5W; 5%	Allen Bradley	2
R66	185-158	Resistor: 3.9K; .5W; 10%	Allen Bradley	1
R67	185-393	Resistor: 15K; .5W; 10%	Allen Bradley	1

A. ELECTRICAL (BSD CONSOLE ASSEMBLY) CONT'D.

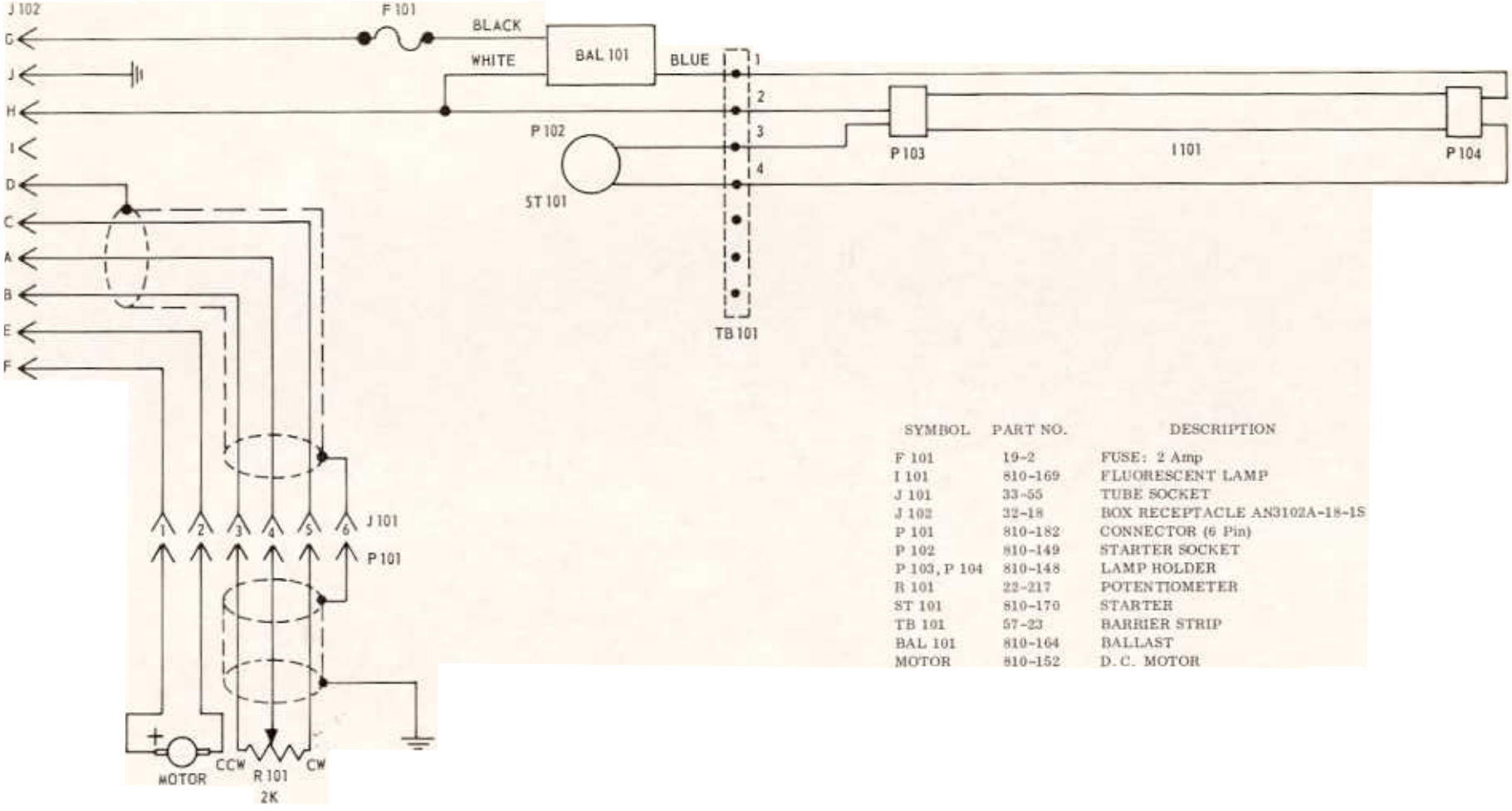
Symbol Desig.	Vico Part No.	Description	Manufacturer and Part No.	Qty.
R69, R71	185-657	Resistor: 2.2K; .5W; 10%	Allen Bradley	2
R70	185-614	Resistor: 750Ω; .5W; 5%	Allen Bradley	1
R75	22-212	Potentiometer: 200Ω	IRC #100-1PC201	1
R77	185-901	Resistor: 8.2 Meg; 1W; 10%	Allen Bradley	1
R101	22-217	Potentiometer: 2K	Beckman Model A	1
S2	11-39	Switch	Centralab Div. #1460	1
SP1	810-19	Speaker - Main	Cleveland Electronics #PM3X5C	1
T1	14-85	Transformer	Transformer Technician, Inc. #8909	1
V1	GV3A-725	Tube: Regulator	Victoreen Instrument Co.	1
	810-55	Microphone	Sonotone #DM10	1
	810-65	Speaker Assembly	Victoreen Instrument Co.	2
	810-69	External Speaker	Cleveland Electronics #X11918	1
	810-67	Telephone Plug	Smith #308	1
	810-136	Gamma Counter	Amperex #75 NB3-7	1

B. MECHANICAL.

810-45	Cable Assembly	Victoreen Instrument Co.	1
810-68	Cable Assembly	Victoreen Instrument Co.	1
710-72	CD Emblem	Victoreen Instrument Co.	8
200-53	Caution Label	Victoreen Instrument Co.	2
33-30	Tube Socket	Amphenol #78-S3S	1
50-45	Cable (9 Feet) RG59/U	Victoreen Instrument Co.	1
30-6	Connector (Co-Axial) UG932/U	Victoreen Instrument Co.	1
810-138	Stand Assembly	Victoreen Instrument Co.	1
810-137	Bead Chain	Bead Chain Mfg. Co. #6NP Brass With 6AD Cplg. 8" C/C	1
810-192	Padlock	American Lock Co. #MS100DL	3
810-120	Plug Assembly	Victoreen Instrument Co.	1
810-121	Vinyl Table Cover	Midwestern Rubber Co. #213 (24")	1
711-48	Rubber Foot	Atlantic India Rubber Co. #698	12
810-179	Hasp	Victoreen Instrument Co.	1

B. MECHANICAL CONT'D.

Symbol Desig.	Vico Part No.	Description	Manufacturer and Part No.	Qty.
	810-218	Name Plate	Victoreen Instrument Co.	3
	810-172	Tape (2-1/2" Lg.)	Dutch Brand #521 (3/4" Wide)	2
	810-171	Film Assembly	Victoreen Instrument Co.	1
	810-169	Lamp: Fluorescent	General Electric #F30TS/Green	1
	810-160	Spring, Support	Victoreen Instrument Co.	1
	810-162	Sleeve Lamp Support	Victoreen Instrument Co.	1
	38-18	Retaining Ring	Waldes Kohinoor #5133-25	14
	810-148	Lamp Holder	Circle F #9208-B	2
	38-19	Retaining Ring	Waldes Kohinoor #5133-18	1
	46-53	"O" Ring	Parker #2-223 Compound E54-0-8	1
	810-164	Ballast, Lamp	Universal Mfg. #202B	1
	57-23	Barrier Strip	Jones #7-140	1
	810-170	Starter	Masterlite #FS-4	1
	810-149	Starter Socket	Circle F #9214B	1
	475-98	Handle	Phila. Handle Co. #919R414-173 Blk.-3K34-FK	1
	9-37	Knob Assembly	Victoreen Instrument Co.	3
	570-94	Power Cord	Belden #17408	1
	810-175	Extension Assembly	Victoreen Instrument Co.	1
	810-50	Jar Assembly	Victoreen Instrument Co.	2
	810-221	Squat Jar	Victoreen Instrument Co.	3
	810-225	Jar Assembly	Victoreen Instrument Co.	2
	810-178	Lead Absorber	Victoreen Instrument Co.	2
	810-222	Wood Absorber	Victoreen Instrument Co.	2
	810-238	Magnetic Marker Buttons, Absorber Sample Label Set (Set of 6)	Victoreen Instrument Co.	1
	810-243	25' Extension Power Cord Set	Belden #17475-S	1
	810-230	Radiation Area Warning Sign	Ready Made Sign Co. #DR-21	1
	32-46	Box Receptacle	Amphenol Corp. MS3102A-18-1A	1



SYMBOL	PART NO.	DESCRIPTION
F 101	19-2	FUSE: 2 Amp
I 101	810-169	FLUORESCENT LAMP
J 101	33-55	TUBE SOCKET
J 102	32-18	BOX RECEPTACLE AN3102A-18-1S
P 101	810-182	CONNECTOR (6 Pin)
P 102	810-149	STARTER SOCKET
P 103, P 104	810-148	LAMP HOLDER
R 101	22-217	POTENTIOMETER
ST 101	810-170	STARTER
TB 101	57-23	BARRIER STRIP
BAL 101	810-164	BALLAST
MOTOR	810-152	D.C. MOTOR

Figure 19. Circuit Diagram for Remote Readout