PANAX

OPERATOR'S HANDBOOK

FOR

RADIATION MONITORS

SERIES TM.64

PANAX EQUIPMENT LIMITED

HOLMETHORPE INDUSTRIAL ESTATE, REDHILL, SURREY

REDHILL 3511 (2 lines)

GENERAL DESCRIPTION AND APPLICATIONS

These monitors have been designed to meet the requirements called for in the regulations covering the use of radioactive sources in factories. They also meet the need for general beta-gamma monitoring equipment in hospitals and laboratories using radioactive isotopes or for ultra sensitive search instruments for geological or similar applications.

Provision can also be made for the use of a wide variety of external probes including very thin mica window detectors suitable for use with weak beta and alpha emitters. The battery life is in the order of 1,000 hours and the batteries used are the popular 1.5V cell type U.2 which has a very good shelf life and is readily available. Facilities are provided to check the battery voltage, the drop in voltage with time being automatically compensated. Indication is on a 2" diameter moving coil meter which has a linear scale and sockets are provided for the use of headphones. (See headsets type PHON/1T and PHON/2T in price list). The ranges have been carefully selected to give maximum accuracy and ease of reading at the 0.75 mR and 2.5 mR levels with the choice of much higher sensitivities on the TM64G or higher radiation intensity measurements on TM64H.

NOTE: These instruments are fully sealed and waterproof and the batteries are housed in a separate waterproof compartment. All the instruments have an integrating time constant switch which gives the choice of a slow or fast response time on all ranges. This enables both an accurate measurement to be made or the location and size of a field of activity to be easily plotted.

The monitors available and their ranges are as follows:

Type TM64G - fitted with large internal gamma counter mounted the full length of the instrument. Calibrated in mR/hour for radium gamma rays.
Ranges 0 - 0.1, 0 - 0.3, 0 - 3, 0 - 10.
Integrating time constants fast - 3 seconds, slow - 15 seconds.

Type TM64H - fitted with a small gamma counter. Calibrated in mR/hour for radium gamma rays.
Ranges 0 - 1, 0 - 3, 0 - 30, 0 - 100.
Integrating time constants fast - 3 seconds, slow - 15 seconds.

Type TM64B - fitted with a large beta sensitive thin glass walled counter mounted behind a protected slot cut in the bottom of the instrument case. Calibrated in counts per second.
Ranges 0 - 10, 0 - 30, 0 - 300, 0 - 1000.
Integrating time constants fast - 3 seconds, slow - 15 seconds,

approximate. Accuracy ± 10% over the temperature range - 5°C. to + 55°C.

Probes The instruments can be supplied with a special link plug which enables external probes to be used. This automatically disconnects the internal counter. When this facility is required add ES to the type number when ordering.

Probes available:

Beta-Gamma

BG-B6H - Slotted type for use with Counter type MX133 or B6H.
Can also be used as a dipping counter.

BG-B12H - Long slotted type for use with Counter type B12H.
Can also be used as a dipping counter.

B-108/01 - End window beta probe for Counter type MX108/01.

Gamma

G120/6 - Waterproof gamma probe for counter type MX120/01.
Calibration unchanged when used with the TM64G monitor.

G120-H3 - A high sensitivity gamma probe fully sealed which uses three large gamma counters mounted on the end of a collapsible handle 4 feet long. With this probe and headphones small sources of activity can be located more efficiently and with less fatigue than with a scintillation counter due to the lower background level. Increases sensitivity of the TM64G by a factor of 3.

BATTERIES

Power is derived from two 1.5 volt single cell batteries type U2. These batteries were selected because they are universally obtainable and have an exceptionally long shelf life. The battery voltage can be checked and the expected battery life is approximately 1,000 hours.

NOTE: If the correct polarity is not observed when inserting these batteries, permanent damage to the instrument will result.

CONSTRUCTION AND COMPONENTS

The instrument uses printed circuit boards, one for the metering circuit and one for the stabilised EHT supply. These boards are available as spares. The 2" diameter meter is mounted independently on the top casting together with the control and range switches. A gasket between the top and lower castings and special sealed controls makes the instrument fully waterproof.

The batteries are housed in a separate compartment and can be replaced without breaking the main seal of the instrument. The geiger counters used are halogen quenched low voltage types chosen for their rugged construction and reliability.

The circuit incorporates several transistors and is compensated against temperature variations up to 60°C. Excessive temperatures will, however, damage transistors and 60°C is the maximum temperature to which the instrument should be exposed. For this reason, prolonged strong direct sunlight on the instrument, which would rapidly raise the internal temperature, must be avoided. As far as possible the instrument should be kept in the shade and stored in a well ventilated place.

CIRCUIT DESCRIPTION

See back of book for circuit diagram.

Q1 and T1 form a blocking oscillator circuit which generates the voltage necessary for the Geiger-Müller tube, Mullard type MX120/01. R1 biases Q1 into conduction, and regeneration bottoms the transistor. After about 150 microseconds T1 core starts to saturate and the transistor turns off. The collector voltage rings to about 30V and output is taken for 20 microseconds from the secondary winding, charging C1 to between 400 - 480 volts.

When the output voltage tends to be high the Zener diode MR3 conducts, thus limiting the output voltage and also applying positive bias to the base of Q1.

Q2 and T2 form another blocking oscillator circuit working from the stabilised + 6V line provided by the Zener diode. When the Geiger tube is ionised by a radiation particle, C4 is discharged and a negative pulse to the base of Q2 turns the transistor on for a pulse length of approximately 30 microseconds. Part of the energy stored in T2 during the pulse is used to provide the phones signal.

A third winding on T2 bottoms Q3 during the pulse, so that a standard pulse of voltage equal to the stabilised 6V line is applied to the integrating circuit consisting of MR5 and 6 and C11. The ranges are obtained by choice of feed capacitor C5 to C10, and the speeds by changing the integrating time constant.

A 50 microamp meter is used to measure the battery voltage and the output signal and is shorted in the off position.

CONTROL PANEL

The meter, controls and headphone socket are mounted on the top plate of the instrument. The large knurled cap is the cover to the battery compartment. It should be kept screwed down tightly. The left hand control has four positions, namely, OFF, TEST, FAST, SLOW. In the TEST position of this switch the battery volts are indicated on the meter and should fall within the box marked 'battery'. In the FAST position the time constant of the metering circuit is 3 seconds and in the SLOW position 15 seconds approximately.

The right hand switch is the range switch, the switch positions corresponding with the ranges quoted against the three types of instruments. See page 2.

A pair of lightweight headphones can be plugged into the 2-pin socket.

USE OF THE INSTRUMENT

1. Method of taking readings

Switch ON by turning the control knob to the test position and check the battery voltage. Turn the Range switch to fast. Clicks indicating pulses from the geiger counter and a whistle from the oscillator should be heard in the headphones. After 3 seconds, turn the Range switch to the most suitable range starting from the highest range position.

In order to ensure that the instrument responds quickly to any abnormal radioactivity and yet will give accurate readings when required, the instrument averages the counts over a short period of time, approximately 3 seconds in the FAST position and over a comparatively long period of time, approximately 15 seconds in the SLOW position of the control switch.

In the FAST position of the control switch 10 seconds should be allowed before taking a reading and in the SLOW position, 45 seconds. The meter reading fluctuates because of the random way in which cosmic rays and gamma rays reach the counter and it is advisable to average the readings over a short interval of time on all ranges to obtain the most accurate results. After use switch OFF by turning the control switch fully anticlockwise.

GEOLOGICAL APPLICATIONS

2. Background count

All rocks are slightly radioactive and the gamma radiations they emit together with the cosmic rays, which reach the earth's surface from outer space, go to make up what is commonly called background radioactivity or the background count. It is readings above the background average that are important in prospecting and therefore before commencing prospecting in any particular area the background radioactivity should be determined.

The background activity varies from place to place mainly due to differences in the radioactivity of the various rock types. The background over granite for example is usually higher than over limestone, sandstone or dark coloured igneous rocks.

To determine background switch to the most sensitive range and note the average reading. This should be about 0.01 mR/hr (milliroentgens per hour) in a low background area. It is, of course, essential to remove all sources and radioactive specimens well away from the instrument before taking a background reading.

It is advisable to check the background periodically when the instrument is in use as this provides a useful check on whether or not the instrument is functioning properly.

3. Field traversing

Prospecting is often carried out in a rather haphazard manner, but to get best results a chosen area should be traversed on a regular pattern so that it is covered adequately. The counter should normally be carried at hip height as this gives better coverage on either side of the path traversed than would be obtained if the counter were to be held near the ground. As a rough guide it can be stated an increase of count rate of four times should be investigated further and if necessary samples taken. Gamma rays are, however, absorbed by about a foot of inactive rock and by two to three feet of peat or water and where overburden is present smaller increases in background may lead to the discovery of an important ore body. Prospecting should normally be carried out at a slow walking pace with the instrument switched to Range 2 otherwise a narrow zone of mineralization may be crossed without any appreciable reading above background being recorded.

4. Comparative assays

Rough comparative assays can be made in the field by comparing a standard of known uranium content with an unknown specimen or sample of the same volume. Single specimens can be compared in this way, by placing them in the same position relative to the instrument and taking a reading on the meter, or a pulped sample representing part of an ore body can be checked against a similar volume of pulp of known uranium content. If assays of this type are always made in areas of low background, any corrections for background count can usually be ignored and the reading for the unknown taken as being proportional to its uranium content.

For example, if the reading on a standard of 1% U_3O_8 were 0.3 mR/hr and the reading obtained on an unknown sample 1.5 mR/hr then the equivalent uranium content of the unknown would be five times that of the standard or 5%.

It should be noted that because of factors such as density, admixture of uranium and thorium, and radioactive disequilibrium resulting from weathering of the ore, the true uranium content cannot be estimated in this way. Results obtained should therefore always be quoted as equivalent uranium content.

OTHER APPLICATIONS

The TM64G and H are calibrated in dose rate for radium and other radioactive materials. The rate of detection of gamma rays by a geiger counter for a given dose rate depends however on the energy of the gamma rays, i.e. on the quality of the radiation and therefore the calibration of the instrument will be different for radiation of different quality from that of the radium gamma radiation for which it is calibrated. The calibration should be checked for the radiation with which the instrument is to be used and the appropriate correction factor determined. The approximate value of the correction factor by which the meter reading should be multiplied for cobalt 60 gamma rays is 1.2.

MAINTENANCE

1. Replacement of batteries

The batteries used are 1.5 volt single cells, Ever Ready type U2 or equivalent. They should be changed when the supply voltage falls below the calibration box on the meter marked 'TEST'. Run-down batteries should never be left in the instrument. If the instrument is to be stored for any length of time, the batteries should be removed and stored separately in a cool dry place. Batteries must be replaced with the correct polarity.

To remove the batteries, take off the large knurled cover of the battery compartment and tip out the first battery, taking careful note of its position, i.e. positive contact (brass cap) upwards. With this battery removed, a sharp jerk of the instrument against the hand will cause the second battery to fall down into the first position. It can then be tipped out, its position (positive contact downwards) being carefully noted.

To insert new batteries, place one battery in with its positive contact downwards. Slide it along inside the battery compartment and insert the next battery with its positive contact upwards. Screw home the large knurled battery compartment cover.

2. Checking instrument calibration

Although proper laboratory facilities are necessary to check and adjust the calibration of the instrument, a rough routine check in the field may be performed by placing a radioactive source in a suitable position close to the counter and noting the meter reading. The reproducibility of such readings is unlikely to be sufficient for an accurate calibration of the instrument, but this method affords a safeguard against serious changes in calibration.

3. Diagnosis of simple faults

Possible causes of simple faults which may be rectified with limited facilities are described below. The description is not complete in that the symptoms could be caused by faults other than those described. These faults could be traced only with complete test facilities. More detailed in formation for qualified engineers is given in the paragraph 'Circuit Description'.

(a) No reading on battery test, no clicks in headphones.
Cause: no battery voltage
Remedy: remove test battery, clean contacts, replace if faulty.

(b) Battery test normal, no clicks in headphones.
Cause: no E.H.T.; Geiger counter failed; Q2 failed
Remedy: replace as appropriate.
(c) Battery test normal, clicks in headphones but no meter reading
Cause: Q3 failed, S1 faulty
Remedy: test S1 by joined positive meter terminal to '8' on AMP board while switched to F if working then clean or replace S1; change Q3.

4. Changing the geiger counter

Unscrew the eight cover screws and remove the instrument from its case. Turn the instrument upside down. Unsolder the two connections making careful note oftheir position and slide out counter. Replace new counter and reconnect. NOTE: These counters can be permanently damaged if wrongly connected.

APPENDIX

The following figures are given as a rough indication of the sensitivity of the TM64 for Uranium and Thorium prospecting.

1. Measurements over bed rock

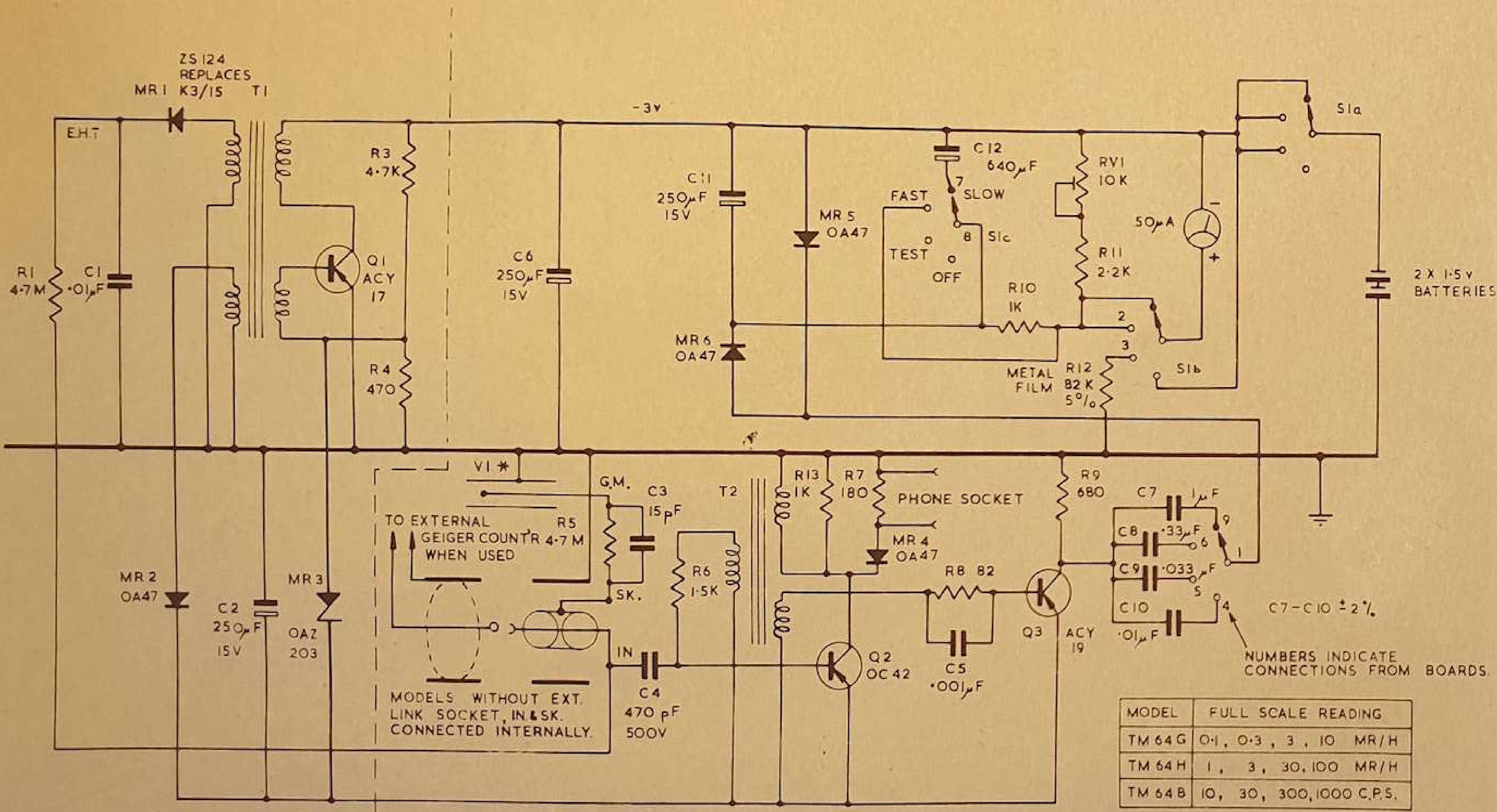
For measurement over an extensive area of uranium bearing bed rock by which is meant a large flat area having a uniform uranium content from the surface to at least a few feet deep in which the uranium is in equilibrium with its decay products. A reading of 0.5 mR/hour corresponds approximately to 0.15% uranium oxide content. For similar readings over thorium bearing bed rock a meter reading of 0.5 mR/hour corresponds approximately to 0.25% thorium oxide content.

2. Measurements on samples

A convenient type of sample holder for the measurement of mineral pulp is a cylindrical (50) cigarette tin. Two such tins level filled placed along a long side of the instrument give a reading of 0.15 mR/hour when containing approximately 1% uranium oxide ore. One tin would give approximately half this reading and four tins placed two on either side of the instrument double it.

NOTE

Great care must be taken in applying the figures given above since the density of ore, distribution of uranium and its possible dis-equilibrium will have marked effects on the instrument readings.



MODEL	FULL SCALE READING
TM 64 G	0·1, 0·3, 3, 10 MR/H
TM 64 H	1, 3, 30, 100 MR/H
TM 64 B	10, 30, 300, 1000 C.P.S.

* V1 TM 64 G – MX 120/01
TM 64 H – G4 H
TM 64 B – B10HB

CIRCUIT DIAGRAM TM 64 G, H, B. DRG. Nº 64/3/B/3