MODEL 216-1

countmaster

Hoffman
SERVICE DATA
GEIGER
COUNTER-ASSAYER
Model 216-1
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COUNTMASTER DESCRIPTION

The Hoffman COUNTMASTER is a portable, Geiger-Mueller radiation counter-detector, suitable for use in contamination investigations, as well as in prospecting and field assaying operations. The unit (figure 1) consists of two separate parts which are connected by a cable. One part of the instrument contains all of the electronic components and the batteries. The other part of the COUNTMASTER is the probe, and contains the detecting element (Geiger-Mueller Tube). The probe is snapped into the handle on the front panel of the COUNTMASTER, and can be separated by pulling it away from the handle. For survey work, the probe does not have to be removed from the handle.

The probe of the COUNTMASTER has a sliding shield. With the shield retracted, so that the protective transparent windows on the side of the probe are exposed, the presence and intensity of both beta and gamma rays is measured. With the shield in place, covering the windows, the detector responds to gamma rays only.

The COUNTMASTER has two indicating devices for measuring the amount of radioactive energy present. The first of these is a meter, which gives a reading in milliroentgens per hour (MR/HR). The second indicator is the Scaler-Computer which, when used in conjunction with the built-in timer mechanism, automatically registers the pulses made by the Geiger-Mueller (GM) tube over any time interval selected by the operator. The Scaler-Computer is direct reading in counts per unit-time selected.

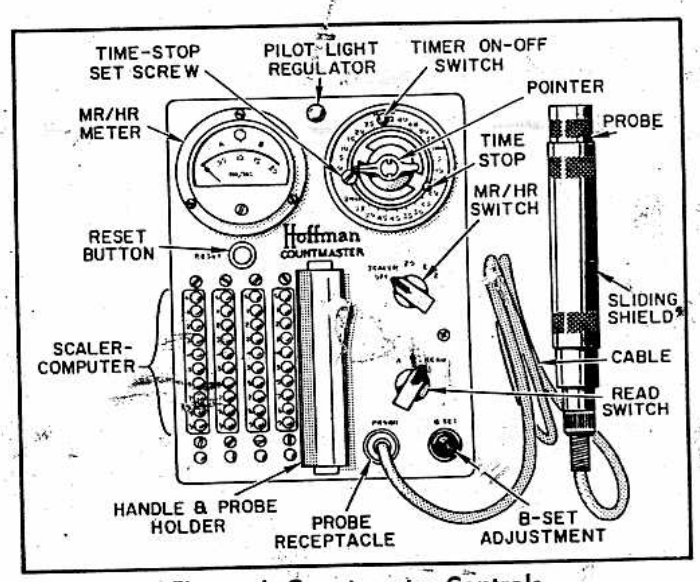


Figure 1. Countmaster Controls

Table 1. Countmaster Specifications

MR/HR METER RANGES	0 - .2 milliroentgens/hour 0 - 2 milliroentgens/hour 0 - 20 milliroentgens/hour
SCALER-COMPUTER COUNTING RATE	Up to 12,000 counts per minute
TIMER	Built-in automatic timer. Provides preset time from 2 seconds to 2 minutes with one second increments
SENSITIVITY	Beta - Gamma
HIGH VOLTAGE	900 volts Regulated
CIRCUIT	Monostable ("one-shot") multivibrator, electronic power supply, neon-diode ring dis counter

POWER	Two 75-volt "B" batteries One 15-volt "B" battery Four 1-1/2-volt "A" batteries
BATTERY LIFE	"B" batteries: 65 hr Scaler-Computer operation at 6 hr/day; 200 hr MR/HR Meter operation at 6 hr/day. "A" Batteries: 165 hr at 6 hr/day. 15-volt "B" battery: 8 to 12 mo.
ACCURACY	Within 15% of indicated reading; 5% on evenly spaced pulses
DIMENSIONS	6-1/2" by 8-1/8" by 6-1/8"
	7-1/4 pounds - with batteries

Generally speaking, in contamination investigation work or prospecting, the MR/HR Meter is used to give a quick index of the presence of inordinately high centers of radioactivity. The Scaler-Computer, since its method of registration is more precise, is particularly well suited for charting contamination areas, checking the effectiveness of various decontamination procedures, making a grid survey, and taking a radiometric assay.

A selector switch (Read switch) allows the COUNTMASTER MR/HR meter to be used also to check the output voltage of the "A" and "B" batteries in the instrument. Another control ("B-SET") allows the output voltage of the two 75-volt "B" batteries to be adjusted so that the accuracy of the COUNTMASTER is not affected by changing load or temperature conditions. The useful life of the "B" batteries is also extended in this manner.

Table II. Tube and Neon Bulb Complement

Quantity	Type	Function
1	CK1021 or 6530	Geiger-Mueller Tube
1	CK1038 or 5841	High Voltage Regulator
1	3A5	One-Shot Multivibrator
1	1U5	High Voltage Supply
1	D-3273	High Voltage Regulator

Quantity	Type	Function
1	NE2 Neon Bulb	High Voltage Supply Oscillator (Relaxation Oscillator)
1	NE2A Neon Bulb	Pilot Lamp and Voltage Regulator
40	*NE96 Neon Bulb	Scaler-Computer Indicators
4	*NE96 Neon Bulb	Decade Trigger Bulbs

*Special stabilized and voltage-rated bulbs; individually selected as to ionizing-potential. Refer to REPAIR Section of this Bulletin.

GENERAL CIRCUIT DESCRIPTION

(See Schematic, Figure 7 and Block Diagram, Figure 2)

LOW-VOLTAGE POWER SUPPLY

Low-voltage DC for the COUNTMASTER is obtained from seven batteries. Four 1-1/2-volt "A" batteries, BT4, provide filament voltage to the one-shot multivibrator, V2, and the high-voltage supply, V3. Two 75-volt "B" batteries, BT2 and BT3, provide plate voltage to the high voltage supply and one-shot multivibrator, as well as reference voltage to the positive bus of the Scaler-Computer neon bulbs. A 15-volt "B" battery, BT1, provides bias to tube V2B of the one-shot multivibrator.

HIGH-VOLTAGE POWER SUPPLY

The high-voltage circuit, V3, provides 900 volts DC for the GM tube, V1. The neon bulb, I23, in the grid circuit of V3, is connected as a form of relaxation oscillator consisting of the capacitor C29, the resistor R38, and the source of power through R43. Since the voltage acorss the capacitor C29 may be controlled by the neon oscillator, the circuit is called a neon relaxation oscillator. When constant voltage is supplied to the input of this circuit, that is at the junction of R38 and R43, the capacitor, C29, is charged through the resistor R38. The voltage across the capacitor rises from zero, approaching the full supply voltage along a normal R-C charging curve. The voltage across the neon tube, I23, is the same as the voltage across the capacitor because these elements are connected in parallel. The neon tube does not light until the voltage across it reaches the firing potential. At this point the neon tube ionizes and forms a discharge path for the capacitor. The capacitor thus discharges very rapidly, until the voltage falls to the de-ionizing potential of the neon tube, when conduction stops and the tube becomes an open switch again. The capacitor then begins to charge again towards the source supply voltage. The voltage rises along the R-C curve towards the firing potential of the neon tube, and then falls again. This process continues as long as the MR/HR Switch, S1, is out of the OFF position, that is, as long as a D-C supply is maintained. Frequency is approximately 400 cycles per second.

This sawtooth waveform from the oscillator is applied to the grid of the high voltage supply, V3, and appears at the plate of that tube. The high voltage which is thus produced in the plate of V3, appearing across the inductance L1, is rectified by the high voltage regulator in the plate circuit of V3. Capacitors C31, C32, and C34 further tend to reduce the amount of ripple in the high voltage supply, filtering out the 400 cycle A-C voltage.

Voltage regulator tube, V4, between the high-voltage point and I24, provides constant voltage regulation of approximately 960 volts at that point. The neon bulb, I24, which is between the voltage regulator tube, V4, and ground, provides some further voltage regulation, establishing a reference point (approximately 60 volts) in the voltage-divider network of R7 and R8. I24 also provides some voltage regulation in dividers for the plate circuit of the one-shot multivibrator, V2, and the positive bus of the Scaler-Computer neon bulbs I1, I12, I25, and I36. I24 is also used as an "on-off" indicator light on the front [illegible]e COUNTMASTER.

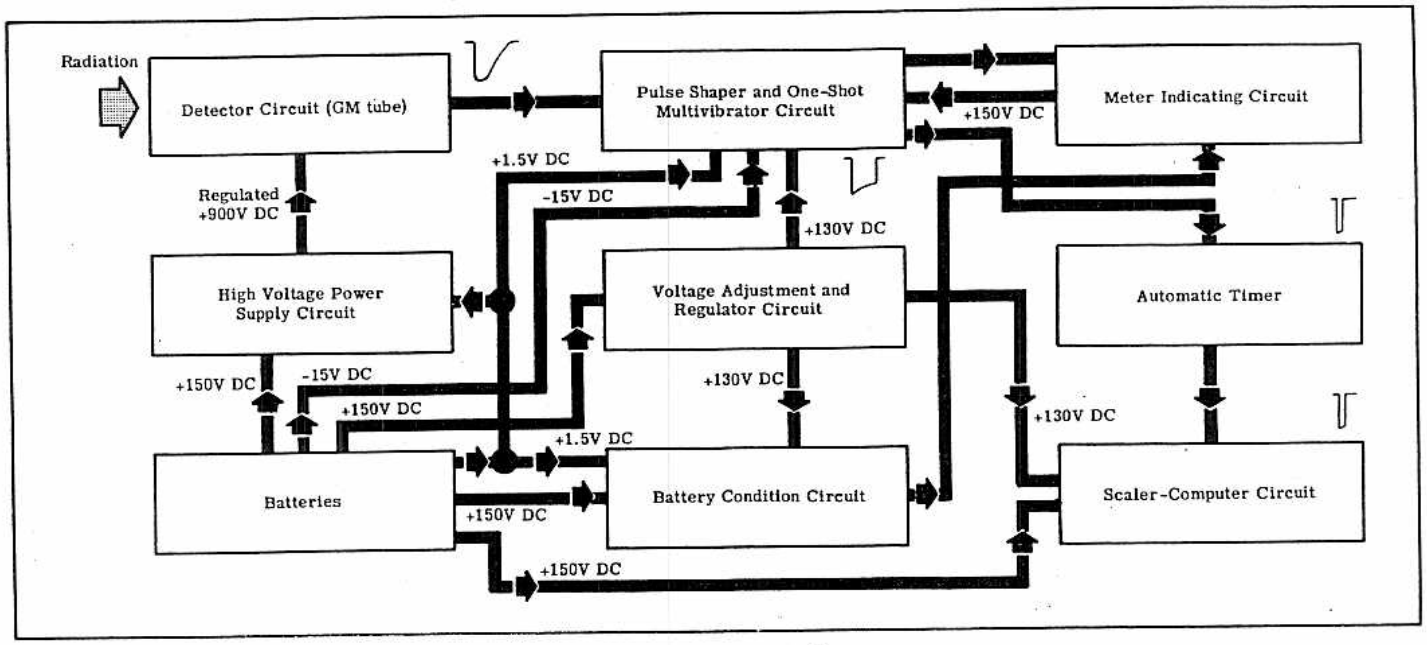


Figure 2. Countmaster Block Diagram

GEIGER-MUELLER TUBE -- Signal Input

The Geiger-Mueller (GM) tube, V1, in the probe of the COUNTMASTER, responds to gamma and beta rays. When a gamma or beta ray passes through the tube, the tube gas is ionized, effectively creating a short. The resulting ionization then takes approximately 80 microseconds before the tube is capable of producing another pulse; in other words, it takes approximately 80 microseconds recovery time before the tube is capable of a second pulse of full amplitude. This recovery time is satisfactory for even extreme conditions which might be encountered.

Each time a beta or gamma ray causes ionization of the GM tube, the negative pulse developed across R92 is injected into the input circuit of the COUNTMASTER through C1.

ONE-SHOT MULTIVIBRATOR

The negative pulse from the GM tube, V1, is used to trigger the one-shot multivibrator, V2. The grid of V2A is returned to a positive potential, and, in the stable condition, V2A is conducting since the grid is held slightly positive with respect to ground by the connection through R2 to the B-plus supply. V2B is cut off by the negative bias developed by the 15-volt "B" battery, BT1. The grid of V2A is only slightly positive because the voltage produced across R2 by the flow of grid current is nearly equal to the supply voltage. This circuit is put into operation by a negative trigger pulse from the GM tube, developed across R92 and applied through capacitor C1 to the grid of V2A. This pulse decreases the plate current of V2A. The increase of plate voltage is coupled to the grid of V2B through the capacitor C2. Plate current begins to flow at V2B and the voltage at that point decreases. Capacitor C3 couples this decrease to the grid of V2A, causing a further increase in the plate potential of V2A, which is impressed on the grid of V2B. This action continues until the grid of V2A is cut off and V2B is conducting heavily.

The circuit remains in this condition as long as the discharge of C3 maintains a high enough negative potential on the grid of V2A to keep the tube cut off. When C3 has discharged sufficiently to allow the grid of V2A to rise above cutoff, V2A conducts, and its plate potential decreases. The decrease is passed to the grid of V2B, and its plate current decreases, causing its plate potential to rise. This rise is impressed on the grid of V2A which increases its plate current. This action takes place almost instantaneously, so that V2A quickly returns to its normal state of conduction, and V2B is again cut off.

The output of the one-shot multivibrator, V2, is a negative pulse of widths ranging from 800 to 1500 microseconds, depending upon the position of the MR/HR Switch, S1.

MR/HR METER CIRCUIT

The MR/HR Meter, M1, is normally connected in the output circuit (plate of normally "off" tube, V2B, of one-cycle multivibrator). Note that the normal plate load of that tube is from pin 6 through R5, through the meter, and then back to the positive 150-volt power supply. This hook-up occurs when the Read Switch, S2, is in the READ position. A 250-uuf capacitor, C16, is placed across the MR/HR Meter in the READ position to further smooth out the meter indication; thus the meter reads the average plate current of the normally "off" tube, V2B, of the one-shot multivibrator.

The MR/HR Meter is also used to measure the plate supply voltage which is supplied to the one-shot multivibrator, V2, and the positive bus of the trigger bulbs in the Scaler-Computer. This is accomplished when the Read Switch, S2, is positioned to B. In this position, the MR/HR Meter is connected between ground and the center lug (or variable arm) of the B-Set potentiometer, R7. A green "B-SET" graduation on the meter face is referred to while the B-Set potentiometer, R7, is adjusted to about 135 volts (meter pointer on black line in green area). When the Read Switch is positioned to "A", the meter is connected through resistor R4 to the 1-1/2-volt batteries. A green area on the MR/HR Meter scale indicates whether the "A" battery voltage is within usable range.

SCALER-COMPUTER CIRCUIT

The COUNTMASTER Scaler-Computer is a neon-diode ring counter circuit, capable of counting relatively low speeds up to 12,000 impulses per minute, using neon tubes and diodes. The counter can be reset instantaneously, and the glow-discharge neon bulbs serve not only as the basic circuit elements of the counter, but also provide visible indication of the count.

The circuit is basically a ring circuit, and decades, or rings, of ten are used in the COUNTMASTER. Forty-four neon bulbs are used; four rows of eleven bulbs each.

Each row starts with the numeral "0" at the top, progressing "1", "2", "3", etc., to "9" at the bottom. A trigger bulb -- located below the numeral "9" bulb in each row -- is used to trigger each related row.

Referring to the Hoffman COUNTMASTER circuit schematic, figure 8, note that when the MR/HR Switch is positioned to SCALER, a ground circuit is provided the diodes in the cathode circuits of the trigger neon bulbs, I1, I12, I25, and I36, and the numeral "0" bulbs, I2, I13, I26, and I37, in each row. The unit potentiometers related to each of the trigger bulbs, are adjusted to just below the firing voltage of the trigger bulbs, and these bulbs are not illuminated except when a negative pulse is applied to their ground sides. The remainder of the neon bulbs in each row are connected to ground through the reset switch, S4. The values of the resistors R11, R27, R49, and R80, which are between the 150-volt supply and the B-plus bus of each decade, are selected so that when any one neon bulb in a decade is conducting, the B-plus bus is maintained lower than the firing voltage of the rest of the neon bulbs in that decade. When the reset button is depressed, the ground line is removed from the numeral "1" to "9" bulbs. Depressing this switch -- removing the ground -- also tends to raise the positive bus voltage of each row of neon bulbs, and, since the numeral "0" bulb is the only bulb in each row with its ground permanently connected, that bulb will be fired. Thus, in the initial state, that is, with no pulses coming into the trigger bulbs at each row, and immediately after the reset button has been released, the numeral "0" bulb in each row will be fired (illuminated), and the trigger bulbs and the remainder of the numeral bulbs will be out (de-ionized).

Note that when the numeral "0" bulb, I2, of the one-unit row of the Scaler-Computer is conducting, current flows from the source of supply voltage, 150 volts, through R11, through R12, through I2, and through CR2 in the forward direction to the ground bus. Capacitor C6 is charged to the voltage across R12.

The negative pulse from the one-shot multivibrator, V2, passes through the Timer Switch, S3, and capacitor C4, and is applied to the ground-side of the trigger bulb I1, lowering the D-C potential on the ground side of that bulb, causing it to fire. During the period when I1 is not conducting, there is no current flow through R9 which is on the plate side -- or positive side -- of I1, and the junction of I1 and R9 is at just below the firing voltage of the neon bulb I1. When the bulb fires, caused by the negative pulse at its ground side, current flow through R9 depresses the voltage at the junction of I1 and R9, and this negative pulse is coupled through C5 to the positive bus (decade bus) of that row of neon bulbs(I2 through I11). This negative pulse, passing through C5, causes the potential of the decade bus to be depressed by an amount equal to the original pulse potential produced by the trigger bulb, I1.

The decade bus voltage is made to drop below the operating voltage of I2, with the result that I2 is extinguished (de-ionized). The time-constant of the pulse (created by C5 and R11) is sufficiently long that the potential across I2 remains below its operating voltage for an interval which allows complete de-ionization.

Meanwhile, none of the numeral neon bulbs in the decade are conducting, and the discharge current of the capacitor C6 discharges through CR3, in the inverse direction, and through R12. Hence, at the conclusion of the pulse, the positive potential on I3, with respect to ground, is the sum of the voltage developed by C6 and the decade bus voltage, the total of which exceeds that across any of the other neon bulbs; hence, I3 fires, and the Scaler-Computer has recorded one count (numeral "1" illuminated). If another succeeding pulse is applied to the trigger bulb, I1, from the one-shot multivibrator, V2, the decade bus voltage is again depressed, causing I3 to be extinguished. None of the other neon bulbs in the decade are conducting, and the discharge current of capacitor C7 flows through R13 and through CR4 in the inverse direction. Since the value of R13 is much smaller than the inverse resistance of CR4, a large proportion of the voltage across C11 appears across CR4. Thus, at the conclusion of the negative pulse through C5, the potential of the upper electrode of each neon bulb becomes more positive with respect to ground; but the lower electrode of neon bulb I4 assumes a more negative potential with respect to ground, and hence, a greater voltage appears across I4 than across any other the bulbs.

As soon as I4 fires, current flows through R11, R14, I4, and CR4 in the forward direction. This prevents further increase in the voltage of the positive bus, and actually causes a transient drop in the voltage. Capacitor C8, charges, and C7 discharges rapidly through a resistance essentially equal to R13. Thus, the counter has now recorded two pulses since I4 is now conducting rather than I3 (numeral "2" is illuminated).

Each subsequent pulse advances the count one step, until neon bulb I11 becomes fired (numeral "9" illuminated). The next pulse causes the ignition of I2 again (numeral "0" bulb), and, through capacitor C10, closes the ring. This same negative pulse from I11 is also applied to the trigger bulb, I12, of the ten-unit row (second decade of neon bulbs), causing that bulb to fire, transferring its resulting negative pulse through C18 to the positive bus of the ten-unit row of neon bulbs. The numeral "0" bulb, I13, in that row is extinguished, and the numeral "1" bulb, I14, fired, giving a visual indication of the numeral "10". The count then proceeds as was described for the one-unit row.

The operation of the Scaler-Computer circuit depends essentially on two inherent characteristics of the circuit elements. The first of these is the difference in the striking (ionizing potential) and operating voltages of the neon bulbs which insures that when any one of the bulbs is conducting, the potential across all the other bulbs is maintained below their firing potential -- yet not so low as to de-ionize the conducting bulb. Thus, no more than one bulb is illuminated at any one time.

The second item of importance is the difference between the forward and the backward resistances of the diodes which allows each coupling capacitor to charge quickly whenever its related neon bulb is conducting, but which allows that capacitor to discharge only very slowly after its neon bulb has been extinguished (de-ionized).

In operation of the Scaler-Computer, the Timer Switch may be set at some selected figure so that the Scaler-Computer runs for some predetermined time. At the end of that time the counter Timer On-Off Switch will open, negative pulses will no longer be applied to the trigger bulb in the input to the Scaler-Computer (one-unit row trigger bulb, I1) and the counter will stop at the last counted pulse. The Scaler-Computer may then be reset to zero by depressing the reset button, S4, which removes the ground circuit from all but the numeral "0" bulbs and trigger bulbs in each row. If it is not desired to use the timer, its on-off switch will be left in the ON position.

OPERATING INSTRUCTIONS

(See Figure 1)

CONTROLS:

Read Switch.

The Read Switch, S2, has three positions: Read, B, and A.

In the READ position, the MR/HR Meter, M1, is connected so as to read plate current of the normally "off" tube, V2B, of the one-shot multivibrator. The meter is calibrated to read in milliroentgens per hour, the scale depending upon the position of the MR/HR Switch, S1.

In the B position, the MR/HR Meter is connected to the variable arm of the B-Set potentiometer, R7, and provides visual indication of the 135-volt setting.

NOTE: The Read Switch should be left in the B position during Scaler-Computer operation to provide continuous monitoring of the B-plus voltage, and to prevent damage to the MR/HR Meter from high MR/HR readings.

In the A position, the MR/HR Meter is connected to the 1-1/2 volt batteries through R4.

The third pole of the Read Switch, S2C, keeps the plate circuit of the one-shot multivibrator, V2, energized, even though the MR/HR Meter is to be taken out of the circuit for battery checks, so that Scaler-Computer operation can continue while checking the batteries.

MR/HR Switch

The MR/HR (milliroentgens per hour) Switch, S1, provides on-off control of the COUNTMASTER, controlling application of the seven batteries to the various circuits, and ground for the Scaler-Computer. The MR/HR Switch has five positions: OFF, SCALER, 20, 2, and .2.

In the OFF position, the batteries are disconnected from the COUNTMASTER, and the ground circuit is removed from the Scaler-Computer neon bulbs.

In the SCALER position, the ground circuit to the Scaler-Computer is connected, making that circuit operative, and the 0 to 0.2 milliroentgens per hour bias is applied the one-shot multivibrator, V2 (MR/HR Meter will read that scale).

In the 20 position, R22 is inserted in the normally "off" tube V2B, of the one-shot multivibrator to establish an R-C time constant such that full scale reading of the MR/HR Meter, M1, is equivalent to 20 MR/HR; that is, the meter has a range of 0 to 20 milliroentgens per hour.

In the 2 position, resistance R23 is switched into the circuit, and full-scale reading of the meter is 2 MR/HR.

In the 0.2 position, resistance R24 is switched in, and full-scale reading is 0.2 MR/HR; a range of 0 to 0.2 milliroentgens per hour. Note that this is the same resistance that the switch puts in when the MR/HR Switch is in the SCALER position.

In the 20, 2 and 0.2 positions of the MR/HR Switch, the ground is removed from the Scaler-Computer, making that circuit inoperative.

B-Set Control

The B-Set Control, R7, provides front-panel adjustment of B-plus voltage applied to the one-cycle multivibrator and the trigger neon bulbs of the Scaler-Computer. With the Read Switch, S2, in the B position, the B-Set control is adjusted so that the meter pointer is on the black line in green area under "B-SET" on meter face.

Reset Button

The Reset Button, S4, is used to return the Scaler-Computer count to zero. Depressing the button removes the ground connection to the ground bus of the numerals "1" through "9" neon bulbs in each decade (row), leaving only the numeral "0" bulb in each row illuminated (conducting).

Timer

The timer, S3, provides means of establishing an accurate time base for making timed counts with the Scaler-Computer. A selector knob on the face of the timer provides means of selecting duration -- period -- of Scaler-Computer operation.

With the timer on-off switch at the top center of the timer in the OFF position, the circuit through the timer is open. With the pointer of the timer set to some selected time, positioning the on-off switch to ON will start timer operating, and will connect the output (negative pulse) of the one-shot multivibrator, V2, to the input of the Scaler-Computer. The on-off switch is then manually returned to the OFF position before the timer has returned to the "0" time position. This manual operation of the on-off switch while the timer is running will not open the circuit however, but the timer will automatically open the circuit when it reaches zero. If on-off switch is not returned to OFF after timer has started, the timer will return to zero position after its selected run, but it will not open the circuit to the Scaler-Computer.

The timer is spring wound, tension being applied when the selected time is set with the pointer knob. Time durations up to two minutes, in increments of one second, may be selected. For operation of the Scaler-Computer at longer periods -- where slow counts are encountered, and over two minutes of counting is required -- the on-off switch is positioned to ON at the start of the count, and returned to OFF at the end of the selected period, timed against some known standard.

MR/HR Meter

The MR/HR Meter, M1, is a 50-microampere meter, calibrated to read in milliroentgens per hour. "A" and "B-SET" markings are engraved on the face of the meter, and are used when checking the "A" batteries, and when adjusting the B-plus voltage applied to the one-shot multivibrator and the Scaler-Computer trigger bulbs. Refer to Read Switch, preceding.

Meter Adjustments (figure 3)

The meter adjustment potentiometers, R22, R23, and R24, provide service adjustment of the T-C time constant in the grid circuit of the normally "off" tube, V2B, of the one-shot multivibrator. These potentiometers are adjusted while an object of known radioactivity is placed in the vicinity of the Geiger-Mueller tube, V1, or while a known pulse rate is being applied to the input of the one-shot multivibrator, so as to provide accurate scale representation on the MR/HR Meter, M1. Refer to the SERVICE section of this bulletin for adjustment details.

NOTE: This adjustment must be performed against known accurate standards to insure accuracy of the COUNT-MASTER.

Scaler-Computer Adjustments (figure 3)

The Scaler-Computer adjustments, R10, R26, R48, and R70, adjust reference voltage applied to the trigger neon bulbs, I1, I12, I25, and I36.

Each of the potentiometers is connected across the approximately 135-volt regulated voltage which is established by adjustment of the B-Set potentiometer, R7. The variable arm of each of the Scaler-Computer adjustment potentiometers is connected to the positive load resistors of the related trigger bulbs. Each is adjusted, as described in the SERVICE section of this bulletin, to just below the firing voltage of the related trigger bulb, so that the trigger bulbs are ionized only during the period of the trigger pulses from the one-shot multivibrator (to one-unit decade trigger bulb), or the count pulses from each succeeding row (to I12, I25, and I36) as the units increase.

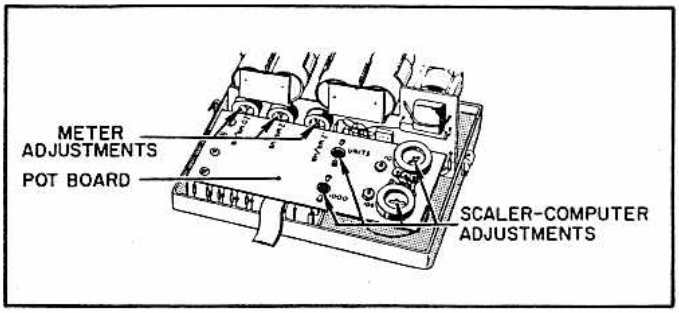


Figure 3. Calibration & Adjustment Potentiometers

OPERATION -- Meter Use

1. Turn Read Switch to B position.
2. Turn MR/HR Switch to 20. Pilot light regulator should glow.
3. Turn B-Set knob until MR/HR Meter pointer is on black line in green area under "B-SET".
4. Turn Read Switch to READ position.
5. If MR/HR Meter does not read above the first two black lines to the left of .05, advance MR/HR Switch to 2 position. If meter reading is still below the first two lines, advance switch to .2 position. Read milliroentgens per hour on meter face.
6. Turn MR/HR Switch to OFF position when the COUNTMASTER is not in use.

OPERATION -- Scaler-Computer Use

NOTE: The neon bulbs of the Scaler-Computer require ultra-violet light, such as sunshine, fluorescent lamps, strong incandescent illumination, or an ultra-violet lamp, to count properly.

1. Turn Read Switch to B position.
2. Be sure toggle switch (on-off switch) above timer pointer knob is in OFF position.
3. Turn MR/HR Switch to SCALER position. Pilot light regulator should glow.
4. Turn B-Set knob until MR/HR Meter pointer is on black line in green area under "B-SET" on meter face.

NOTE: If Scaler-Computer has not been operated for some time, stabilize neon bulbs by advancing B-Set knob until each decade has had a chance to race (free run). As knob is advanced, trigger bulbs may illuminate without decade racing; back off knob until bulb goes out, then advance again until decade races. After each decade has raced, back off B-Set knob until all trigger bulbs go out and numeral bulbs stop racing; then adjust B-Set knob until MR/HR Meter pointer is on black line in green area.

5. Press Reset Button. Scaler-Computer should reset to zero (only numeral "0" bulbs in each row illuminated).
6. Turn timer knob clockwise to desired time. Loosen timer stop setscrew. Turn timer stop until it rests against the pointer to repeat selected time. Tighten setscrew.
7. Place timer on-off switch to ON position, then immediately return it to the OFF position. Timer will operate for the selected time, then automatically shut off the Scaler-Computer. Neon bulbs of Scaler-Computer will show total count until reset button is depressed to reset total -- or until MR/HR Switch is moved from the SCALER position.

NOTE: If timer has not been operated for several hours, it is recommended that the first count or two be disregarded as the spring in the timer may have taken a set which can reduce the accuracy. It is suggested that the timer be operated two or three times before using Scaler-Computer.

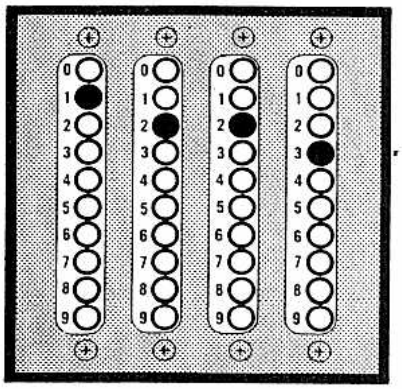
8. Read lights on Scaler-Computer from left to right in thousands, hundreds, tens, and units (see figure 4).

9. For additional counts, repeat steps 5 through 8 inclusive; do not reset timer stop as described in step 6.

Background Count:

The COUNTMASTER will always record a small reading in any area, even if there is no uranium ore present. This reading is called a background count. It is caused principally by cosmic rays and minute quantities of radioactive material which are present nearly everywhere. Actual deposits of uranium are indicated by increases over the average background count. Background count varies with geographical locations as well as the time of day. When taking a background count, be sure to note the exact location of the MR/HR Meter pointer for reference.

To take a background count, set the timer and operate Scaler-Computer as previously described. A one-minute background count is recommended as a minimum time. The average count will usually be between 30 and 60 counts per minute.



Solid circles indicate bulbs are lit. Read this count as 1,223 counts per minute.

Figure 4. Scaler-Computer Counting

OPERATION -- Battery Condition Checks

"A" Batteries:

Turn the Read Switch to the READ position, and the MR/HR Switch to any position past OFF. MR/HR Meter should indicate in the green area under "A".

"B" Batteries:

Turn the Read Switch to the B position, and the MR/HR Switch to any position past OFF. Turn B-Set knob until MR/HR Meter pointer is on black line in green area under "B-SET". If meter pointer cannot be brought up to this point, replace the 75-volt "B" batteries.

MAINTENANCE

CAUTION: Voltage supply to the probe of the COUNTMASTER is 960 volts (approximately). Be sure the MR/HR Switch is in the OFF position during maintenance operations which require removal of the instrument from its case.

CHANGING BATTERIES (figure 5)

A complete list of batteries that are usable with the COUNTMASTER is printed on the inside bottom of the COUNTMASTER case. If batteries do not meet the battery condition checks, replace as follows:

75-volt "B" batteries: Unlock the latches at the ends of the COUNTMASTER case, and lift the cover by the handle and probe support. Unhook the spring holding the batteries to case, and carefully pull the clipboards away from the batteries. Do not use tools or the clips may be damaged.

"A" batteries: Remove by unhooking springs. Batteries will lift out. Be sure and replace with correct polarity.

15-volt "B" battery: This battery is mounted immediately under "A" battery brackets, and is removed by pulling back spring bracket; the battery will then fall out.

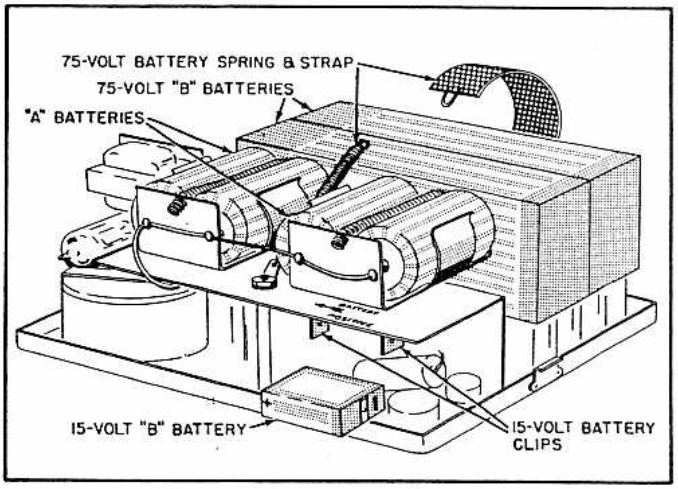


Figure 5. Battery Replacement

CAUTION: Plus and minus polarity is marked on board just above 15-volt "B" battery. Be sure to line up polarity markings on the battery with markings on board when replacing. If markings have become obliterated, refer to figure 4 for correct polarity.

REPLACING GM TUBE (figure 6)

The GM tube is replaced by unscrewing the probe shield and slotted tube from that portion of the probe assembly that contains the tube socket.

CAUTION: Do not unscrew knurled nut from probe assembly; wires to tube socket will be broken.

Use care when replacing GM tube in socket to avoid bending or denting tube. Tighten probe shield and slotted tube on probe assembly by hand; use no tools.

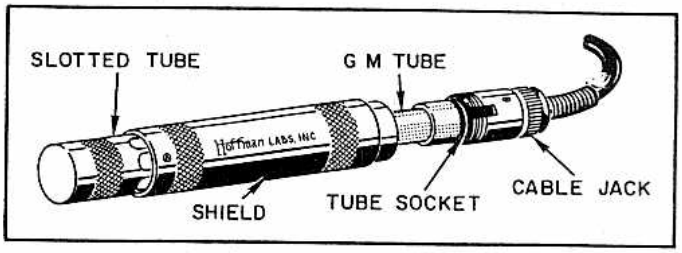


Figure 6. Probe Disassembly for GM Tube Replacement

SERVICE ADJUSTMENTS

METER CALIBRATION

The meter may be calibrated by either of two methods: radiation method or pulse generator method.

Radiation Method

A gamma ray source of known value in milliroentgens per hour, may be used to calibrate the MT/HR Meter. It is desirable to use three different radioactive sources; one source for each range, for the most accurate calibration. Slide the probe shield back, and place the gamma ray source against one of the slots on the probe. Take readings at all four slots in probe, and average.

Adjust the calibration controls (figure 3) until the MR/HR Meter reads the same intensity plus the background count.

To gain access to the three meter calibration adjustments, remove the COUNTMASTER from its case, turn it over, and unhook the spring holding the "B" batteries in place. The meter adjustments are located just below the "A" batteries.

Pulse Generator Method

1. Adjust B-Set control on COUNTMASTER for correct MR/HR Meter indication.

2. Use a pulse generator, such as a Measurements Model 71 modified to obtain 3-volt negative pulses at a width of 5 microseconds. Set the MR/HR Switch on the COUNTMASTER to the 20 position, and, with the pulse generator set at a frequency of 1060 pulses per second, apply this signal to pin 1 of the probe connector socket and ground.

CAUTION: Decouple the pulse generator from the COUNTMASTER with a 0.0047 mfd capacitor rated at 1500 volts (there is 900 volts applied to pin 1 of the probe socket for operation of the GM tube).

Adjust the control marked "20 MR/HR" under the front panel (see figure 3) so MR/HR Meter reads 20 MR/HR, or full-scale deflection.

3. Set pulse generator frequency to 133 pulses per second, set MR/HR Switch on COUNTMASTER to the 2 position, and adjust 2 MR/HR Meter adjustment control until MR/HR Meter reads 2 MR/HR, or full-scale deflection.

4. Set pulse generator frequency to 17 pulses per second, set MR/HR Switch on COUNTMASTER to .2 position, and adjust .2 MR/HR Meter adjustment control until MR/HR Meter reads .2 MR/HR, or full-scale deflection.

SCALER-COMPUTER CALIBRATION

NOTE: The MR/HR Meter must be calibrated first (see preceding). Turn Read Switch to "B" position, and leave in this position while calibrating Scaler-Computer.

NOTE: Scaler-Computer neon bulbs require ultra-violet light for reliable operation: sun, fluorescent, strong incandescent illumination, or other ultra-violet light source.

1. Set timer switch in OFF position.

2. Set MR/HR Switch to SCALER position.

3. Adjust B-Set knob until meter pointer is one division above black line in green area under "B-SET".

4. Adjust control marked "UNITS" (see figure 3) on back panel, until all unit lamps are counting. Then back off adjustment until the bulbs just stop counting.

5. Repeat step 3.

6. Adjust scaler adjustment controls marked "10", "100", and "1000", in the same manner -- in that order.

NOTE: Be sure to repeat step 3 after each row of lights is adjusted.

7. Turn B-Set knob until meter pointer is on black line in green area under "B-SET". Scaler-Computer is now in calibration.

HIGH-VOLTAGE CHECK

1. Disconnect probe at probe receptacle on front panel of COUNTMASTER.

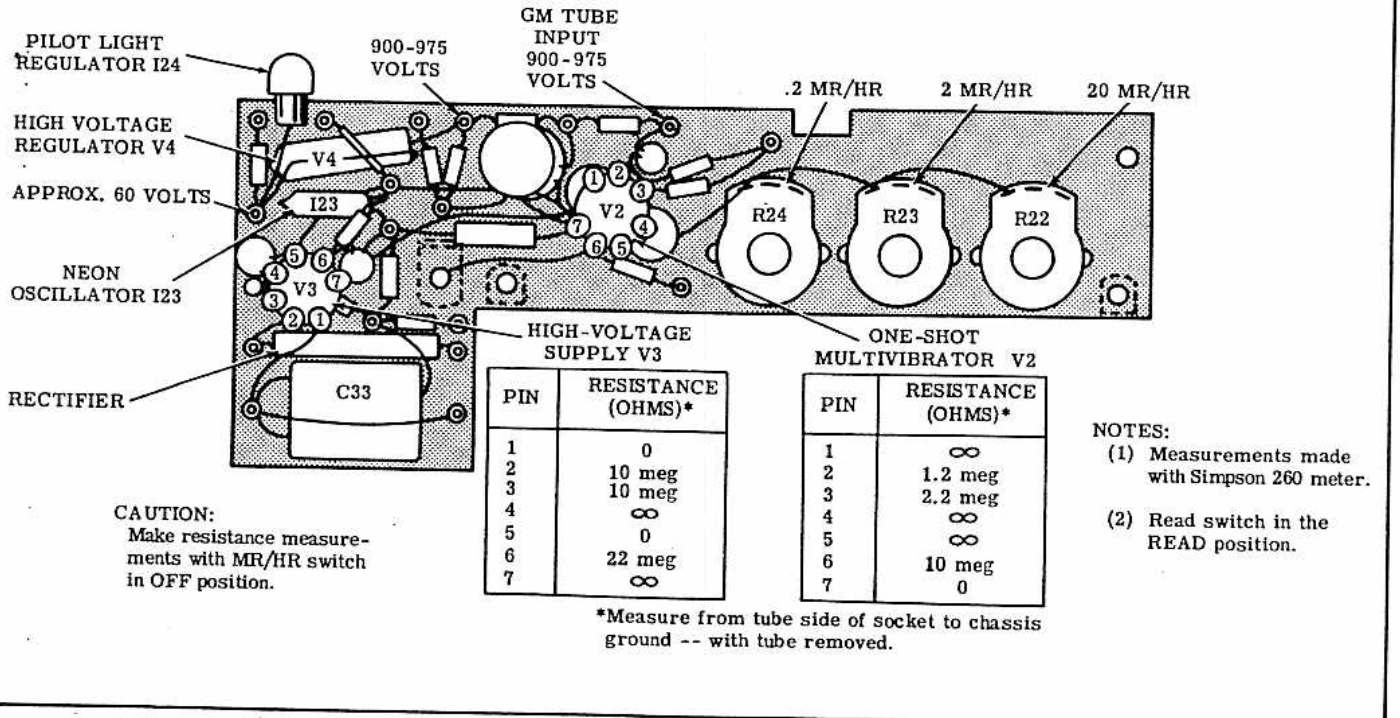
2. Turn Read Switch to B position.

3. Turn MR/HR Switch to 20 position. The pilot light regulator should illuminate.

4. Turn B-Set knob until meter pointer is on black line in green area under "B-SET".

5. Check high voltage between pin 1 and ground at the probe socket. This voltage should be 900 to 975 volts dc.

NOTE: The probe high voltage can only be accurately measured with an electrostatic voltmeter, or a VTVM such as the General Radio Type 728-A. An ordinary voltmeter, or even other vacuum-tube voltmeters, will load the circuit sufficiently to cause a drop in indicated voltage of 100 volts or more.



PIN	RESISTANCE (OHMS)*
1	0
2	10 meg
3	10 meg
4	∞
5	0
6	22 meg
7	∞

PIN	RESISTANCE (OHMS)*
1	∞
2	1.2 meg
3	2.2 meg
4	∞
5	∞
6	10 meg
7	0

*Measure from tube side of socket to chassis ground -- with tube removed.

Figure 7. Voltage and Resistance Measurements

LOW-VOLTAGE CHECK

1. Perform steps 1, 2 and 3 of High-Voltage Check, preceding.
2. Check low voltage under chassis at variable arm (center lug) of the B-Set potentiometer, R7. This voltage should be between 126 to 138 volts after adjustment of B-Set potentiometer, as described in OPERATION section of this bulletin.
3. Turn B-Set knob full clockwise. The MR/HR Meter should read between 18 and 20 MR/HR for fresh "B" batteries.
4. Turn Read Switch to "A" position and MR/HR Switch to any position out of OFF. Meter should indicate in green area under "A" if batteries are fresh.

TROUBLE SHOOTING AND REPAIR

TROUBLE SHOOTING

When trouble shooting the COUNTMASTER, make sure that all operating adjustments and service adjustments and checks have been accurately performed before proceeding with trouble shooting.

If battery voltage is satisfactory, and replacement of V2, V3, or V4 does not solve difficulties, perform voltage-resistance measurements indicated in figure 7. Other visual checks are to see that the high voltage neon oscillator, I23, and the voltage regulator-pilot light, I24, are illuminated, indicating that high voltage is present and satisfactory.

Table III. Trouble Shooting

Trouble	Suggested Remedial Action
No meter or counter operation, or no indication of count against known radioactive source	GM tube may be defective; however, check cable between the probe and the COUNTMASTER chassis. It may have become loose or damaged. The 3A5 tube, V2, or IU5, V3, may be defective. Replace and check. Check batteries; then check high-voltage source. Make high-voltage check. If satisfactory, check voltages at V2. Disconnect cable to GM tube at front panel, and with timer switch at ON, touch pin or paper clip wire to pin 1 of probe receptacle. CAUTION: Do not touch COUNTMASTER with body while doing this. If counter records one count each time contact is made, trouble is with GM tube. If no count indication appears, try turning timer on-off switch ON and OFF several times. If counter records one count each time, trouble is in one-shot multivibrator circuitry.
High-voltage out or low	Make voltage-resistance checks of IU5 tube, V3. Note whether I23 is glowing. If not, check C29 and R38. I23 should glow, even with V3 removed from socket. Check high voltage at pin 2 of V3 (across L1). With GM tube disconnected, check for voltage across C34.
High voltage too high (over 975 volts)	Replace voltage regulator, V4. Check if I24 is glowing.
B-Set voltage cannot be adjusted within range	"B" batteries defective; replace. Check for open circuit through R7 and R8 if batteries are satisfactory. Also check if I24 is glowing.
Meter operative; Scaler-Computer inoperative	If Scaler-Computer will reset to zero when Reset button, S4, is depressed, and numeral "0" bulbs are illuminated, trouble is in input to Scaler-Computer; check timer switch, S3, capacitor, C4, and the first trigger bulb I1 and its circuitry -- particularly the diode. Check adjustment of unit potentiometer R10. If I1 cannot be fired, trigger pulses will not reach the counter circuit. Check that ground bus through Reset button, S4, and the MR/HR Switch, S1, is complete in SCALER position.

Trouble	Suggested Remedial Action
Scaler-Computer counts just so far and then stops -- always at the same number	Check for defective diode in circuit of next numeral bulb. Check adjustment of trigger bulb potentiometer in defective unit-row.
Scaler-Computer count does not proceed to next unit row	Check capacitor between numeral "0" bulb in preceding row and trigger bulb of inoperative row. If early model COUNTMASTER, replace C5 with .002, C18 with .005, C36 with .005, and C48 with .005 capacitors to improve operation.
Scaler-Computer counts continuously	Make certain MR/HR Meter pointer is on black line in green area under "B-SET". Open timer switch, S3. If Scaler-Computer stops counting, the one-shot multivibrator, V2, may be free-running. If counting continues after S3 is opened, trouble is in Scaler-Computer. Check adjustment of trigger potentiometers. Voltage on trigger bulbs may be too high.

REPLACING NEON BULBS IN SCALER-COMPUTER

To replace Scaler-Computer neon bulbs, uncover base of bulbs by removing the four screws and two nuts which hold the potentiometer board in place on the back of the COUNTMASTER. and carefully tip the board back.

NOTE: All bulbs are color-coded on the base. Check the following chart for bulb voltages. Any bank of ten bulbs must have all bulbs with the same voltage within five volts.

Table IV. Scaler—Computer Voltages

Color Dot	Lowest Starting Voltage (starts glowing)
Black	Between 110 to 115 volts
Brown	Between 115 to 120 volts
Red	Between 120 to 125 volts
Orange	Between 125 to 130 volts
Yellow	Between 130 to 135 volts
Green	Between 135 to 140 volts

CAUTION: The row of four trigger bulbs at the base of the Scaler-Computer must be replaced with bulbs with voltages corresponding to the black, brown or red bulbs. The color coding on the base of the bulbs was done at the factory. When replacing bulbs, do not look for bulbs with similar color coding. Instead check lowest firing voltage.

NOTE: If black, brown, or red bulbs are not available for trigger bulb replacement, a bulb of lower starting voltage than those in related decade may be used.

When soldering neon bulbs in place, be careful that heat is not applied to any of the adjacent circuitry. The diodes can be damaged beyond repair by application of heat or rough handling. Avoid bending leads to diodes.

REPLACING DIODES

When replacing any of the diodes, a pair of long nose pliers should be held on the wire between the soldering iron connection and the body of the diode to dissipate the soldering iron heat away from the diode.

CAUTION: Do not twist leads to body of diode; if twisted inside diode, film will break instantly, destroying diode.

PARTS LIST – HOFFMAN COUNTMASTER, MODEL 216-1

SYMBOL	PART NO.	VALUE	TOLERANCE	WATTS OR VOLTS	DESCRIPTION
			BATTERIES		
BT1	CM29			15 V	Bias voltage
BT2	CM28	See list of interchangeable batteries printed on inside bottom of Countmaster box		75 V	Plate voltage
BT3	CM28			75 V	Plate voltage
BT4	CM30			1.5 V	Filament voltage
			CAPACITORS		
C1	CM21	.001 GMV		200 V	Circular disc
C2	CM23	.005 GMV		200 V	Circular disc
C3	CM22	.002 GMV		200 V	Circular disc
C4	CM20	390 MMF		150 V	Type SSM
C5*	CM19	.001 GMV		150 V	Type SSM
C5**		.002 GMV		150 V	
C6-C15	CM18	.005 GMV		150 V	Type SSM-.005-7
C16	CM27	250 MFD		6 V	
C17	CM18	.005 GMV		150 V	Type SSM-.005-7
C18*	CM19	.001 GMV		150 V	Type SSM
C18**		.005 GMV		150 V	
C19-C28	CM18	.005 GMV		150 V	Type SSM-.005-7
C29	CM24	1300 MMF		200 V	Mica
C30	CM21	.001 GMV		200 V	Circular disc
C31	CM25	.0047 GMV		1600 V	Circular disc
C32	CM25	.0047 GMV		1600 V	Circular disc
C33	CM26	1.0 MFD		150 V	Paper
C34	CM25	.0047 GMV		1600 V	Circular disc
C35	CM18	.005 GMV		150 V	Type SSM-.005-7
C36*	CM19	.001 GMV		150 V	Type SSM
C36**	CM18	.005 GMV		150 V	Type SSM- 005-7
C37-C47	CM18	.005 GMV		150 V	Type SSM-.005-7
C48*	CM19	.001 GMV		150 V	Type SSM
C48**	CM18	.005 GMV		150 V	Type SSM-.005-7
C49-C58	CM18	.005 GMV		150 V	Type SSM-.005-7
C59	CM21	.001 GMV		200 V	Circular disc
			DIODES		
CR1-CR44	CM35				Rectifier Type ITI

* Early Countmasters
** Later and Modified Countmasters

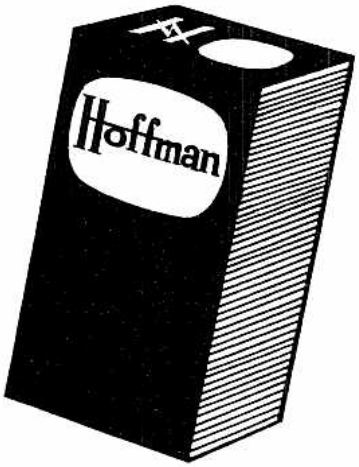
SYMBOL	PART NO.	VALUE	TOLERANCE	WATTS OR VOLTS	DESCRIPTION
			METER		
M1	CM39	50 Micro-amps dc			2-1/2 in. dia
			NEON LAMPS		
11-122 & 125-146	CM33#				NE96#
123	CM34				NE2
124	CM63				NE2A

Color Code	Lowest starting voltage (starts glowing)
Black	110 to 115
Brown	115 to 120
Red	120 to 125
Orange	125 to 130
Yellow	130 to 135
Green	135 to 140

Special stabilized and voltage-rated bulbs; individually selected as to ionizing potential. Refer to REPAIR section of this bulletin.

			REACTOR		
L1	CM51	8.35 HY, 3000 ohm dc res.	±1/2 HY		Pulse reactor
			RECTIFIER		
CR45	CM62				Type D-3273
			RESISTORS		
R1	CM12	2.2 Meg	20%	1/3 or 1/2 Watt	
R2	CM2	8.2 Meg	10%	1/3 or 1/2 Watt	
R3	CM9	1.5 Meg	20%	1/3 or 1/2 Watt	
R4	CM4	82K	5%	1/3 or 1/2 Watt	
R5	CM3	47K	20%	1/3 or 1/2 Watt	
R6	CM10	3.3 Meg	+5% -1%	1/3 or 1/2 Watt	
R7	CM17	100K	20%	1/3 Watt	B-Set
R8	CM5	100K	20%	1/2 Watt	
R9	CM7	220K	20%	1/3 Watt	
R10	CM16	1.5 Meg	20%	1/3 Watt	"Unit" Scaler Cal.
R11	CM7	220K	20%	1/3 Watt	

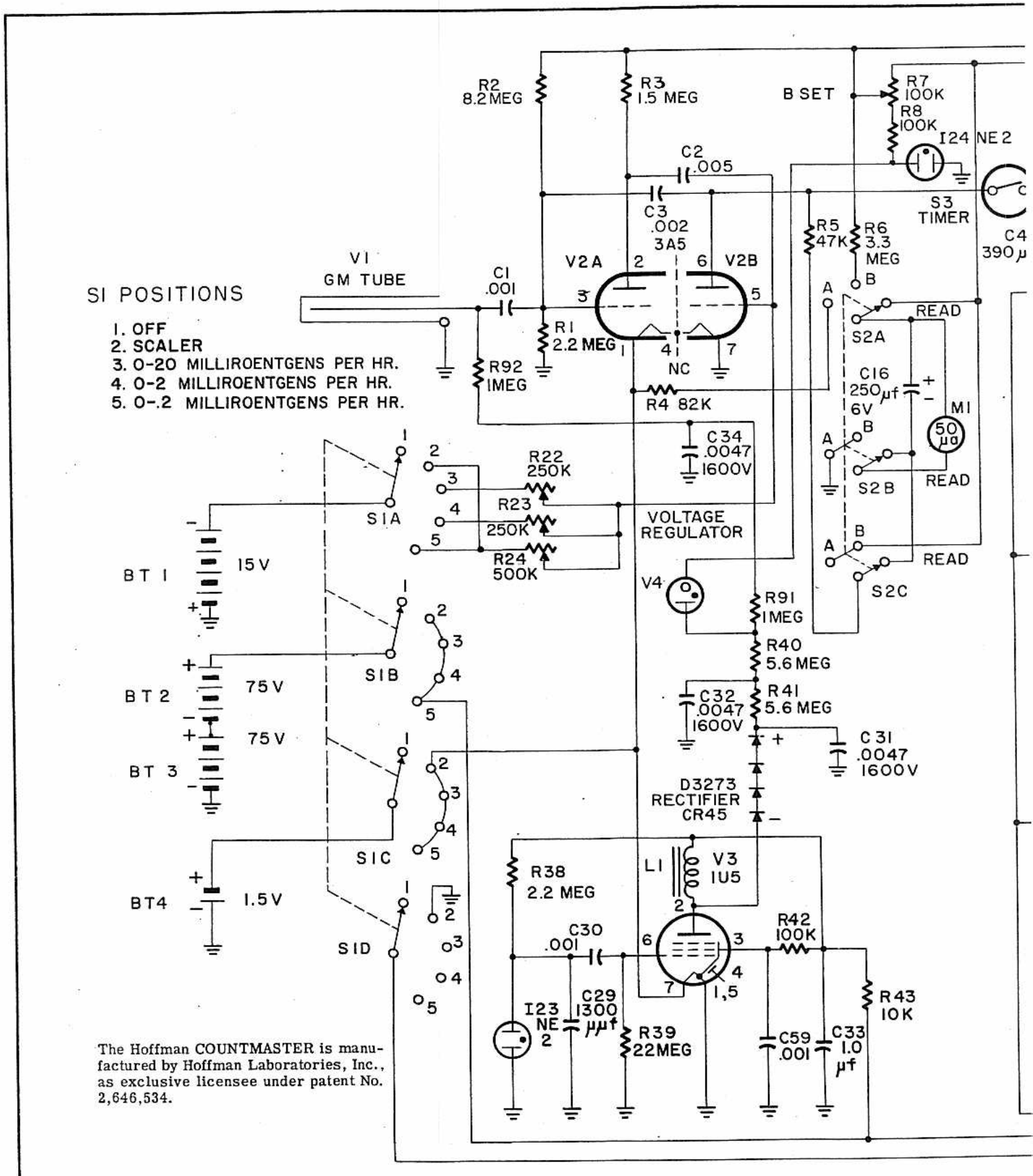
	TOLERANCE	WATTS OR VOLTS	DESCRIPTION
			MISCELLANEOUS
			Receptacle, Probe Cable, 80-PC 2F
			Cable Jack 91-MC 3%
			Probe Cable Plug 80-MC 2M
			Knob, Small Round Type 1450, Reset Button
			Knob-Pointer Type 2150, Switch
			75 Volt - Battery Straps
			Schematic
			15-Volt Battery Clip
			Lamp Block - Scaler
			Pull Down Catch
			Golder for Size "D" Battery
			"A" Battery Chassis
			Printed Terminal Board 390
			Printed Terminal Board 389
			7 Pin Miniature Wafer Socket for V2
			7 Pin Molded Mica Socket for V3
			Scaler Indicator
			Chassis - Potentiometer Assembly
			Chassis - Electrical
			Box
			Cover
			Handle Assembly
			Probe Assembly
			Spring
			Instruction Sheets



Use genuine Hoffman replacement parts. Hoffman replacement parts are manufactured to factory specifications for the model in which they are to be used. Matched replacement parts assure satisfactory repair with minimum installation time for the technician. To insure receipt of identical replacement parts use part number when ordering from your Hoffman distributor.

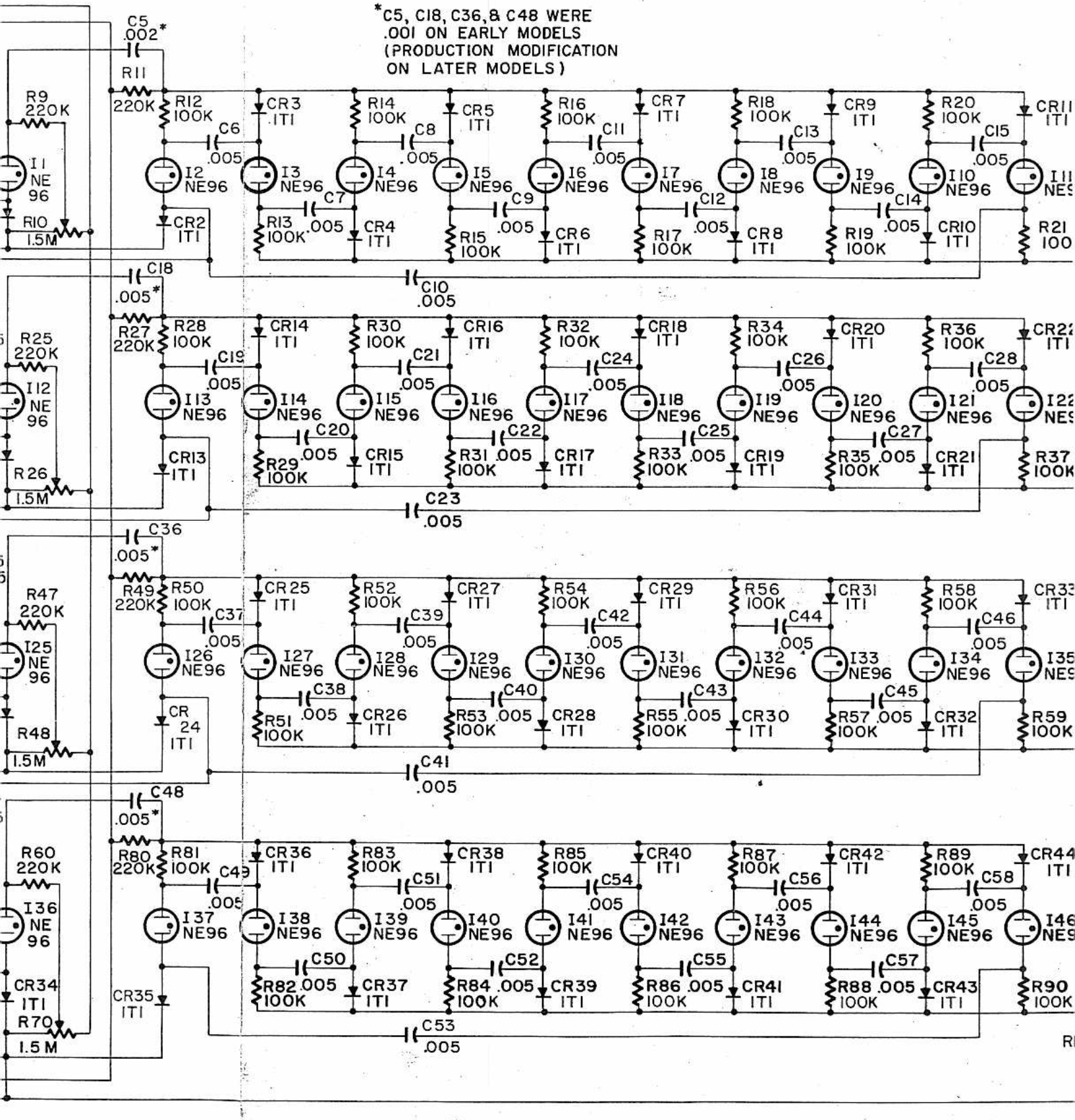
SYMBOL	PART NO.	VALUE	TOLERANCE	WATTS OR VOLTS	DESCRIPTION
			MISCELLANEOUS		
	CM44				Receptacle, Probe Cable, 80-PC 2F
	CM46				Cable Jack 91-MC 3%
	CM45				Probe Cable Plug 80-MC 2M Knob, Small Round Type 1450, Reset Button
	CM47				Knob-Pointer Type 2150, Switch
	CM50				75 Volt - Battery Straps
	CM60				Schematic
	CM61				15-Volt Battery Clip
	CM68				Lamp Block - Scaler
	CM73				Pull Down Catch
	CM82				Golder for Size "D" Battery
	CM87				"A" Battery Chassis
	CM88				Printed Terminal Board 390
	CM89				Printed Terminal Board 389
	CM31				7 Pin Miniature Wafer Socket for V2
	CM32				7 Pin Molded Mica Socket for V3
	CM90				Scaler Indicator
	CM91				Chassis - Potentiometer Assembly
	CM92				Chassis - Electrical
	CM93				Box
	CM94				Cover
	CM95				Handle Assembly
	CM96				Probe Assembly
	CM104				Spring
	CM108				Instruction Sheets

SYMBOL	PART NO.	VALUE	TOLERANCE	WATTS OR VOLTS	DESCRIPTION
R12-R21	CM6	100K	20%	1/3 Watt	
R22	CM14	250K	20%	1/3 Watt	"20 MR/HR" Meter Cal.
R23	CM14	250K	20%	1/3 Watt	"2 MR/HR" Meter Cal.
R24	CM15	500K	20%	1/3 Watt	".2 MR/HR" Meter Cal.
R25	CM7	220K	20%	1/3 Watt	
R26	CM16	1.5 Meg	20%	1/3 Watt	"10" Unit Scaler Cal.
R27	CM7	220K	20%	1/3 Watt	
R28-R37	CM6	100K	20%	1/3 Watt	
R38	CM12	2.2 Meg	20%	1/2 or 1/3 Watt	
R39	CM13	22 Meg	20%	1/3 or 1/2 Watt	
R40	CM11	5.6 Meg	10%	1/3 or 1/2 Watt	
R41	CM11	5.6 Meg	10%	1/3 or 1/2 Watt	
R42	CM5	100K	20%	1/2 Watt	
R43	CM1	10K	20%	1/2 Watt	
R47	CM7	220K	20%	1/3 Watt	
R48	CM16	1.5 Meg	20%	1/3 Watt	"100" Unit Scaler Cal.
R49	CM7	220K	20%	1/3 Watt	
R50-R59	CM6	100K	20%	1/3 Watt	
R60	CM7	220K	20%	1/3 Watt	
R70	CM16	1.5 Meg	20%	1/3 Watt	"1000" Unit Scaler Cal.
R80	CM7	220K	20%	1/3 Watt	
R81-R90	CM6	100K	20%	1/3 Watt	
R91	CM8	1 Meg	20%	1/3 or 1/2 Watt	
R92	CM8	1 Meg	20%	1/3 or 1/2 Watt	
			SWITCHES		
S1	CM41				MR/HR Switch
S2	CM42				Read Switch
S3	CM40	0-2 Minutes			Timer
S4	CM43				Reset Button



The Hoffman COUNTMASTER is manufactured by Hoffman Laboratories, Inc., as exclusive licensee under patent No. 2,646,534.

Figure



uit Schematic — Hoffman Countmaster