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INSTRUMENT DEPARTMENT

DESCRIPTION AND INSTRUCTIONS
For
Q-762 SCALE OF 64

C. G. GOSS, K. N. FORRESTAL

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OPERATED BY
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DESCRIPTION AND INSTRUCTIONS FOR
Q-762 Scale of 64

C. G. Goss, K. N. Forrestal

GENERAL

The Q-762 scale of 64 is designed, primarily, to be used with counting tubes operating in the Geiger region, but dependable operation is obtained for other purposes within its design limitations. It features a 6AK5 cathode follower preamplifier at the glass G.M. tube, a 6SN7 Schmitt trigger input circuit with a pulse height selector, a 6BG6-G shunt regulated, high voltage supply, unregulated B plus supply, Higinbotham scaling stages, and a 230 V.D.C., resettable, panel-mount Wizard register driven by a 6SN7 tube. A 6J6 difference amplifier is used with mica-window G.M. tubes, because, since the pulse height is a function of anode length, they produce smaller pulses than the conventionally used glass and brass tubes.

B PLUS SUPPLY

A Chicago transformer No. 11821 rated at 680 volts, center-tapped, at 120 ma, furnishes 50 ma at 400 volts to the scaler. For the scaling and input stages, this is dropped to 275 volts with a resistor. Three amperes of excess 6.3 V.A.C. is available at terminal No. 5. One miniature and three octal spare sockets are supplied.

HIGH VOLTAGE SUPPLY.

The high voltage supply is added to the B plus supply to give better regulation of the high voltage. A 6BG6-G (6L6 with plate cap) is used in a shunt regulator circuit. Its reference voltage is furnished by a VR-75 which is fed by a Vr-150 supplied from B plus. A line variation of 100 to 115 V.A.C. changes the high voltage output less than 0.5 volts out of 1200, a regulation of 0.003% change per percent change of line voltage. The output is adjustable from below 700 to above 1400 volts at less than one microampere. Ripple is below 0.1 volt on the plate of the 6BG6-G and spikes of

0.1 volt may be expected on the connectors at 1500 volts and 90% humidity. A filter in the preamplifier reduces the 60 cycle ripple by a factor of seventy-five and practically eliminates the spikes.

PREAMPLIFIER

At present, two circuits are in use, and two chassis are available for supporting each circuit. One is a 6AK5 cathode follower (Q-762-A) used with glass G.M. tubes, and the other is a 6J6 difference amplifier (Q-762-L) used with mica window G.M. tubes.

The portable probe model (Q-762-F) has the 6AK5 cathode follower mounted in a cylinder 1½ inches in diameter by 6 inches, attached to the base of the glass G.M. tube holder. For use with glass G.M. tubes in horizontal shields of 4 inches diameter by 9½ inches, the 6AK5 is mounted as per Q-762-J. Mounting the cathode follower adjacent to the G.M. tube allows the combination to deliver pulses of approximately 20 volts to the scaler at the G.M. tube operating voltage.

One model of the 6J6 difference amplifier fits into the vertical mica window G.M. tube shield of five inches internal diameter, and the other fits into the horizontally-mounted counting pipette shield (Q-459) whose internal diameter is three and thirteen-sixteenths inches diameter. Both supports are shown on Q-762-K. At the Geiger threshold, the 6J6 amplifier will deliver pulses of about three volts to the scaler. At 50 volts above, 15 to 20 volt pulses are delivered. This information may be used to determine the operating voltage, but the use of a scope is to be preferred. Due to the distribution of pulse sizes in a mica-window tube, it is important that the pulse height selector be set well below the maximum pulse size. Also, the Geiger threshold of a mica window G.M. tube may increase about 20 volts during the first hour of operation, and about 10 volts more during the next few hours. For maximum stability, the mica window tube should be kept in operation continuously. And the high voltage should not be increased over 100 volts above the Geiger threshold.

The high voltage filter mentioned before is formed by a 20 meg. ohm. resistor and a 0.01 microfarad condenser. The pulse length to 63% reduction in size is of the order of 30 microseconds.

INPUT STAGE

A five volt pulse is necessary to operate the input stage, but a ten to twenty volt pulse is to be preferred. The input stage uses a 6SN7 in a Schmitt trigger circuit with a pulse height selector. This P.H.S. is not recommended for accurate measurements, but serves as an input stage adjustment. For general purpose work using over ten volt pulses of 2 microseconds or longer duration, the error in calibration will be less than 5% plus the percentage variation of the A.C. supply. Line voltage changes do not shift the zero point of the P.H.S. Pulses to plus 100 and minus 50 volts may be excluded. The upper limit of pulse rise time is set by the 0.01 microfarad-470,000 ohm input circuit. The kickback of long pulses is not recorded as an extra count, but where a damped, oscillatory wave train is encountered whose "ring" frequency is of the order of 200,000 cycles or less, one count will be recorded for every cycle the voltage exceeds the P.H.S. setting. Using 0.25 microsecond pulses, the resolving time is 10 microseconds for positive and 5 microseconds for negative pulses. When used with an A-1 linear amplifier, the A-1 should be modified according to Q-541-F to produce 20 volt, 0.25 microsecond negative pulses. This modification involves one condenser and two half-watt resistors. The Schmitt trigger circuit involves a D.C. regenerative feedback (with shunting condenser for high speed operation) with a net gain of slightly more than unity (for stability) through the two triode sections. This gives two conditions of equilibrum depending upon which triode is conducting, and the change of conduction from one tube to the other occurs in approximately one microsecond. As the P.H.S. dial is varied from plus 100 to 0, the potential of tube #1 varies from 0 to 100 volts, the cathode voltage remains at 112 V. tube #2 is conducting and tube #1 is cut off. After the dial has been moved past zero, tube #1 conducts, and a negative pulse that reduces the instantaneous grid potential below 100 volts produces a negative output pulse. This introduces one count into the scaler. Similarly, with the P.H.S. set at plus 25, the grid potential of tube #1 is cut-off. If, say, a 30 volt positive pulse is added to the D.C. grid potential, the equilibrum point is passed and a positive pulse is produced. This pulse does not pass through the diodes, but the kickback does, introducing one count into the scaler. Since the gain of the stage is more than 1.00, if one tube in conducting, the P.H.S. must be moved a few volts past zero to cause the other tube to conduct. And when the second tube is conducting, the P.H.S. must be moved a few volts past zero in the opposite direction to change the first tube to conduct again. This effect is called hysteresis and is very important, for if the hysteresis is zero (the gain equalling 1.00 or less) the input stage will oscillate when the P.H.S. is adjusted to zero, and if the oscillation is stopped by setting the P.H.S. dial away from zero to the proper operation point, the stage may give several output pulses for each input pulse. The hysteresis should be from two to four volts and may be checked in several ways (more than four volts requires larger input pulses and upsets the dial calibration excessively for pulses with long rise time). Rocking the P.H.S. dial back and forth past zero is equivalent to a slow pulse, which introduces one count per cycle of rotation into the scaler. One edge of the hystersis may be determined by the flashing of the first stage interpolation light, while rotating the P.H.S. in the negative direction, and the other edge by the amount that the dial may be rotated in the positive direction and not have the light flash when the original flashing point is passed. This may be more easily observed by connecting a voltmeter across the 8.2 K resistor from pin 5 of the 6SN7 to B plus.

A 60 cycle test switch is provided that connects the input grid to the 6.3 V.A.C. filament supply, which for a 110 volt A.C. supply (rare at ORNL) provides a pulse of 1.414 times 6.3, or 8.9 volts positive and negative. Record the positive P.H.S. dial setting that just gives operation, record the negative dial setting similarly (will be same as positive if "zero set" is properly adjusted), add the two, subtract from 17.8, and the result will be the hystersis. If the hystersis is less than two volts, repair before using. Check in order: B plus, P.H.S. dial zero, "slope set", "zero set", cathode voltage at a positive dial setting, the tube, cathode resistor, and plate resistor to pin 2. Changing tubes may be expected to change the hysteresis by one-half to one and one-half volts, but the "zero set" must be readjusted (use 60 cycle test) before rechecking the hystersis. If the tube emission is not low and the transconductance remains constant, the cathode resistor is approximate, and the 100 K direct coupling resistor has not changed so that the zero set cannot be made on the potentiometer, the most effective method of increasing the hystersis is by increasing the plate load resistor to pin 2. This is <u>NOT</u> to be used as a crutch for a tube in the process of emission failure. A long time, accurate, operational check of the input, scaling, and output stages may be performed by the 60 cycle test switch. The time elapsed during a count may be measured by a 110 V.A.C. timer connected to the plug marked "Timer".

OUTPUT STAGE

In the output stage a single 6SN7 drives a 230 V.D.C., resettable, panel-mount Wizard register. A switch allows an external 230 V.D.C. Wizard to be used if it is preferred. Also, a 2D21 thyratron, whose grid is in parallel with the output tube, may be used to drive an Edwards type 560, 110 V.A.C. bell, an Esterline-Angus operational recorder (110V. A.C. elements), or a 110 V.A.C. Wizard register at 600 evenly spaced register counts per minute.

The 230 V.D.C. register will record 1200 evenly spaced register counts per minute. The high voltage inductive kick of the register when operating at high speeds is absorbed by non-linear resistances (thyrite), whose resistance decreases with increasing voltage.

Original plans called for the use of a 1N39 germanium diode in the output stage bias supply, but since they are not available, 1N38's are being used with a lowered safety factor. If difficulties are experienced, these should be replaced with a 6H6 or 6AL5 diode in a spare socket located nearby.

OPERATION:

1. Connect power cable and timer.

* 2. Turn master switch on (wait at least 30 seconds before turning H.V. on).

3. Set P.H.S. dial at zero and make a 10 minute, 60 cycle test. Results should be 36,000 plus or minus 30 counts. The allowable error is due to inaccurate time measurement and will be a constant number of counts incurred at starting and stopping <u>if</u> a synchronous clock is used.

4. Rotate High Voltage adjustment control to left. Turn H.V. switch on.

5. If H.V. is below 800 volts, connect probe or preamplifier.

6. Check hysteresis (2 to 4 volts) and zero set by 60 cycle test switch (See description, Input Stage.)

7. Connect scope to output of preamplifier using a 0.01 Microfarad condenser.

8. Increase H.V. until Geiger threshold is reached (all pulses are of same height). Increase H.V, 60 volts and record as operating voltage for glass G.M. tubes. Compare with voltage specified for tube by manufacturer. For mica window G.M. tubes, see description, Preamplifier.

9. The pulse height, by the P.H.S. dial, should now be approximately minus 15 to 20 volts.

10. Clamp P.H.S. dial at minus 5 to 7 volts and the instrument is ready for use.

11. Check maximum pulse height periodically, particularly during the first few hours operation of mica window G.M. tubes. This is equivalent to a check of the Geiger threshold, if the preamplifier is still working.

* 12. To shut down instrument, turn High Voltage off, rotate High Voltage to left, wait 30 seconds, then turn Master Switch off.

13. After initial set-up, eliminate steps #5, #7, and #8.

* NOTE:

The delay in steps two and twelve is to prevent placing overvoltage surges on the counter tubes. In step two, the cathode of the control tube should be at operating temperature before the high voltage is applied to it's plate. In step twelve, the high voltage input condenser (0.1 Mfd., 3000 volt Glassmike) should be partially discharged before the control tube's heater is turned off.