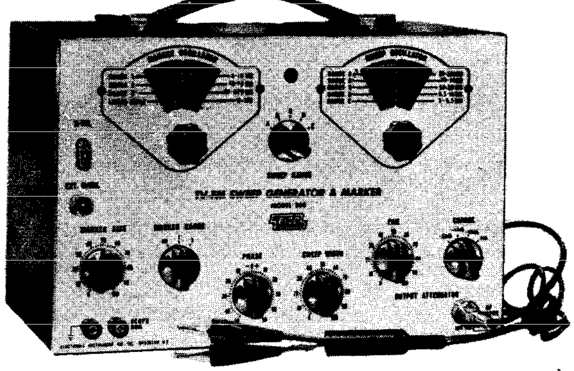


MODEL 368

TV-FM SWEEP

GENERATOR & MARKER

SPECIFICATIONS

FREQUENCY RANGE AND OUTPUT	Range A: 3-6.5 mc, output .30 volts rms, flat ±1/2 db; Range B: 6.5-16 mc, output .40 volts rms, flat ±1/2 db; Range C: 15-36 mc, output .35 volt rms, flat ±1/2 db; Range D: 34-90 mc, output .20 volt rms, flat ± 1/2 db; Range E: 80-216 mc, output .10 volt rms, flat ±1 db;

(Note: All frequency ranges are fundamental. Output measured with Boonton Model 80 VTVM Linearity checked with Techtronix Model 531 oscilloscope, and the maximum deviation in output level over the frequency limits of each range is noted in db.)

OUTPUT IMPEDANCE	50Ω, terminated at both ends of output cable
SWEEP WIDTH	Continuously variable from 0-3 mc lowest maximum deviation to 0-30 mc highest maximum deviation.
VARIABLE FREQUENCY MARKER	Range 1: 2-6 mc; Range 2: 6-20 mc; Range 3: 20-75 mc; Range 3': 60-225 mc;

(Note: All ranges are fundamental, except range 3', which is the third harmonic of range 3.)

FIXED FREQUENCY MARKER	Crystal oscillator using accurate 4.5 mc crystal included with instrument. Panel mount permits other crystal to be substituted if desired.
EXTERNAL MARKER	RF signals of any frequency may be mixed with crystal and variable marker oscillators to provide as many as three marker pips on one trace. Marker frequencies available at external connector for separate applications
ATTENUATORS	Continuously variable separate marker size control. 4-step (decade) "coarse" attenuator and continuously variable "fine" attenuator for both sweep and marker output together.
BLANKING	Complete 2-way blanking eliminates return trace.
PHASING	Narrow range phasing control for accurate alignment.
TUBE COMPLEMENT	12AV7 — sweep oscillator and cathode follower output; 12AT7 — variable and crystal marker oscillator; 12AX7 — blanking and AGC amplifier; 6AU6 — 2nd AGC amplifier; 12B4 — series regulator; 6X4 — rectifier; plus selenium rectifier for bias voltage.
CABLES	Output cable, scope horizontal cable and compensated scope vertical cable.

POWER REQUIREMENTS .... 105-125 volts ac, 50/60 cps; 50 watts.

SIZE .... H.W.D — 8 3/4" X 13 1/2" X 7 1/4".

NET WEIGHT .... 11 lbs.

SHIPPING WEIGHT .... 16 lbs.

FEATURES

The EICO Model 368 TV-FM Sweep generator is to our knowledge the finest and most highly perfected instrument of its type available for factory and service alignment of tv and fm receivers. The Model 368 not only incorporates new features which are unusual for instruments in the price range, but provides more ranges and better performance than any competitive make. The features are listed below.

• Entirely electronic sweep circuit (no moving parts, hum, or vibration) using an increductor unit, in which the oscillator coil inductance depends on the controllable excitation current in the primary windings of the unit. The increductor provides a large and smoothly variable sweep width and the sweep obtained is extremely linear and stable. There is also nothing to fatigue or wear out with use and age. The availability of a large sweep width renders operation of the instrument non-critical, since the band-pass region is easily located on the scope trace even when tv set or generator are considerably off frequency. Once the band-pass waveform is located, it is only a matter of adjusting the sweep generator center frequency, the sweep width, and the phasing of the 60 cps sweep voltage fed to the horizontal amplifier of the 'scope to cause the pattern to fill the desired section of the 'scope screen.

• Extremely flat RF output provided by newly-designed AGC circuit which automatically adjusts the oscillator for maximum output on each band with minimum amplitude variations. Resonance-free RF choke eliminates "suck-out" points anywhere in the RF spectrum. The AGC action constitutes an electronic regulation of the output, not the power supply (which would be undesirable).

• Extremely high RF output level on all five bands permits the cold alignment of all tuned circuits and filters.

• Phased 60 cps sine sweep (fed to horizontal axis of 'scope) is obtained by bleeding and filtering a large voltage from a secondary winding of the power transformer. In this way, the 60 cps sweep voltage is both undistorted and isolated from the line. The undistorted sine sweep provides excellent linearity of frequency versus horizontal displacement on the 'scope screen.

• Multiple marker system for easier alignment. A variable frequency marker oscillators covers from 2 mc to 75 mc on fundamentals in three ranges and from 60 mc to 225 mc on harmonics of highest fundamental range. (Note that the marker range includes the color burst frequency of 3.58 mc.) The fixed marker is a crystal controlled oscillator employing a 4.5 mc crystal supplied with the instrument. As the crystal plugs into a panel mount, other crystals may easily be substituted when desired. Fixed and variable oscillators have a common output, controlled by a fine attenuator, which affects the markers only, and a coarse step attenuator, which affects both the markers and the swept RF output. When fixed and variable markers are mixed, pips appear on the 'scope trace at the fundamental and harmonic frequencies of both and at the difference and sum frequencies. If the pips so obtained are not close enough for a particular job, a crystal of lower frequency can be used. The output to another marker generator can be fed into an external marker connector on the panel if the work requires a marker frequency not covered by the internal variable oscillator. The external marker can also be used to beat against the internal fixed and variable markers to provide a third set of marker pips. The output of the internal marker oscillator can also be taken out of the external marker connector for external use, if desired.

• Positive action return trace blanking.

• Double pi line isolation filter.

• Tuning dials protected by plexiglass windows. Edge-lit hairline indicators provide exceptional tuning accuracy because parallax error is eliminated from settings. 6 : 1 vernier tuning mechanism for ease of fine adjustment.

• Advanced wiring techniques and heavy filtering eliminates hum and leakage.

CIRCUIT DESCRIPTION

The swept oscillator is of the Colpitts type, using half of a 12AV7 tube (V2). The coils are built into the increductor unit (L6) and are connected in series. All coils are used on the lowest band and one more coil is shorted out on each successively higher band, until only the straps and switch remain to act as the coil on the highest band.

The coil cores are made of a special ferrous composition and are located between and make contact with the laminated pole pieces of the inductor core. A control winding (primary) on the inductor core controls the magnetic flux density in the inductor core and the cores of the signal coils. Thus when current is supplied to the control winding, the permeability of the special core materials is reduced.

This in turn causes the inductance of the signal windings to decrease. The low frequency edge of each swept band occurs at zero control current and the high frequency edge at maximum control current. The center frequency of each swept band depends on the setting of the tuning capacitor (C15).

The inductor control current and the horizontal sweep voltage fed to the horizontal axis of the scope are both sinusoidal variations at 60 cps and are derived from the 117 volt, 60 cps line. Thus the sweep display on the scope exhibits a linear variation of frequency versus horizontal displacement from the low edge to the high edge of the swept band.

The magnitude of the inductor control current, which sets the sweep width (overall frequency variation), is controlled by a potentiometer (R28) connected across the 117 volt line in series with a limiting resistor (R29) which prevents the overloading of the controllable inductor. The increductor unit is connected to one end and to the arm of the potentiometer through a blocking capacitor (C21). Capacitor C20, which is in parallel with the inductor primary, has been chosed to resonate with the inductor at 60 cycles in order to increase the available range of control current and therefore the available range of sweep width.

Center frequency sweep is achieved through the use of a DC bias current through the control winding of the increductor unit. The DC voltage that developes the bias current is obtained by rectifying (CR1) and filtering (C22) the 117 volt, 60 cps line voltage. The DC bias current is controlled by series resistors (R26 and R27), which are selected on each band so that at zero sweep width, the operating frequency is mid-way between the zero current and saturation current points of the inductor to assure excellent linearity on all bands. As the stated ranges of the swept oscillator are all fundamental ranges, the user is assured of entirely adequate output on all bands.

The 60 cps horizontal sweep voltage fed to the scope must be controllable as to phase and also be a true sine wave to ensure a linear display. R37 is the variable phase control and the network composed of C26, C27, R38, R39, and R40 performs the functions of filtering and attenuating the 60 cycle voltage obtained from high voltage secondary of the power transformer T1. This voltage is taken from the secondary of the transformer to provide isolation from the line, and filtering is required to eliminate distortion introduced by the transformer.

The second half of the 12AV7 tube V2 is connected as a cathode follower. The swept RF voltage is coupled from the grid circuit of the oscillator section to the grid of the cathode follower section. As a cathode follower exhibits a high input impedance, the loading effect on the oscillator is very slight. The cathode follower provides a low impedance output and is connected to the attenuator network.

If the swept RF output is not blanked during the negative excursion of the horizontal 60 cps sine sweep, the return trace (mirror image of the forward trace) will be superimposed on the forward trace and difficulty in interpreting the pattern will result. The important blanking function is achieved in the 368 by driving the oscillator grid highly negative to cut-off and simultaneously feeding a portion of the negative grid blanking voltage to the AGC circuit which results in a reduced B+ voltage to the oscillator tube. A more detailed description of the blanking process follows.

Plate and grid of one-half of the 12AX7 blanking and AGC amplifier tube (V3) are tied together and connected to the oscillator grid through isolating resistor R20. One side of the high voltage secondary winding of the power transformer is connected to the cathode of the blanking tube through a voltage dividing network consisting of resistors R23 and R24. Throughout the positive excursion of the voltage applied to the cathode, the plate is negative with respect to the cathode and no current can flow. At this time, the oscillator operates with its own grid leak (R19) only. During the negative excursion of the voltage at the cathode, the grid and plate become effectively positive with respect to the cathode and the tube will conduct. As the plate follows the cathode, a high negative voltage is applied to the oscillator grid, thus cutting the oscillator tube off. Also, the negative voltage pulse is coupled to the grid of the second half of the 12AX7 tube (V3), which is the 1st AGC amplifier, thus causing a positive pulse at the plate of this tube. The positive pulse is coupled to the grid of the 6AU6 2nd AGC amplifier (V4), resulting in a large negative pulse at the plate of this tube. This negative pulse appears at the grid of the 12B4A series regulator tube V5 to cut this tube off, and consequently the B+ supply to the oscillator section of V2 is cut off. Therefore, the oscillator tube is cut off in two ways during the blanking period. L5 is a non-resonant choke which prevents the oscillator RF output from getting back to the regulator circuit.

Automatic gain control of the RF output voltage is achieved by coupling part of the varying DC voltage developed at the oscillator grid to the control grid of the 1st AGC amplifier, one-half of the 12AX7 tube (V3). To understand the operation, we utlize the well known fact that the negative voltage at the oscillator grid increases with the amplitude of the RF output. Supposing that instanteously the RF output has increased, we can anticipate that the negative oscillator grid voltage will increase. By tracing the effect of this increase through the AGC chain, we can see the regulating action. The negative pulse results in a positive pulse at the plate of the 1st AGC amplifier, which is coupled to the control grid of the 6AU6 2nd AGC amplifier tube (V4) and results in a negative pulse at the plate of this tube. This negative pulse is fed to the grid of the 12B4A series regulator tube (V5), which is in the path of the B+ voltage applied to the plate of the oscillator. The increase in the effective resistance of the regulator tube as a result of the negative pulse on its control grid, provides the reduction in B+ voltage at the oscillator plate necessary to reduce the RF amplitude to the predetermined level. Similarly, an instantaneous drop in RF amplitude will produce effects opposite to those just described at each point in the AGC chain to increase the B+ voltage at the oscillator plate sufficiently to restore the RF amplitude to a predetermined level. Level control R32 (internal adjustment) is used to set the AGC circuit for maximum output on all bands with minimum amplitude variations.

One-half of the 12AT7 dual triode tube V1 is employed as a Colpitts variable frequency marker oscillator and the other half is used as a crystal marker oscillator. The variable marker oscillator covers the range from 2 mc to 75 mc in 3 fundamental bands and the range from 60 mc to 225 mc on the third harmonic of the highest fundamental band. The oscillator coils are slug-tuned so the oscillator can be trimmed and padded for perfect tracking over the whole frequency range.

The output of both oscillators is taken from the same cathode load, through marker size control R42. The use of a common load results in mixing of the outputs of the two oscillators, so that the two oscillator frequencies, their harmonics, and the sum and difference of the fundamental frequencies and their harmonics, will all be present in the output. For example, if the 4.5 mc crystal supplied is used and the variable oscillator is set at 30 mc, markers will be obtained 30 mc, 34 1/2 mc, 25 1/2 mc, 39 mc, 21 mc, and at 22 1/2 mc, 27 mc, 31 1/2 mc, and 36 mc, which are direct harmonics of the crystal oscillator. Crystals of other frequencies may be used to give different marker spacing or direct frequency checks. The output of an external marker generator can also be mixed with the internal markers by connecting it to the EXT. MARK. connector on the panel.

The marker frequencies are taken from the arm of the MARKER SIZE control R42; the swept RF output is taken from the arm of the FINE ATTEN. control R41. These outputs together are fed to the 5-step COARSE OUTPUT ATTENUATOR control S2. As a result the marker output energy is attenuated proportionally to the swept RF output signal, thus avoiding marker overloading while maintaing a wide range of amplitude control.

A 6X4 full-wave rectifier tube (V6) is employed in the power supply, and the DC output is well-filtered by dual-section electrolytic C25 and resistor R34. Plate voltage for the rectifier and the required filament voltage for all tubes is supplied by power transformer T1, as well as voltage for the phasing and blanking circuits.

FUNCTIONS OF CONTROLS AND TERMINALS

SWEEP RANGE SELECTOR — Provides coarse adjustment of sweep oscillator frequency. Selects one of 5 fundamental ranges marked on panel alongside the sweep oscillator dial.

SWEEP OSCILLATOR tuning control — Provides fine adjustment of sweep oscillator frequency. Approximate sweep center frequencies are all read on dial scale corresponding to the sweep range selected.

MARKER RANGE selector — Provides coarse adjustment of variable marker oscillator frequency and on-off (marker) control. Selects one of 3 fundamental ranges marked on panel alongside the marker oscillator dial. The crystal marker oscillator is operative at all positions, provided a crystal is inserted in the X-TAL panel socket. At OFF position, the variable marker oscillator is disabled and only the crystal marker oscillator functions.

MARKER OSCILLATOR tuning control — Provides fine adjustment of marker oscillator frequency. Fundamental marker frequencies are read on dial scale corresponding to the sweep range selected. Range 3 (fundamental) and Range 3' (3rd harmonic) are both read at position 3 of the MARKER RANGE selector.

SWEEP WIDTH control — Provides adjustment of sweep width from zero to a maximum deviation depending on the selected center frequency (3 mc lowest max. deviation, 30 mc highest max. deviation).

MARKER SIZE control — Provides voltage amplitude adjustment of variable oscillator, crystal oscillator, and external markers.

FINE OUTPUT ATTENUATOR control — Provides adjustment of swept RF voltage amplitude.

COARSE OUTPUT ATTENUATOR switch — Provides voltage amplitude adjustment of combined marker and swept RF output in 20 db steps.

SCOPE HOR. binding posts — Take-off terminals for phase-adjustable 60 cps sine sweep fed to horizontal input terminals of scope.

PHASE CONTROL/AC ON-OFF power switch — Permits phase adjustment of 60 cps sine sweep available at SCOPE HOR. binding posts. The AC ON-OFF power switch is actuated at the extreme counter-clockwise position.

RF OUTPUT connector — Output connection for combined marker and swept RF output.

EXT. MARK. connector — The combined output of the crystal and variable marker oscillators, or the output of either marker oscillotor alone, is available at this connector for external use (see MARKER RANGE selector). The MARKER SIZE control has no effect on the output at this connector. Also, the output of an external marker generator may be mixed with the internally generated markers by feeding it in through this connector.

X-TAL socket — Insertion of the 4.5 mc crystal supplied with the instrument in this socket closes the crystal oscillator circuit and results in 4.5 mc marker energy, and harmonics thereof, to be present at the EXT. MARK connector and at the RF output connector (attenuated by the MARKER SIZE control.

Output Cable — 50Ω coaxial cable properly terminated for connecting swept RF and marker output energy from RF output connector to input of circuit under test without undersirable mismatch effects.

Compensated Scope Vertical Cable — Coaxial cable and lowpass RC network for connecting output of circuit under test to vertical input terminals of wide-band 'scope. Necessary to obtain sharp marker pips when a wide-band 'scope is used.

'Scope Horizontal Leads — For connecting phase-controlled 60 cps sine sweep voltage from SCOPE HOR. binding posts to horizontal input terminals of scope.

OPERATION

The use of a sweep signal generator economizes on time and effort and also provides greater refinement of measurement in a very practical manner. For example, an adjustable frequency, adjustable output RF signal generator might be used to obtain output-vs.-input data for an IF amplifier at several discrete frequency points. This information can be plotted on a graph showing response-vs.-frequency to obtain the pass-band of the circuit. The procedure would have to be repeated after each circuit readjustment. While a plot for a narrow-band circuit would be laborious but possible, the time required for a broad-band circuit would make this procedure highly impractical.

A sweep signal generator in conjunction with a 'scope provides a simultaneous display of the response of a circuit at all frequencies within the swept band on the screen of the scope, in the form of a response-vs.-frequency curve. The immediate indication of changes caused by adjustments to the circuit under study expedites alignment work or circuit design enormously. Also, information is instantly obtained by sweep methods which might easily be missed using the point-by-point method. For example, regeneration effects and "suck-outs" may cause changes in the response curve over only a narrow range of frequencies. This effect might very easily be entirely within two adjacent discrete frequencies chosen for the point-by-point method. Obviously such effects will be missed, and a smooth response curve would be drawn which does not correspond in its entirely to the actual response.

Fig. 1 shows the Model 368, a broad band detector, and an oscilloscope interconnected. The resultant display on the 'scope screen is shown in Fig. 2. The pattern is a graph with abscissa (horizontal axis) proportional to frequency and the ordinate (vertical axis) proportional to the amplitude response of the detector circuit.

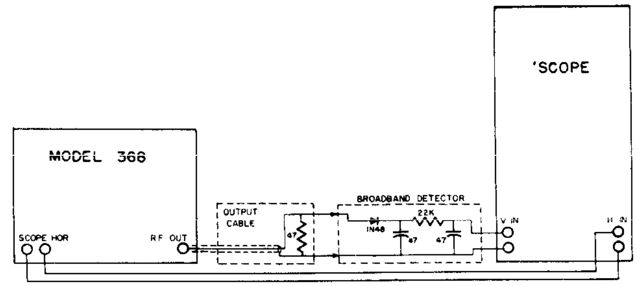


Fig. 1. Typical interconnections of Model 368 Sweep Generator & Marker, Test Circuit (Broad-Band Detector) and Oscilloscope.

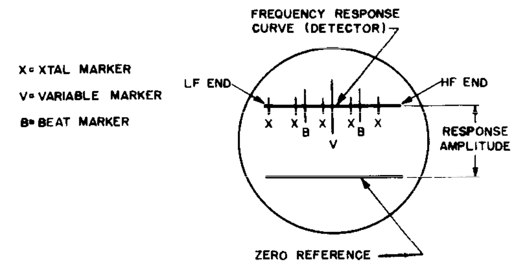


Fig. 2. Drawing of display appearing on scope screen in Fig. 1.

The interconnections in Fig. 1 required to obtain the display include the connection of the RF OUTPUT terminal of the Model 368 to the detector, whose output connects to the V IN terminals of the scope, and the connection of SCOPE HOR. terminals of the Model 368 to the H IN terminals of the scope.

Of the two approximately parallel horizontal lines that appear on the screen, one is the reference line of zero input, signifying the blanking period that occurs during every other 1/120th of a second, and the other is the rectified RF output. The rectified RF output will be the upper trace if the detector provides a positive dc output (i.e. as shown in Fig. 2) and the scope beam is deflected upward by a positive voltage at the vertical input terminal that is not grounded. The left-hand end of the rectified RF output trace will represent the lower frequency edge of the swept band if the 60 cycle sine sweep is phased so that the start of the positive-going excursion of the 60 cps sine sweep applied to the horizontal deflection plates of the scope is synchronized with the start of the increasing-frequency excursion of the rectified swept RF band applied to the vertical deflection plates of the scope, and the scope beam is deflected to the right by a positive voltage at the horizontal input terminal that is not grounded. It is not possible to interpose the low and high frequency edges of the swept band trace by use of the phasing control of the Model 368, since the latter provides a narrow range of adjustment for fine compensation for small phase shifts.

In this connection, note that tv receiver RF curves are shown deflecting downward because, when RF response curves are observed, the scope is usually connected through an isolating resistor to the mixer grid circuit in the tuner, which goes increasingly negative as signal strength increases. As a result, these response curves deflect downward and are seen below the zero input reference trace. IF response curves are usually shown deflecting upward and are seen above the zero input reference trace. Of course, these curves may be upward or downward, depending on the connections to the rectifier or second detector.

Similarly, as regards to horizontal deflection, confusion will be avoided if the low frequency edge of RF response curves appear on the scope at the left side. With this connection, picture RF carriers will be to the left of associated sound RF carriers. Keep in mind that the low-frequency being placed on the left-hand side pertains to RF response curves only. When observing IF response curves, the opposite condition is obtained and the low frequency is on the right-hand side because the heterodyning action causes a reversal of right and left so far as frequency direction is concerned. To avoid confusion on this subject, it is best to check the direction of frequency increase with an RF response curve obtained at the mixer grid, thereby establishing the left-hand side of the curve as the low-frequency side. The direction of frequency increase on any response display, can always be determined by noting the direction of travel of the variable marker as its frequency is increased.

To interpret a response curve, facilities must exist for identifying frequencies along the abscissa. This is the function of the highly versatile marker circuits found in the Model 368. Single, dual, or multiple markers may be obtained as desired. High output levels on harmonics as well as fundamentals greatly increase the value of the marker facilities.

The marker appears on the RF response curve trace at a point along the frequency axis corresponding to its own frequency. This occurs because a portion of the marker oscillator output beats against the sweep oscillator output within the instrument. As the instantaneous frequency of the swept oscillator approaches the marker oscillator frequency, the difference frequency enters into the pass-band of the 'scope and becomes visible. As the two frequencies near equivalence, the increasing response of the scope to the decreasing difference frequency causes the amplitude to increase correspondingly. The same phenomenon occurs in reverse when the swept oscillator frequency passes the marker oscillator frequency. Immediately adjacent to zero beat (frequency equivalence) the marker reaches its greatest amplitude, which serves to identify the frequency at that point on the RF response curve. If a wide-band oscilloscope is used, response to the difference frequencies will be constant over a wide bandwidth and the marker will appear as a fuzzy line that may even extend the full horizontal length of the swept RF trace in some cases. For this reason, the compensated scope probe supplied is used to connect the output of the detector to the V input terminals of the 'scope. This probe contains a low-pass filter which attenuates the higher frequency portions of the beat marker to sharpen the marker appearing on the trace.

All of the specfic uses of this instrument, interpretations of abnormal 'scope traces, and the variations in procedure appropriate to different types of receiver circuitry can not be covered in a brief instruction book. Many excellent books and magazine articles have appeared on the subject, some of which are listed in the bibliography. In any case, a detailed alignment procedure for each make and model of receiver is available as prepared by the manufacturer or from information supplied by the manufacturer. When aligning a receiver, it is imperative that you have access to the specfic service and alignment notes for the particular model. The following description of operation, therefore, will be confined to general information on setting up the instrument for the specific alignment procedures given by set manufacturers.

SWEEP OSCILLATOR

The Model 368 employs a center frequency sweep. This means that as the SWEEP WIDTH control is advanced clockwise, the sweep increases evenly on both sides of the center frequency read on the sweep oscillator dial. The sweep is blanked during half of the line cycle to provide a straight line zero input reference. The voltage response of the tuned circuit at any frequency in the swept band is proportional to the vertical distance from the corresponding frequency point on the response curve to the zero input reference line. To observe the response curve of a tuned circuit to be aligned with the Model 368, set the SWEEP RANGE and SWEEP OSCILLATOR controls to the nominal center frequency of the tuned circuit and advance the SWEEP WIDTH control clockwise until a satisfactory trace is obtained. If the left-hand edge (low frequency side) of the trace ends abruptly instead of sloping down to a point on the zero input reference line, reduce the frequency setting of the SWEEP OSCILLATOR control until the start of the trace appears on the zero reference line. If the right-hand edge of the trace ends abruptly, increase the frequency setting of the SWEEP OSCILLATOR control. When both edges and abruptly, advance the SWEEP WIDTH control clockwise until both edges of the curve are on the zero reference line. See Fig. 3.

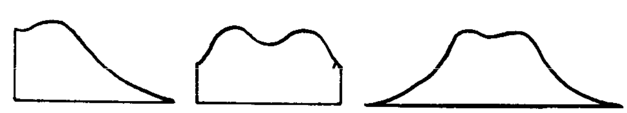


Fig. 3

In connection with sweep width, it should be noted that the uppermost frequency of the sweep oscillotor is not limited by the highest indicated frequency on the SWEEP OSCILLATOR dial for the selected band, since the unit is capable of sweeping across bands. Furthermore, it is worth knowing that the maximum sweep width available, on any band is obtained at a frequency setting near the high frequency end. This means that greater sweep width is available at the high end of band B than at the same frequency at the low end of band C.

PHASING

Adjustment for phase shift in the receiver stages under test is achieved by proper use of the PHASING control. The PHASING control is set to zero on the dial before setting the SWEEP RANGE, SWEEP OSCILLATOR, and SWEEP WIDTH control to obtain the band-pass waveform. After the band-pass waveform is obtained, the PHASING control is adjusted until the trace is centered and exhibits no fold-over at the right or left hand edges. See Fig. 4. The linearity of the horizontal frequency axis is contingent on correct adjustment of the PHASING control. Should non-linearity become evident, reset the PHASING control.

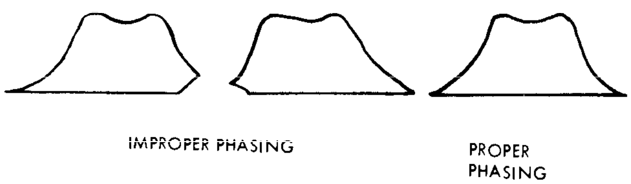


Fig. 4

MARKER OSCILLATORS

To determine the bandwidth of a tuned circuit, the MARKER RANGE and MARKER OSCILLATOR controls are used to set the variable frequency marker pip to a point 30% of the maximum voltage response down the slope of one side of the waveform and the frequency on the marker dial noted. Then the pip is set to the 30% down point on the other side of the waveform and the frequency on the marker dial noted again. The difference between the two frequencies is the bandwidth of the tuned circuit under test.

The effect of mixing the outputs of the crystal and variable marker oscillators has been discussed in the circuit description section and the selection of either or both outputs is given in the functions of controls section. Thus, if the variable marker is set at 30mc and the 4.5mc crystal is inserted in the panel socket, the output marker frequencies will be 30mc, 34.5mc, and 25.5mc. Therefore, if the variable marker is set to one side of a broad-band RF or IF response waveform, another marker will appear 4.5mc away on the opposite side of the waveform. Closer or further spacing of markers can be obtained by substituting crystals of lower or higher frequencies respectively.

Note that the markers produced by the higher harmonics of the 4.5mc crystal oscillator and the variable marker oscillator will be smaller in amplitude than the fundamental marker provided by the variable oscillator and the markers at the sum and difference frequencies of the fundamental variable and crystal marker frequencies (4.5mc on each side of the variable oscillator fundamental marker).

The crystal marker oscillator has many other uses. Using the 4.5mc crystal supplied, this oscillator can be used for alignment of the 4.5mc sound IF to be found in intercarrier sets. A 10.7mc or 5.35mc crystal can be used for FM alignment purpose with the harmonics useful for FM RF alignment. In the same way, crystals having useful harmonics in the TV IF or RF regions could be used if required.

If multiple markers are needed, an external signal generator can be fed into the EXT. MARK. connector on the panel. The MARKER size control will attenuate the level of any signal fed into the EXT. MARK. receptacle. Multiple markers are obtained by mixing the external generator output with either the variable or crystal oscillator outputs to obtain difference frequency markers at any chosen frequency interval. If, for example, 250kc spaced markers are required, the external generator should be set to 4.75mc or 4.25mc if being mixed with the crystal oscillator or to a frequency 250kc above or below the variable oscillator if mixed with the variable oscillator. Of course, multiple markers can obtained without an external generator by similarly mixing the outputs of the variable and crystal oscillators in the instrument. Where multiple markers are desired on a very high frequency sweep, stronger markers will be obtained by beating an external generator set to a frequency in the swept range against the internal variable oscillator set above or below the external generator frequency by the desired difference frequency.

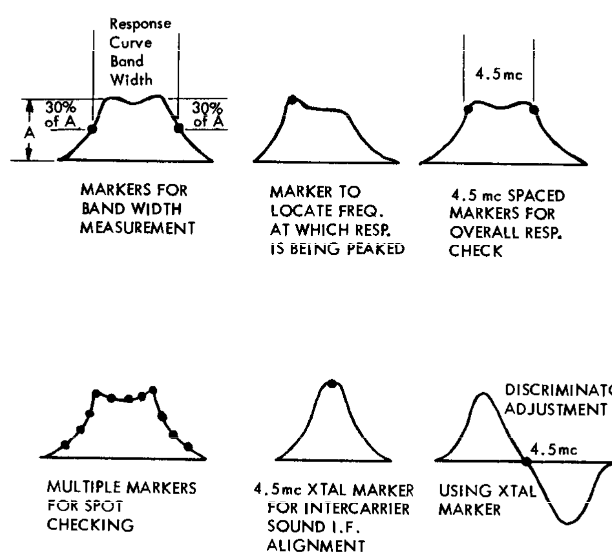


Fig. 5

It is of course essential that markers be easily identified. To quickly determine which marker is the fundamental or harmonic of the variable oscillator, remove the crystal from the panel socket and disconnect or turn off the external generator if used. The signal marker pip remaining will be the fundamental or harmonic of the variable oscillator. Restoring the crystal oscillator and external generator frequencies one at a time will permit identification of all the other markers. A fixed marker that remains when all internal and external markers have been' removed can be assumed to be generated by the local oscillator of the set under test. A pip of this type can be eliminated by connecting a shorting jumper between oscillator grid and chassis.

In this instrument, there are two methods of taking out either the variable or crystal oscillator outputs for fixed alignment work. If a very low level signal is needed, or very fine level adjustment at low signal levels, take the output from the RF OUT connector with the FINE OUTPUT ATTENUATOR (affects swept oscillator output only) turned maximum counter clockwise (minimum) and the MARKER SIZE and COARSE OUTPUT ATTENUATOR controls set to the desired level. When higher output levels are required, it is simpler to take the marker output from the EXT. MARKER connector, where the level is affected only by the MARKER SIZE control and no other. Uses of the variable or crystal marker oscillator without the sweep oscillator include alignment of traps, RF and IF tuned amplifiers, and discriminators. The 4.5 mc crystal oscillator output may be used directly for sound IF alignment of intercarrier type tv sets. Using a vtvm or 'scope as a null indicator, the variable oscillator (set to the trapped frequency) may be used for trap adjustment. It should be noted that the crystal oscillator has been designed for operation with higher frequency crystals and that dependable operation can not be assured with crystals of frequency lower than 1 mc. In fact, any crystal near 1 mc that is purchased should be of the high sensitivity type, as many 1 mc crystals will not function in this type of circuit.

MARKER SIZE CONTROL

The MARKER SIZE control should be used to set the marker to an amplitude no greater than that required for easy observation. Too great a marker amplitude will cause objectionable trace distortion.

FINE & COARSE OUTPUT ATTENUATORS

The FINE control attenuates the sweep oscillator output only. The COARSE decade attenuator attenuates both the sweep oscillator and marker outputs simultaneously. Start an alignment job with the COARSE control set at X1000 (least attenuation) and the FINE control set at approximately 50. When the response curve is obtained on the scope screen, increase or decrease the attenuation as required. It can not be overly stressed that the generator output (input to the circuit under test) should be kept as low as possible, no higher than is necessary for a good indication of the response on the scope screen. Use fully the gain provided by the oscilloscope to assist in this practice. The reason for this is that too much output will result in serious distortion of the response curve, resulting in misleading information, and therefore misalignment. To ensure that overloading has not distorted the response curve, reduce the setting of the FINE control while observing the waveform. If at a reduced FINE control setting the response curve changes shape, you can be sure the tuned circuit under test was being overloaded previously. Should the original FINE setting be near or below 10 on the dial, the COARSE control should be turned counter-clockwise one position (greater attenuation) and then the FINE control reset.

GENERAL ALIGNMENT PROCEDURE

Do not undertake realignment of a tv set unless there is evidence of misalignment. Many symptoms of incorrect alignment may also arise from other causes. Even an abnormal response curve is not certain evidence of misalignment and may sometimes be remedied by tube substitution. By connecting an oscilloscope and the Model 368 to a tv set as described below, gain checks may be made to locate a dead or weak stage. Tubes and other circuit components should be checked before making adjustments on tuned circuits.

It is unusual for RF realignment to be required unless the adjustments have been tampered with. Misalignment of the front end (RF, mixer, oscillator) is usually manifested by both picture and sound troubles, either on one channel, several channels, or all channels depending on the set design. Normal sound and raster when there are picture troubles on all channels is associated with picture IF misalignment. However, in intercarrier sets the sound will also be affected by this type of misalignment. Sound troubles only on all channels, with picture and raster normal, is associated with sound section misalignment.

For all alignment except RF, it is required to render the local oscillator of the tv set inoperative. This may be done either by removing the oscillator tube or temporarily disconnecting the B+ lead going to its plate circuits. If necessary, also remove the vertical oscillator. For safety, disable the horizontal oscillator to eliminate the high voltage to the picture tube by grounding the control grid to chassis. Also, render the AGC circuit inoperative by removing the AGC tube, if necessary, and ground the AGC bus or apply a fixed dc potential from a "bias box" (battery and potentiometer).

Usually the trap circuits are aligned before the rest of the set. These include the sound traps which keep the audio signal from modulating the picture and the adjacent channel traps which prevent interference between adjacent channels. The 4.5 mc trap in most intercarrier sets should be aligned after the sound and video IF strips have been adjusted. Sound IF sections are aligned by conventional FM alignment methods. As was stated previously, the RF, mixer, and oscillator sections are aligned only if there exists indications of misalignment.

TRAP ALIGNMENT

A vtvm, set for DC voltage measurement, is connected across the second detector load resistance for trap alignment. An unmodulated CW signal from the marker generator is coupled via a .001 mfd capacitor (or larger) to the grid of an IF stage preceding the trap circuit. The marker generator is then tuned to the frequency for which the trap is intended and the generator output increased until a usable reading is obtained on the VTVM. The trap is then adjusted for a minimum reading. Either the variable or crystal marker oscillator may be used and the marker output taken from the RF OUTPUT or EXT. MARK connectors depending on what is required or convenient as described previously. Where the manufacturer specifies that a modulated signal be used for trap alignment, refer to the SUPPLEMENTARY PROCEDURES section in this book.

IF ALIGNMENT - GENERAL

There are two general types of picture IF amplifiers, the stagger-tuned type and the overcoupled type. The final response curve is the same in either case, but the alignment procedure is different. Note that if the trap adjustments are made after the IF alignment, the response curve will be spoiled. Keep in mind also that the correct bias must be applied to the IF tubes during the picture IF alignment (or on RF tubes during RF alignment) if the alignment is to be successful. The best procedure is to follow the manufacturer's instructions in this regard for the particular set being aligned.

IF ALIGNMENT - STAGGER-TUNED TYPE

To align stagger-tuned type IF stages, feed the output of the generator (from the RF OUTPUT connector via the Output Cable) to the grid of the mixer tube or the grid of the individual stage being aligned, through a capacitor. The stages are taken in sequence, starting at the stage before the video detector, or in accordance with the set manufacturer's instructions. Connect an oscilloscope across the load resistance of the video detector, using the Compensated Scope Vertical Cable. Use the Scope Horizontal Leads to connect the SCOPE HOR. and ground terminals of the generator to the horizontal input terminals of the oscilloscope. Disable the tv set oscillator tube as described previously. Select the appropriate SWEEP RANGE and set the SWEEP OSCILLATOR to the desired IF frequency. Adjust the SWEEP WIDTH control to obtain the entire frequency response curve, reducing the sweep width if the response curve occupies too small a section of the trace and increasing the sweep width if the response curve does not return to the zero input reference trace at both the left and right. Also readjust the SWEEP OSCILLATOR setting, if necessary, to properly center the trace. Adjust the generator PHASE control as described previously and make sure that the response is not distorted due to overloading.

Select the appropriate MARKER RANGE position and then set the MARKER OSCILLATOR to the IF frequency of the first IF stage as given in the set manufacturer's service notes. Set the MARKER SIZE control to obtain a clearly visible pip without essentially distorting the curve. If recommended, the primary of the IF transformer preceding the stage being aligned should be shorted. The marker oscillator is then set at the frequency of the next stage and this stage is adjusted. It will be necessary to reduce the output of the generator as alignment procedes, using the FINE & COARSE OUTPUT ATTENUATOR controls. Do not reduce the scope vertical amplifier gain instead, but rather keep it at a maximum while holding the output from the generator to a minimum. After all the IF stages have been aligned in this manner, feed the generator output to the mixer grid through a suitable capacitor and compare the overall response obtained with the curve recommended by the manufacturer in the service notes. The position on the curve of the sound and picture carriers can be checked with the dual markers. Small readjustments in the individual stages may be required to obtain the manufacturer's recommended curve.

In some cases, the IF stages will be prealigned using single frequencies, with a vtvm as an output indicator connected across the load resistance of the video detector stage. For this procedure, use the marker generator in the instrument to provide the required CW frequencies. The pertinent information for this use of the generator has been given previously.

IF ALIGNMENT - OVERCOUPLED TYPE

Connect the scope as for the stagger tuned type. Operate and take the swept oscillator output from the generator as was described for alignment of the stagger-tuned type. Couple the generator output to the grid of the final IF stage through a .001 mfd capacitor. Then align the last IF stage as instructed in the set manufacturer's service notes. If recommended, shunt the primary of the transformer ahead of the control grid to which the signal is applied with a jumper or a 100-200 mmfd capacitor to prevent it from absorbing energy and causing a dip in the response curve. When alignment of the particular stage is completed, this shunt is removed. The proper trace to be obtained in each case will usually be found in the manufacturer's service notes and should be followed. Alignment procedes stage by stage from the stage nearest the picture detector to the mixer tube. The overall response curve should be similar to the one shown in the manufacturer's instructions. Here too, the dual markers are used to locate the sound and picture carriers and to provide check points for determing whether the proper curve is being obtained.

Fixed frequency pre-alignment procedures may be used for over-coupled IF types also. When this is the case, use the same procedure given for the stagger tuned types, following the manufacturer's instructions.

SOUND IF ALIGNMENT

The common detector types found with tv sound IF systems are the discriminator, ratio detector, and gated-beam circuit. For the discriminator and ratio detector types, alignment procedures are similar except for the oscilloscope connection point. Adjustment of gated-beam detectors is usually performed using a transmitted tv signal according to procedures given in the manufacturer's service notes.

If the circuit uses a discriminator, connect the 'scope to the grid return of the last limiter tube, and adjust the alignment generator output for the lowest output that will give a satisfactory trace. Set the marker oscillator to the exact intermediate frequency of the sound IF strip, and perform adjustments maintaining a symmetrical waveshape on each side of the marker. Then shift the 'scope connection to the volume control, or to the opposite side of the resistor going to the control, and adjust the discriminator transformer for the maximum amplitude and straightness of the slanted detecting curve. The adjustment is finished when the marker is at the center of the response curve. In intercarrier type sound systems, use the 4.5 mc crystal oscillator to furnish the marker.

As for the ratio detector, note that in the output circuit of the two ratio detector diodes there are two capacitors, one connected to the plate of one diode and the other connected to the cathode of the other diode. Connect the 'scope to the junction of these two capacitors and ground. The i-f amplifiers and the detector transformer can then be aligned as described above for the case where a discriminator is employed.

OSCILLATOR AND RF ALIGNMENT

Again it should be cautioned that oscillator and RF alignment should not be performed unless it is necessary. The general procedure is outlined below.

Restore the oscillator to operation, and feed the output of the alignment generator (from the RF OUTPUT connector via the Output Cable) through a balun (impedance matching device) to the antenna input terminals. (For a 300 ohm antenna input, the balun will consist of 120 ohm resistors in series with both the "hot" and ground leads of the Output Cable.) Connect the 'scope to the video detector as before. Start alignment at the highest frequency channel (13) and finish at the lowest frequency channel (2).

Adjust the oscillator tuning to locate the picture and sound markers at the specified positions on the response curve given in the set manufacturer's notes. No required marker will be outside the calibration range of the variable marker oscillator in the alignment generator. The crystal oscillator marker is mixed with the variable marker to provide beat markers spaced 4.5 mc above and below the variable marker for location of the other carrier.

If fixed frequency alignment is recommended by the manufacturer, the output of the variable marker oscillator may be used. A VTVM will serve as an output indicator when this method of alignment is used. The VTVM is connected, as a rule, to the sound detector load and the oscillator adjusted for a zero reading (a null). Other VTVM connection points may be recommended by the set manufacturer and his instructions should be followed when available.

On completion of oscillator alignment, perform the RF and mixer alignment, keeping the identical sweep generator connections to the antenna input terminals. The 'scope is normally connected to the grid return of the mixer tube, using the point provided for this purpose. Again, begin alignment at the highest frequency channel and adjust the response curve to the shape recommended by the manufacturer. (Note: If 'scope gain is inadequate for a clearly visable display, use a single stage pentode preamplifier, such as a microphone preamplifier, ahead of the scope. A demodulator probe connected to the recommended test point may sometimes give more satisfactory results without a preamplifier. Of course, there will be no problem of insufficient 'scope gain if the manufacturer's alignment instruction specify connection to the video detector.)

ALIGNMENT OF INTERCARRIER SETS

Use fixed frequency methods for video IF strip alignment with a VTVM connected across the video detector. The output from either the variable or crystal oscillator may be used. If sweep techniques are prescribed, the previously described methods can be employed.

On completion of fixed frequency alignment, check the overall response with sweep generator and scope. Connect the generator to the mixer stage and the 'scope to the video detector and touch up the IF adjustment screws to obtain the recommended response curve.

Alignment of the sound IF strip is performed as described previously, except that the 4.5 mc crystal oscillator is used as the signal source or marker, depending on which alignment method is employed. When this is done, adjust the 4.5 mc trap (if any) using the 4.5 mc output of the crystal marker oscillator and a VTVM with an RF probe at the cathode or grid of the picture tube. For some sets, the DC probe of a VTVM will instead be connected to a point in the sound detector circuit. Follow the set manufacturer's instructions in all cases.

The tuner in an intercarrier set is aligned acording to the same general methods described previously.

FM RECEIVER ALIGNMENT

The procedure for aligning an FM receiver is similar to sound IF alignment in tv receivers. The usual IF frequency is 10.7 mc, although higher IF frequencies are used in some receivers. The variable marker oscillator will supply the required 10.7 mc signal. If extremely accurate alignment is desired, the crystal oscillator may be employed, using a 10.7 mc or 5.35 mc crystal inserted in the crystal socket on the panel. In the latter case, the variable marker oscillator may be set to a frequency 100 kc above or below the crystal oscillator frequency to obtain additional bandwidth markers. If the variable marker oscillator is used to provide the 10.7 mc or other IF frequency, an external signal generator set to a frequency 100 kc above or below the IF frequency may be used to provide additional bandwidth markers.

SPECIAL PROCEDURES

If it is essential that a modulated signal be used for adjustment of traps, detectors, etc., a separate signal generator having modulation facilities may be used. If such a generator is not available, an unmodulated signal can often be used together with a VTVM set for DC voltage measurement connected to the video or audio detector. When a modulated signal is used, a VTVM set for AC voltage measurement or a 'scope is usually connected to the grid or cathode of the picture tube. In either case, the trap will be set for a null indication. If a modulated signal is required far sound IF alignment in a TV or FM set, it may be possible to substitute the procedure described under SOUND IF ALIGNMENT. Follow the recommended procedure, however, if there is doubt as to the efficacy of this method.

ACCESSORY INSTRUMENTS

For routine servicing of both monochrome and color tv sets without undue difficulty, a stable, sensitive, and wide-band scope (essentially flat to at least 3.58mc) is a necessity. For sweep alignment, however, wide-band response is not required, since all that is required is faithfull reproduction of a 60 cycle square wave. For this purpose, the 'scope should be flat from 6 to 600 cycles, or preferably 3 to 1200 cycles, and introduce very little phase shift over the range. A scope having DC (direct-coupled) vertical amplifiers is ideal for this purpose. The EICO Model 460 Oscilloscope has both 5 mc bandwidth and DC vertical amplifiers and is required if color tv servicing is to be done as well monochrome tv and FM servicing. For monochrome tv only and FM servicing, the EICO Model 470 scope, with 1 mc bandwidth, is excellent if a 7" diameter 'scope tube is desired as well as extremely high sensitivity. To meet minimum requirements for sweep alignment of monochrome TV and FM receivers, the EICO Model 425 is recommended.

Three EICO probes are available to increase the usefulness of your oscilloscope. These types of probes are available: Oscilloscope Demodulator Probe Model PSD for signal tracing and waveform checks in the RF and IF sections of tv and radio receivers and olso for stage gain measurements in low impedance RF circuits; Oscilloscope Low Capacity Probe Model PLC for accurate reproduction of sync signal waveforms and generally for tracing high frequency, wide-band waveforms in high impedance circuits since this probe effectively reduces the capacitive loading of the oscilloscope by a factor of ten; Oscilloscope Direct Probe Model PD for use in low frequency or low-impedance test circuits and where it is desired to eliminate stray pick-up and signal re-radiation.

Another essential instrument for alignment work and routine tv servicing is a high input impedance VTVM, preferably of the type with true peak-to-peak response such as the EICO Models 232, and 249. Bath these models have an impedance of 11 megohms. This impedance is sufficiently high to make loading effects negligible and to give true voltage readings in the circuits under investigation. A high voltage probe and an RF probe are available as accessories for use with the VTVM.

For horizontal and vertical linearity adjustments on a properly o rating or completely serviced tv receiver, use the EICO Model 352 Bar Generator. This instrument produces an adjustable number of evenly spaced vertical or horizontal bars when connected to the antenna input terminals of a tv receiver to facilitate rapid and accurate linearity adjustments. This service will help gain the good will of your customers.

MAINTENANCE

GENERAL

Included in this section are instructions for mechanical adjustments calibration, trouble-shooting, and part replacement. All adjustments and calibration procedures must be performed in the order given on completed kit instruments before they can be placed in use. The same procedures will serve for periodic readjustments in both kit and factory-wired instruments when required by component aging or replacement.

REMOVAL FROM CABINET

To remove the instrument from the cabinet, first disconnect it from the power line and remove the two screws at the cabinet rear. Then slide the chassis out the front of the cabinet.

MECHANICAL ADJUSTMENTS

Both the MARKER OSCILLATOR and SWEEP OSCILLATOR dials must be positioned so that the radial lines marking the low frequency end of all bands is brought exactly behind the hairline in the plexiglass window when the variable capacitor plates are fully meshed. The procedure to make this adjustment is described below.

1) Loosen the set screw in the brass dial bushing.

2) Turn the knob clockwise until the capacitor plates are fully meshed without forcing. NOTE: The knob can be turned slightly beyond this point with a little forcing, but doing this is undersirable because it would throw off the calibration. A sure way of avoiding this mistake is to watch the two thin adjacent gears on the capacitor shaft (both of which mesh with the thick brass gear on the driving shaft) while turning the knob clockwise. You are not forcing while the two thin adjacent gears move together; you are forcing when the thin gear nearest the capacitor frame is moved while the thin gear in front of it remains stationary. As forcing is possible only over a few degrees of rotation, you will have to observe closely.

3) Position the dial so that the radial line marking the low frequency end of all bands rests directly behind the

hairline in the plexiglass window. While the dial is in this position, retighten the set screw on the dial bushing.

CALIBRATION OF MARKER GENERATOR

1) Connect the line cord to the AC line (117 volt, 60 cps) and turn the power on (turn PHASE control clockwise from zero). NOTE: Be careful to avoid personal contact with the operating voltages of the instrument.

2) Connect the Output Cable to the EXT. MARKER connector.

3) Wire the broad-band detector circuit shown below to the V input terminals of your scope, using the shortest possible leads between the components and the scope terminals. Connect the other end of the Output cable to the input terminals of the broad-band detector. The set-up is shown in Fig. 6.

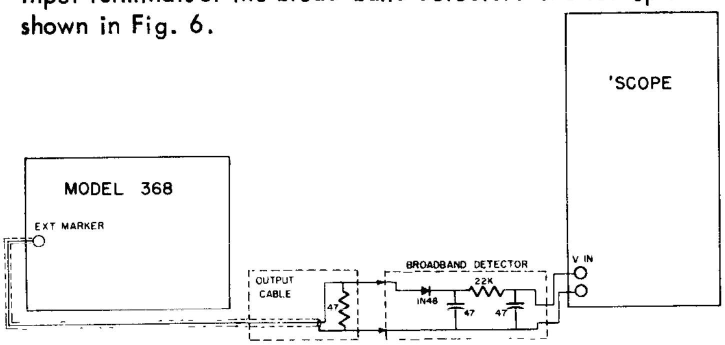


Fig. 6

4) Set the scope sweep frequency at somewhere between 1000 and 5000 cps and the vertical gain to maximum. Set the horizontal gain for a horizontal deflection roughly 1/2 to 2/3 the screen diameter.

5) Insert the 4.5 mc crystal in the X-TAL socket on the panel and advance the MARKER SIZE control to maximum.

6) Set the MARKER RANGE selector at position 3 and the MARKER OSCILLATOR to 22.5 mc (5th harmonic of the crystal). Adjust the marker oscillator coil slug for Band 3 (see Fig. 7 for location) for zero beat between the crystal and variable marker oscillators. The approach of zero beat will be indicated by an increased trace amplitude, signifying a high frequency beat signal coming into the band-pass of the scope; immediately adjacent to zero beat individual frequencies will be visible and exactly at zero beat the amplitude of the trace will drop to zero. These phenomena will be repeated in reverse order on the opposite side of zero beat. As there are strong crystal harmonics every 4.5 mc, you can not be sure that the variable oscillator is zero beating against the selected harmonic without checking. For this reason, the coil slugs have been pre-set in production at approximately the correct position, so that the zero beat that occurs when the coil slug is adjusted a few turns on one side or the other of the pre-set position should be with the desired 5th harmonic. However, this is not a certainty, and the adjustment of the coil slug must be checked by setting the MARKER OSCILLATOR dial at 27 mc (6th harmonic), 31.5 mc (7th harmonic), and 36 mc (8th harmonic), at all of which frequencies zero beat should occur again. If these checks do not confirm the correctness of the coil slug adjustment, reset the dial to 22.5 mc and readjust the coil slug for zero beat at a different point. In all these adjustments, it will be necessary to adjust the 'scope controls for a display of convenient amplitude.

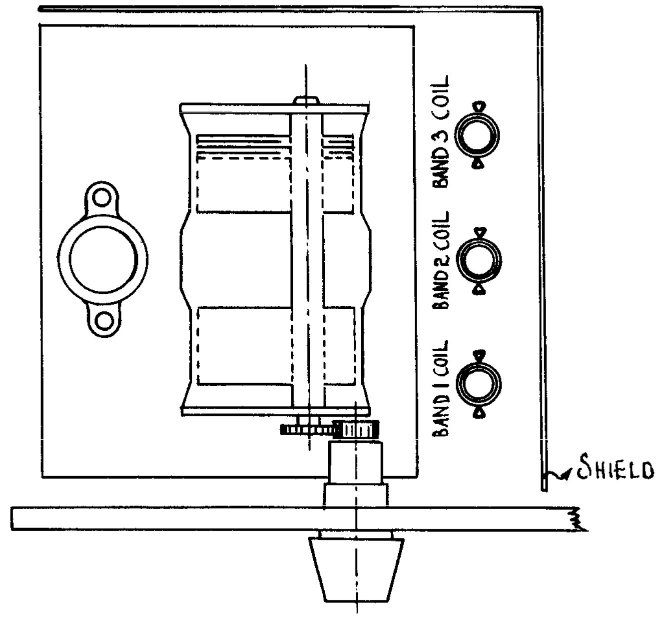


Fig. 7

7) Set the MARKER RANGE selector at Range 2. Set the MARKER OSCILLATOR dial at 9 mc. Adjust the slug in the Band 2 coil for zero beat. To confirm the correctness of the coil adjustment, check for zero beat at dial settings of 13.5 mc, 18 mc, and 22 mc on the Range 2 scale. Redo the coil adjustment if confirmation is not obtained.

8) Set the MARKER RANGE selector at Range 1. Set the MARKER OSCILLATOR dial at 4.5 mc. Adjust the slug in the Range 1 coil for zero beat. To confirm the correctness of the coil adjustment, check for zero beat at dial settings of 9 mc, 13.5 mc, and 18 mc on the Range 1 scale. Redo the coil adjustment if confirmation is not obtained. This completes the calibration of the marker generator.

9) Remove the crystal and turn the MARKER RANGE selector to the OFF position. Disconnect the output cable from the EXT. MARK. connector but leave the opposite end connected to the broad-band detector ahead of the scope as it will be required for the adjustment of the sweep oscillator that follows.

ADJUSTMENT OF SWEEP OSCILLATOR

NOTE: The SWEEP OSCILLATOR dial is not calibrated accurately because the marker oscillators serve to provide accurate identification of frequencies along the response curve.

1) Connect the Output Cable to the RF OUTPUT connector and retain the connection of the opposite end to the broad-band detector ahead of the scope. Connect the 'Scope Horizontal Leads from the SCOPE HOR. and GND

terminals of the 368 to the horizontal input terminals of the 'scope. See Fig. 8.

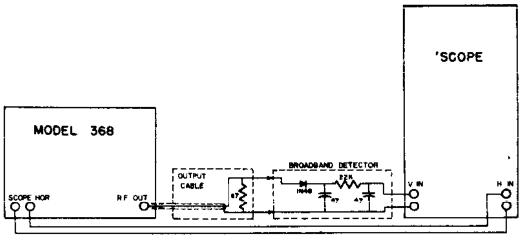
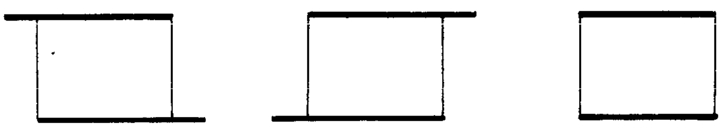


Fig. 8

Set the scope for exteınal input to the horizontal amplifier. Set the FINE and COARSE OUTPUT attenuators to the furthest counter-clockwise position (maximum output). Set the SWEEP RANGE selector to position E and the SWEEP WIDTH control at zero, and the PHASE control at zero. Set the scope controls for a horizontal deflection of 1/2 to 2/3 the screen diameter and a convenient pattern height.

2) A rectangular shaped trace should result from the preceding operations. Refer to the instructions for corrective operation of the PHASE control if there is any evidence of overlapping in the trace, indicating an incorrect phase adjustment. See Fig. 9.



IMPROPER PHASING

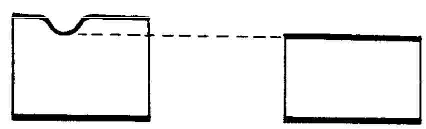
PROPER PHASING

Fig. 9

Note that the correct display consists of two bright, straight, and parallel horizontal lines connected by two light vertical lines at the extremities. If the 'scope does not have good response below 60 cycles, the detected response line vill be tilted. For this reason, it is preferable to use a scope with dc (direct-coupled) vertical amplifiers (such as the EICO Model 460. In the OPERATION section (page 5), information is given as to how to determine which of the horizontal lines is the detected sweep output and which the zero input reference; also, how to determine which is the high-frequency end and which is the low-frequency end of the sweep.

3) Now set the SWEEP RANGE selector successively to each of the other ranges. At each position, wait for the AGC action to complete itself (finding the maximum output level with minimum amplitude variation). On each range the trace should consist of the same two straight horizontal parallel lines, although the vertical distance between the lines need nat be the same on all ranges, and in fact, will usually not be. On each range position, turn the SWEEP OSCILLATOR dial through the full frequency range to determine whether there are any "dead" spots where the sweep oscillator does not function. The amplitude of the response curve will normally vary over any one sweep range, particularly on the two highest ranges. At one point at least, check the operation of the FINE and COARSE OUTPUT attenuators by turning them fully counter-clockwise and then returning them to the furthest clockwise position.

4) Advance the SWEEP WIDTH control to maximum. The COARSE OUTPUT ATTENUATOR should be set at X1000 and the FINE OUTPUT ATTENUATOR at 100 (minimum attenuation). Rotate the AGC level adjust potentiometer R32 (on the chassis) maximum counter-clockwise. Set the the SWEEP RANGE selector at Range E, and turn the SWEEP OSCILLATOR dial through the entire frequency range while observing the pattern on the scope. If a dip occurs, as shown in Fig. 10A, turn the AGC level control R32 clockwise just enough to bring the amplitude down to where the dip disappears, as shown in Fig. 10B. (Note thot the ultimate effect of adjusting R32 is not evident instantaneously. Make the adjustment in small increments and allow time for AGC action.) Then set the SWEEP RANGE selector at Range D, and again turn the SWEEP OSCILLATOR dial through the entire range while observing the pattern on the 'scope. If a dip occurs on this range, turn AGC level control R32 further clockwise until the dip disappears. Procede successively to each of the remaining sweep ranges and turn R32 as far clockwise as is required to eliminate any dip in the output curve on every band. (Note that adjustment of R32 can only correct dips in the output of the swept oscillator, not irregularities due to resonances in the broad-band detector circuit.) Adjustment of the instrument is now completed.



A B

Fig. 10

TROUBLE-SHOOTING

The schematic diagram of the Model 368 plus the information given in the CIRCUIT DESCRIPTION section should aid in isolating the circuit in which the trouble is located. The next step is to localize the trouble in the particular section to the tube circuit involved and then to try a replacement tube. If the trouble is not eliminated, voltage and resistance checks should be made and compared with the data provided in the voltage and resistance chart (Fig. 11). Note that the sweep oscillator section consists of the oscillator, cathode follower, blanking, and AGC circuits and that the voltages in these circuits are interdependent. Because of this voltage interdependance, first attempt to locate the defect by making wiring and cold resistance checks on each of these stages individually.

As an aid in localizing trouble, common symptoms together with their possible causes and remedies have been listed in groups corresponding to the major sections of the instrument (Fig. 12). Of course, all possible troubles could not be included in the chart and the make-up of the chart has been based on the assumption that the instrument has worked properly at some previous time. Keep in mind that in trouble-shooting, the main endeavor is to find and eliminate the source of the trouble. Recurrence of a trouble usually indicates that the effect, not the cause has been remedied.

Fig. 11 TROUBLE-SHOOTING CHART

SYMPTOM	DEFECT	REMEDY
Pilot lamp, I1, fails to light	No a-c line voltage Pilot lamp, I1, defective Transformer, T1, defective Defective filament wiring Short in B+ circuit	Trace line failure Replace Replace Repair Check for a shorted electrolytic capacitor, tuning capacitor, or a short in the B+ wiring paths.
Some or all filaments fail to light	Defective tube or tubes Defective wiring T1 defective	Check and replace Repair Replace
No output from the sweep oscillator	V2 defective AGC level control R32 misadjusted Oscillator coil or coils of L6 open Defective wiring	Replace Re-adjust Replace L6 Repair
No regulation (AGC action)	R32 misadjusted V3,V4, or V5 defective R20 open C24 defective	Re-adjust Check and replace Replace Replace
Poor regulation at full sweep width	Defective C17, C18 R21, R22 open Defective wiring to S1	Replace Replace Repair
No blanking	Defective V3 R20, R23, R24 open C14 shorted	Check and replace Replace Replace
No sweep	Field coil of L6 defective C21 defective R26, R27, R28 open Defective CR1	Replace L6 Replace Replace Replace
No variable marker oscillator output	Defective V1 L2, L3, L4 open Defective R4 (check if no negative voltage present at pin 2 of V1)	Replace Check for continuity and replace Replace
No crystal marker oscillator output	Crystal defective R2 open C2 shorted C1 open	Replace Replace Replace Replace

Fig. 12 RESISTANCE CHART

TUBE	V1 12AT7	V2 12AV7	V3 12AX7	V4 6AU6	V5 12B4	V6 6X4
PIN#						
1	Above 300K	INF.	14.7KΩ	Above 1M	INF.	190Ω
2	22KΩ	100KΩ	14.7KΩ	0	Above 300K	
3	150Ω	300Ω	15.5KΩ	NEGL	0	NEGL
4	0	NEGL	NEGL	0	NEGL	0
5	0	NEGL	NEGL	Above 300K	NEGL	
6	Above 300KΩ	Above 300KΩ	Ab. 300KΩ			190Ω
7	47K	4.7KΩ	4.7MΩ	150Ω		Ab. 300K
8	150Ω	0	0			
9	NEGL	0	0	Above 300K		

REFERENCES FOR VOLTAGE & RESISTANCE CHART

* Voltages will change with Marker Range and Tuning positions.
** Voltages will vary with setting of level control R32 and with Sweep Range and Sweep Tuning positions.
Sweep Circuit Voltages: Across C22-140VDC; Across C20-0 to 65VAC varies with Sweep Width Setting R38. For this measurement use a blocking capacitor at least .1 UF.
Unless otherwise noted, all voltage and resistance values may normally vary by ±10%.

CONTROL SETTINGS

TUNING KNOBS fully clockwise
SWEEP RANGE at E
SWEEP WIDTH at 0
FINE at 100
COARSE at X1000
MARKER SIZE at 100
MARKER at 1
XTAL in.

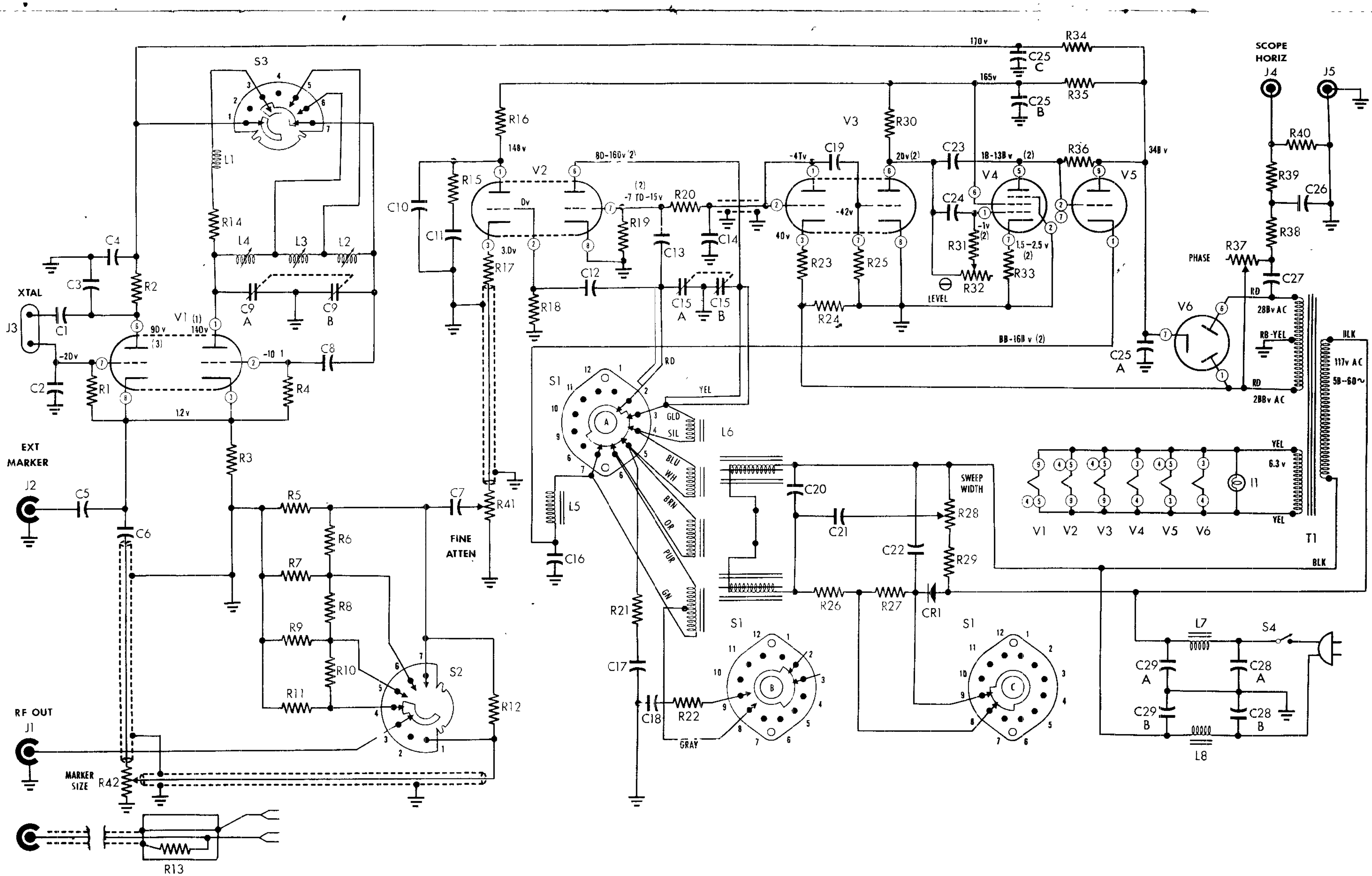
Fig. 13 VOLTAGE CHART

TUBE	V1 12AT7	V2 12AV7	V3 12AX7	V4 6AU6	V5 12B4	V6 6X4
PIN#						
1	140VDC *	140VDC	-47VDC	-1V **	80-160VDC *	280VAC
2	-10VDC *	0	-47VDC	0	10-130VDC **	NC
3	1.2VDC	3VDC	40 VDC	6.3VAC	0	6.3VAC
4	0	6.3VAC	6.3VAC	0	6.3VAC	0
5	0	6.3VAC	6.3VAC	10-130VDC*	6.3VAC	NC
6	90VDC	80-160VDC**	10-20VDC**	165VDC	NC	280VAC
7	-20VDC	-15VDC **	-42VDC	1.5-2.5VDC **	connected int. to #2	340VDC
8	1.2VDC	0	0	NC		
9	6.3VAC	0	0		340VDC	

REPLACEMENT PARTS LIST

Stock#	Symbol.	Description	Am't.
22500	C1,4,5,6 7,16	cap., disc, 1000 mmf	6
22005	C2,3	cap., cer., 25 mmf	2
22516	C8	cap., disc., 47 mmf	1
29007	C9	cap., tuning, marker	1
22527	C10, 12	cap., disc., 15 mmf	2
22526	C11,18	cap., disc., 5000 mmf	2
22524	C13,23	cap., disc., 100 mmf	2
22515	C14,17	cap., disc., 500 mmf	2
29006	C15	cap., tuning, sweep	1
20501	C19	cap., paper, 2 mf - 150 V	1
~~20035~~	~~C20~~	~~cap., paper, .22 mf-200 V~~	~~1~~
23010	C21	cap., elec., 10 mf - 150 V	1
23015	C22	cap., elec., 50 mf - 150 V	1
20034	C24	cap., paper, .5 mf - 200 V	1
24002	C25	cap., elec., 3 X 10mf-450 V	1
20001	C26	cap., paper, .05 mf-400 V	1
22503	C27	cap., disc., .01 mf-1000 V	1
22528	C28,29	cap., disc., 2 X .05 mf	2
93003	CR1	rectifier	1
92000	I1	bulb, #47	1
50002	J1,2	connector, male	2
97500	J3	holder, crystal	1
52001	J4, 5	binding post	2
35021	L1	choke, RF	1
36011	L2	coil, marker 1	1
36012	L3	coil, marker 2	1
36013	L4	coil, marker 3	1
35019	L5	choke, high loss	1
37000	L6	increductor unit	1
35020	L7,8	choke, RF line	2
10428	R1	res., 47KΩ, 1/2W, 10%	1
10426	R2	res., 33KΩ, 1/2W, 10%	1
10441	R3,33	res., 150Ω, 1/2W, 10%	2
10424	R4	res., 22KΩ, 1/2W, 10%	1
10437	R5,7,9	res., 56Ω, 1/2W, 10%	3
10429	R6,8,10	res., 470Ω, 1/2W, 10%	3
10436	R11,13	res., 47Ω, 1/2W, 10%	2
10004	R12	res., 220Ω, 1/2W, 20%	1
10430	R14,19	res., 4.7KΩ, 1/2W, 10%	2
10000	R15	res., 22Ω, 1/2W, 20%	1
10423	R16,22	res., 2.2KΩ, 1/2W, 10%	2
10003	R17	res., 100Ω, 1/2W, 20%	1
10410	R18,31,39, 40	res., 100KΩ, 1/2W, 10%	4
10400	R20	res., 10KΩ, 1/2W, 10%	1
10427	R21	res., 1.2KΩ, 1/2W, 10%	1
10851	R23	res., 22KΩ, 1W, 10%	1
10849	R24	res., 47KΩ, 1W, 10%	1
10418	R25	res., 4.7MΩ, 1/2W, 10%	1
10953	R26	res., 8.2KΩ, 2W, 10%	1
10833	R27	res., 18KΩ, 1W, 10%	1
16010	R28	pot., 10KΩ (sweep width)	1
10854	R29	res., 6.8KΩ, 1W, 10%	1
10408	R30	res., 680KΩ, 1/2W, 10%	1
18030	R32	pot., 1MΩ (level)	1
10905	R34	res., 22KΩ, 2W, 20%	1
14300	R35	res., 10KΩ, 10W, 10%	1
10845	R36	res., 220KΩ, 1W, 10%	1
18026	R37	pot., 100KΩ, w/spst (phase)	1
10407	R38	res., 1MΩ, 1/2W, 10%	1

Stock#	Symbol	Description	Am't.
16013	R41	pot., 200Ω (fine)	1
16013	R42	pot., 200Ω (marker)	1
60039	S1	switch, rotary, 5 pos. (Range)	1
60040	S2	switch, rotary, 4 pos. (ATTEN)	1
60045	S3	switch, rotary, 4 pos. (Marker)	1
30002	T1	transformer, power	1
54004	TB1,16,17	terminal strip, 2P. w/ground	3
54016	TB2	terminal strip, 3P. upright	1
54013	TB3	terminal strip, 1P. left w/gnd	1
54007	TB4,7,12	terminal strip, 3P. 2 rt. w/gnd	3
54002	TB5,14	terminol strip, 1P. right w/gnd	2
54001	TB6,8,15	terminal strip, 1P. right	3
54003	TB9	terminal strip, 2 Post	1
54000	TB10	terminal strip, 1 P. left	1
54008	TB11	terminal strip, 4 Post	1
54006	TB13	terminal strip, 3P. 2 right	1
90012	V1	tube, 12AT7	1
90022	V2	tube, 12AV7	1
90034	V3	tube, 12AX7	1
90020	V4	tube, 6AU6	1
90037	V5	tube, 12B4A	1
90036	V6	tube, 6X4	1
97711	XI1	pilot lite assembly, snap	1
97025	XV1,3,5	socket, 9 pin min.	3
97005	XV2	socket, 9 pin wafer	1
97024	XV4,6	socket, 7 pin min.	2
10023		res., 68KΩ, 1/2W, 20%	1
22500		cap., disc., 1K mmf	1
40000		nut, hex, #6-32	23
40001		nut, hex, #3/8-32	15
40008		nut, hex, #8-32	7
40022		nut, hex, #4-40	13
41000		screw, #6-32 X 1/4	29
41002		screw, #6 self tapping	2
41003		screw, #8-32 X 3/8	4
41009		screw, #4-40 X 3/4	1
41014		screw, #6-32 X 3/8	10
41016		screw, #4-40 X 1/4	14
41041		screw, #6 set	2
42000		washer, lock, #3/8	9
42001		washer, flat, #3/8	8
42002		washer, lock, #6	44
42007		washer, lock, #4	12
42008		washer, lock, #8	6
42017		washer, fibre, flat #8	1
42018		washer, fibre, shoulder #8	2
42019		washer, rubber	2
43001		lug, pot ground	3
43004		lug, #8	2
43005		lug, spade	6
44009		spacer, #6 X 1 1/2	8
46000		grommet, 3/8	3
46006		feet, rubber	4
47001		spring	2
49000		crystal 4.5 mc	1
51000		connector, female	1
51502		clip, crocodile	4
53006		knob, round bar	7
53015		knob, tuning	2
54512		board, probe	2



Sym.	Description	Sym.	Description	Sym.	Description	Sym.	Description	Sym.	Description	Sym.	Description
C1	cap., disc, 1000mmf	C16	cap., disc, 1000mmf	I1	bulb, #47	R7	res., 56Ω, 1/2W, 10%	R22	res., 2.2KΩ, 1/2W, 10%	R37	pot., 100KΩ, w/spst (phase)
C2	cap., cer., 25mmf	C17	cap., disc., 500mmf	L1	choke, RF	R8	res., 470Ω, 1/2W, 10%	R23	res., 22KΩ, 1W, 10%	R38	res., 1MΩ, 1/2W, 10%
C3	cap., cer., 25mmf	C18	cap., disc., 5000mmf	L2	coil, marker 1	R9	res., 56Ω, 1/2W, 10%	R24	res., 47KΩ, 1W, 10%	R39	res., 100KΩ, 1/2W, 10%
C4	cap., disc, 1000mmf	C19	cap., paper, 2mf - 150V	L3	coil, marker 2	R10	res., 470Ω, 1/2W, 10%	R25	res., 4.7MΩ, 1/2W, 10%	R40	res., 100KΩ, 1/2W, 10%
C5	cap., disc, 1000mmf	C20	cap., paper, .22mf - 200V	L4	coil, marker 3	R11	res., 47Ω, 1/2W, 10%	R26	res., 8.2KΩ, 2W, 10%	R41	pot., 200Ω (fine)
C6	cap., disc, 1000mmf	C21	cap., elec., 10mf - 150V	L5	choke, high loss	R12	res., 220Ω, 1/2W, 20%	R27	res., 18KΩ, 1W, 10%	R42	pot., 200Ω (marker)
C7	cap., disc, 1000mmf	C22	cap., elec., 50mf - 150V	L6	increductor unit	R13	res., 47Ω, 1/2W, 10%	R28	pot., 10KΩ (sweep width)	S1	switch, rotary, 5 pos. (Range)
C8	cap., disc., 47mmf	C23	cap., disc., 100mmf	L7	choke, RF line	R14	res., 4.7KΩ, 1/2W, 10%	R29	res., 6.8KΩ, 1W, 10%	S2	switch, rotary, 4 pos. (ATTEN)
C9	cap., tuning, marker	C24	cap., paper, .5mf - 200V	L8	choke, RF line	R15	res., 22Ω, 1/2W, 20%	R30	res., 680KΩ, 1/2W, 10%	S3	switch, rotary, 4 pos. (Marker)
C10	cap., disc., 15mmf	C25	cap., elec., 3X10mf-450V	R1	res., 47KΩ, 1/2W, 10%	R16	res., 2.2KΩ, 1/2W, 10%	R31	res., 100KΩ, 1/2W, 10%	V1	tube, 12AT7
C11	cap., disc., 5000mmf	C26	cap., paper, .05mf - 400V	R2	res., 33KΩ, 1/2W, 10%	R17	res., 100Ω, 1/2W, 20%	R32	pot., 1MΩ (level)	V2	tube, 12AV7
C12	cap., disc., 15mmf	C27	cap., disc., .01mf - 1000V	R3	res., 150Ω, 1/2W, 10%	R18	res., 100KΩ, 1/2W, 10%	R33	res., 150Ω, 1/2W, 10%	V3	tube, 12AX7
C13	cap., disc., 100mmf	C28	cap., disc., 2X.05mf	R4	res., 22KΩ, 1/2W, 10%	R19	res., 4.7KΩ, 1/2W, 10%	R34	res., 22KΩ, 2W, 20%	V4	tube, 6AU6
C14	cap., disc., 500mmf	C29	cap., disc., 2X.05mf	R5	res., 56Ω, 1/2W, 10%	R20	res., 10KΩ, 1/2W, 10%	R35	res., 10KΩ, 10W, 10%	V5	tube, 12B4A
C15	cap., tuning, sweep	CR1	rectifier	R6	res., 470Ω, 1/2W, 10%	R21	res., 1.2KΩ, 1/2W, 10%	R36	res., 220KΩ, 1W, 10%	V6	tube, 6X4

EICO **MODEL 368 TV-FM SWEEP GENERATOR & MARKER** Electronic Instrument Co., Inc