WATERMAN PRODUCTS

WATERMAN PRODUCTS CO., INC.

DESIGNERS AND MANUFACTURERS OF

POCKETSCOPE®

PULSESCOPE®

RAKSCOPE®

RAYONIC® Cathode Ray Tubes

PRINTED IN U.S.A.

INSTRUCTION MANUAL

WIDE BAND

The POCKETSCOPE

MODEL S-14-B OSCILLOSCOPE

WATERMAN PRODUCTS COMPANY, INC.

PHILADELPHIA 25, PENNSYLVANIA, U.S.A.

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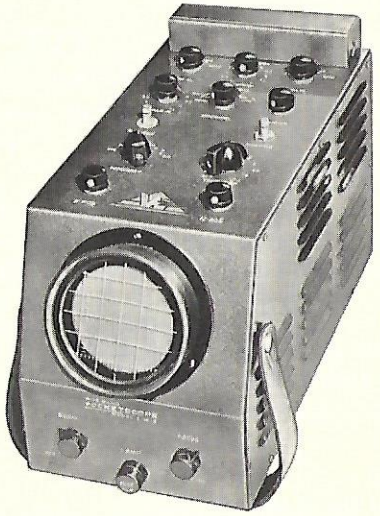
THE WATERMAN

POCKETSCOPE

MODEL S-14-B

INSTRUCTION MANUAL



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SECTION I

GENERAL DESCRIPTION

The Waterman POCKETSCOPE model S-14-B is a complete oscilloscope featuring wide band pass amplifier and unusual flexibility. Other voltages may be substituted for the time base depending upon the information desired and the ability of the operator to interpret the resultant patterns. The instrument uses a Waterman Rayonic 3RP1 cathode ray tube with the necessary beam, focus, vertical and horizontal positioning controls.

VERTICAL CHARACTERISTICS

The vertical amplifier has a maximum sensitivity of 50 millivolts rms (140 millivolts DC) per inch and a frequency response which is flat within —2db from DC to 700 KC. Its pulse rise time is equal to approximately 0.35 microseconds. In addition to the amplifiers non-frequency discriminating gain control, a compensated step attenuator permits additional attenuation of 100, 10 and 1. A fixed calibration voltage of 100 millivolts rms at line frequency is provided as a position on the vertical attenuator.

TIME BASE

The sweep frequency is variable from 0.5 cycles to 50KC and may be operated in either the repetitive or trigger mode. Synchonization is from either internal or external sources regardless of polarity.

TIME BASE AMPLIFIER

The horizontal amplifier has a maximum sensitivity of 0.3 volts rms per inch and a frequency response which is flat within —2db from DC, or 0 cycles, to 200 KC. Its pulse rise time is equal to 1.8 microseconds. The amplifier has a non-frequency discriminating gain control in addition to three steps of compensated attenuation 100, 10 and 1. The output of the linear time base generator is connected to the horizontal amplifiers by rotating the FUNCTION switch in the extreme clockwise position (HOR). A fixed calibration voltage of 250 millivolts rms at line frequency is provided as a position on the horizontal attenuator.

BLANKING

Provisions are made for connecting or disconnecting the internal blanking pulse. This thus provides a means for externally modulating the beam.

CATHODE RAY TUBE CONTROLS

Individual vertical and horizontal positioning as well as beam and focus controls are provided for the cathode ray tube.

PHYSICAL CHARACTERISTICS

Convenient and functional layout of all controls and terminals permits maximum flexibility with minimum of complexity. The width is 6 inches, the depth is 12 inches and the height is 7 inches. Its weight is but 14 pounds.

SECTION II

TECHNICAL DATA

Power Supply:

Input Supply	105-125 volts, 60 to 400 cycles
Input Consumption	65 watts at 117 volts 60 cycles
Fuse Protection	1.5 amp., replaceable from front

Vertical Amplifiers: Gain max.

Deflection Sensitivity*	50 millivolts rms/inch or 0.14 volts DC/inch
Deflection Plate Sensitivity*	23 volts rms/inch
Frequency Response*	within -2db from 0 cycles to 700 kc
Pulse Rise Time*	0.35 microseconds
Input Resistance and Capacity*	1 megohm shunted by 25mmf
Attenuator Positions	OFF, CAL and compensated steps of 100, 10 and 1
Deflection Polarity	+ is↑

Horizontal Amplifier: Gain max.

Deflection Sensitivity*	0.3 volts rms/inch or 0.84 volts DC/inch
Deflection Plate Sensitivity*	34 volts rms/inch
Frequency Response*	within -2db from 0 cycles to 200 kc
Pulse Rise Time*	3.0 microseconds
Input Resistance and Capacity*	1 megohm shunted by 25mmf
Attenuator Positions	OFF, CAL and compensated steps of 100, 10 and 1
Deflection Polarity	+ is ←

Linear Time Base

Sweep Frequency Range	Continuously adjustable from 0.5 cycles to 50 kc in five convenient steps
Operation	Repetitive or Trigger
Synchronization	Internal or External in either operation regardless of polarity
Blanking	Optional

Calibration

Vertical*	100 millivolts rms at line frequency
Horizontal*	250 millivolts rms at line frequency

Positioning

Independent vertical and horizontal controls for the cathode ray tube.

Stability

Normal line voltage fluctuations have little effect upon performance.

Tube Complement

Vertical Amplifier	V1	12AU7
	V2	12AX7
	V3	12AT7
Horizontal Amplifier	V4	12AU7
	V5	12AU7
	V6	12AT7

NOTE: **Figures given are bogie values*

Linear Time Base Generator	V7	12AX7
	V8	12AT7
	V9	12AU7
	V10	12AU7
Power Supply	V11	6X4
	V12	1V2
Cathode Ray Tube	V13	3RP1

Overall Dimensions

Height	7 inches
Width	6 inches
Depth	12 inches
Weight	14 pounds

Terminals

On top — 7 binding posts—Vertical INPUT AC, Vertical INPUT DC, GND, TEST, GND, Horizontal INPUT/SYNCronization DC and Horizontal INPUT/SYNCronization AC.

Back of rear cover — 14 terminals provide direct connections to the deflection plates, the vertical and horizontal amplifier outputs, the second anode, and grid of the cathode ray tube.

WARNING: High voltages are present at these terminals. Turn off power before opening rear cover!

Controls—From left to right

Vertical ATTenuator — 5 position rotary switch having the following positions:

- OFF — grounds amplifier input but not signal for balancing of amplifier.
- CALibration — applies 100 millivolts rms at line frequency to input for calibrating amplifier gain.
- 100 — attenuates V INPUT signal 100 to 1 (40db).
- 10 — attenuates V INPUT signal 10 to 1 (20db).
- 1 — connects V INPUT signal directly to amplifier with no attenuation.

SYNCronization / TRIGger — potentiometer for selecting the amplitude and polarity of synchonizing voltage.

Horizontal ATTenuator — 5 position rotary switch having the following positions:

- OFF — grounds amplifier input but not signal for balancing of amplifier.
- CALibration — applies .25 volts rms at line frequency to input for calibrating amplifier gain.
- 100 — attenuates H INPUT signal 100 to 1 (40db).

- 10 — attenuates H INPUT signal 10 to 1 (20db).
- 1 — connects H INPUT signal directly to amplifier with no attenuation.

Vertical GAIN — potentiometer for adjusting the gain of the vertical amplifier.

FUNCTION — 5 position rotary switch for selecting the desired source of synchronizing voltage having the following positions:

- REPetitive INTernal — selects repetitive mode of operation for sweep generator and connect signal from the vertical amplifier for synchronization.
- REPetitive EXTernal — selects repetitive mode of operation for sweep generator and connects the H INPUT/SYNC terminals to the sweep generator for synchronization.
- TRIGger INTernal — selects trigger mode of operation for sweep generator and connects signal from the vertical amplifier for "triggering".
- TRIGger EXTernal — selects trigger mode of operation for sweep generator and connects the H INPUT/SYNC terminals to the sweep generator for synchronization.
- HORizontal — connects the H INPUT/SYNC terminals to the external input grid (pin 2) of V4.

Horizontal GAIN — potentiometer for adjusting the gain of the horizontal amplifier.

Vertical BALANCE — potentiometer for adjusting balance in the vertical amplifier.

Horizontal BALANCE — potentiometer for adjusting balance on the horizontal amplifier.

FREQUENCY — dual potentiometer for the fine control of the sweep frequency within each range.

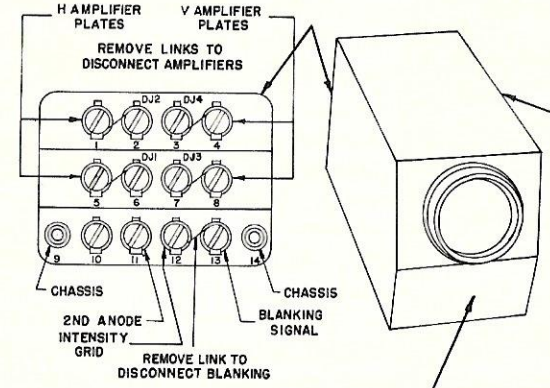
RANGE — 5 position rotary switch for selecting range of sweep frequencies having the following positions: 0.5-5, 5-50, 50-500, 500-5K and 5K-50K cycles.

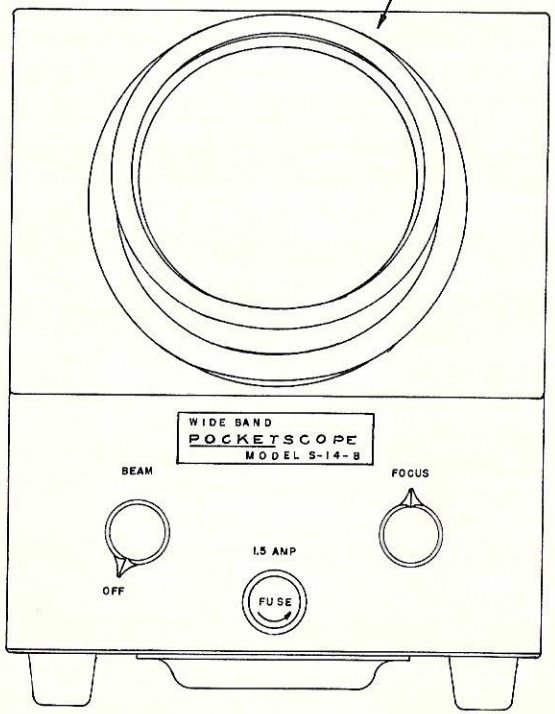
Vertical POSition — potentiometer for positioning the beam vertically on cathode ray tube screen.

Horizontal POSition — potentiometer for positioning the beam horizontally on the cathode ray tube screen.

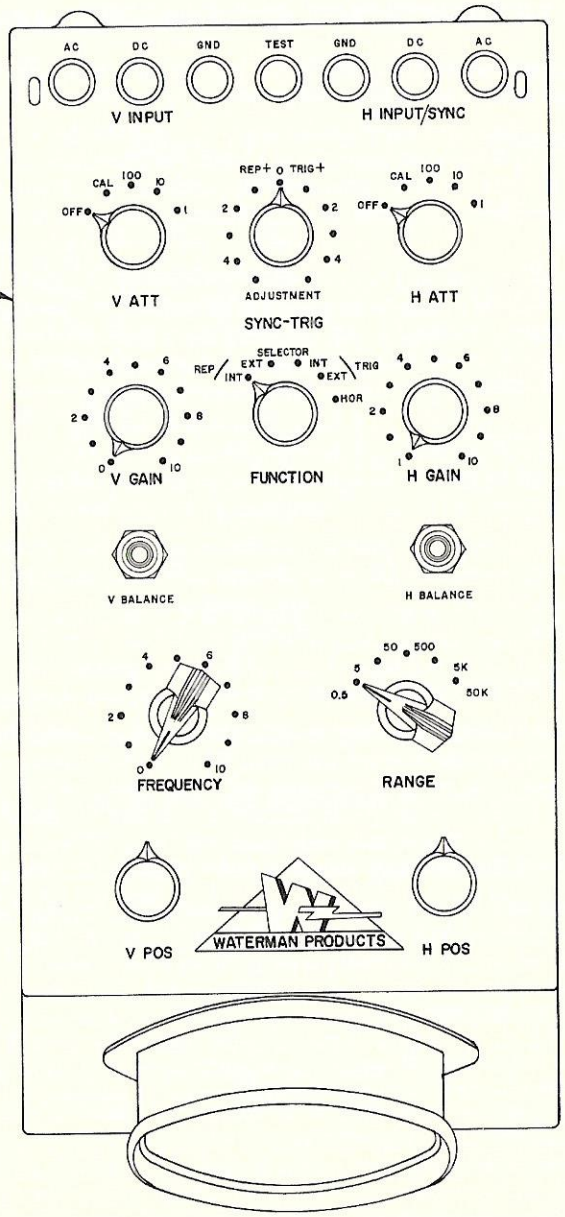
BEAM — potentiometer for adjusting beam brightness of the cathode ray tube. Maximum counter-clockwise position turns off power.

FOCUS — potentiometer for adjusting the beam of the cathode ray tube.





S-14-B LOCATION OF



CONTROLS AND TERMINALS

SECTION III

PRELIMINARY INSTALLATION AND ADJUSTMENT

1. The following procedure is suggested as a guide and is not to be construed as the only one possible.

CONTROL	SETTING
V ATT	GND
SYNC-TRIG	O
H ATT	OFF
V GAIN	counter-clockwise
FUNCTION	REP-INT
H GAIN	halfway
V BALANCE	These controls have been set at the factory. Do not reset them before reading OPERATION section.
H BALANCE	
RANGE	5-50
FREQUENCY	halfway
V POS	halfway
H POS	halfway
BEAM	counter-clockwise
FOCUS	halfway

2. Connect the POCKETSCOPE to the power line using power cord supplied.

3. Rotate the BEAM control clockwise until the attached switch (S5) clicks. Wait 30 seconds for warming.

4. Advance BEAM control in clockwise direction until the trace appears on the cathode ray tube.

5. Center this line on the screen by means of the V POS and H POS controls.

6. Adjust FOCUS and BEAM controls for desired brightness and sharpness of trace.

AMPLIFIER BALANCING

Since checking or adjusting the amplifier balance consumes little time, this operation should be checked each time the oscilloscope is turned on.

Control Setting: V ATT and H ATT to OFF; V and H GAIN to minimum (CCW); V and H POS to center beam on cathode ray tube screen.

Procedure: After a few minutes warm up, advance the corresponding GAIN control in clockwise direction and note any movement of the beam from this position. Rotate the corresponding BALANCE control, located just in front of the GAIN control, until the spot returns to the original position. When the BALANCE control is properly set, turning the GAIN will not move the spot more than 1/16 of an inch. In most cases the balance can be adjusted so that no movement of the spot is observed.

SECTION IV

OPERATION AND CIRCUIT

The operation of the S-14-B POCKETSCOPE can be more readily understood if the schematic diagram is consulted while reading the explanation below.

Basically, the S-14-B is a complete oscilloscope having a cathode ray tube, vertical and horizontal amplifiers, a time base generator which can be synchronized from internal or external source in either the repetitive or trigger mode of operation, provisions for modulating the intensity of cathode ray tube trace and a self contained power supply.

The Waterman Rayonic 3RP1 cathode ray tube contains all of the essential parts; a cathode for producing the electron source, a number of elements for controlling and focusing these electrons into a beam as they travel toward the luminescent screen. Before the beam strikes the screen it passes through two sets of deflection plates which are used to deflect the beam in the vertical and horizontal directions.

The BEAM control is provided for varying the trace brightness. It actually varies the negative grid to cathode voltage of the 3RP1, thus regulating the amount of electrons emitted by the "gun."

The FOCUS control is provided for varying the potential of the first anode. This in turn permits complete adjustment of the sharpness of the trace.

The vertical amplifier is a dc amplifier with tubes V1 (12AU7), V2 (12AX7) and V3 (12AT7). A .1mf capacitor is connected between V INPUT AC and V INPUT DC binding posts. When ac signals are to be viewed without any accompanying dc component the V INPUT AC is used.

The V ATT switch (S1) precedes the amplifier. It has five positions. The most counterclockwise position (OFF) grounds the grid of V1 (12AU7) through R6, a 220 ohm resistor, whenever the amplifier is to be dc balanced. The second position applies 0.1 volt rms at line frequency to the vertical amplifier for calibrating the amplifier gain. The most clockwise positions are arranged as a two step attenuator of 100 to 1, 10 to 1, and a direct position which couples the input directly to the grid.

The input tube V1 is a 12AU7, with its plates tied together and is connected as a balanced bridge with each triode representing the upper elements and the cathode resistors (R7, R8 and R9) as the lower elements. R9 is a 500 ohm potentiometer which can be adjusted to equalize the voltage between the two cathodes. R10, a 1000 ohm potentiometer, and R11, an 82 ohm resistor in series with it, are wired as the cross arm of the bridge.

Hence, any unbalance in current between the two voltage paths of the bridge (the triodes and their respective cathode resistors) will appear across this arm. When a signal is applied to the grid of the upper triode, the current in that tube will change according to the instantaneous amplitude of that signal. This changed current upsets the balance in the bridge and appears as a signal between the cathodes. The resulting signal between the two cathodes is then applied to V2, a 12AX7.

In this stage the plates have identical load resistors and the cathodes are tied together. Both grids of the 12AU7 are at the same dc level so long as no signal is applied to the input of the 12AU7. R18, a 5K potentiometer between the B+ sides of the two plate load resistors, is adjusted until the voltages on both plates

are equal. The common cathode resistor R56 is in series with a rheostat R17 which is adjusted until the plates reach +90 volts dc. Because of the common cathode load, some inversion takes place in this stage and the amplified input signal appears on the plates as push-pull voltage.

The voltage at the plates of V2 (12AX7) appears at the grids of the output tube V3, type 12AT7. R19, R20 and R21 form a higher impedance shunt across the output of V2 (12AX7). By coupling this network back to a higher B+ voltage through R24, the dc voltages on the two grids can be adjusted in either direction without distorting the signal voltage. This has the effect of altering the dc voltages on the plates of V3 (12AT7) without distorting the signal. In this manner vertical positioning is introduced into the amplifier.

The plates of V3 (12AT7), which have equal load resistors, drive the deflection plates of V13 (3RP1) the cathode ray tube. The cathodes of V3 (12AT7) are tied to a common resistance R27 and R28. This arrangement fully inverts the signal so that the signal voltage appearing across the output plates is true push-pull.

The plates of V3 (12AT7) are connected to the vertical deflection plates of the cathode ray tube (V13) by way of TB1 and TB2 located behind the small rear plate cover. Removal of short wire jumpers (see location of S-14-B controls and terminals) makes the 10 megohm resistors high impedance push-pull input to the deflection plates while maintaining spot positioning control through the amplifier by means of the V POS control R19.

R28 is adjusted to a point where the average dc plate voltage is equal to that of the second anode. Condenser C7A and C7B is plate-to-opposite-grid connected to improve the high frequency response of the amplifier. R29 and C8 are part of the internal synchronization "pick off" network, and will be explained later as part of the synchronization system.

The horizontal amplifier tubes are V4 (12AU7) and V5 (12AU7) and V6 (12AT7). The horizontal amplifier is preceded by the FUNCTION and H ATT switches (S2 and S3). The first four positions of the FUNCTION switch (S3) connect the output of the linear time base generator to the sweep input of the amplifier through the internal grid (pin 7) of V4 which is bridge connected.

The most clockwise position grounds the sweep input grid of V4 (12AU7) and connects the H INPUT/SYNC through the H ATT to external INPUT grid (pin 2).

The first position (OFF) of the H ATT grounds the remaining or external input grid (pin 2) of V4 (12AU7) but not the signal for balancing the amplifier and is used to prevent accidental mixing of the calibrating voltage and the time base sweep in the horizontal amplifier whenever the FUNCTION switch is set for time base sweeps. The CAL position connects .25 volts rms of the line frequency to the external INPUT grid for calibrating the amplifier.

The next two steps (100 and 10) insert compensated attenuations of 100 to 1 and 10 to 1 between the H INPUT/SYNC terminals and the amplifier. The most clockwise position (1) directly connects the H INPUT/SYNC terminals to the input of the amplifier.

The sweep signals, which are positive going, are fed into the horizontal amplifier so that time is portrayed on the cathode ray tube screen from left to right. Hence, positive going signals fed into the amplifier through the H INPUT/SYNC terminal will deflect the trace towards the left. This is of utmost importance when the instrument is used for phase measurements. For these measurements lissajous figures are rotated 90° counterclockwise.

Signals applied to either grid appear across the cathodes just as in the vertical amplifier. However, positive going time base signals to the internal grid (pin 7) cause the spot to move from left to right. While positive going signals fed to the external grid (pin 2) cause the spot to move from right to left. R50, a 2K potentiometer, is used to balance the amplifier. The H GAIN control bridges the cathodes and feeds signal to tube V5, a 12AU7.

In this stage the plates have identical load resistors and the cathodes are tied together. Both grids of the 12AU7 are at the same dc level so long as no signal is applied to either input of V4. R58, a 10K potentiometer between the B+ sides of the two plate load resistors, is adjusted until the voltages on both plates are equal. The common cathode resistor R56 is in series with a rheostat R57 and is adjusted until the plates reach +90 volts dc. Because of the common cathode load, some inversion takes place in this stage and the amplified input signal appears on the plates as push-pull voltage.

The plates of V6 (12AT7) are connected to the horizontal deflection plates of the cathode ray tube (V13) by way of TB1 and TB2 located behind the small rear plate cover. Removal of the short wire jumpers (see location of S-14-B controls and terminals on page 5) makes the 19 megohm resistor high impedance push-pull inputs for the deflection plates while maintaining spot positioning control through the amplifier by means of the H POS control R58.

The voltage at the plates of V5 (12AU7) appears at the grids of the output tube V6, type 12AT7. R59, R60 and R61 form a higher impedance shunt across the output of V5 (12AU7). By coupling this network back to a higher B+ voltage through R62, the dc voltages on the two grids can be adjusted in either direction without distorting the signal voltage. This has the effect of altering the dc voltages on the plates of V6 (12AT7) without distorting the signal. In this manner horizontal positioning is introduced into the amplifier.

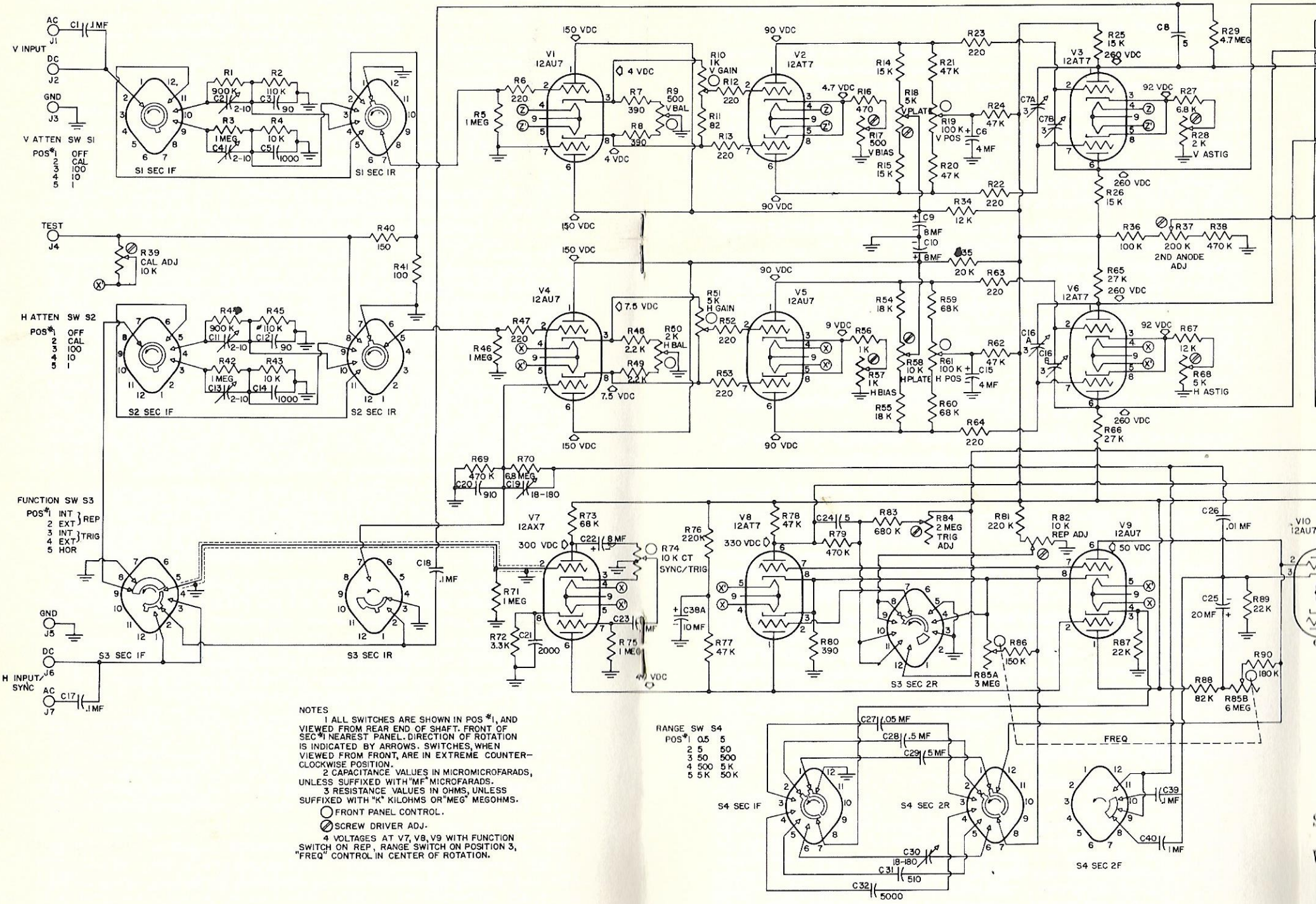
The plates of V6 (12AT7), which have equal load resistors, drive the horizontal deflection plates of V13 (3RP1) the cathode ray tube. The cathodes of V6 (12AT7) are tied to a common resistance R67 and R68. This arrangement fully inverts the signal so that the signal voltage appearing across the output plates is true push-pull.

R68 is adjusted to a point where the average dc plate voltage is equal to that of the second anode. Condenser C16A and C16B is plate-to-opposite-grid connected to improve the high frequency response of the amplifier.

The linear time base generator is connected to the horizontal amplifier whenever the FUNCTION switch is set to any of its four most counterclockwise positions. The generator is a multivibrator type which produced a linear sawtooth voltage in either the repetitive or trigger mode of operation.

The multivibrator proper, consists of V8 (12AT7) and V9 (12AU7), while V7 (12AX7) acts as a synchronization voltage amplifier. V10 (12AU7) is a grounded plate amplifier with a two-fold purpose. It couples a portion of the sweep output back into the multivibrator circuit through C25 to insure optimum sweep linearity and provides isolation between the horizontal amplifiers and the generator. The frequency, or writing speed, of the sweep is variable from 0.5 cycles to 50KC.

The output of the linear time base generator is coupled to the horizontal amplifier through an attenuating network consisting of R69, R70, C20 and C19. The compensating capacitor C19 is accessible through the plug button on the side cover.



NOTES

1 ALL SWITCHES ARE SHOWN IN POS *1, AND VIEWED FROM REAR END OF SHAFT. FRONT OF SEC *1 NEAREST PANEL. DIRECTION OF ROTATION IS INDICATED BY ARROWS. SWITCHES, WHEN VIEWED FROM FRONT, ARE IN EXTREME COUNTER-CLOCKWISE POSITION.

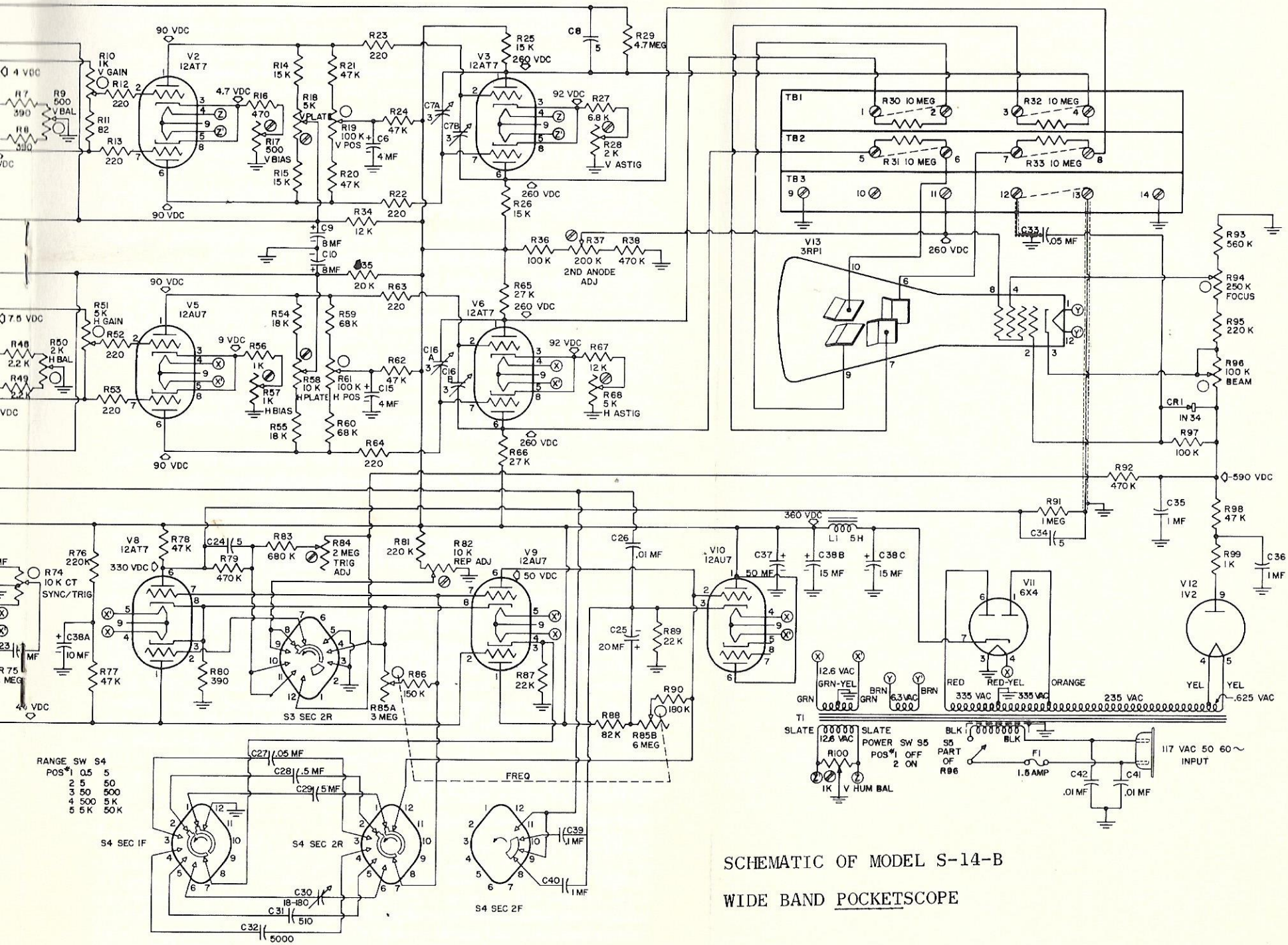
2 CAPACITANCE VALUES IN MICROMICROFARADS, UNLESS SUFFIXED WITH "MF" MICROFARADS.

3 RESISTANCE VALUES IN OHMS, UNLESS SUFFIXED WITH "K" KILOHMS OR "MEG" MEGOHMS.

◯ FRONT PANEL CONTROL.

⊘ SCREW DRIVER ADJ.

4 VOLTAGES AT V7, V8, V9 WITH FUNCTION SWITCH ON REP, RANGE SWITCH ON POSITION 3, "FREQ" CONTROL IN CENTER OF ROTATION.



SCHEMATIC OF MODEL S-14-B

WIDE BAND POCKETSCOPE

The FUNCTION switch (S3) changes the bias applied to the multivibrator which permits it to oscillate freely on repetitive operation or cut it off for trigger operations.

Synchronization can be from external or internal sources. It is to be noted that in either INT-TRIG or INT-REP position the signal voltage is attenuated down from the vertical amplifier through R29 and C8.

In V7 (12AX7), the synchronization amplifier, one triode is so connected that R74, the SYNC-TRIG control, selects the polarity of synchronization as well as the amplitude. The other triode amplifies the signal and couples it to the multivibrator.

The BEAM and FOCUS potentiometers are located below the screen of the cathode ray tube on the front of the oscilloscope.

The 2nd ANODE ADJ (R37) is for setting the voltage of the 2nd anode equal to the mean voltage of the deflection plates.

When the unit is shipped from the factory wire jumpers are connected between terminals 12 and 13 located on TB3 behind the cover door on the rear of the instrument. This connects a blanking pulse from the sweep generator to the cathode ray tube grid. This dims the beam during the return time of each sweep of the horizontal. When these jumpers are removed external signals can be applied to the grid.

The power transformer T1 supplies all the necessary voltages for operating the unit. V11 is a type 6X4 tube for supplying the B+. The negative supply utilizes a IV2 (V12) half wave rectifier.

The power switch S5 (a part of R96) applies the line voltage to T1. The fuse F1, which is replaceable from the front, provides overall protection.

AMPLIFIER BALANCING

Since checking or adjusting the amplifier balance consumes little time, this operation should be checked each time the oscilloscope is turned on.

Control Setting: V ATT and H ATT to OFF; V and H GAIN to minimum (CCW); V and H POS to center beam on cathode ray tube screen.

Procedure: After a few minutes warm up, advance the corresponding GAIN control in clockwise direction and note any movement of the beam from this position. Rotate the corresponding BALANCE control, located just in front of the GAIN control, until the spot returns to the original position. When the BALANCE control is properly set, turning the GAIN will not move the spot more than 1/16 of an inch. In most cases the balance can be adjusted so that no movement of the spot is observed.

CALIBRATION TECHNIQUES

Internal Calibration Voltages

Connect the input voltage to the V INPUT terminal and turn the H ATT control to OFF (or vice versa). Then any ac input signal voltage will appear as a straight vertical line, whose length is proportional to the input voltage. DC input voltages will appear as a spot displacement proportional to the dc input voltage. The difference in trace length and input sensitivities between the vertical and horizontal axis permit a judicious choice for any given voltage. (Larger voltages through the H INPUT, lower voltages through the V INPUT.)

Fixed Scale Method

The vertical calibration voltage is 100 millivolts rms at line frequency. The horizontal calibration signal is equal to 250 millivolts rms at line frequency.

Since a calibration voltage is available by rotating the ATT switch to CAL, it is possible to select a setting of the GAIN control so that the calibration voltage is equal to a given deflection. Any fraction or multiple thereof is then easily interpolated.

If the vertical calibration voltage deflection is set equal to one inch; signal inputs causing one inch deflection will equal 10V rms when the V ATT is set to 100, and 1V rms when the V ATT is set to 10. Half inch deflection will equal 5V rms, .5V rms respectively. This technique is also applicable to horizontal inputs, keeping in mind that the calibration voltage is equal to 250 millivolts rms.

Variable Scale Method

Adjust the GAIN and ATT controls so that the incoming signal causes a conveniently usable amount of deflection. Using the graph screen supplied with the POCKETSCOPE note the number of scale divisions occupied by this signal. For dc signals note number of divisions of spot displacement. (There are 10 such divisions per inch on the graph screen.)

Rotate the ATT switch to CAL and note the number of divisions occupied by the calibrating voltage. Use the following formula to calculate the signal voltage.

$$\text{Signal in millivolts rms} = \frac{DS}{DC} \times \text{CAL voltage} \times \text{ATT setting}$$

Where: DS = amplitude of signal in scale divisions

DC = amplitude of calibration voltage in scale divisions

External Calibration Voltages

Any known external voltage may be substituted for the internal calibration voltages. Again either the fixed or variable scale methods may be employed.

There is, however, a calibrating technique peculiar to dc coupled oscilloscopes.

The dc coupled amplifiers permit the observation of the ac component of a complex wave in relation to its dc level. By adjusting the GAIN control to calibrate the amplifiers sensitivity, as described under the fixed scale method above, the ac swings with respect to the dc may be viewed.

For example, in observing the behavior of the plate voltage in a simple resistance coupled amplifier, it is possible to move the trace to a line at the bottom of the cathode ray tube screen when the V ATT is at OFF and the V GAIN to minimum. This will, therefore, represent zero voltage—or ground. The B+ is connected to the V INPUT DC terminal and the V ATT and V GAIN are adjusted until the trace moves to a position near the upper extreme of the screen. The plate voltage is connected to the oscilloscope (in place of the B+) without disturbing the V POS, V ATT and V GAIN setting. The plate signal will be displayed in true relation to ground and B+. Thus, it is possible to view the plate waveform and more readily understand any distortion or inconsistencies.

The same technique can be employed for viewing signals in any circuit. Other potentials can be substituted for either B+, ground or both depending upon the particular limits desired to be viewed.

SECTION V

MAINTENANCE

Access to the equipment inside may be obtained by removing the screws which hold the side plates to the cabinet.

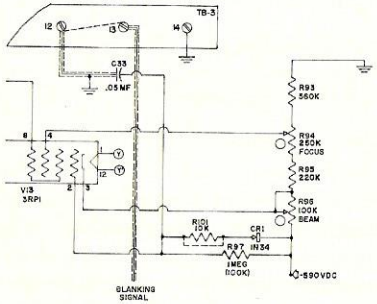
Under ordinary usage, the life of the tubes is consistent with that obtained in other applications. However, due to the DC amplifiers used, it is necessary to balance the unit whenever the tubes in either the horizontal or vertical amplifiers are changed. Instructions for this are given below under AMPLIFIER BALANCING.

The determining factor in life of the Waterman Rayonic 3RP1 Cathode Ray Tubes is deterioration of their luminescent screens. It is, therefore, advisable not to leave a bright concentrated spot on the screen. The approach to the limit of useful life is indicated by the inability to obtain satisfactory focus and by the screen becoming streaked and spotted.

The Schematic Diagram and the Replacement Parts List give the value of all parts, so that resistance and continuity checks can be readily made. A table of tube voltages as well as a tube location chart are listed at the end of this section.

The Blanking Coupling Circuit shown in the small diagram differs from the schematic diagram in that the value of R97 has been changed to 1 megohm and resistor R101, 10K, is inserted between C33 and the diode 1N34. The S-14-B POCKETSCOPES beginning with serial number 1262 are wired accordingly. Instruments bearing previous serial numbers are as per the main schematic diagram. In a few instruments bearing early serial numbers, though wired as per the main schematic, the value of R97 is 1 megohm.

It is recommended that R101, 10K, be inserted as shown and the value of R97 changed to 1 meg, to prolong the life of the crystal, and insure better blanking.



Dotted Line and/or Values
In ( ) Indicate Previous Circuit.
This Change Is Effective Serial #1262

BLANKING COUPLING CIRCUIT S-14-B

CONTROL ADJUSTMENTS

From time to time it may become necessary to make adjustments to the oscilloscope. Usually these adjustments must be checked after the replacement of parts. Below are listed the explanation and procedure for all the adjustments. By necessity, the setting of the basic controls such as BEAM, FOCUS, etc., have been omitted.

ASTIGMATIC: If the beam becomes defocused as it approaches the edge of the screen, the output plate voltage of the amplifiers require resetting. The mean voltage of the deflection plates which are directly connected to the output amplifier plates, must equal the second anode voltage.

Control Setting: V ATT and H ATT to OFF; V GAIN and H GAIN to minimum (ccw); V POS and H POS to approximate mechanical center. Both BALANCE to proper setting as per directions in Section IV.

Procedure: Remove the cover plate from under side and rear of the POCKETSCOPE. Connect a dc voltmeter between terminal 11 on TB3 and ground. Rotate 2nd ANODE ADJ (R37) control, which is accessible from the underside of the unit, until the voltage reads +260 volts. Measure voltage of the output amplifier plates (pins 4 and 8 of TB1 and TB2 for the vertical amplifier and pins 1 and 5 for horizontal amplifier), and adjust each POS control until these voltages are equal to each other. Adjust their ASTIG controls (R28 and R68), which are accessible from the underside of the unit, until the voltage at these plates equals +260 volts.

HUM BALANCE: Because of the sensitivity of the vertical amplifier, slight hum levels in the first stage could appear on the cathode ray screen. Therefore, provisions are made to balance out any such hum by carefully selecting the center voltage of each filament winding.

Control Setting: V ATT control to OFF; V GAIN controls to maximum (cw); H ATT control to OFF; FUNCTION to INT-REP; H GAIN for 2½ inch trace; RANGE to 5-50; FREQUENCY for approx. 20 cycles sweep.

Procedure: Adjust HUM control (see schematic diagram) located on under side of unit for minimum hum signal on the cathode ray tube screen.

POSITIONING RANGE: When the setting of either POS control is noticeably different from its mechanical center setting, positioning has become more limited in one direction than the other. This is corrected by the following method.

Control Setting: V ATT and H ATT controls to OFF; V GAIN and H GAIN controls to minimum (ccw); FUNCTION to HOR; V POS and H POS controls to approximately center.

Procedure: Rotate the V PLATE and H PLATE control until the spot returns to the center of the cathode ray tube screen.

AMPLIFIER BIAS: The gain and voltages of the output amplifiers are to a great extent controlled by the voltage appearing at the plates of the preceding stage (V2 or V5).

Control Setting: Remove both side covers from the instrument. V ATT and H ATT controls to OFF; V GAIN and H GAIN controls to minimum (ccw); FUNCTION to HOR; V POS and H POS controls to center spot on screen of the cathode ray tube.

Procedure: Use a dc voltmeter to compare both plate voltages of each amplifier to ground. Reset each POS control until these plates are equal. Now adjust the corresponding BIAS control located on the under side of the unit until the plates are at +90 volts.

REPETITIVE SWEEP ADJUSTMENT: Since the sweep generator is basically a multivibrator in which the bias is set to permit repetitive or trigger operation it is necessary to select the optimum bias voltage for repetitive operation.

Control Setting: V ATT control to CAL; V GAIN control for approximately one inch deflection; FUNCTION control to INT-REP; H ATT

control to OFF; H GAIN control for approximately two inches of deflection; SYNC SEL control to REP—INT; RANGE control to 50-500; SYNC ADJ control in clockwise direction from "O"; FREQUENCY for one cycle on screen.

Procedure: Adjust REP ADJ control (R82) located on the under side of the unit for optimum between maximum horizontal amplitude and minimum distortion of the right hand portion of the pattern.

TRIGGER SWEEP ADJUSTMENTS:

Control Setting: V ATT to CAL; V GAIN to maximum (cw); FUNCTION control to INT-TRIG; H ATT to OFF; H GAIN approximately halfway; RANGE to 0.5-5; SYNC ADJ to "O"; FREQUENCY to "5".

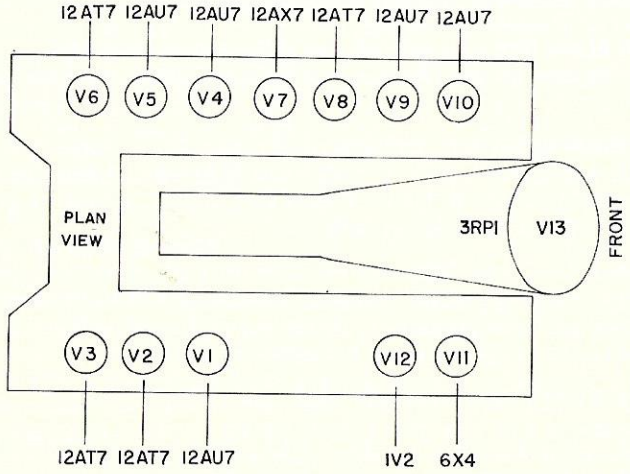
Procedure: Adjust TRIG ADJ (R84) until sweep generator no longer puts out a signal. Rotating SYNC ADJ in either direction from "O" should "fire" sweep generator. Repeat with RANGE to 5-50 and repeat again with RANGE set to 50-500.

CALIBRATION VOLTAGE: On rare occasions it may become necessary to re-adjust the CAL voltage.

Control Setting: V ATT control to appropriate setting (See Procedure below) V GAIN to maximum (CW); H ATT to GND; FUNCTION to HOR.

Procedure: From a known source connect 10 volts rms (V ATT at 100) or 1 volt rms (V ATT at 10) etc. to the V INPUT and adjust V GAIN for a convenient trace length, carefully noting total deflection. Turn V ATT to CAL and adjust the CAL ADJ potentiometer (R39) until the deflection is equal to the previous. All CAL voltages are now adjusted since R39 is in series with all the calibration network.

For convenience in trouble shooting, a table of tube voltages, a tube location chart, and list of replacement parts are included.



S-14-B TUBE LOCATIONS

TUBE VOLTAGE CHART

Pin	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13
1	150	90	260	150	90	260	300	45	360	360	335 AC	—	U
2	0	4	90	0	7.5	90	0	.7	45	50	—	—	-610
3	4	4.7	92	7.5	9	92	3.5	.8	65	67	Gnd.	—	-560
4	Z	Z	Z	6.3 AC	6.3 AC	6.3 AC	6.3 AC	6.3 AC	6.3 AC	6.3 AC	6.3 AC	T670 AC	-340
5	Z	Z	Z	6.3 AC	6.3 AC	6.3 AC	6.3 AC	6.3 AC	6.3 AC	6.3 AC	—	T670 AC	—
6	150	90	260	150	90	260	45	330	50	—	335 AC	—	260
7	0	4	90	0	7.5	90	0	-20	-20	—	365	—	260
8	4	4.7	92	7.5	9	92	.25	.8	.8	—	—	—	260
9	—	—	—	—	—	—	—	—	—	—	—	-660	260
10													260
11													—
12													U

Voltages as referenced to ground with vacuum tube voltmeter of at least 10 Meg. input resistance with range switch in center range, function switch on "REP" and "FREQ" control in center of rotation. Based on 117 V. line supply.

U Not referenced to ground. Read from pins 1 to 12. Normal voltage 6.3 VAC.
T To obtain filament voltage, read from pins 4 to 5. Normal voltage 0.625 VAC.
Z Ground return through V hum pot. Read from pins 4 to 5. Normal voltage 12.6 VAC.

D. C. voltages given are nominal with oscilloscope in operation with centered trace of normal brilliance and depend upon tube characteristics, adjustments and panel control settings. For detailed information relative to adjustments affecting the voltages given in this chart, see adjustment instructions.

SECTION VI
S-14-B REPLACEMENT PARTS LIST

INSIST UPON FACTORY-TESTED PARTS ON ALL ITEMS MARKED WITH ASTERISK. ALL OTHER STANDARD PARTS MAY BE MORE READILY PURCHASED FROM YOUR REGULAR SOURCES.

SYMBOL	DESCRIPTION	PART NUMBER
C1, C17, C18, C23	Capacitor, .1 mf, 400V, paper tubular	CPB001-001*
C2, C4, C11, C13	Capacitor, 1.5-10 mmf, 300V, Ceramic tubular	CZB002-001*
C3, C12	Capacitor, 90 mmf, 500V, mica CM15	CMA771-091
C5, C14	Capacitor, 1000 mmf, 500V, mica CM20	CMA701-102
C6, C15	Capacitor, 4 mf, 450V, electrolytic tubular	CDB003-009*
C7, C16	Capacitor, Dual neutralizer	CZB006-A01*
C8, C24, C34	Capacitor, 5 mmf, 500V, ceramic tubular	CCZ004-001
C9, C10	Capacitor, 8 mf, 250V, electrolytic tubular	CDB003-010*
C19, C30	Capacitor, 18-180 mmf, compression trimmer	CXA002-003
C20	Capacitor, 910 mmf, 300V, mica CM20	CMA800-911
C21	Capacitor, .002 mf, 400V, paper tubular	CPB003-001*
C22	Capacitor, 8 mf, 350V, electrolytic tubular	CDB003-006*
C25	Capacitor, 20 mf, 250V, electrolytic tubular	CDB003-007*
C26	Capacitor, .01 mf, 200V, paper tubular	CPB003-009
C27	Capacitor, .05 mf, 200V, paper tubular	CPB003-005
C28	Capacitor, .5 mf, 200V, metal paper tubular	CPM002-001*
C29	Capacitor, 5 mf, 150V, metal paper tubular	CPM003-001*
C31	Capacitor, 510 mmf, 300V, mica CM15	CMA770-511
C32	Capacitor, .005 mf, 200V, paper tubular	CPB003-002
C33	Capacitor, .05 mf, 1000V, paper tubular	CPB003-006
C35, C36	Capacitor, 1 mf, 600V, metal paper tubular	CPM002-002
C37	Capacitor, 50 mf, 350V, electrolytic can	CDC003-002*
C38	Capacitor, 10 x 10 x 10 mf, 350V, electrolytic can	CDA016-003*
C39	Capacitor, .1 mf, 200V, paper tubular	CPB003-010*
C40	Capacitor, 1 mf, 200V, paper tubular	CPM002-003*
C41, C42	Capacitor, .01 mf, 400V, paper tubular	CPB003-003*
F1	Fuse, 1.5 amp, type 3AG	SFG001-008
J1, J2, J3, J4, J5 J6, J7	Binding Post	ETP001-001*
R1, R44	Resistor, 900K ±1%, 1/2W, carbofilm	RQC001-024*
R2, R45	Resistor, 100K ±1%, 1/2W, carbofilm	RQC001-025*
R3, R42	Resistor, 1 Meg ±1%, 1/2W, carbofilm	RQC001-012*
R4, R43	Resistor, 10K ±1%, 1/2W, carbofilm	RQC001-026*
R5, R46, R71, R75, R91, R97	Resistor, 1 Meg, 1/2W, composition	RCC010-105
R6, R12, R13, R22, R23, R47, R52, R53, R63, R64	Resistor, 220 ohms, 1/2W, composition	RCC020-221
R7, R8	Resistor, 390 ohms, 1/2W, composition	RCC005-391
R9	Potentiometer, 500 ohms, linear taper	RVD001-012*
R10	Potentiometer, 1K, linear taper	RVD001-014*
R11	Resistor, 82 ohms, 1/2W, composition	RCC010-820
R14, R15	Resistor, 15K, 1/2W, composition	RCC010-153
R16	Resistor, 470 ohms, 1/2W, composition	RCC020-471
R17	Potentiometer, 500 ohms, linear taper	RVD001-018*
R18, R68	Potentiometer, 5K, linear taper	RVD001-004*
R19, R61	Potentiometer, 100K, linear taper	RVD001-015*
R20, R21, R24, R62, R98	Resistor, 47K, 1/2W, composition	RCC020-473
R25, R26	Resistor, 15K, 1W, composition	RCD010-153
R27	Resistor, 68K, 2W, composition	RCE010-682
R28	Potentiometer, 2K, linear taper	RVD001-016*
R29	Resistor, 4.7 megs, 1/2W, composition	RCC020-475
R30, R31, R32, R33	Resistor, 10 meg, 1/2W, composition	RCC020-106
R34	Resistor, 12K, 10W Koolohm type 10KT	
R35	Resistor, 20K, 5W Koolohm type 5KT	
R36	Resistor, 100K, 1/2W, composition	RCC020-104
R37	Potentiometer, 200K, linear taper	RVD001-006*
R38, R69, R79, R92	Resistor, 470K, 1/2W, composition	RCC020-474
R39, R58, R82	Potentiometer, 10K, linear taper	RVD001-007*
R40	Resistor, 150 ohms, ±1%, 1/2W, carbofilm	RQC001-031*
R41	Resistor, 100 ohms, ±1%, 1/2W, carbofilm	RQC001-032*
R48, R49	Resistor, 2.2K, 1/2W, composition	RCC010-222
R50	Potentiometer, 2K, linear taper	RVD001-017*
R51	Potentiometer, 5K, linear taper	RVD001-001*
R54, R55	Resistor, 18K, 1/2W, composition	RCC010-183
R56, R99	Resistor, 1K, 1/2W, composition	RCC020-102

R57, R100	Potentiometer, 1K, linear taper	RVD001-008*
R59, R60, R73	Resistor, 68K, 1/2W, composition	RCC020-683
R65, R66	Resistor, 27K, 1W, composition	RCD010-273
R67	Resistor, 12K, 1W, composition	RCD010-123
R70	Resistor, 6.8 meg, 1/2W, composition	RCC020-685
R72	Resistor, 3.3K, 1/2W, composition	RCC010-332
R74	Potentiometer, 10K, linear taper	RVD001-003*
R76	Resistor, 220K, 1W, composition	RCD010-224
R77	Resistor, 47K, 1W, composition	RCD020-473
R80	Resistor, 390 ohms, 1/2W, composition	RCC010-391
R81, R95	Resistor, 220K, 1/2W, composition	RCC020-224
R83	Resistor, 680K, 1/2W, composition	RCC020-684
R84	Potentiometer, 2 meg, linear taper	RVD001-009*
R85	Potentiometer, dual, 3 meg & 6 meg, linear taper	RVD001-013*
R86	Resistor, 150K, 1/2W, composition	RCC010-154
R87	Resistor, 22K, 2W, composition	RCE020-223
R88	Resistor, 82K, 1/2W, composition	RCC010-823
R89	Resistor, 22K, 1W, composition	RCD020-223
R90	Resistor, 180K, 1/2W, composition	RCC010-184
R93	Resistor, 560K, 1/2W, composition	RCC010-564
R94	Potentiometer, 250K, linear taper	RVD001-010*
R96	Potentiometer, 100K, linear taper, with power switch	RVD001-011*
R101	Resistor, 10K, 1/2W, composition	RCC010-103
S1	Switch, rotary, 5 positions 1 section	SWR031-005*
S2	Switch, rotary, 5 positions 1 section	SWR031-006*
S3	Switch, rotary, 5 positions 2 sections	SWR031-002*
S4	Switch, rotary, 5 positions 2 sections	SWR031-001*
S5	Switch, part of R96	
T1	Transformer, power	LPU012-001*
V1, V4, V5, V9, V10	Tube, 12AU7	
V2, V3, V6, V8	Tube, 12AT7	
V7	Tube, 12AX7	
V11	Tube, 6X4	
V12	Tube, IV2	
V13	Tube, cathode ray, 3RP1	Waterman Rayonic 3RP1
CR1	Crystal, IN34	
	Cover, rear	MPA010-001-990*
	Ring, Escutcheon	MPA030-001-240*
	Rubber, Escutcheon	INB001-001*
	Strap, leather	ILB002-001*
	Bumper feet	INA016-001*
	Knob, large pointer	NKB003-001*
	Knob, small pointer	NKB001-001*
TB1	Terminal Board (TB1) engraved 1-4	ETB002-001*
TB2	Terminal Board (TB2) engraved 5-8	ETB002-002*
TB3	Terminal Board (TB3) engraved 9-14	ETB002-004*

WARRANTY

The Waterman Products Company, Inc., warrants the instrument manufactured by it to be free from defective material and workmanship and agrees to remedy any such defects or to furnish a new part in exchange for any part of the instrument which, under normal installation, use and service discloses such defect, provided the unit is delivered by original registered owner to us intact, for our examination, with all transportation charges prepaid to our factory, within ninety days from the date of sale to original purchaser and provided that such examination discloses in our judgment that it is thus defective. In no event can the instrument be returned to us without requesting return order authorization.

This warranty does not extend to any of our instruments which have been subjected to misuse, neglect, accident, incorrect wiring not our own, or to use in violation of instructions furnished by us, nor extend to units which have been repaired or altered outside of our factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith not of our manufacture.

Any part of instrument approved for remedy or exchange hereunder will be remedied or exchanged by us without charge to the owner.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with sale of our products.

Replacement part orders will be billed at current net prices. Shipping will be via best way to any point within the Continental United States unless specified in your order.

All prices and design are subject to revision without notice.

MODEL S-14-B

Serial No._____ Date Purchased_____

From_____

_____

NOTICE

In all correspondence, it is best to include the serial number as well as the model number of your instrument. The serial number is stamped on the bottom of the instrument and your reference to it may often facilitate satisfaction.

Nov. 1955

S-14-B Modifications

This S-14-B POCKETSCOPE includes the latest circuit changes designed for improved synchronization characteristics.

A sweep clamping circuit has been added so that the trace expands from left to right when the horizontal gain control is advanced. This also maintains the trace in its same relative position regardless of changes in the triggering rate. Provisions are made for disconnecting the clamp whenever desired by simply removing the jumper wire on the two terminal boards located just behind the right side cover above W10.

The following resistor values have been changed to the values shown:

Change	From	To
R72	3.3K	2.2K
R76	220K	68K
R80	390	470

The clamp is wired as below: