Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

MODEL 476 MIRROSCOPE

SIMPSON ELECTRIC COMPANY

5200 West Kinzie St., Chicago 44, Illinois. COlumbus 1-1221

In Canada, Bach-Simpson, Ltd., London, Ontario

Price $1.50

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FIG. 1. THE MODEL 476 MIRROSCOPE.

MODEL 476 MIRROSCOPE

GENERAL

Simpson takes pleasure in presenting the new and revolutionary Model 476 Mirroscope.

The Simpson Model 476 Mirroscope was designed with specific objectives in mind that eliminate certain inherent disadvantages found in conventional types of equipment.

By use of the Mirroscope principle, the 5″ cathode ray tube is mounted in a vertical position. This construction reduces bench space requirements to an area of only 9″ x 8″; thereby permitting better concentration of associated equipment for any type of test procedure.

The cathode ray image is reflected from a high grade front surface mirror mounted in the adjustable cover at the top of the cabinet; thus, the viewing surface is brought near eye level when the instrument is used on benches of normal height. The mirror angle is quickly and easily adjusted to any convenient position by the operator.

The cover, with integral side wings, forms an effective shield against external light sources, and may be closed down for protection of the tube and mirror when the instrument is not in use.

The upright construction permits location of controls and connections for maximum convenience, and allows for internal cathode ray tube connections on the front panel instead of at the rear.

The electrical specifications of Model 476 are as follows:

Sensitivity:

Vertical direct	12 volts rms per inch
Vertical amplifier	20 millivolts rms per inch
Horizontal direct	14 volts rms per inch
Horizontal amplifier.....	38 millivolts rms per inch

Input Impedance:

Vertical direct.........	10 megohms, 15 mmf
Horizontal direct	10 megohms, 15 mmf
Vertical amplifier.......	300,000 ohms, 30 mmf
Horizontal amplifier	500,000 ohms, 15 mmf

Horizontal trace expansion is over four times tube diameter. This makes it possible to examine minute portions of a response pattern for finer detail.

Linear sweep frequency is continuously adjustable in five overlapping ranges from 15 cycles to 60,000 cycles. Internal, external, or line frequency synchronization is available with variable amplitude.

Means for intensity, or "Z axis", modulation is provided. Approximately 14 volts peak will blank a trace of normal intensity.

The vertical amplifier frequency response is within 3 db from 20 cycles to over 300,000 cycles, and is useable to well over three megacycles. Square wave slant and overshoot are held to less than five per cent of amplitude. This response will be found adequate for all phases of television receiver service, including observation and diagnosis of TV sync signals.

A circular piece of plastic, marked as a graph with 10 lines per inch, mounts over the top of the cathode ray tube with the aid of three spring clips. By viewing the face of the tube through the plastic graph, the operator can analyze any wave form for balance and homogeneity, or compare amplitudes of either vertical or horizontal inputs. It is possible, when moving the Mirroscope, to cause the plastic graph unit to be loosened from its mounting around the tube due to vibration. If this should occur with the top cover closed, the graph could cause damage to the mirror surface unless this surface is protected. Observe the following:

> **CAUTION:**
>
> Protect the surface of the mirror from damage by inserting the original packing material, or equivalent, over the top of the plastic graph when closing the top cover prior to shipping.

Tube Complement:

1 - 5UP4	Cathode Ray Tube
4 - 6J6	Horizontal and Vertical Amplifiers
1 - 12AU7	Vertical Preamplifier
1 - 6J6	Linear Sweep Oscillator and Sync Injector
2 - 6X4	High Voltage Rectifiers

Size:

Height--16-1/4" Width--9-1/8" Depth--8" over-all

Weight:

24 pounds Shipping Weight--30 pounds.

CAUTION

DO NOT CLEAN MIRROR BY ORDINARY MEANS.

The Mirroscope Mirror is a front surface optical type, and can be seriously damaged by improper cleaning.

Fingerprints, dust, loose particles, etc., can usually be removed with clean, dry absorbent cotton, using short light strokes.

For more stubborn cases, apply a small quantity of WINDEX with clean absorbent cotton. Allow the WINDEX sufficient time to dissolve the dirt or foreign matter before wiping the mirror; then brush clean with dry cotton, using light strokes.

NEVER USE CLOTH OR PAPER.

NEVER USE PRESSURE.

OPERATION

Front Panel Controls and Their Functions.

FOCUS--This control is used to adjust the sharpness of the trace or point of light on the screen.

INTENSITY--This control enables the operator to adjust the brilliance of the spot or trace.

VERT. CENTERING--Positions the trace or spot vertically on the face of the cathode ray tube at any desired point.

HORIZ. CENTERING--Positions the trace or spot horizontally on the face of the cathode ray tube at any desired point.

SYNC.--This control enables the operator to hold a trace or pattern stationary on the face of the tube by controlling the amplitude of synchronizing signal fed into the sweep circuit. It keeps the horizontal sweep in step with the vertical signal.

SWEEP RANGE--Selects the frequency range for the horizontal linear sweep. The exact frequency within any range will be selected with the RANGE FREQUENCY control.

RANGE FREQUENCY--This control is used in conjunction with the SWEEP RANGE control. It is the fine adjustment which selects the exact horizontal sweep frequency desired for operation.

FUNCTION--This is a 5 position switch which controls the power input and selects the desired horizontal deflection signal. The power is off in the OFF position of the switch, and is on in the INT. SYNC., LINE SYNC., EXT. SYNC., and HOR. AMP. positions. In addition, it makes the following connections in its 5 positions:

1. OFF.--Opens the circuit for the power input.

2. INT. SYNC.--A linear sweep is applied to the horizontal amplifier, and a portion of the VERT. INPUT signal is applied into the sweep circuit through the SYNC. control. If the VERT. INPUT frequency is near the fundamental or a harmonic of the sweep frequency, the pattern can be locked steady on the screen of the cathode ray tube V9.

3. LINE SYNC.--A linear sweep is applied to the horizontal amplifier. A 60 cycle pulse is injected into the sweep circuit through the SYNC. control which allows the linear sweep to be locked in sync with the line frequency. This is useable for 20, 30, 60, 120, and 180 cps, and other subharmonics and harmonics of 60 cycles.

4. EXT. SYNC.--A linear sweep is applied to the horizontal amplifier. An external signal is injected into the sweep circuit through the EXT. SYNC. connection and the SYNC. control on the front of the scope.

5. HOR. AMP.--In this position an external signal should be applied to the HORIZ. INPUT connection on the front of the scope to be amplified by the horizontal amplifier and applied to the horizontal deflection plates of the Mirroscope cathode ray tube. Always set the SWEEP RANGE at OFF when the FUNCTION switch is in the HOR. AMP. position.

VERT. GAIN--This control adjusts the amplitude of the signal fed into the vertical preamplifier and, thus, controls the height of the pattern on the viewing screen.

VERT. ATTENUATOR--This control is a 4 step attenuator with ranges of 0 to .5 volts, 0 to 5 volts, 0 to 50 volts, 0 to 500 volts. Never apply a voltage in excess of the amount marked for any position. An excess voltage on any range may give a faulty pattern or may possibly cause internal damage in the Mirroscope. In order to facilitate the adjustment of the VERT. GAIN control, set the VERT. ATTENUATOR in as low a position as possible, considering the above limitations.

HORIZ. GAIN--This is a potentiometer which adjusts the input to the horizontal amplifier to produce the desired width of pattern on the screen of the cathode ray tube. This control determines the horizontal deflection for either the external horizontal input, or the internal sweep circuit.

HORIZ. SENS.--This 2 position switch is in series with the signal fed in at the HORIZ. INPUT terminal before it reaches the horizontal amplifier. The HORIZ. SENS. is marked "HIGH" for the closed position of the switch. The HORIZ. SENS. is marked "LOW" for the open position of the switch, and a 12 megohm resistor is placed in series with the input to the HORIZ. GAIN.

TERMINAL POSTS ON FRONT OF SCOPE.

GND.--Two ground terminal posts are provided, one on each side, on the front panel for grounding input circuits.

VERT. INPUT--Any signal connected between this terminal and GND. will be coupled through an isolating amplifier to the vertical amplifier to be used for vertical deflection.

60~ TEST SIGNAL--A 6.3 volt, 60 cycle signal is available at this connection for any outside use including calibration of the sweep frequency of the Mirroscope.

EXT. SYNC.--When the function control is in the EXT. SYNC. position, any signal connected between the EXT. SYNC. terminal and the GND. terminal will be coupled into the SYNC. control.

HORIZ. INPUT--Any signal connected between this terminal and GND. can be fed into the horizontal amplifier if the FUNCTION switch is in HOR. AMP. position. (Turn SWEEP RANGE to OFF.)

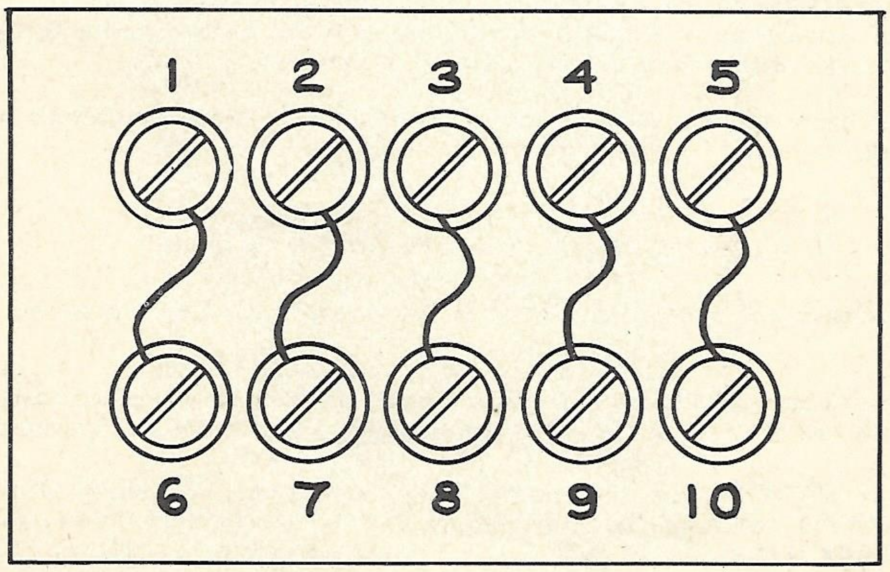


FIG. 2. INTERNAL OSCILLOSCOPE CONNECTIONS.

DIRECT INPUT TERMINALS.

Refer to figure 1 for the location on the front panel of the cover plate marked "REMOVE FOR INTERNAL OSCILLOSCOPE CONNECTIONS." When the four mounting screws are removed and this plate is taken off, a terminal board with 10 numbered terminals appears as shown in figure 2. Note that jumper wires connect the following terminal pairs: 1 and 6, 2 and 7, 3 and 8, 4 and 9, and 5 and 10. In the schematic diagram, Figure 14, these jumpers are shown with broken lines.

To insert a horizontal, or X axis, direct input, loosen the screws at terminals 9 and 10 and disconnect the jumpers; then connect the two input leads to terminals 9 and 10.

To insert a vertical, or Y axis, direct input, loosen the screws at terminals 6 and 7 and disconnect the jumpers; then connect the two input leads to terminals 6 and 7.

To insert an intensity, or Z axis, direct input, loosen the screw at terminal 8 and disconnect the jumper. Then connect the two input leads to terminal 8 and a GND. terminal.

A-M RECEIVER ALIGNMENT.

The process of aligning a-m receivers requires the use of a signal generator. Refer to the Signal Generator Instruction Manual for specific information on setting up frequency, modulation, and connections. Most signal generators will be provided with an amplitude modulation of 400 cycles. The Mirroscope may be adjusted to reproduce the 400 cycle modulated envelope of the intermediate frequency amplifier or it may be adjusted to reproduce simply the 400 cycle audio note after the second detector. In either case, the sweep frequency of the Mirroscope should be set at 200 cycles to produce results similar to figures 4 and 5. Set the SWEEP RANGE control to 75-350~ and RANGE FREQUENCY control at approximately 6. Adjust HORIZ. GAIN for a convenient horizontal deflection (about 4 inches); FUNCTION switch at INT. SYNC.; VERT. GAIN at a position to give desired vertical deflection; and SYNC. control at as low a position as will hold the pattern steady on the face of the cathode ray tube. It may be necessary to work back and forth between the setting of the RANGE FREQUENCY and the SYNC. control.

If the receiver connection to the Mirroscope is made across any section of the i-f amplifier (for adjustment of the r-f section), the Mirroscope should have a pattern similar to figure 4. However, if the receiver output connection to the Mirroscope is made in the audio circuits (for adjustment of the i-f stages), the Mirroscope should have a pattern similar to figure 5.

In either case, the alignment should produce a maximum vertical amplitude of the picture on the Mirroscope screen.

HIGH FIDELITY A-M RECEIVER ALIGNMENT.

To properly align high fidelity receivers an understanding of what must be accomplished is important.

The i-f amplifiers in high fidelity receivers usually have a wider bandpass which is obtained by overcoupling or loading one or more of the i-f stages to obtain a double-peaked characteristic.

The accuracy of reproduction in the speaker of the modulation on the signal entering the receiver is the indication of fidelity. Low fidelity distorts the modulation and emphasizes some ranges of frequencies while degenerating others. High fidelity retains the original balance between the various portions of modulation.

The modulation of a radio-frequency carrier by an audio frequency signal is really a heterodyning action and, therefore, results in beat frequencies corresponding to the sum and difference frequencies of the r-f carrier and the various modulating audio frequencies. For each audio frequency used to modulate the carrier, two radio frequency signals are created, one equal to the carrier frequency plus the audio frequency and the other equal to the carrier frequency minus the audio frequency.

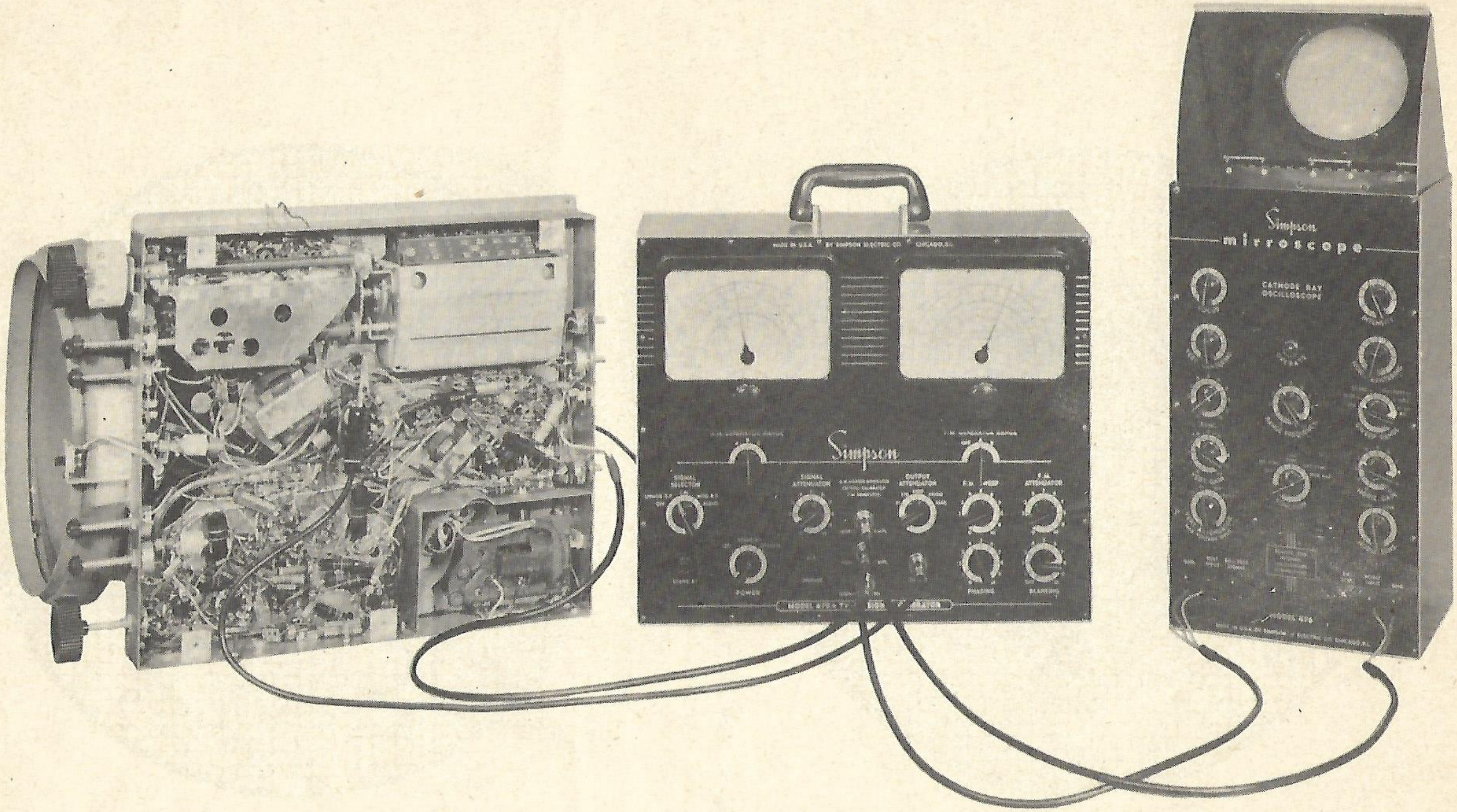


FIG. 3. TEST BENCH SETUP FOR USING A SIGNAL GENERATOR, RECEIVER, AND MIRROSCOPE.

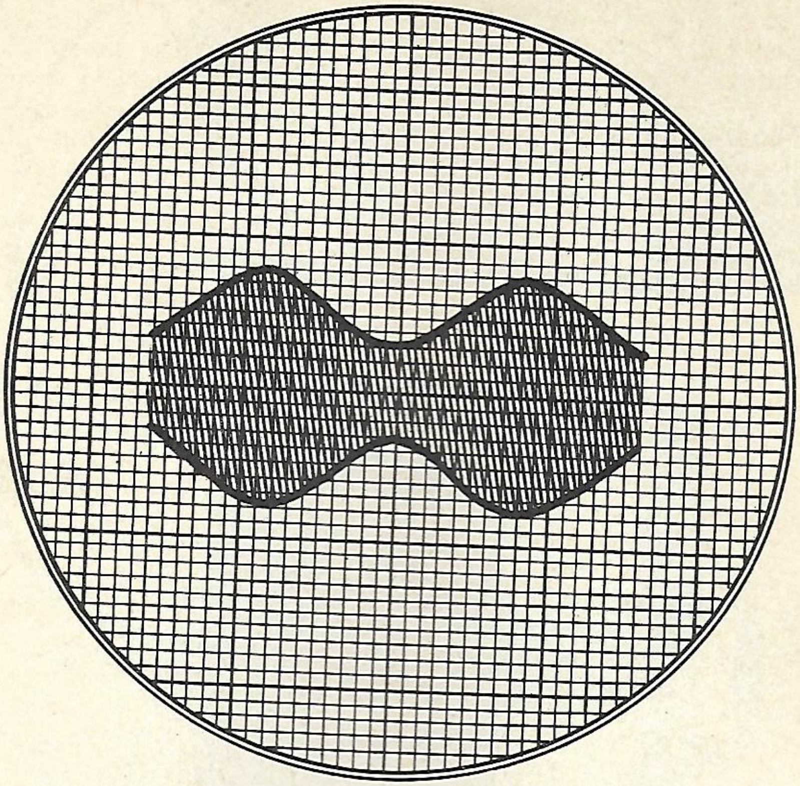


FIG. 4. 400 CYCLE MODULATED I-F ENVELOPE. 200 CYCLE MIRROSCOPE SWEEP.

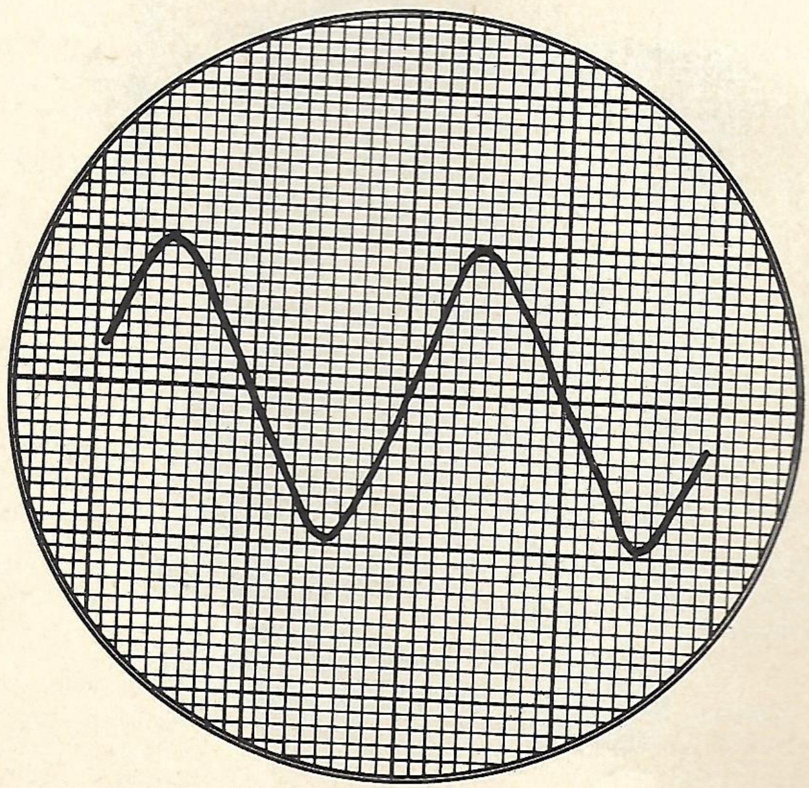


FIG. 5. 400 CYCLE SINE WAVE. 200 CYCLE MIRROSCOPE SWEEP.

A modulated signal is then made up of many side frequencies in addition to the original r-f carrier or center frequency and thus, a modulated signal occupies a frequency band equal to twice the highest modulating frequency.

Exact reproduction of the modulation carried by a broadcast signal requires that the receiver bandwidth be great enough to pass the highest modulating frequency transmitted. Also high fidelity demands that the various frequencies constituting the modulated signal pass through the receiver with no change in their relative amplitudes.

To faithfully reproduce the modulated frequencies contained in a transmitted signal which could be symphonic music, requires that the receiver be capable of amplifying, equally, all frequencies in the band from 5000 cps above the carrier frequency to 5000 cps below the carrier frequency. Uniform amplification of all frequencies in the modulated wave, which are within the i-f bandpass of the receiver, requires that alignment of a high fidelity receiver be optimum in terms of the receiver design, allowing a wider-than-normal range of frequencies to be equally amplified through it. This can best be done with an F-M Signal Generator. Set the center frequency of the signal generator at the i-f of the receiver and apply this signal through the i-f strip. Connect the output of the second detector across the VERT. INPUT and GND. terminals of the Mirroscope. Adjust the horizontal sweep frequency of the Mirroscope to 120 cycles by placing SWEEP RANGE in the 75-350~ position and RANGE FREQUENCY control between 5 and 6. Place the FUNCTION switch in INT. SYNC. position and use the SYNC. control to steady the pattern on the Mirroscope screen. Adjust the SWEEP RANGE of the signal generator to about twice the bandpass desired in the i-f strips. Adjust the tuning of the i-f transformers to provide a pattern on the Mirroscope as shown in figure 6. An A-M Signal Generator may be used as a marker generator to identify the frequencies at various points along the bandpass line.

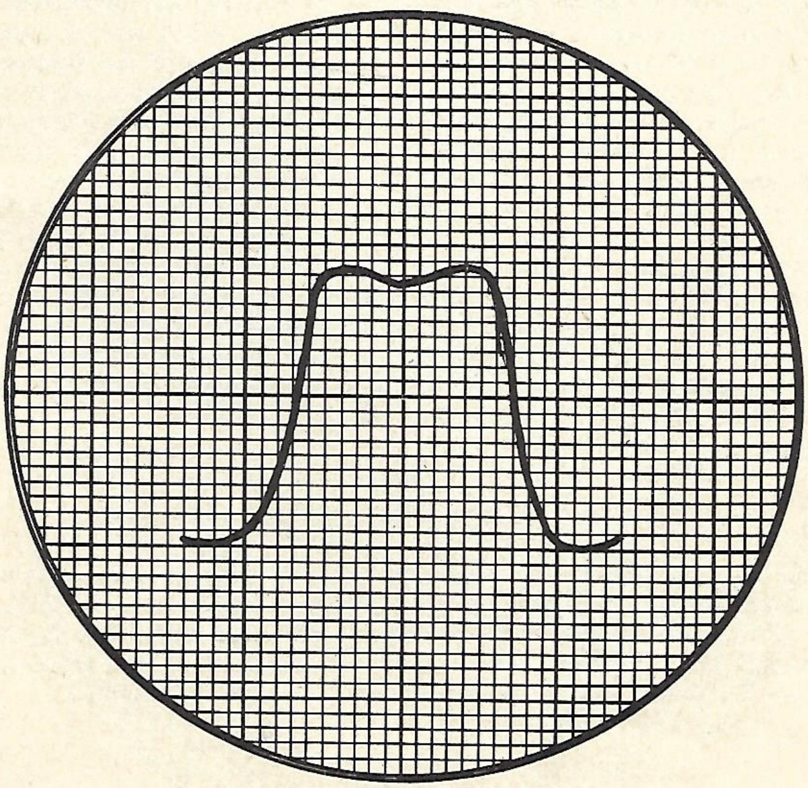


FIG. 6. I-F BANDPASS FOR HIGH FIDELITY A-M RECEIVERS.

F-M RECEIVER ALIGNMENT.

There are three separate and distinct sections of alignment proceedings for f-m receivers. Manufacturers literature or signal generator operating instructions should be consulted for the proper sequence of alignment procedure. The three divisions of alignment include the r-f amplifier, the i-f section, and the demodulator section. There are several types of demodulation devices now in use but the pattern on the Mirroscope will be the same for any of these.

R-f and i-f alignment are similar, except for the carrier frequency set up on the signal generator. In either case, the frequency of the carrier is swept back and forth through a range chosen by the operator at a steady rate of 60 cycles per second. This means that the frequency output of the generator is changed from its lowest to its highest frequency in a period of 1/120 sec. During the next 1/120 sec. the frequency is swept from the highest to the lowest frequency. Thus, the frequencies are swept in opposite directions during each subsequent 1/120 sec.

Most F-M Signal Generators have a terminal marked "HORIZONTAL AMPLIFIER", or its equivalent. When the signal generator is furnished with such a terminal, connect it across the HORIZ. INPUT and GND. terminals of the Mirroscope. Turn the FUNCTION switch to HOR. AMP. and the SWEEP RANGE to OFF. Consult the manual for the signal generator for further instructions.

If the signal generator has no horizontal amplifier output, set the Mirroscope sweep circuit at 120 cycles to observe the frequency response characteristics of the tuning stages through which the signals are passing. Since one sweep will represent the increasing frequency range while the next will represent the decreasing range, there will probably be two separate lines in the picture as shown in figure 7. If the tuning of the receiver circuits can be balanced, the two traces will be superimposed and will appear as one single trace. An a-m signal generator can be used to inject a marker signal to identify bandpass characteristics and specific frequency points on the Mirroscope trace.

The demodulation circuit takes the modulation off the carrier and produces an audio signal which may be sent through the audio amplifier circuits to the speaker. When an f-m signal generator is used, the modulation consists of a 60 cycle sine wave and the audio output of the demodulator should be made to reproduce faithfully this 60 cycle sine wave. The nature of f-m demodulation requires a balance of tuning between the two phases of the i-f output transformer such that each phase is critically tuned to a position about 75 kc away from the intermediate frequency, one higher and the other lower. An f-m signal generator using an intermediate frequency for its center frequency and a sweep range greater than twice the maximum frequency shift (150 kc) will produce a pattern on the Mirroscope screen as shown in figure 8. The Mirroscope should be adjusted to produce a 120 cycle sweep, if the signal generator does not have a horizontal sweep output. However, in most cases, the sweep circuit is taken from the signal generator to be applied to the HORIZ. INPUT and GND. terminals of the Mirroscope. Set the FUNCTION switch at HOR. AMP. and the SWEEP RANGE to OFF. Manufacturer's literature and signal generator instruction manuals should be consulted for proper adjustment procedures, but the resulting pattern on the screen of the Mirroscope needs to be balanced vertically and horizontally for an acceptable tuning indication.

AUTOMATIC FREQUENCY CONTROL ALIGNMENT.

Receivers which include automatic frequency control are provided with a circuit similar to an f-m intermediate frequency and demodulator section. The basic idea of automatic frequency control is to provide a variable voltage at the grid of the reactance tube to correct the oscillator frequency in the receiver in case of a signal shift at either the receiver oscillator or the transmitter oscillator. The alignment procedures are the same as for "F-M Receiver Alignment" above.

TELEVISION RECEIVER ALIGNMENT.

The nature of television circuits is similar to both a-m and f-m receiver circuits, except that an extremely wide bandpass is required in the tuning stages to allow all modulation to be equally amplified in passing through the receiver. R-f stages are aligned as in the "F-M Receiver Alignment" proceedings, except that a wider bandpass must be employed. Consult the manufacturer's literature for proper

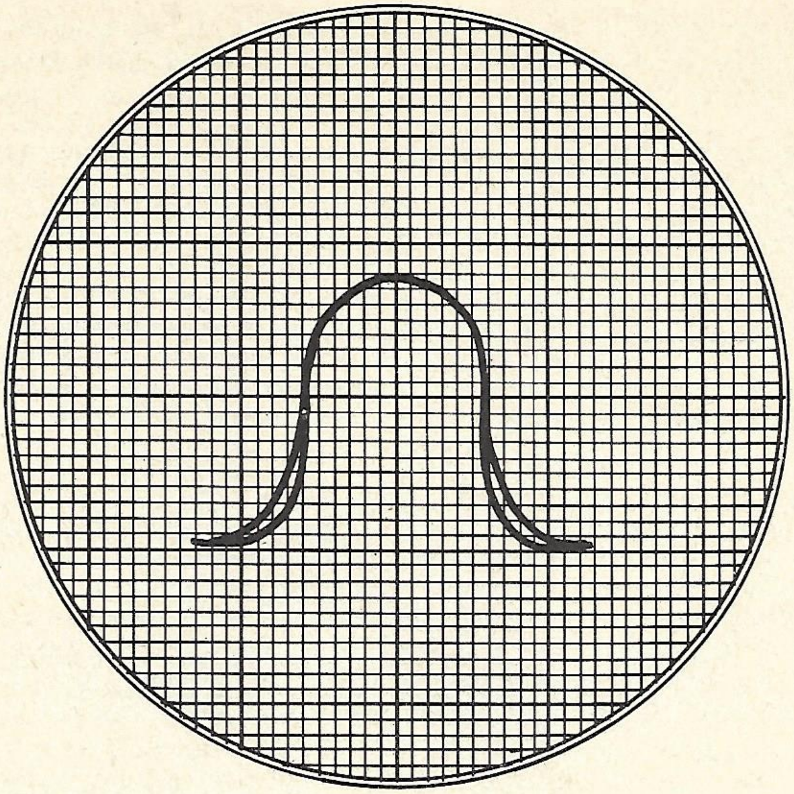


FIG. 7. I-F RESPONSE CURVE IN AN F-M RECEIVER NOT PROPERLY ALIGNED.

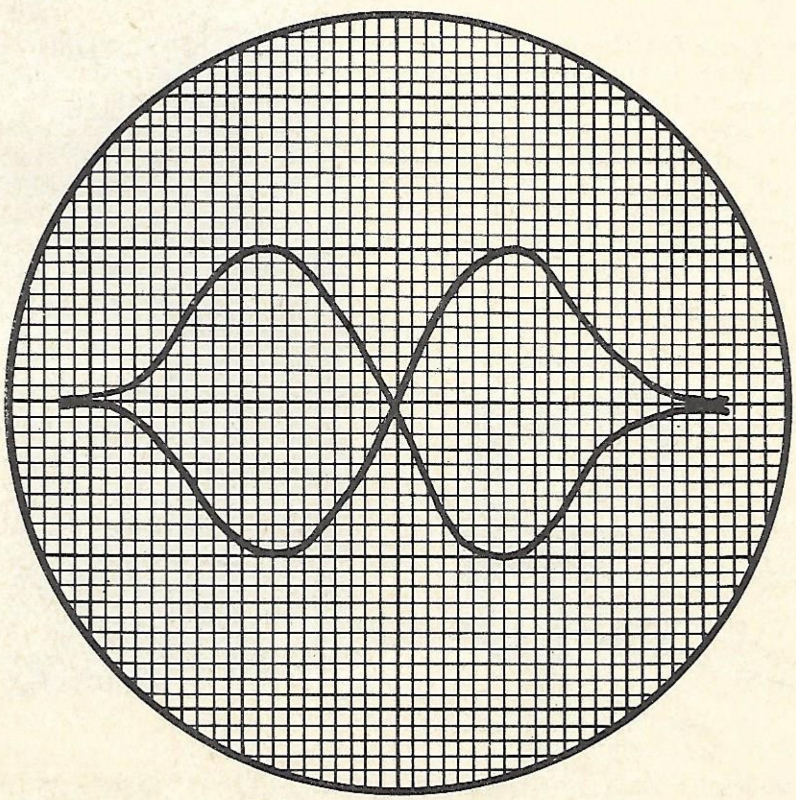


FIG. 8. F-M DEMODULATOR RESPONSE. 120 CYCLE MIRROSCOPE SWEEP.

wave forms at the various points in the circuit and other hints on setting up the controls of the signal generator and the Mirroscope. The Mirroscope sweep circuit should again operate at 120 cycles per second, if the signal generator has no horizontal amplifier output.

If separate intermediate frequency amplifiers are used for video and audio sections, they will terminate in demodulation circuits intended for a specific type of modulation. Align video i-f amplifiers according to the instructions for "A-M Receiver Alignment", and align audio i-f amplifiers in accordance with instructions for "F-M Receiver Alignment".

Some receivers are designed using what is known as intercarrier i-f amplifiers. This means that the entire signal is amplified through the i-f strip before it is separated into its audio and video components. Manufacturer's literature will show proper wave forms at various test points in the circuit. Note that the output of the first video amplifier is used to feed a signal to the audio strip. Frequency traps at this transfer point require alignment for a minimum output. Follow manufacturer's information for proper procedures.

At times when the amplitude of signal voltage needs to be measured on the Mirroscope, an accessory unit such as the Simpson Oscilloscope Calibrator, Model 276, should be used. With the Calibrator in series with the signal to the VERT. INPUT, the operator can switch back and forth between the signal and a 60 cycle sine wave with a variable measured amplitude. Set the vertical deflection of the signal at a convenient amplitude, using the plastic graph as a reference guide. Then switch the Calibrator over to one of the voltage range positions and set the CAL. VOLTAGE ADJUSTMENT on the Model 276, to provide the same vertical deflection on the Mirroscope. Read the effective, peak, or peak-to-peak value as desired directly on the proper scale of the Calibrator meter.

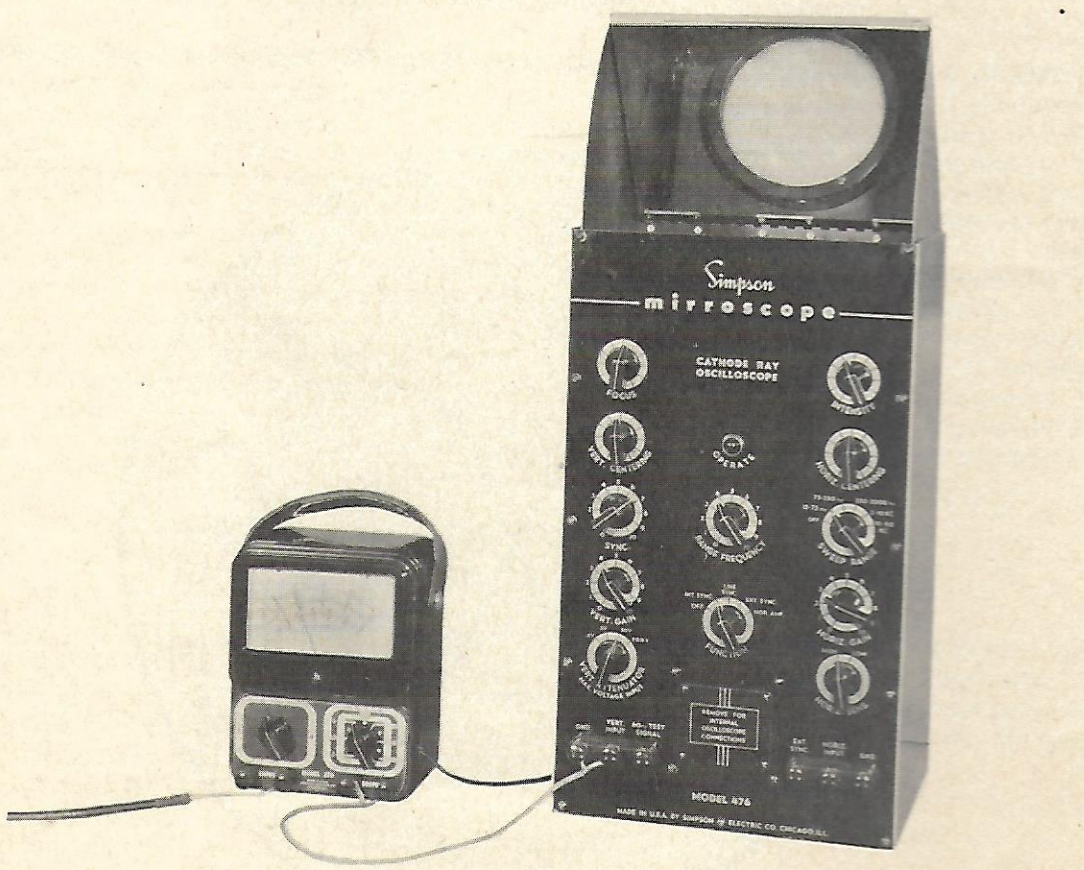


FIGURE 9. TEST BENCH SETUP USING AN OSCILLOSCOPE CALIBRATOR AND A MIRROSCOPE.

All television receivers are provided with horizontal and vertical sweep circuits for displacement of the spot on the face of the tube during presentation of the video information. The frequency and wave shape for each of these sweep circuits must conform to a specific shape and time in order to provide proper sequence of spot position on the screen of the television set. In addition, these circuits need to be both horizontally and vertically synchronized with the pattern as it is being presented from the transmitter. Manufacturer's literature will indicate the proper wave shapes at various points in these circuits and the Mirroscope can be used to reproduce the wave forms in the set. The horizontal sweep frequency of the Mirroscope will need to be adjusted for the proper frequency of each of these television set circuits. The horizontal sweep frequency of the TV set is 15,750 cycles per second and the vertical sweep frequency of the TV set is 60 cycles per second. The horizontal and vertical sync pulses from the transmitter will have the same frequency rate as the horizontal and vertical sweep frequency in the TV set. Ordinarily it is a good practice to set the sweep frequency of the Mirroscope at a subharmonic of the wave shape frequency being sampled from the TV set. For example: If the horizontal sweep circuit of the TV set is being analyzed, set the sweep frequency of the Mirroscope at 5,250 cycles per second to provide a series of three waves across the face of the scope, but if the vertical circuits are being analyzed, set the Mirroscope sweep to 20 cycles for three wave forms or to 30 cycles for two wave forms. By showing more than one wave form in one horizontal sweep on the Mirroscope, a better analysis is possible because the pattern has some complete cycles with no lost portions due to retrace time on the Mirroscope.

AUDIO AMPLIFIERS.

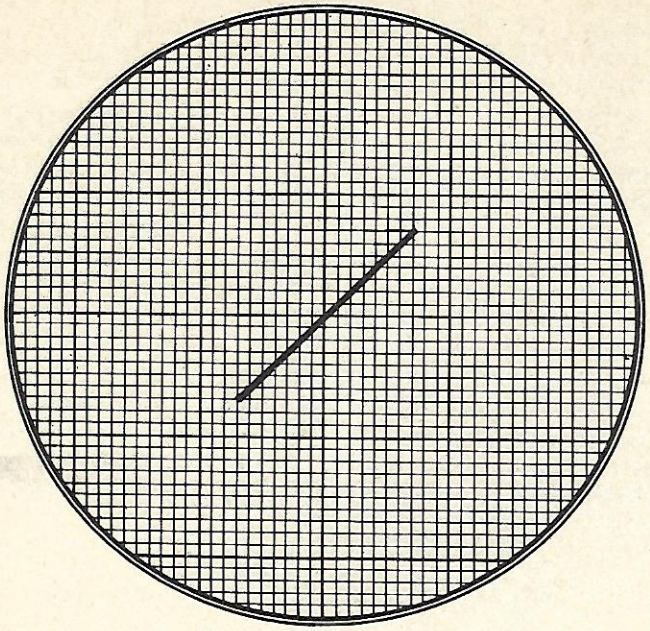
Two possible difficulties may arise in audio amplifier stages which may be checked with the Mirroscope. One is phase distortion and the other is a degeneration of an input wave shape. As was mentioned in the general description of the Mirroscope, the vertical amplifier frequency response varies less than 3 db between 20 cycles and 300,000 cycles. Because of this, all audio frequencies, including complex combinations of several fundamental frequencies together with overtones (harmonics) of each, can be amplified through the vertical amplifier circuits of the Mirroscope with a minimum of distortion. Use the Mirroscope to compare input and output wave shapes in an audio amplifier for distortion and relative amplitudes. Use a horizontal sweep on the Mirroscope which will provide two or three cycles of a high amplitude component and use the internal sync circuit.

To compare phase relations of the input and output of an audio amplifier, connect the input of the audio amplifier to the VERT. INPUT of the Mirroscope and the output of the audio amplifier to the HORIZ. INPUT of the Mirroscope. Set the FUNCTION switch at HOR. AMP., the SWEEP RANGE to OFF, and adjust the VERT. ATTENUATOR, VERT. GAIN, HORIZ. SENS., and HORIZ. GAIN controls to obtain similar and convenient amplitudes of horizontal and vertical deflection. Compare the Lissajou figure obtained with those shown in figure 10 to approximate the phase relations of input and output. Whatever phase relation is obtained with a low frequency audio signal, the phase and the resultant Lissajou figure should remain the same as the audio frequency is changed through its range to the high frequency end of the audio spectrum.

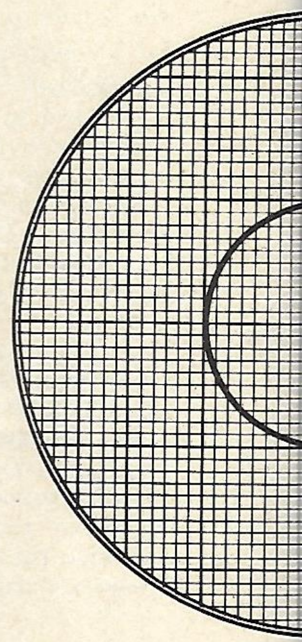
TRANSMITTER TESTING.

The Mirroscope may be used to check the wave form of a transmitter oscillator, the frequency multiplying characteristics of any transmitter, and the per cent of modulation of carrier in amplitude modulated transmitters.

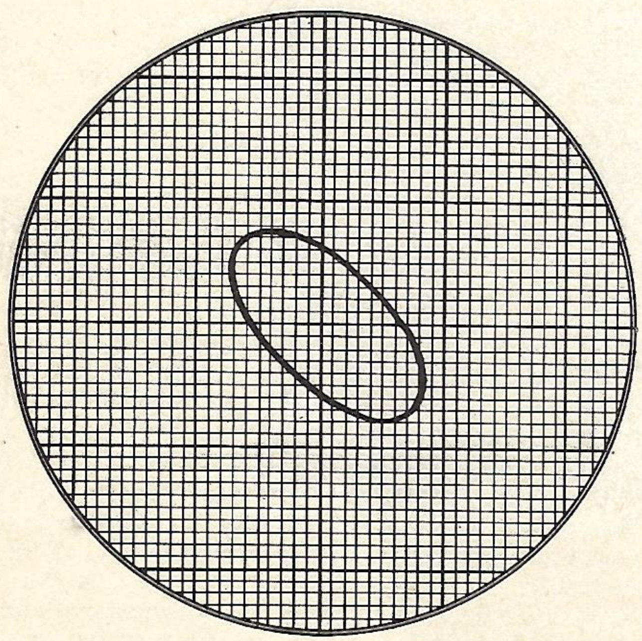
To check the wave form of the oscillator output, loosely couple the output of the oscillator to the VERT. INPUT terminal of the Mirroscope. Be careful to not place more voltage on the vertical system than the attenuator position calls for. A safe way to do this is to move an insulated wire pick-up into the vicinity of the oscillator output until the signal is picked-up in the vertical system of the Mirroscope without making any d-c connections between these points. Set the FUNCTION switch at INT. SYNC. and the SWEEP RANGE and RANGE FREQUENCY to a position that will allow several wave forms to be seen. Use the SYNC. control as required to study the picture on the scope screen. Depending on the frequency of oscillation of the transmitter, it may be possible to obtain a pattern with only two or three complete cycles shown, or it may be necessary to settle for a large number of cycles in the pattern. For example: If the frequency of the transmitter oscillator is 3 megacycles, the smallest number of wave forms which could be presented on the Mirroscope screen would be obtained with a sweep rate of 60,000 cycles, and this would present 50 cycles on the face of the Mirroscope. The purity of the wave form can be examined and adjustments can be made while observing the voltage variations.



A. IN PHASE

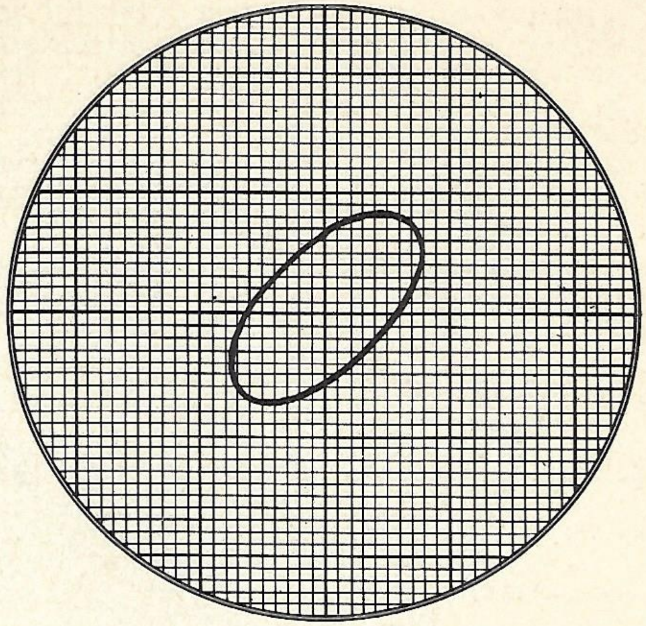


C. 90° PHAS

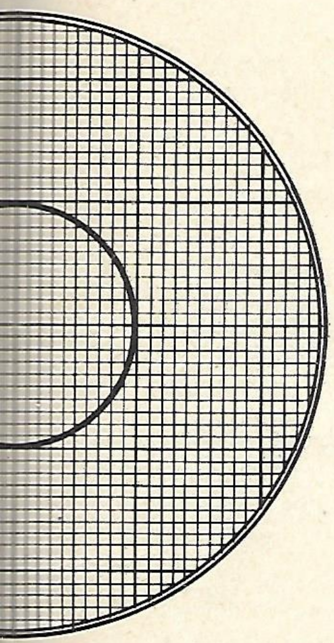


D. 135° PHASE DIFFERENCE.

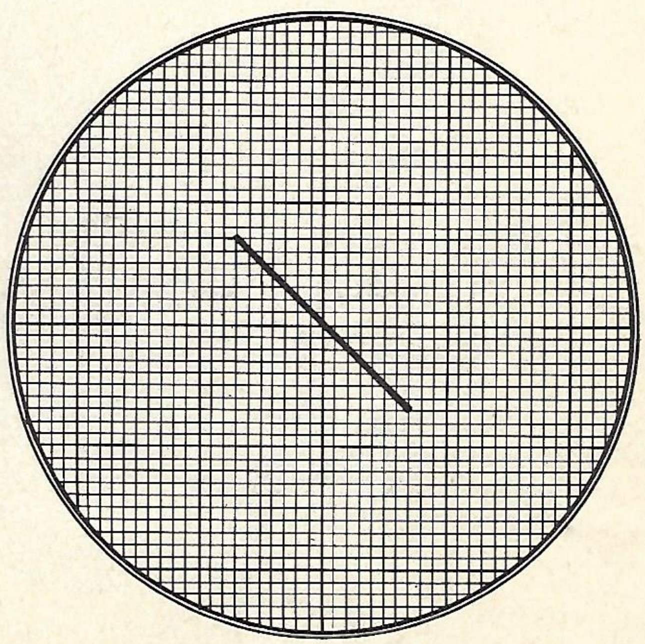
FIG. 10. LISSAJOU FIGURES S



B.   45° PHASE DIFFERENCE.

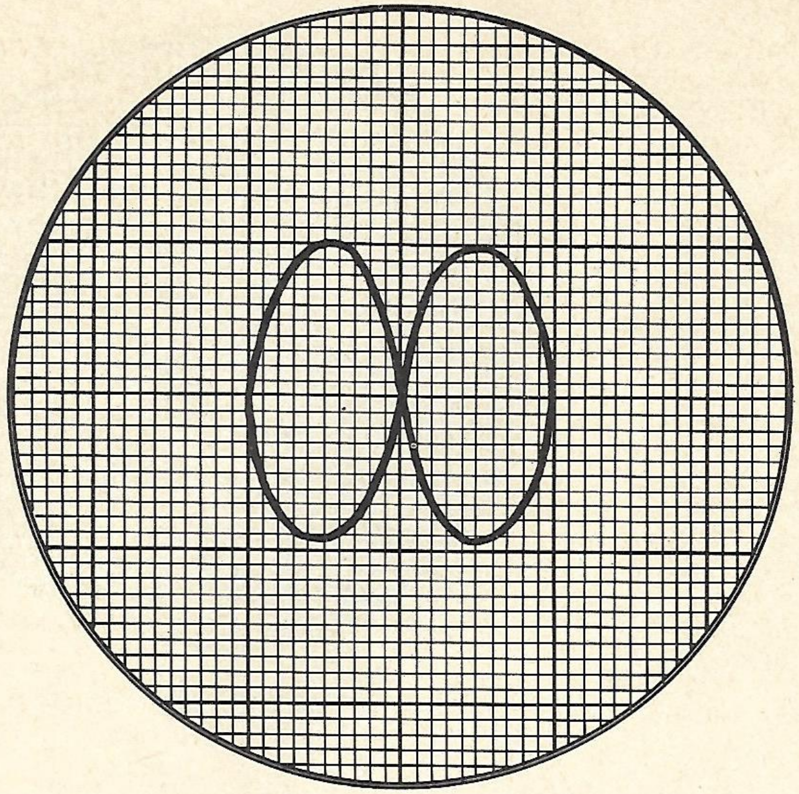


DIFFERENCE.

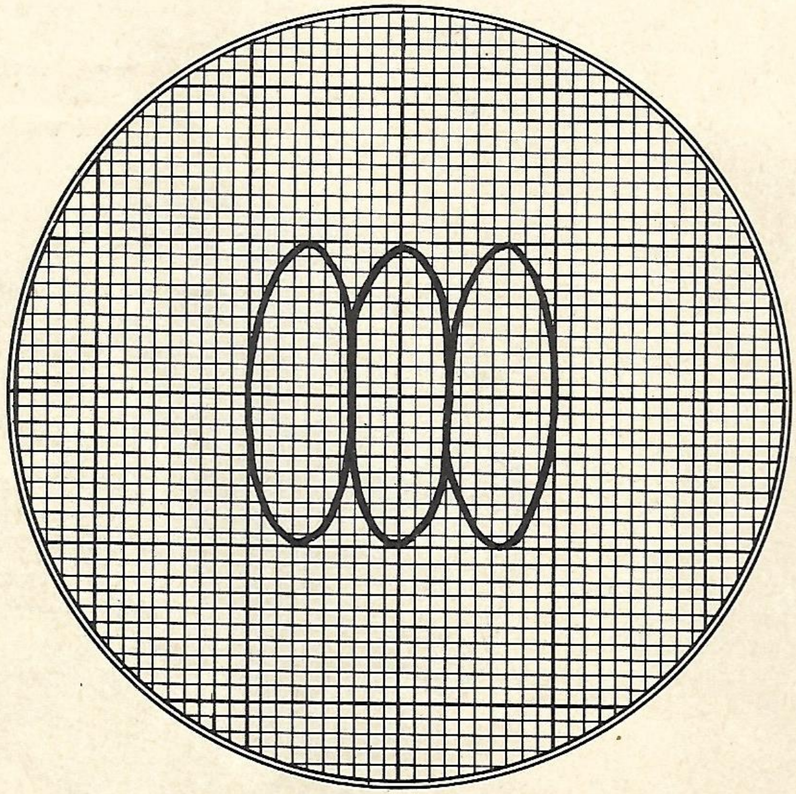


HOWING PHASE RELATIONS.

E.   180° PHASE DIFFERENCE.



A. Frequency of Vertical Input Twice the Frequency of Horizontal Input.



B. Frequency of Vertical Input Three Times the Frequency of Horizontal Input.

FIG. 11. LISSAJOU FIGURES SHOWING FREQUENCY RELATIONS.

Frequency multiplying may be checked by using Lissajou patterns. Use a probe to obtain signals at the input and output of the frequency multiplying stage. Connect the input signal of the frequency multiplier to the HORIZ. INPUT terminal and the output of the frequency multiplier to the VERT. INPUT terminal. Turn the FUNCTION switch to HOR. AMP., the SWEEP RANGE to OFF, and adjust the VERT. GAIN and HORIZ. GAIN to produce a convenient and balanced deflection in both directions on the face of the Mirroscope. Figure 11 shows a sample of Lissajou patterns which will indicate frequency doubling and tripling with this type of connection into the Mirroscope.

To check for per cent of modulation of amplitude modulated transmitters, loosely couple a probe in the output section of the power amplifier stage and connect this lead to the VERT. INPUT terminal. Place the transmitter in operation with a constant frequency of audio modulation. Set the FUNCTION switch at INT. SYNC. and the SWEEP RANGE and RANGE FREQUENCY controls to produce a sweep frequency equal to one-half or one-third the audio modulation frequency. Connect the audio signal to the EXT. SYNC. terminal and set the FUNCTION switch to EXT. SYNC. Use the SYNC. control to steady the pattern on the Mirroscope face. This should produce 2 or 3 cycles of amplitude modulated carrier as shown in figure 4. Adjust the vertical deflection to a convenient amplitude and make a ratio between the peak-to-peak distance between the maximum points of modulation swing and the average peak-to-peak value of deflection due to the carrier. Use the plastic graph over the face of the Mirroscope to indicate relative amounts of deflection. This ratio, translated into per cent, is interpreted as per cent of modulation of the carrier. For example: Suppose the peak-to-peak variation of the audio wave form is eight lines on the graph and the average peak-to-peak value (deflection due to the carrier) is twelve lines on the graph. Divide eight by twelve and change this to per cent to provide a 66-2/3 per cent modulation indication.

CHECKING POWER SUPPLIES.

The most interesting check that can be made with the aid of the Mirroscope in any power supply is for the wave form, frequency, and percentage of ripple superimposed on the d-c output of the power supply. The frequency of ripple of a half wave single phase rectifier is 60 cycles per second. The ripple frequency of a full wave single phase rectifier is 120 cycles per second. The wave form may be close to a sine wave or it may have a triangular or complicated shape, depending on the nature of the filter network. Place a capacitor of sufficient dielectric strength in series with the connection point between the output of the filter network and the VERT. INPUT terminal. Adjust the VERT. GAIN and the SWEEP FREQUENCY to produce the wave form of the output on the face of the Mirroscope. Adjust the SYNC. control to steady the pattern on the screen with the FUNCTION switch in INT. SYNC. position.

To check for percentage of ripple, the operator must determine the voltage amplitude of the ripple. Use an accessory such as the Simpson Oscilloscope Calibrator, Model 276, to determine the value of ripple voltage. See page 14 for detailed instructions on the use of the Calibrator. Divide the effective value of ripple voltage by the average value of d-c voltage and change the result to a per cent.

CHECKING VIBRATOR OPERATION.

Vibrators may be checked for frequency and output amplitude as well as for waveshape with the aid of the Mirroscope. The frequency is usually about 400 cycles per second and the wave shape will be somewhat square. Failure of buffer capacitors will produce a noticeable change in the shape of the output wave form. Erratic vibrator operation can be detected easily by checking for a consistent output pattern.

MISCELLANEOUS.

The operator will discover many other uses for his Mirroscope than those discussed here. The information in this section is not intended as a complete listing of all possible uses, but merely as a guide to acquaint the operator with the equipment so he may learn the basic uses of the various controls, and extend the applications of the Mirroscope to include the wide variety of uses required for other commercial and industrial circuits.

THEORY OF OPERATION

HORIZONTAL INPUT.

When a signal is applied to the HORIZ. INPUT terminal on the front of the instrument, the signal is coupled to the horizontal amplifier through a .5 mfd coupling condenser C17 which operates in conjunction with the HORIZ. SENS. control SW3. When the HORIZ. SENS. control is in the LOW position, a 12 meg resistor R49 is in series with the input and the horizontal amplifiers. In the HIGH position, the switch SW3 shorts R49 so that the signal is not attenuated at this point. When switch SW1 is placed in the HOR. AMP. position the signal coming into the HORIZ. INPUT terminal is coupled through the B section of SW1 to the HORIZ. GAIN control R38, from which it is sent to the grid input of the horizontal amplifier V4. This half of V4 is an audio amplifier with normal triode connections, and the other half is a grounded grid amplifier. Phase inversion is accomplished in this circuit, and the push-pull action is balanced by the relative positions of the tap on resistor R34 and the tap on the HORIZ. CENTERING control R31. The output of the grounded grid half of V4 is directly coupled to half of V5, and the output of V5 is applied directly to plate DJ1 of the cathode ray tube V9. The HORIZ. CENTERING control varies the voltage on the plate of V4, as well as the grid of V5. In this manner, the amplification of this half of the horizontal amplifier is either increased or decreased to control the centering of the beam in the horizontal plane on the cathode ray tube V9. The output of the second half of V4 is coupled through inductor L2, directly to the grid of the second half of V5. A screwdriver adjustment controls the voltage tapped on R34 for this plate and grid. The output of the second half of V5 feeds the signal to plate DJ2 in cathode ray tube V9, and is 180^{o} out-of-phase with the voltage sent to plate DJ1. This results in push-pull displacement of the spot, and linear horizontal deflection. Equal voltages are applied to the plates of V5 through the 68K resistors R8 and R9, providing the plate current in each half of V5 is the same.

SWEEP INPUT.

Tube V1 acts as a free running oscillator when the SYNC. control is in the "O" position. Basically, the horizontal sweep oscillator is a cathode coupled multivibrator circuit which, when a sync signal is applied, may be triggered or locked in by the sync signal. In proper operation, the frequency of the sweep generator will be the same as the sync signal, or a harmonic of it. Adjust the sweep frequency to its approximate setting with the SYNC. control set LOW. Then advance the SYNC. control sufficiently to stabilize the trace on the face of the cathode ray tube. The FUNCTION switch (SW1), in three of its positions, selects whether the sync input is internal (the vertical signal), line frequency, or external (a signal tied in at the EXT. SYNC. terminal). Which ever source is used, the signal is coupled through capacitor C18 and is developed across resistor R50. Resistor R50 is the SYNC. control, with which the operator determines the amount of sync signal to feed into the multivibrator. The sweep range switch SW4A and SW4B selects, coarsely, the range of the frequency that is to be used by putting the correct capacitor into the circuit to produce the particular frequency desired. The exact frequency is selected within the coarse range by the two potentiometers R54 and R56, which are both on one shaft. This is the front panel control marked RANGE FREQUENCY. Variation of either capacity or resistance will change the "RC" time, which controls the output frequency of the multivibrator. The values of the parts have been selected to allow the operator to set up any sweep frequency he requires within the nominal range of the equipment. The output of the sweep multivibrator is used for two purposes. First, the output voltage at terminal 2 (plate of V1) is coupled through capacitor C19 into the shaping network which involves capacitor C20 and resistor R48. The sweep signal is developed across capacitor C21 and injected through section B of switch SW1 to the HORIZ. GAIN control R38, with switch SW1 in INT. SYNC., LINE SYNC., or EXT. SYNC. position. Second, the multivibrator output at terminal 1 (the second plate of V1) is coupled from the junction of resistors R57 and R58 through capacitor C29 and injected on the cathode of V9. While the spot is being snapped back, in the return trace after each forward sweep, the bias on V9 is increased to provide blanking. The operator does not see any of the return trace.

VERTICAL INPUT.

When a signal is applied to the vertical input jack on the front of the instrument, it is coupled through a .5 mfd condenser (C16) to the step attenuator switch SW2. This attenuator is a voltage divider network which limits the amount of vertical input signal applied to the control grid of V6. There are four switch positions which make the attenuator connections. The positions names are: .5, 5, 50, and 500 volts. Use the lowest setting which covers the range of voltage from the signal source. Too low a setting results in overdrive, distortion, and possible damage, while too high a setting requires a large amplification.

CAUTION:

This instrument should not be used with input signals larger than 500 volts.

The output of the attenuator is applied to the grid of the isolating amplifier (1/2 of V6), which prevents any reflection of Mirroscope signals out through the signal input connections. The vertical gain control taps off the desired amount of signal to be fed into the vertical preamplifier (1/2 of V6), which amplifies the signal before it is fed to the vertical amplifiers through a .5 mfd condenser (C4). One-half of V2 is a grounded grid amplifier which is directly coupled to one phase of the final amplifier (1/2 of V3). The VERT. CENTERING control R12 adjusts the voltage on the plate of the grounded grid half of V2 and on the grid of the corresponding half of V3. The output of this half of V3 is directly coupled to plate DJ3 within cathode ray tube V9. The signal is fed to the control grid of the other half of V2, which is an audio amplifier connected in the normal manner. The different methods of signal injection to the two halves of V2 cause a phase inversion for push-pull operation. There is an inductor (L1) in the plate circuit, and the signal feeds through it to the control grid of the second half of V3. The output of the second plate of V3 is connected to plate DJ4 in cathode ray tube V9, and presents a signal which is 180° out-of-phase with the signal on plate DJ3. This produces push-pull operation on the vertical deflection circuits and assists in producing linearity of deflection.

DIRECT INPUT.

All three axes (X, Y, and Z) are provided with direct connections for optional use. Use a screwdriver to remove the front panel cover plate marked "REMOVE FOR INTERNAL OSCILLOSCOPE CONNECTIONS". Figure 2 shows the appearance of the internal connections. The terminal numbers are the same as shown inside the dotted line portions of the schematic diagram, figure 14. The jumper wires connect the output of the horizontal amplifier, vertical amplifier, and blanking pulse circuits to the oscilloscope. When the jumper wires are removed, a vertical input can be injected directly to the vertical deflection plates across terminals 6 and 7, or a horizontal input can be injected directly to the horizontal deflection plates across terminals 9 and 10. An intensity modulation can be injected between terminal 8 on the internal terminal board and either GND. terminal on the front panel; the voltage will be coupled through capacitor C29 to the cathode of V9.

If the operator wishes to reverse the trace on the Mirroscope at any time, he may accomplish this with the aid of the direct connections. Loosen the jumper wires between terminals 4 and 9 and between 5 and 10 (see figure 2). Replace these wires to connect terminals 4 and 10 together, and terminals 5 and 9 together. This will form an "X" with the jumper wires. Be sure the jumpers do not touch each other, or the horizontal deflection voltage will be short circuited.

SERVICING THE MIRROSCOPE

TABLE OF COMPONENT PARTS

CIRCUIT SYMBOL		DESCRIPTION	SIMPSON PART NO.
C1	Condenser	10 uf 450 V Electrolytic	1-114399
C2	Condenser	470 uuf (10%)	1-113987
C3	Condenser	470 uuf (10%)	1-113987
C4	Condenser	.5 uf (10%) 200 V metallized	1-114401
C5	Condenser	3300 uuf 500 V	1-113910
C6	Condenser	25 uf 50 V Electrolytic	1-114358
C7	Condenser	25 uf 25 V Electrolytic	1-114357
C8	Condenser	.001 uf (10%)	1-114360
C9	Condenser	50 uf 50 V Electrolytic	1-114359
C10	Condenser	470 uuf (10%)	1-113987
C11	Condenser	220 uuf (10%)	1-113854
C12	Condenser	100 uuf (10%)	1-113912
C13	Condenser	33 uuf (10%)	1-114361
C14	Condenser	25 uuf (10%)	1-114356
C15	Condenser	2.2-20 uuf	1-114364
C16	Condenser	.5 uf 400 V metallized	1-114398
C17	Condenser	.5 uf 400 V metallized	1-114398
C18	Condenser	.01 uf 400 V	1-113896
C19	Condenser	.1 uf 200 V metallized	1-114400
C20	Condenser	2-12 uuf	1-114365
C21	Condenser	470 uuf (10%)	1-113978
C22	Condenser	.5 uf 400 V metallized	1-114398
C23	Condenser	.1 uf 400 V	11-113901
C24	Condenser	.02 uf (10%) 400 V	1-113897

CIRCUIT SYMBOL		DESCRIPTION	SIMPSON PART NO.
C25	Condenser	3900 uuf (10%) 500 V Mica	1-113909
C26	Condenser	680 uuf (10%)	1-114363
C27	Condenser	120 uuf (10%)	1-114362
C28	Condenser	10-10-10 uf 450 V Electrolytic	1-113962
C29	Condenser	.05 uf 1600 WV	1-114354
C30	Condenser	.5 uf 2000 WV	1-114355
C31	Condenser	Part of C28	
C32	Condenser	Part of C28	
C33	Condenser	.01 uf 400 V	1-113896
C34	Condenser	.01 uf 400 V	1-113896
F1	Fuse	2 amp 3 AG	1-112911
LM1	Pilot lamp	G.E. #47	1-113747
R1	Resistor	10 meg (10%) 1/2W	1-111693
R2	Resistor	10 meg (10%) 1/2W	1-111693
R3	Resistor	10 meg (10%) 1/2W	1-111693
R4	Resistor	10 meg (10%) 1/2W	1-111693
R5	Resistor	22 K (10%) 1W	1-114347
R6	Resistor	22 K (10%) 1W	1-114347
R7	Resistor	22 K (10%) 1W	1-114347
R8	Resistor	68 K (10%) 1W	1-113936
R9	Resistor	68 K (10%) 1W	1-113936
R10	Resistor	2700 ohm (10%) 2W	1-114245
R11	Resistor	18 K (10%) 1/2W	1-113943
R12	Potentiometer	25 K (10%)	1-113878
R13	Resistor	6800 ohm (10%) 1/2W	1-113048
R14	Potentiometer	10 K (10%)	1-113879
R15	Resistor	3900 ohm (10%) 1W	1-113932
R16	Resistor	10 K (10%) 1/2W	1-111671
R17	Potentiometer	10 K (10%)	1-113879

CIRCUIT SYMBOL	DESCRIPTION				SIMPSON PART NO.
R18	Resistor	56 K	(10%)	1/2W	1-113947
R19	Resistor	39 K	(10%)	1W	1-113934
R20	Resistor	39 K	(10%)	1W	1-113934
R21	Resistor	2700 ohm	(10%)	1/2W	1-113942
R22	Resistor	510 K	(10%)	1/2W	1-113951
R23	Resistor	47 K	(5%)	1/2W	1-113946
R24	Resistor	22 K	(10%)	1/2W	1-113439
R25	Resistor	10 K	(10%)	1/2W	1-111671
R26	Potentiometer	10 K	(10%)		1-114350
R27	Resistor	2 K	(10%)	1/2W	1-111702
R28	Resistor	18 K	(10%)	1/2W	1-113943
R29	Potentiometer	10 K	(10%)		1-113879
R30	Resistor	3900 ohm	(10%)	1W	1-113932
R31	Potentiometer	25 K	(10%)		1-113878
R32	Resistor	6800 ohm	(10%)	1/2W	1-113048
R33	Resistor	10 K	(10%)	1/2W	1-111671
R34	Potentiometer	10 K	(10%)		1-113879
R35	Resistor	2700 ohm	(10%)	1/2W	1-113942
R36	Resistor	56 K	(10%)	1/2W	1-113947
R37	Resistor	10 meg	(10%)	1W	1-113939
R38	Potentiometer	500 K	(20%)		1-113871
R39	Resistor	330 K	(10%)	1/2W	1-113950
R40	Resistor	2.2 meg	(5%)	1/2W	1-114345
R41	Resistor	330 K	(10%)	1/2W	1-113950
R42	Resistor	2.2 meg	(5%)	1/2W	1-114345
R43	Resistor	330 K	(10%)	1/2W	1-113950
R44	Resistor	2.2 meg	(5%)	1/2W	1-114345
R45	Resistor	330 K	(10%)	1/2W	1-113950
R46	Resistor	680 K	(10%)	1/2W	1-114346

CIRCUIT SYMBOL	DESCRIPTION			SIMPSON PART NO.
R47	Resistor	1 meg (10%)	1/2W	1-113952
R48	Resistor	10 meg (10%)	1/2W	1-111693
R49	Resistor	12 meg (10%)	1/2W	1-113953
R50	Potentiometer	500 K (20%)		1-113871
R51	Resistor	470 ohm (10%)	1/2W	1-113940
R52	Resistor	220 ohm (5%)	1/2W	1-113928
R53	Resistor	27 K (10%)	1/2W	1-113944
R54	Potentiometer	250 K (10%)	(Front of dual)	1-113874
R55	Resistor	68 K (10%)	1W	1-113936
R56	Potentiometer	1 meg (10%)	(Rear of dual	1-113874
R57	Resistor	33 K (10%)	1W	1-113933
R58	Resistor	27 K (10%)	1/2W	1-113944
R59	Resistor	10 K (10%)	1/2W	1-111671
R60	Resistor	47 K (5%)	1/2W	1-113946
R61	Resistor	39 K (10%)	1/2W	1-111672
R62	Potentiometer	25 K (10%)		1-113878
R63	Resistor	56 K (10%)	1/2W	1-113947
R64	Resistor	3.3 meg (10%)	1/2W	1-114348
R65	Potentiometer	2 meg (10%)		1-114351
R66	Resistor	1 meg (10%)	1/2W	1-113952
R67	Potentiometer	500 K (20%)		1-113871
SW1	Switch	3 section, 5 position		1-113888
SW2	Switch	1 section, 4 position		1-114352
SW3	Switch	S.P.S.T. Rotary		1-113890
SW4	Switch	2 section, 6 position		1-114344
T1	Power Transformer			10-890111
V1	Tube	6J6	Sweep Osc.	1-113639
V2	Tube	6J6	Vert. Amp.	1-113639
V3	Tube	6J6	Vert. Amp.	1-113639

CRT socket 10-890110 133

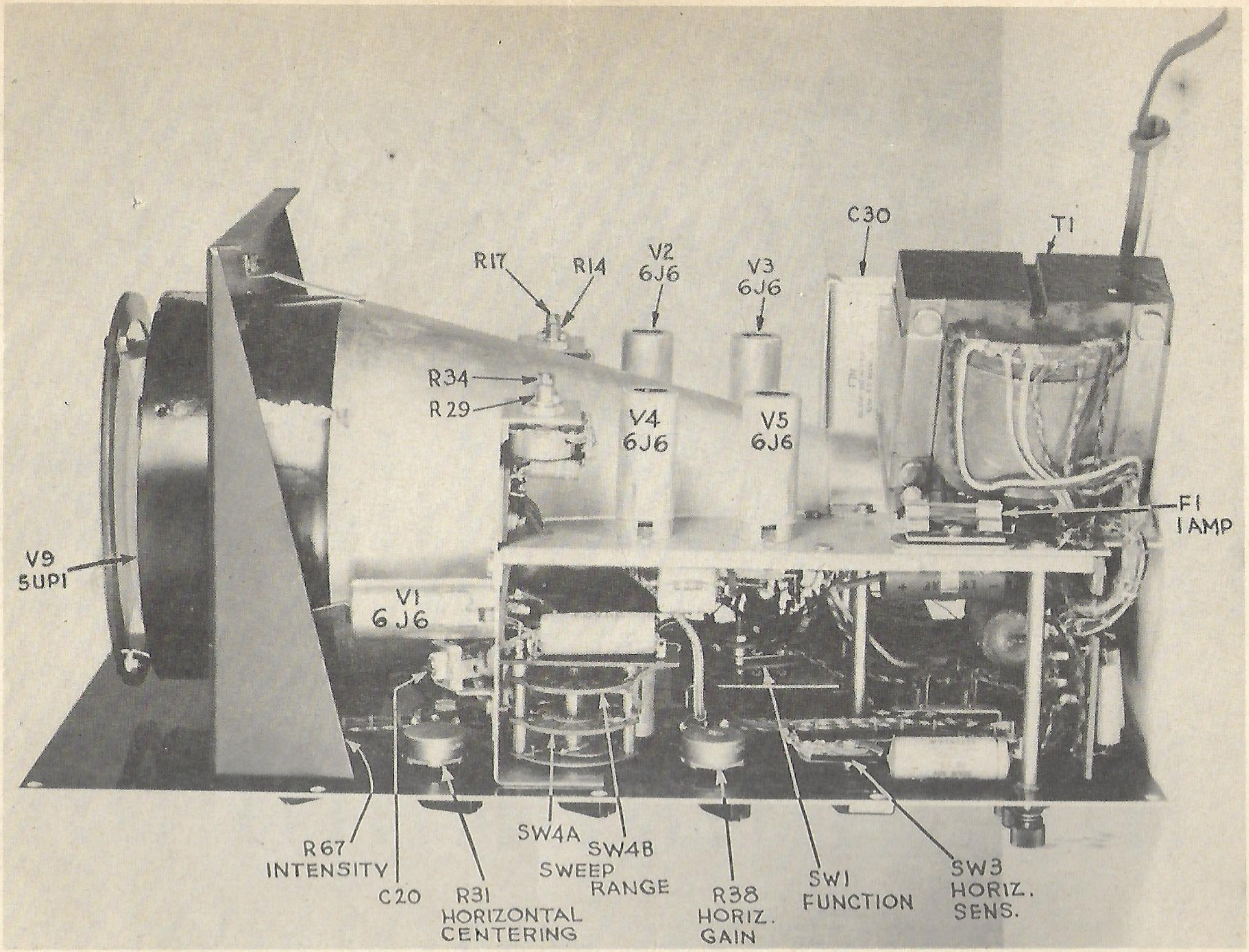


FIG. 12. RIGHT OBLIQUE VIEW OF MIRROSCOPE CHASSIS REMOVED FROM CABINET.

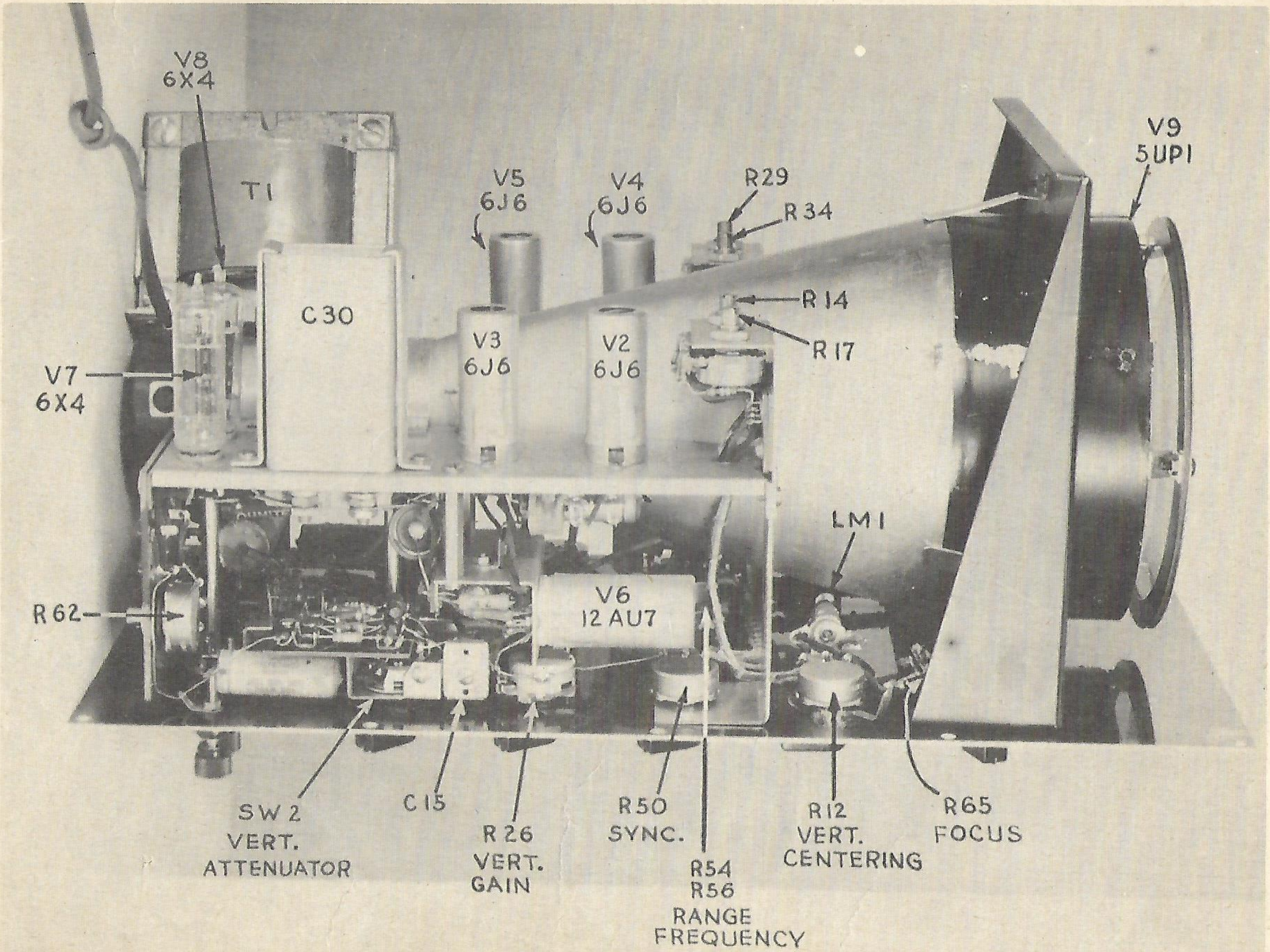


FIG. 13. LEFT OBLIQUE VIEW OF MIRROSCOPE CHASSIS REMOVED FROM CABINET.

CIRCUIT SYMBOL		DESCRIPTION	SIMPSON PART NO.
V4	Tube	6J6 Horiz. Amp.	1-113639
V5	Tube	6J6 Horiz. Amp.	1-113639
V6	Tube	12AU7 Vert. Preamp.	1-114083
V7	Tube	6X4 High Voltage Rect.	1-113974
V8	Tube	6X4 Low Voltage Rect.	1-113974
V9	Tube	5UP1 Cathode Ray Tube	1-114369
	Mirror, 6-15/16" x 8-3/4" x 1/8" Front Surface		1-114382
	Mirror Clips (5 ea.)		3-160042
	Cross Hatch Assembly	Plastic	10-890107
	Knob (12 ea.) Simpson Bar Type		3-260180
	Shield Assembly, Cathode Ray Tube		10-890109

ADJUSTMENT OF SCREWDRIVER CONTROL

Focus of the spot is accomplished in the cathode ray tube of the Mirroscope by means of electrostatic fields between grids 2 and 3 and between grids 3 and 4. If there should be any difference in average voltage between either pair of deflection plates and the number 4 grid, an extra electrostatic field would exist between these elements which would tend to de-focus the spot. To prevent this, identical voltages need to exist at pins 6, 7, 8, 9, and 10 of the cathode ray tube. If there is any difference in d-c voltage between these points with no signal input, readjust according to the following procedure:

1. Set the VERT. CENTERING and HORIZ. CENTERING controls at mid-scale (pointing straight up).

2. With FOCUS at mid-scale, adjust potentiometer R62 for a clearly focussed spot.

3. Measure the voltage from pin 8 of the cathode ray tube to ground. This is the reference voltage.

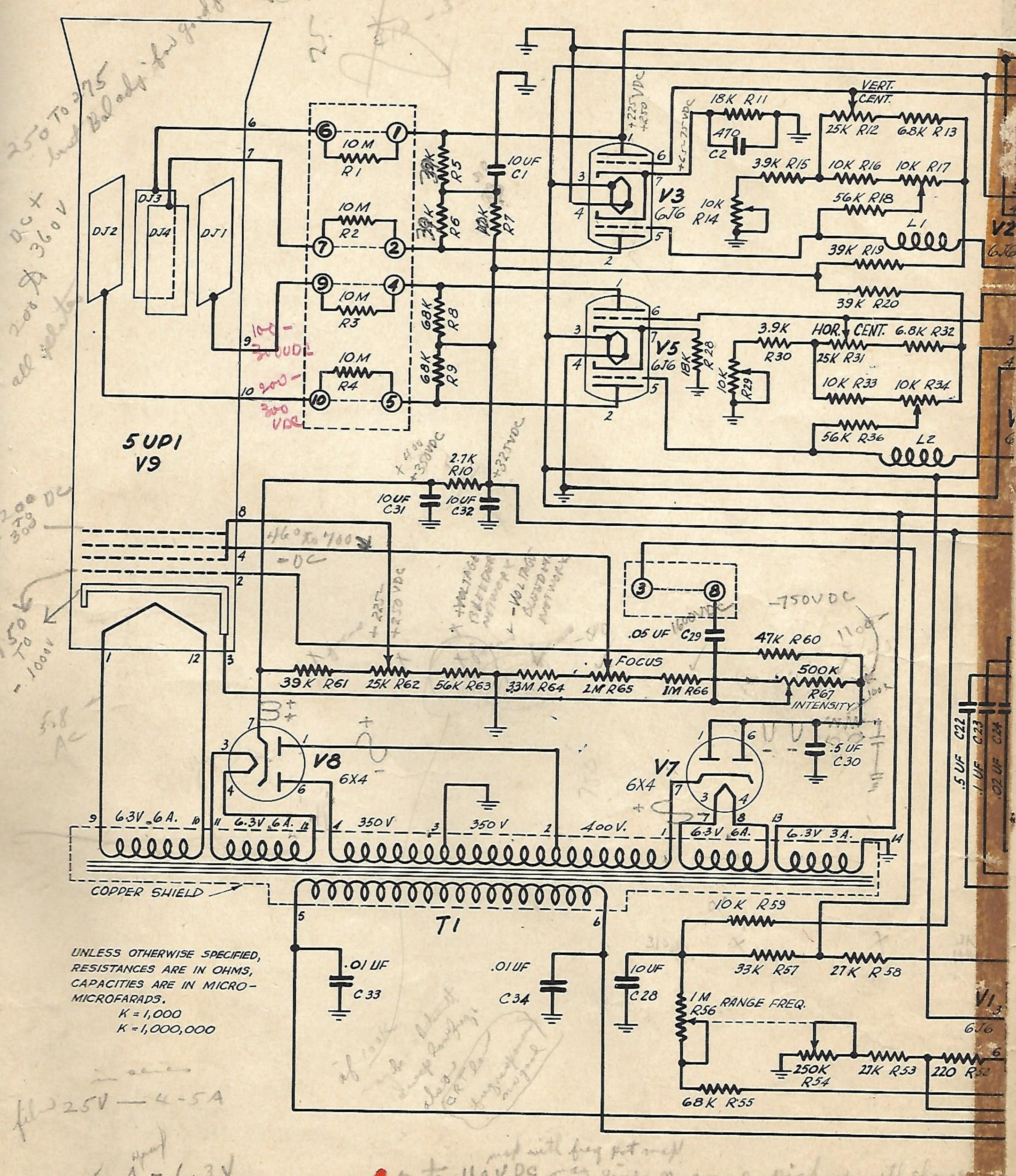
4. Adjust potentiometer R14 until a voltmeter reads the reference voltage from pin 6 of the cathode ray tube to ground.

5. Adjust potentiometer R17 until a voltmeter reads the reference voltage from pin 7 of the cathode ray tube to ground. The spot should be centered vertically on the screen of the cathode ray tube. If it is not, test tube V3 and check over the associated circuit components.

6. Adjust potentiometer R29 until a voltmeter reads the reference voltage from pin 9 of the cathode ray tube to ground.

7. Adjust potentiometer R34 until a voltmeter reads the reference voltage from pin 10 of the cathode ray tube to ground. The spot should be centered horizontally. If it is not, check tube V5 and the associated circuit components.

A high resistance meter should be used to make the above measurements. The 500 or 1000 volt range of a 20,000 ohms per volt meter or a vacuum tube voltmeter with an input resistance of 10 megohms or more will be satisfactory.



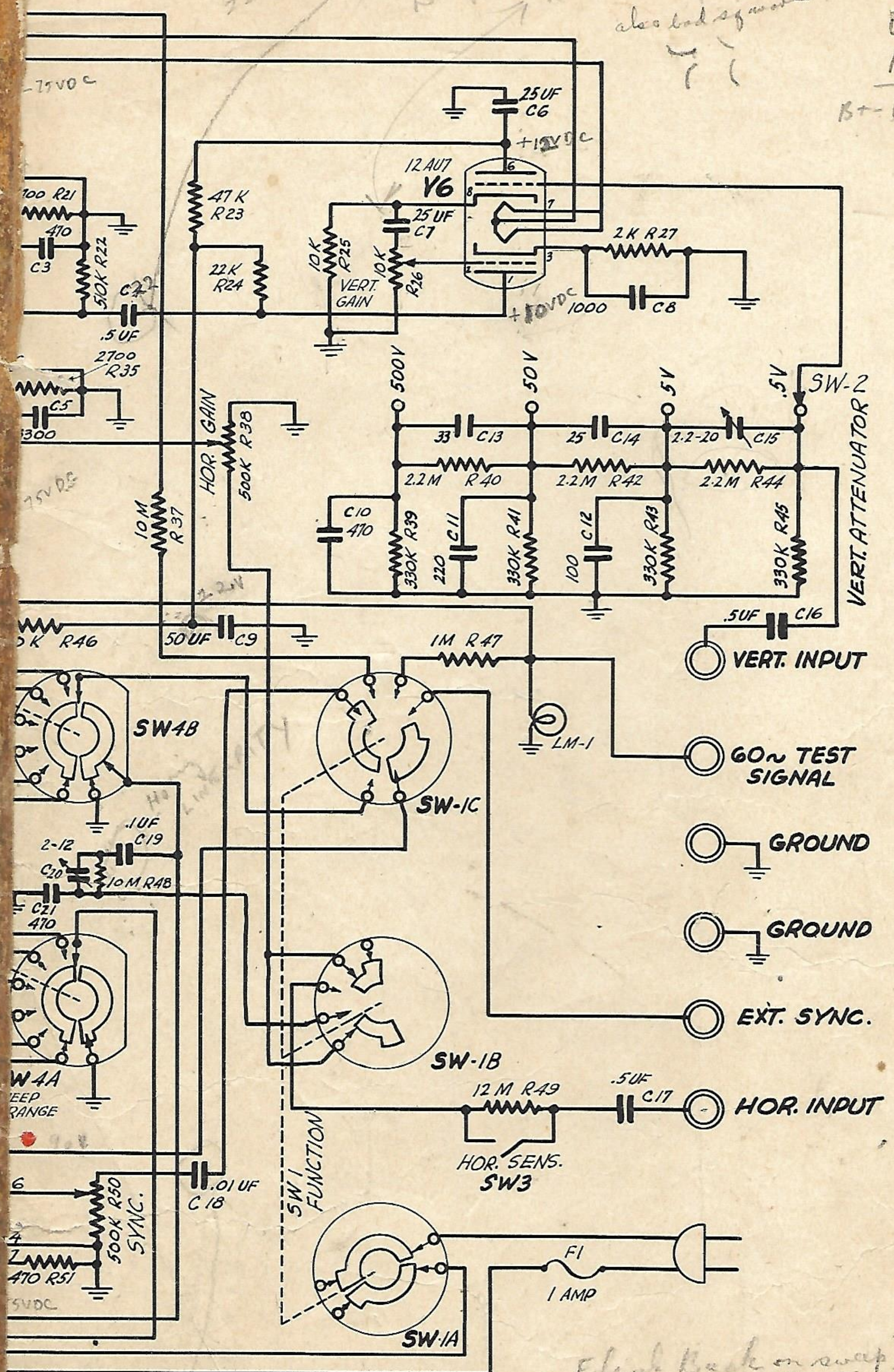
UNLESS OTHERWISE SPECIFIED, RESISTANCES ARE IN OHMS, CAPACITIES ARE IN MICRO-MICROFARADS.
K = 1,000
K = 1,000,000

5 A - 6.3V

1100 — = 70 MA

700 — 190 MA with #1 open.

FIG. 14. SIMPSON MIRROSCOPE, MODE



B+ = +350VDC
B- = -750VDC
B+-B- = 1100VDC

SCHEMATIC DIAGRAM.

SERVICE NOTES

M-330 3-59

50L6

settings not correct reads low

2M 2/51 1-114384
NELSON TECHNICAL ENTERPRISES
Geneva, Illinois