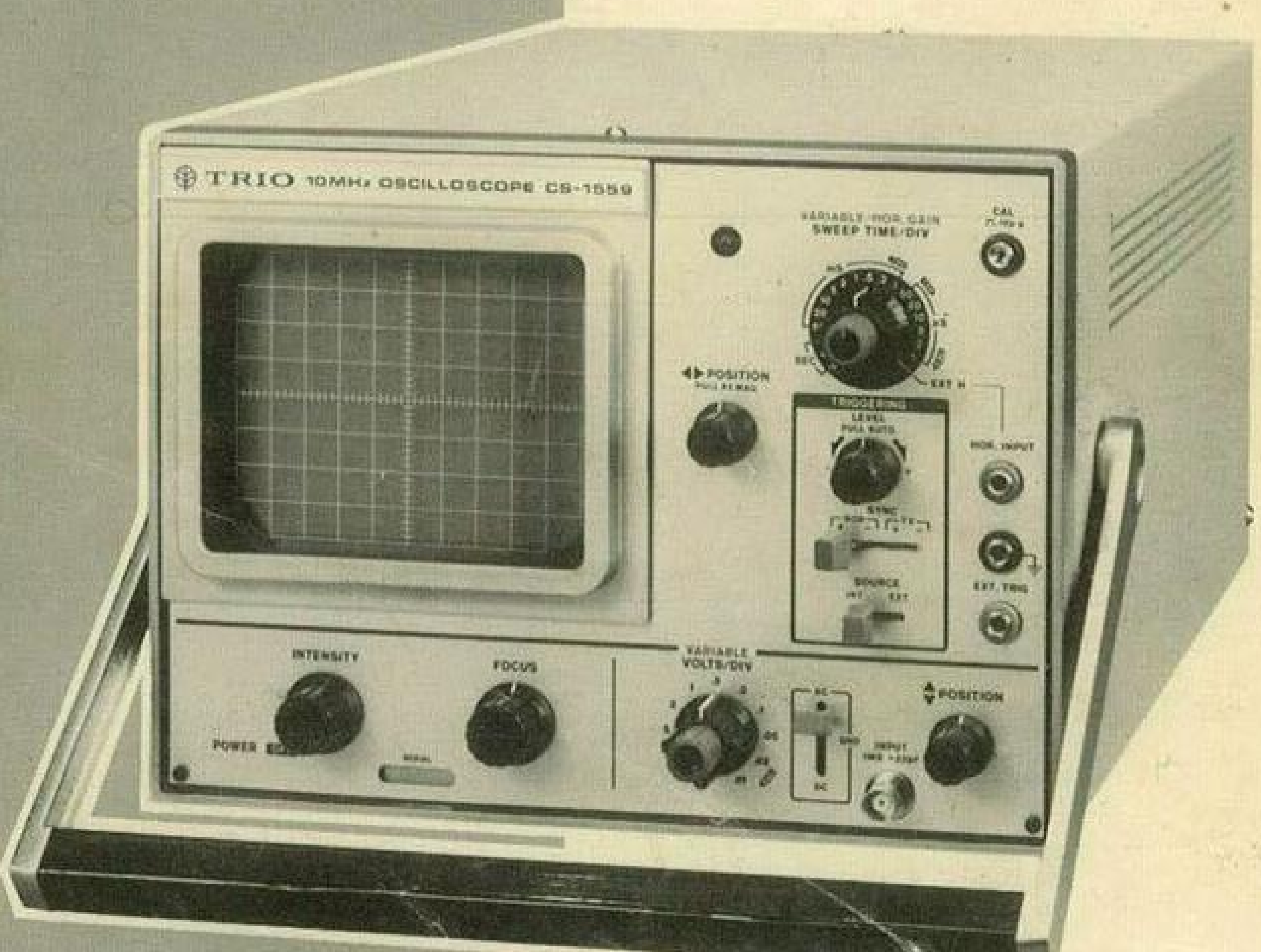
TRIGGERED SWEEP OSCILLOSCOPE

HIGH STABILITY

CS-1559

OSCILLOSCOPE



TRIO

INSTRUCTION MANUAL

CONTENTS

FEATURES

* The adoption of IC's throughout circuitry assures high performance and improved reliability.
* Vertical axis of low input capacitance (22 ±3pF) provides high sensitivity and wideband-width (10 mV/div, 10 MHz).
* The high voltage power for CRT as well as the power for other circuits is fully stabilized because of the use of DC-DC converter, thus the sensitivity and luminance are completely free from effects of voltage variations.
* Low power comsumption (20W) for cool operation.
* The cathode ray tube adjustable for correct bright line angle without removing the case.
* Time base switch allows changeover between V (vertical) and H (horizontal) of TV sync separator circuit, automatically and electronically.
* At AUTO position of TRIG LEVEL, it is possible to check the luminance at no-signal time and to adjust triggering level of input waveforms.
* All component parts are cleverly mounted on circuit boards for improved reliabiligy.

SPECIFICATIONS

Type of Cathode Ray Tube: C529P31B or 130BEB31
Acceleration Voltage: 2 kV

Vertical Axis

Sensivity: 10 mV/div ~ 20V/div ±5%
Attenuator: 10 mV/div ~ 20 V/div, 1-2-5 step (1 div = 1 cm)
Precisely adjustable in all ranges.
Sensitivity error between ranges is ±5%.
Input Impedance: 1 MΩ ±5%
Input Capacitance: 22 pF ±3 pF
Frequency Response: DC DC-10 MHz (less than −3dB)
AC 2 Hz ~ 10 MHz (less than −3 dB)
Rising Time: Less than 35 nsec.
Overshoot: Less than 3%
(at 100 kHz square wave)
Maximum input Voltage: 600 Vpp or 300 V (DC + AC peak)

Sweep Circuit

Sweep System: Triggering sweep and auto sweep (free-running sweep at no-signal time)
Sweep Time: 1 μs/div ~ 0.5 s/div ±5% and EXT H, 1-2-5 step Fine adjustment in all 18 ranges
Magnifier: 5 times ±10% (PULL × 5 MAG)
Linearity: Less than 3% (5 μs/div ~ 0.5 s/div)
Less than 5% (1 μs/div ~ 2 μs/div)

Synchronization

Sync Input:
INT: Vertical input signal
EXT: EXT TRIG input signal

Sync Section:
NOR: Positive and negative
TV: Positive and negative (TVH and TVV are automatically switched by SWEEP TIME/DIV)
TVH (TV-Line):
1 μs/div ~ 50 μs/div
TVV (TV-Field):
0.1 ms/div ~ 0.5 s/div

Sync Voltage: Amplitude on CRT screen, more than 1 div EXT ..... More than 1 Vp-p
Sync Frequency: 20Hz ~ 10 MHz

Horizontal Axis

Operating Mode: EXT H mode is selected by SWEEP TIME/DIV.
Sensitivity: 150 mV/Div (within ±20%) (HOR GAIN MAX)
Frequency Response: DC − 1 MHz (less than −3dB)
Input Impedance: 100 kΩ
Calibrating Voltage: 1 Vp-p ±5%
(50/60 Hz square ware)

Luminance Modulation

Input Voltage: Less than 5 Vp-p (modulation)
Input Impedance: 10 kΩ ±20%

Power Source

Power Supply Voltage: 100/120/220/240V ±10%, 50/60 Hz
Power Consumption: 20W

Dimensions and Weight

Width:	260 mm (280 mm)
Height:	190 mm (204 mm)
Depth	375 mm (433 mm)
	Figures in ( ) show maximum sizes.
Weight:	8 kg

Accessory

Probe:	PC-21 1
	Damping.......................... 1/10
	Input impedance .... 10 MΩ
	Input capacitance........... less than 18 pF
Pin-plug:	Non-shorting type 1
	AC Power Cord..................... 1
Instruction Manual:	1 copy
Fuse:	0.7 2
	0.3A 2

DESCRIPTIONS OF CIRCUITS

Fig. 1 shows the block diagram of the oscilloscope. The circuit is referred to the circuit diagram given at the end of this manual.

VERTICAL AMPLIFIER

The vertical input signal fed from the Input Terminal is controlled by the AC-GND-DC switch as necessary so as to be applied to the 1st attenuator. The out-put thus obtained is fed to the dual FET Q121 through high input impedance. Because of the use of dual FET, DC voltage is well balanced against temperature variation. The output signal is then applied to the emitter follower circuit composed of Q123 and Q124 so that is fed to the 2nd attenuator through low output impedance. This attenuator controls the emitter resistance of Q125 and Q126 to vary the gain. The variable resistor VR111 in the source follower circuit of the first stage is used as a DC balancer to avoid shifting of bright line when the attenuator is manipulated, while the variable amplifier composed of Q403 and Q404 is used to vary the vertical gain. The variable resistor VR402 is a DC balancer for the variable amplifier and is used to avoid shifting of bright line when the variable VR is rotated, while VR112 is used to balance the DC level between Q403 and Q404 to adjust the vertical position.

The output obtained from the 2nd attenuator is fed to the cascade amplifier consisting of Q109, Q110, Q111 and Q112 to reduce mirror effect and obtain sufficient gain which is adjustable by VR113 inserted in the emitter circuit consisting of Q143 and Q144. The signal taken from this circuit is amplified by Q127 and Q128 and is led to the horizontal circuit as sync signal.

The output obtained from the cascade amplifier is amplified by the cascade connected vertical output amplifier Q113 ~ Q120 and is fed to the CRT's vertical deflecting plate.

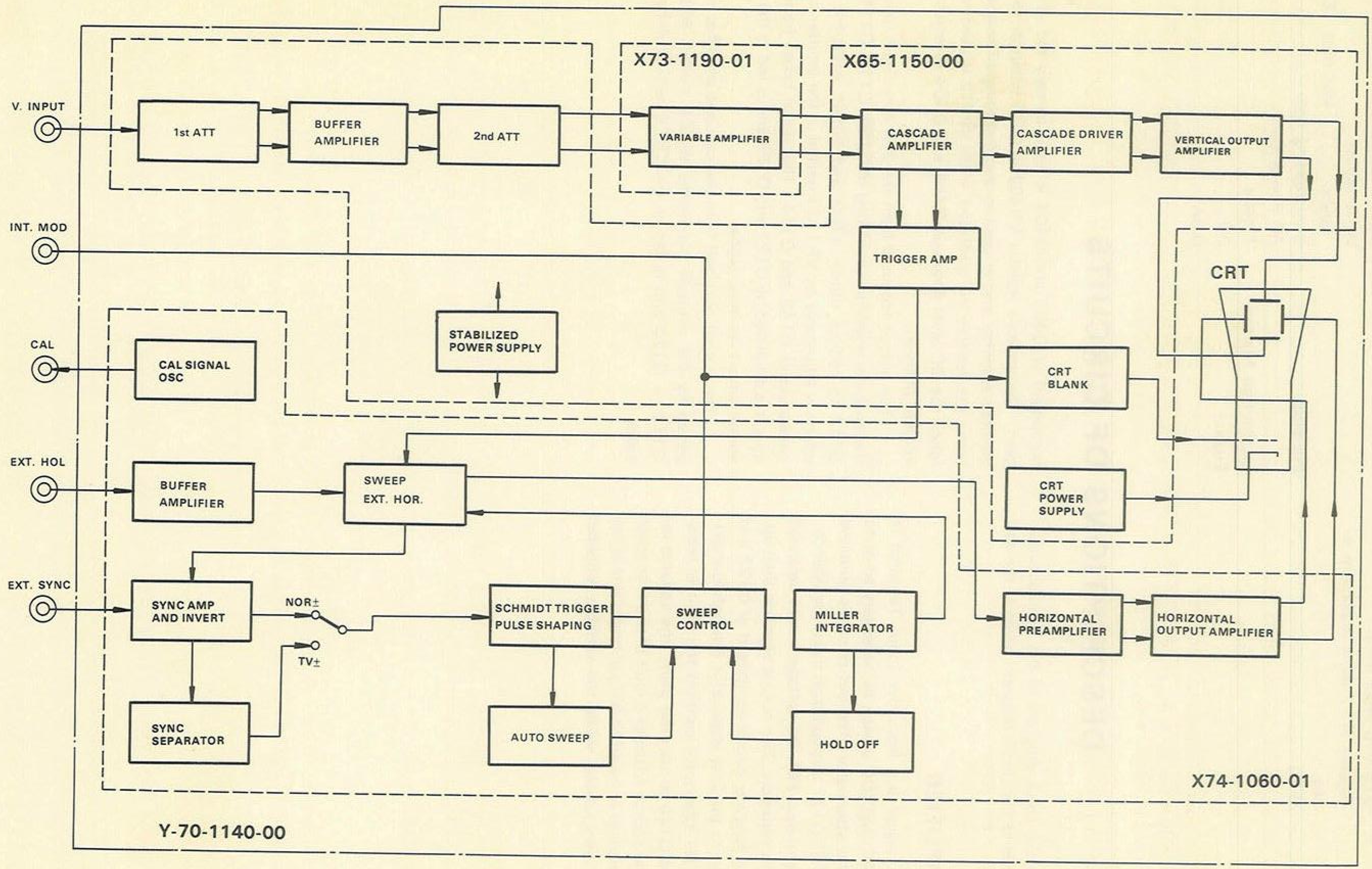


Fig. 1 Block Diagram, CS-1559 Dual-Trace Oscilloscope

SYNCHRONIZING CIRCUIT

The triggering signal, after selecting the type (INT or EXT) of sync voltage is fed to the sync amplifier. In this amplifier, the input point is selected according to the polarity of the SYNC switch to determine the starting point of synchronization, either the rising point or the falling point of the waveform; also, the DC voltage corresponding to the position of the TRIG LEVEL is added to the triggering signal to change the sweep starting point. With the SYNC switch set to TV±, the output is fed to TV sync separator circuit. In the TVH position, the peak point of pulse of horizontal sync signal is amplified and only the horizontal sync signal is fed to the following stage. In the TVV position, the integration circuit is connected and only the vertical sync signal is fed to the following stage. Changeover between TVH and TVV is automatically accomplished by the SWEEP TIME/DIV switch.

The signal passing through the buffer in the emitter follower circuit is shaped into square waves by the 2-gate Schmidt trigger circuit consisting of IC303 and becomes clock pulses for the gate F.F. IC301. The gate F.F. is inverted by the clock pulses, which, in turn, sets Q307 to OFF and thus the Miller integrator becomes charged.

The miller integrator determines the sweep time by the C/R time constant selected by the SWEEP TIME/DIV switch to obtain saw-tooth waves of excellent linearity.

When the output from the Miller integrator fully rises, the hold-off F.F. is inverted and the sweep stops for the time determined by the hold-off time constant.

When the hold-off time passes, the next clock pulse is set in standby mode and thereby the sweep returns to the original status. When the TRIG AUTO switch is turned on, the Miller integrator also detects the presence of triggering signal fed from the Schmidt circuit to drive the AUTO circuit. With no triggering input, the output of AUTO circuit becomes low and, therefore, the gate F.F. starts automatic sweeping. With triggering input, the output of AUTO circuit becomes high and the gate F.F. synchronizes to clock pulses. The sweep time is adjustable with the variable risistor VR306 inserted in the time constant circuit of the Miller integrator, while the DC component in the Miller output is varied by VR305 to adjust the horizontal position.

The saw-tooth waves pass through SWEEP EXT H SELECT and are fed to the horizontal amplifier where the signal is amplified to the specified horizontal deflection voltage and is then directly fed to the horizontal deflecting plate of CRT.

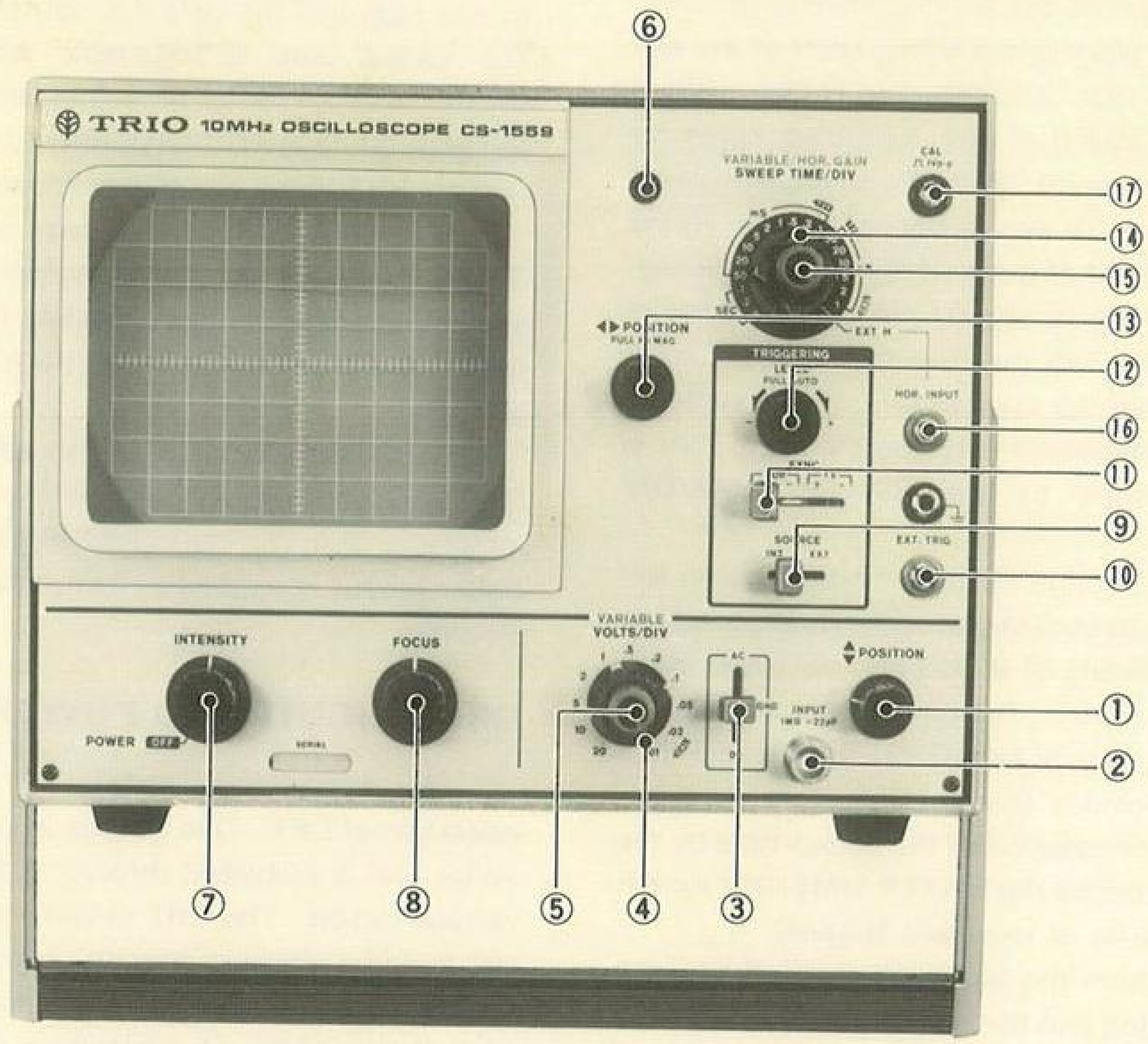
With SWEEP TIME/DIV set to EXT H position, SWEEP/EXT H SELECT is switched to separate the Miller integrator from the horizontal amplifier and thus the EXT H buffer output is applied as horizontal input to the horizontal amplifier.

CRT CIRCUIT AND POWER CIRCUIT

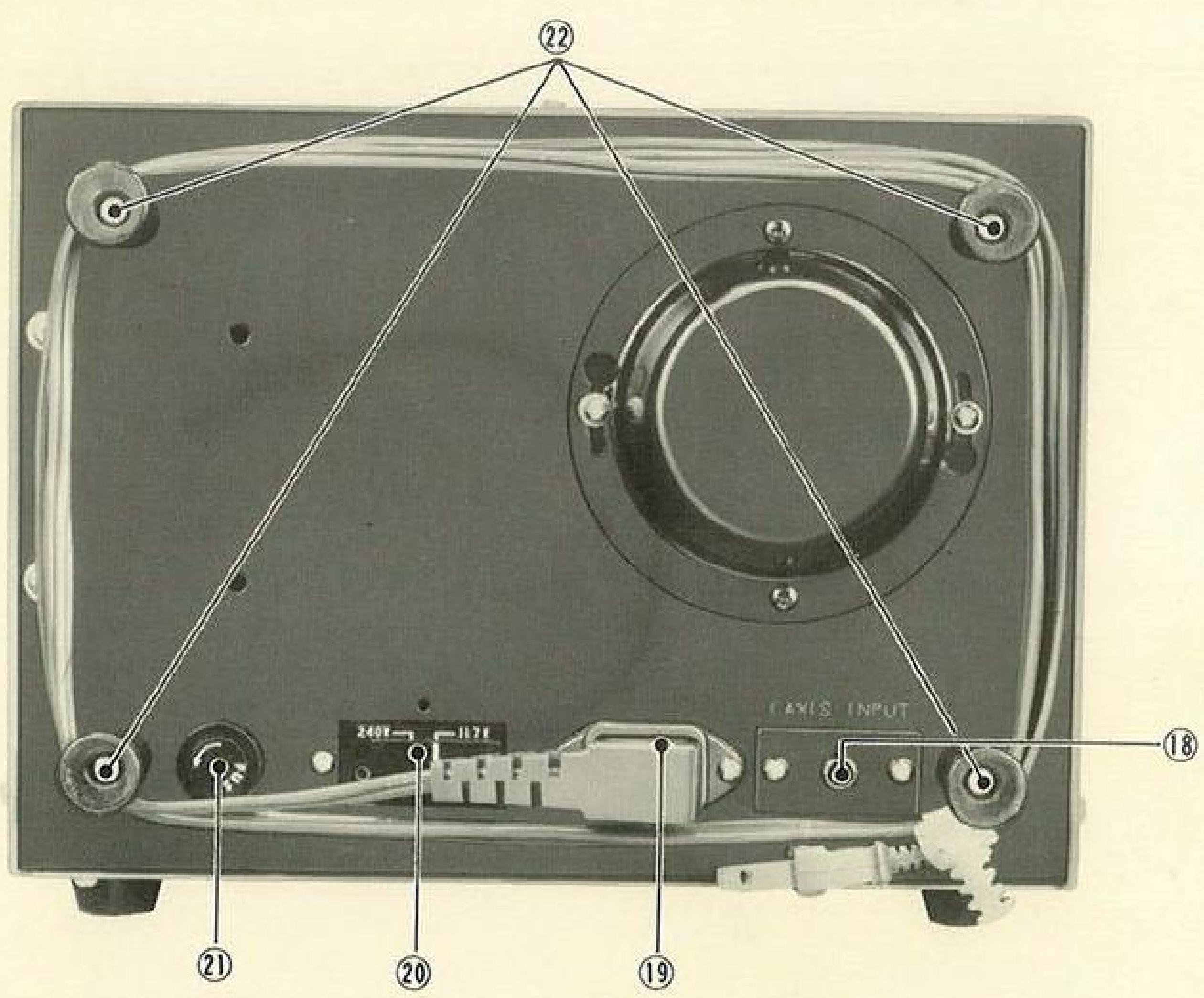
An acceleration voltage of 1.9 kV is required for operation of CRT. This voltage is generated by DC-DC converter and is stabilized through the feedback type constant voltage circuit. The CRT circuit includes a voltage doubler circuit and a blanking amplifier to prevent the change in high voltage due to increased luminance and to improve the rising characteristic of unblanking during high speed sweeping. The power circuit is fully stabilized. The use of a tracking regulator with IC OP amplifier keeps the main power supply constant against variations of power voltage.

CONTROLS ON PANELS

Front Panel



Rear Panel



1. ⇕ POSITION

This control adjusts vertical position. Waveforms can be set to any desired vertical position. A right turn of the control will shift waveform upward, and vice versa.

2. INPUT

Vertical input terminal.

3. AC-GND-DC

In AC position, the DC component of input signal is blocked by capacitor.
In GND position, the input terminal opens and the input of internal amplifier is grounded.
In DC position, the input terminal is directly connected to the amplifier and all components of input signal are amplified.

4. VOLTS/DIV

The scale is graduated in voltage per "div" of CRT screen area. Selectable in 11 ranges from 0.01 V/div to 20 V/div.

5. VARIABLE

Vertical attenuator for fine control of vertical sensitivity. It continuously controls between 11 ranges of VOLT/DIV (4). In the extreme clockwise (CAL) position, the vertical attenuator is calibrated.

6. LED Pilot Lamp

This lamp lights as the power switch (7) is turned on.

7. POWER/INTENSITY

Turning this knob fully counter-clockwise will set power OFF.
Adjusts the brightness of spots and waveforms for easy viewing. A left turn will allow the waveform to disappear.

8. FOCUS

Spot Focus control to obtain optimum wave form according to brightness.

9. SOURCE

Two-position switch to selects triggering source for the sweep. (INT or EXT)

SOURCE: This switch is used to select the mode of sync; either the internal sync (INT) or the external sync (EXT).

INT: The vertical input signal is synchronized.

10. EXT TRIG

External sync terminal. For external synchronization, external sync voltage (more than 1Vp-p) should be applied, with SOURCE switch (10) set to EXT.

11. SYNC

Sync separator switch. It picks up sync signal component in TV video signal and applies to sync circuit for component in TV video signal and applies to sync circuit for complete synchronization of video signal being viewed.

NORM ±: Used for viewing general waveforms. In this position, TV sync separator circuit is not connected.
At "+" polarity, sweep is effected by "+" slope and, at "−" polarity, by "−" slope.

TV ±: Used for viewing wave forms with TV video signal synchronized with sync signal. TVV and TVH are automatically selected for sweep times of 0.5s to 0.1ms and 50μs to 0.5μs of SWEEP TIME/DIV rotary switch, respectively, and are synchronized with vertical and horizontal sync signals.
Polarity should be set to match that of video signal as shown in the illustration.

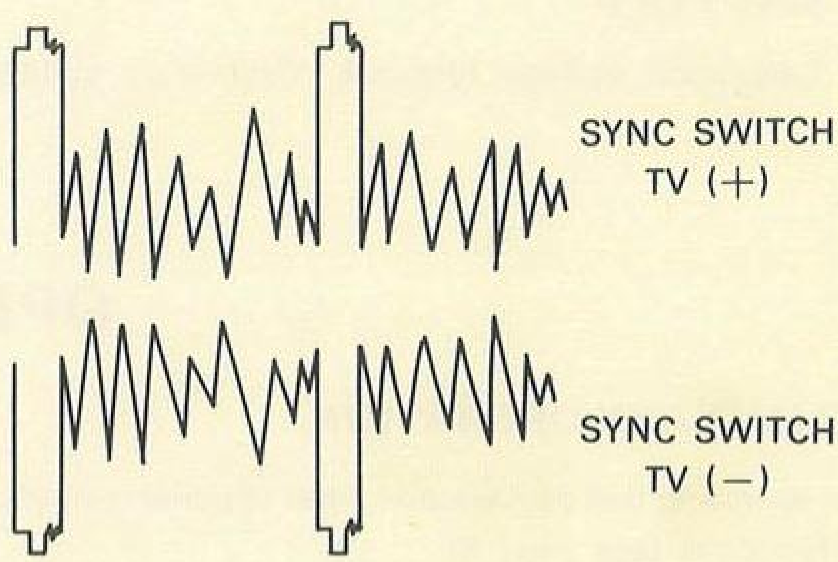


Fig. 2

12. LEVEL

Sync level/PULL AUTO control adjusts sync phase to determine the starting point of sweep on the slope of trigger signal waveform.

PULL Auto:
By pulling LEVEL VR toward you, auto-sweep is effected; The sweep is set in free-running state even when no trigger input signal is applied, with fly-back line displayed on CRT.
With trigger signal, trigger-sweep is effected where sync level is adjustable.

13. ◄► POSITION, PULL X5 MAG

Horizontal position adjuster to shift waveform to any desired horizontal position. A right turn of the adjuster will shift the waveform to right, and vice versa.

PULL X5 MAG:
Sweep magnifier switch. By pulling the knob toward you, waveform is magnified to 5 times in left and right directions. Brightness is slightly decreased.

14. SWEEP TIME/DIV

Horizontal sweep time selector. It selects sweep times of 1μs to 0.5s in 18 steps. EXT H operation is possible by turning the knob fully clockwise. Changeover between TVV and TVH is also accomplished automatically by this selector. When VARIABLE (15) is turned fully clockwise, calibrated reading is obtained which is the sweep time per "div".

15. VARIABLE

Used for fine adjustment of sweep time. Continuous adjustment between 18 steps of SWEEP TIME/DIV (14) is possible. Sweep time is calibrated at the extreme clockwise position (CAL).

16. HOR INPUT

External horizontal input terminal.

17. CAL 1Vp-p

Calibration voltage terminal. Calibration voltage is 1Vp-p of square wave with synchronized power source.

CAL 1Vp-p: This terminal is used to check the condition of vertical gain or to adjust square wave characteristics of the probe.

18. INT MOD

Intensity (brightness) modulation terminal. Intensity is modulated at voltages of 5Vp-p or lower.

19. POWER CONNECTOR

For connection of the supplied AC power cord.

20. AC VOLTAGE SELECTOR

The CS-1559 may be operated from 100V, 120V, 220V, 240V, putting the AC VOLTAGE SELECTOR in the place of another.

21. FUSE HOLDER

For 100 ~ 120V operation a 0.7 ampere fuse should be used.
For 220 ~ 240V operation a 0.3 ampere fuse should be used.

22. CORD REEL

Used to wind power cord when the oscilloscope is to be carried or stored. It also serves as a stand when the oscilloscope is used in upright position.

OPERATION

PRELIMINARY OPERATION

When operating this oscilloscope, refer to panel controls and their functions (see page 6).

When starting this oscilloscope set initially, set the operating controls as follows and the set may be turned on safely.

Control	Position	Control	Position
(7) POWER/INTENSITY	OFF	(12) LEVEL	Center (PULL AUTO)
(8) FOCUS	Center	(13) ◄► POSITION PULL X5 MAG	Center (PUSH)
(3) AC-GND-DC	AC	(11) SYNC	NOR +
(4) VOLTS/DIV	20V	(10) SOURCE	INT
(5) VARIABLE	Extreme clockwise	(14) SWEEP TIME/DIV	1 ms
(1) ▲▼ POSITION	Center	(15) VARIABLE	Extreme clockwise

OPERATING PROCEDURES

Insert the supplied AC power cord to the power connector and power source. The CS-1559 is designed to be operated on 100V, 120V, 220V, 240V. Confirming your power source voltage before insert the power connector.

(1) Turn POWER (7) clockwise. The power is turned to ON and LED pilot lamp (6) lights.
(2) Horizontal axis will be displayed. When fly-back line does not appear at the center of the screen, adjust POSITION (1). Adjust brightness by INTENSITY (7). If fly-back line is unclear, adjust FOCUS (8).

(3) The oscilloscope is now ready for measurements. Apply a signal to be measured to INPUT (2). Turn VOLTS/DIV (4) clockwise to obtain the desired size of waveform.
Set the SOURCE (10) to INT position, the signal applied to INPUT (2) is then displayed.

(4) When the signal voltage is more than 0.01V and waveform fails to appear on the screen, the oscilloscope may be checked by feeding input from CAL 1Vp-p (17). Since calibration voltage is 1Vp-p, the waveform becomes 5 div high at the 0.2V/div position.

(5) By pushing LEVEL (12), the free-running auto function is released. The waveform disappears when the knob is turned clockwise, and appears again at the approximate mid position of it. Sync phase is also adjustable in this case. The waveform will again disappear when the knob is turned counterclockwise from the mid position.

(6) When DC component is measure, set AC-GND-DC to DC position. If, in this case, the DC component contains plus "+" potential, the waveform moves upward and if it contains minus "−" potential, the waveform moves downward.
The reference point of "0" potential is checked at GND position.

APPLICATIONS

Television Servicing:

A triggered sweep oscilloscope is advantageous in servicing and aligning television receivers. This oscilloscope also includes several features that were incorporated to make television servicing easier and more comprehensive.

* With the SYNC switch set to TV position, the SWEEP TIME/DIV control automatically selects the TV vertical sync at sweep speeds appropriate for viewing frames and TV horizontal sync at sweep speeds appropriate for viewing lines.
* Wide band width for high resolution video and high speed pulse presentation.

Peak-topeak Voltage Readings:

For general troubleshooting and isolation of troubles in television receivers, the oscilloscope is an indispensable instrument. It provides a visual display of absence or presence of normal signals. This method (signal-tracing) may be used to trace a signal by measuring several points in the signal path. As measurements proceed along the signal path, a point may be found where the signal disappears. When this happens, the source of trouble has been located.

However, the oscilloscope shows much more than the mere presence or absence of signal. It provides a peak-to-peak voltage measurement of the signal as well as presentation of waveforms. The schematic diagram 'or accompanying service data on the equipment being serviced usually includes waveform pictures. These waveform pictures include the required sweep time and the normal peak-to-peak voltage. Compare the peak-to-peak voltage readings on the oscilloscope with those shown on the waveform pictures.

Composite Video Waveform Analysis:

Probably the most important waveform in television servicing is the composite waveform consisting of the video signal, the blanking pedestal signal and the sync pulses. Fig. 4 and Fig. 5 show typical oscilloscope traces when observing composite video signals synchronized with horizontal sync pulses and vertical blanking pulses. Composite video signals can be observed at various stages of the television receiver to determine whether circuits are performing normally. Knowledge of waveform makeup, the appearance of a normal waveform, and the causes of various abnormal waveforms help the technician locate and correct many problems. The technician should study such waveforms in a television receiver known to be in good operating condition, noting the waveform at various points in the video amplifier.

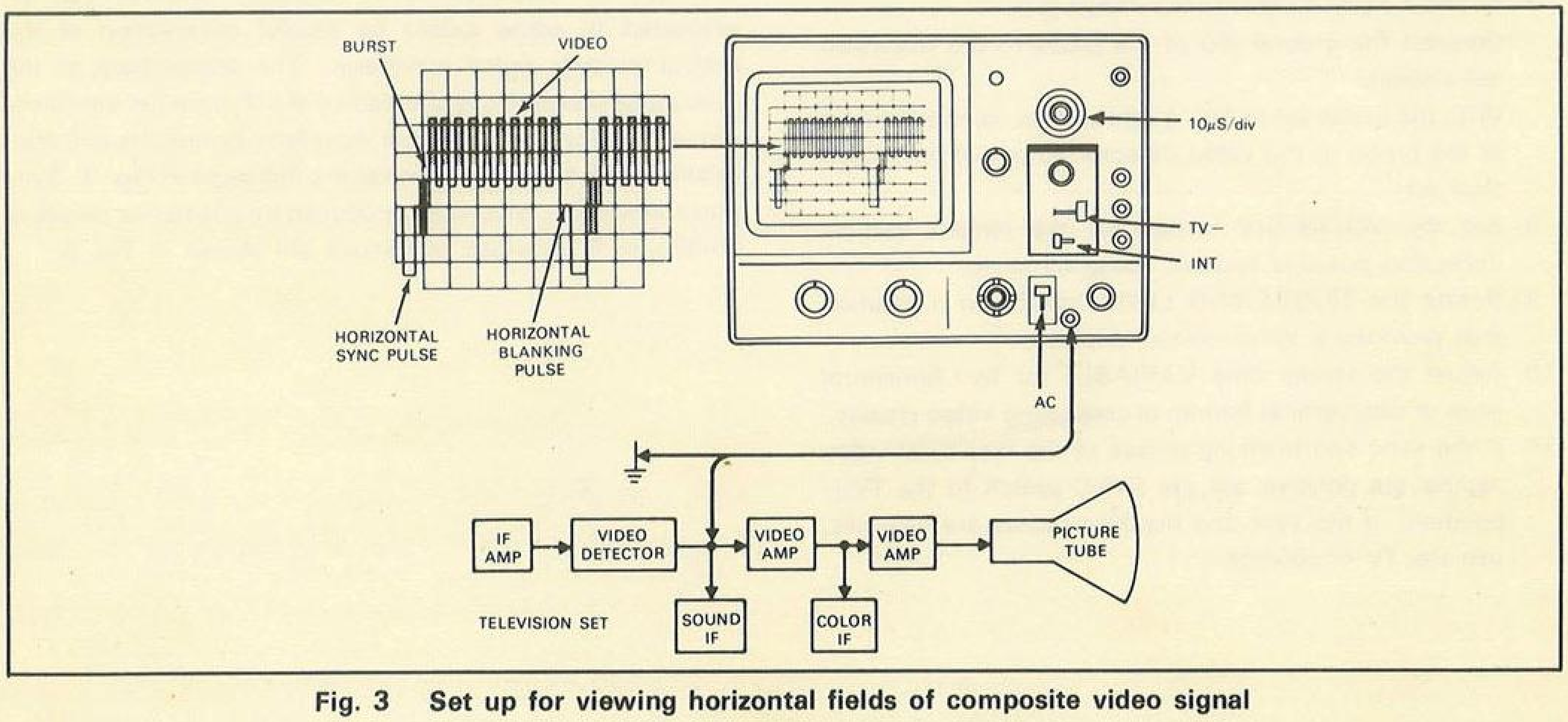


Fig. 3 Set up for viewing horizontal fields of composite video signal

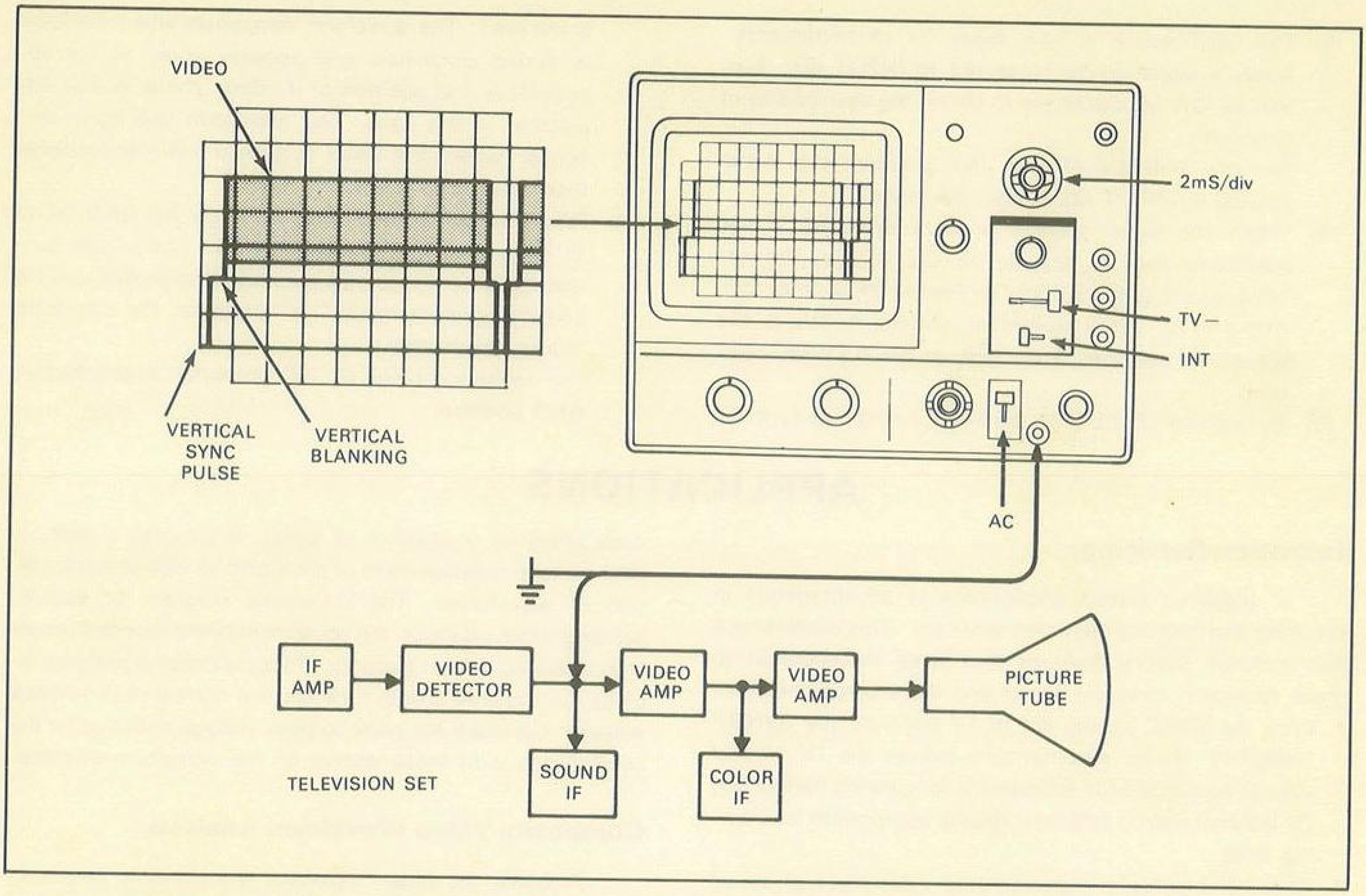


Fig. 4 Set-up for viewing vertical fields of composite video signal

To set up the oscilloscope for viewing composite video waveforms, use the following procedures:

1. Turn the television set to a local channel.
2. Set the SWEEP TIME/DIV switch to the 10μs/div position for observing TV horizontal lines or to the 2ms/-div position for observing TV vertical frames.
3. Set the SYNC switch to the TV+ position.
4. Set the SOURCE switch to the INT position.
5. Set the TRIGGERING LEVEL control to the AUTO position.
6. Set the DC-GND-AC switch to the AC position.
7. Connect a probe cable to the INPUT jack.
   Connect the ground clip of the probe to the television set chassis.
   With the probe set to 10 : 1 attenuation, connect the tip of the probe to the video detector output of the television set.
8. Set the VOLTS/DIV switch for the largest vertical deflection possible without going off-scale.
9. Rotate the TRIGGERING LEVEL control to a position that provides a synchronized display.
10. Adjust the sweep time VARIABLE for two horizontal lines or two vertical frames of composite video display.
11. If the sync and blanking pulses of the displayed video signals are positive, set the SYNC switch to the TV+ position; if the sync and blanking pulses are negative, use the TV− position.
12. Push in the TRIGGERING LEVEL control and rotate to a position that provides a well synchronized display.
13. Adjust the INTENSITY and FOCUS controls for the desired brightness and best focus.
14. To view a specific portion of the waveform, such as the color burst, pull the ◀▶ POSITION control for X5 magnification. Rotate the same control left or right to select the desired portion of the waveform to be viewed.

Sync Pulse Analysis:

The IF response of a television receiver can be evaluated to some extent by careful observation of the horizontal sync pulse waveform. The appearance of the sync pulse waveform is affected by the IF amplifier bandpass characteristics. Some typical waveform symptoms and their relation to IF amplifier response are indicated in Fig. 4. Sync pulse waveform distortions produced by positive or negative limiting in IF overload conditions are shown in Fig. 5.

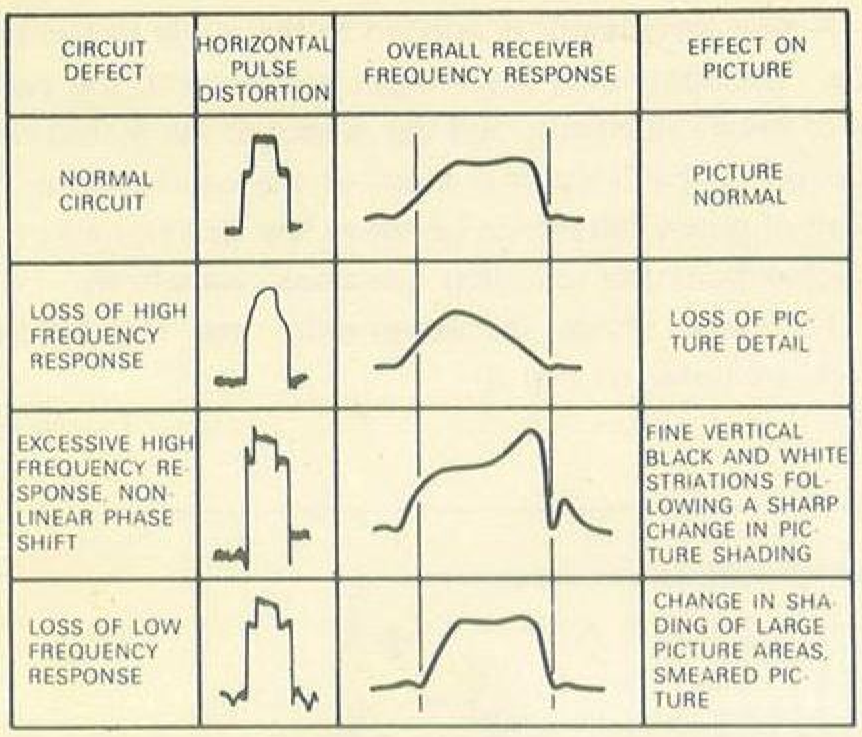


Fig. 5 Analysis of sync pulse distortion

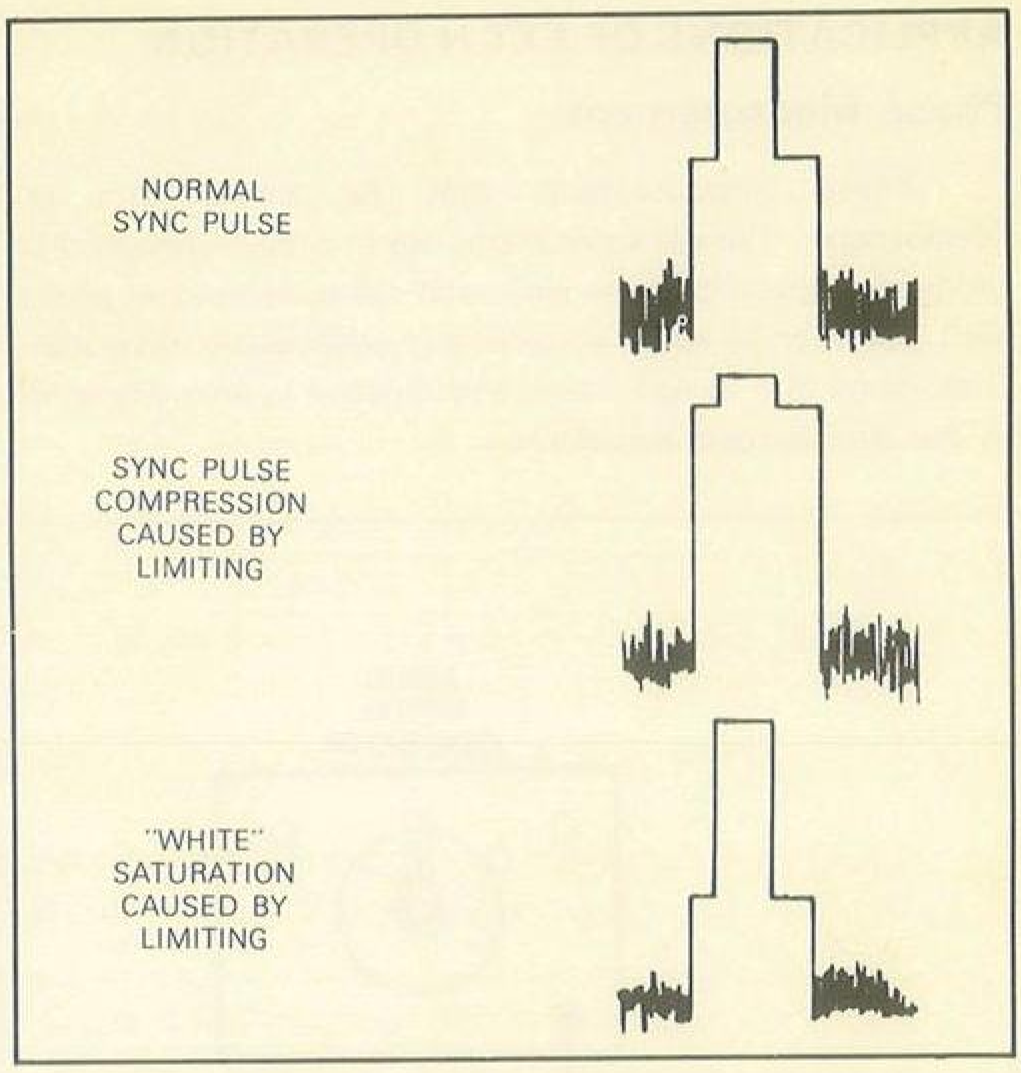


Fig. 6 Sync pulse waveforms

FM RECEIVER ADJUSTMENTS

1. Connect a sweep generator to the mixer input of the FM receiver. Set the sweep generator for a 10.7MHz center sweep.
2. Connect the sweep voltage output of the sweep generator to the vertical input jack of the oscilloscope and set the oscilloscope controls for external horizontal sweep (SWEEP TIME/DIV to EXT H).
3. Connect the vertical input probe to the demodulator input of the FM receiver.
4. Adjust the oscilloscope vertical and horizontal gain controls for display similar to that shown in Fig. 7A.
5. Set the marker generator precisely to 10.7MHz. The marker "pip" should be in the center of the bandpass.
6. Align the IF amplifiers according to the manufacturer's specifications.
7. Move the probe to the demodulator output. The "S" curve should be displayed, and the 10.7MHz "pip" should appear in the center (see Fig. 7B).
   Adjust the demodulator according to the manufacturer's instructions so the marker moves equal distance from the center as the marker frequency is amplified equal amount from the 10.7MHz center frequency.

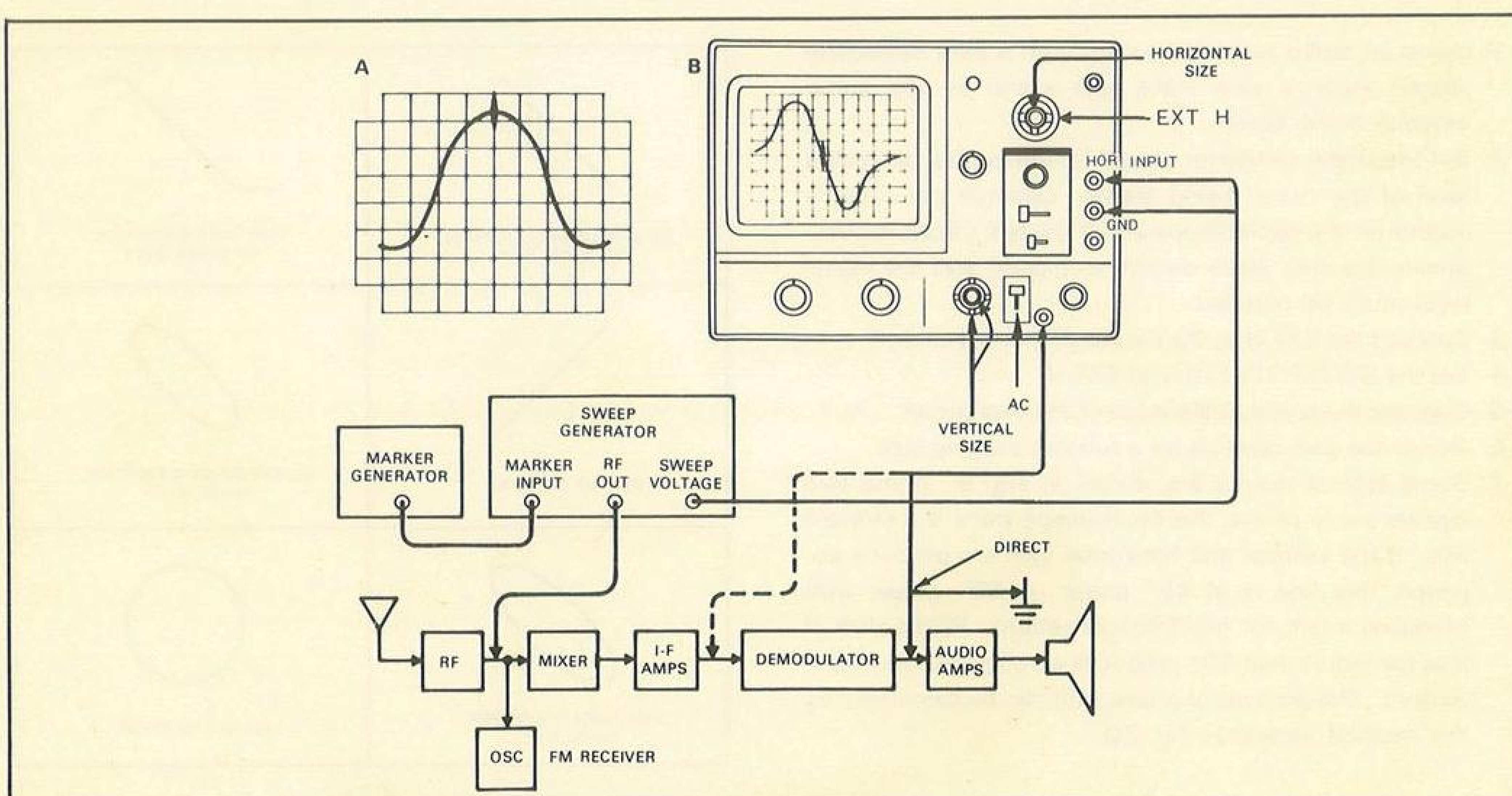


Fig. 7 Typical FM receiver alignment set-up

APPLICATIONS OF EXT H OPERATION

Phase Measurement:

Phase measurements may be made with an oscilloscope. Typical applications are in circuits designed to produce a specific phase shift, and measurement of phase shift distortion in audio amplifiers or other audio networks. Distortions due to non-linear amplification is also displayed in the oscilloscope waveform.

A sine wave input is applied to the audio circuit being tested. The same sine wave input is applied to the vertical input of the oscilloscope, and the output of the tested circuit is applied to the horizontal input of the oscilloscope. The amount of phase difference between the two signals can be calculated from the resulting Lissajous' waveform.

To make phase measurements, use the following procedures (refer to Fig. 8).

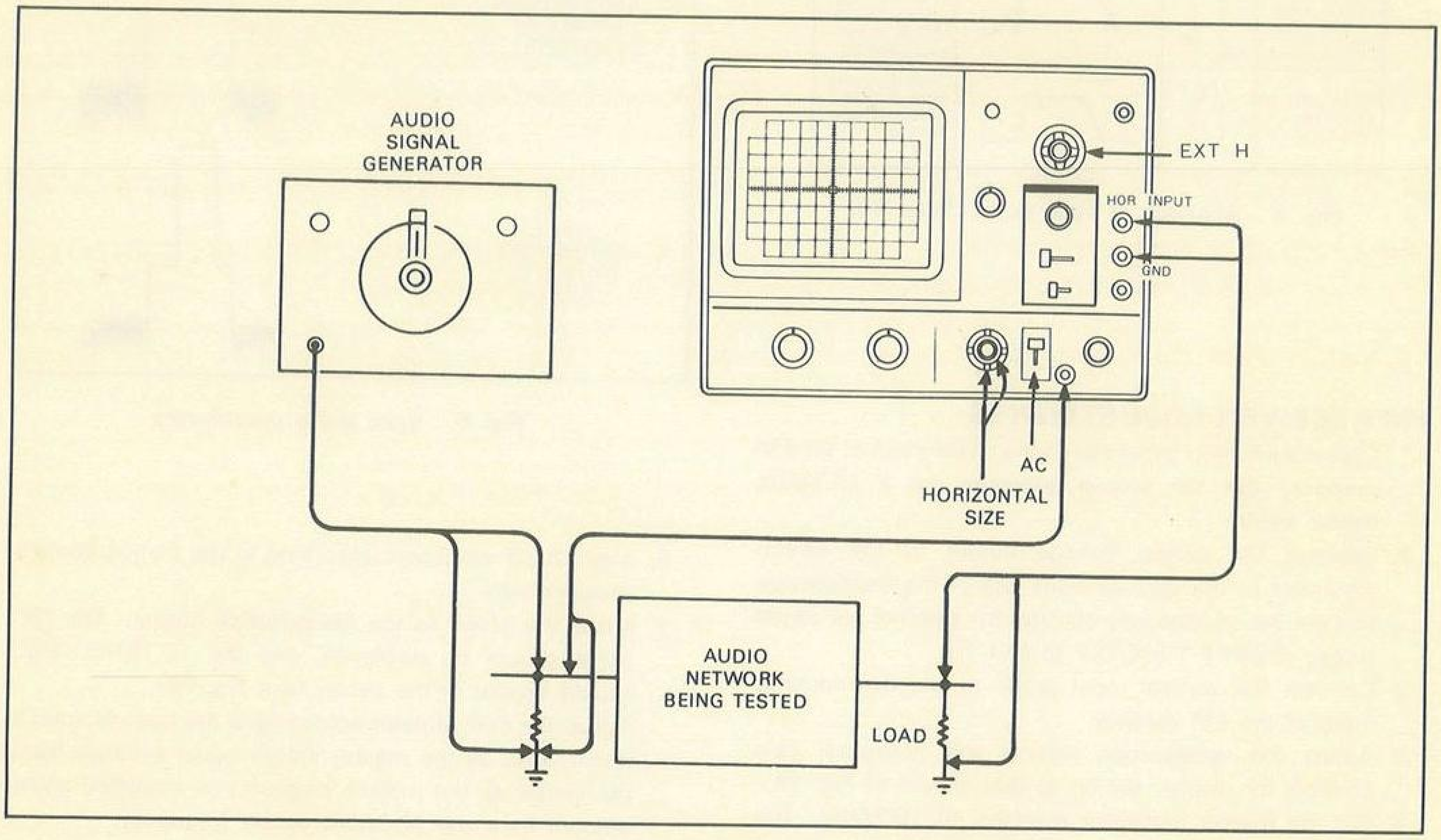


Fig. 8 Typical phase measurement alignment set-up

1. Using an audio signal generator with a pure sinusoidal signal, apply a sine wave test signal to the audio network being tested.
2. Set the signal generator output for the normal operating level of the circuit being tested. Observe the circuit's output on the oscilloscope and if the test circuit is over-driven, the sine wave display is clipped and the signal level must be reduced.
3. Connect the EXT H to the output of the test circuit.
4. Set the SWEEP TIME/DIV to EXT H.
5. Connect the probe to the input of the test circuit.
6. Adjust the gain controls for a suitable viewing size.
7. Some typical results are shown in Fig. 9. If the two signals are in phase, the oscilloscope trace is a straight line. If the vertical and horizontal gain are properly adjusted, this line is at 45° angle. A 90° phase shift produces a circular oscilloscope pattern. Phase shift of less (or more) than 90° produces an elliptical Lissajous' pattern. The amount of phase shift can be calculated by the method shown in Fig. 10.

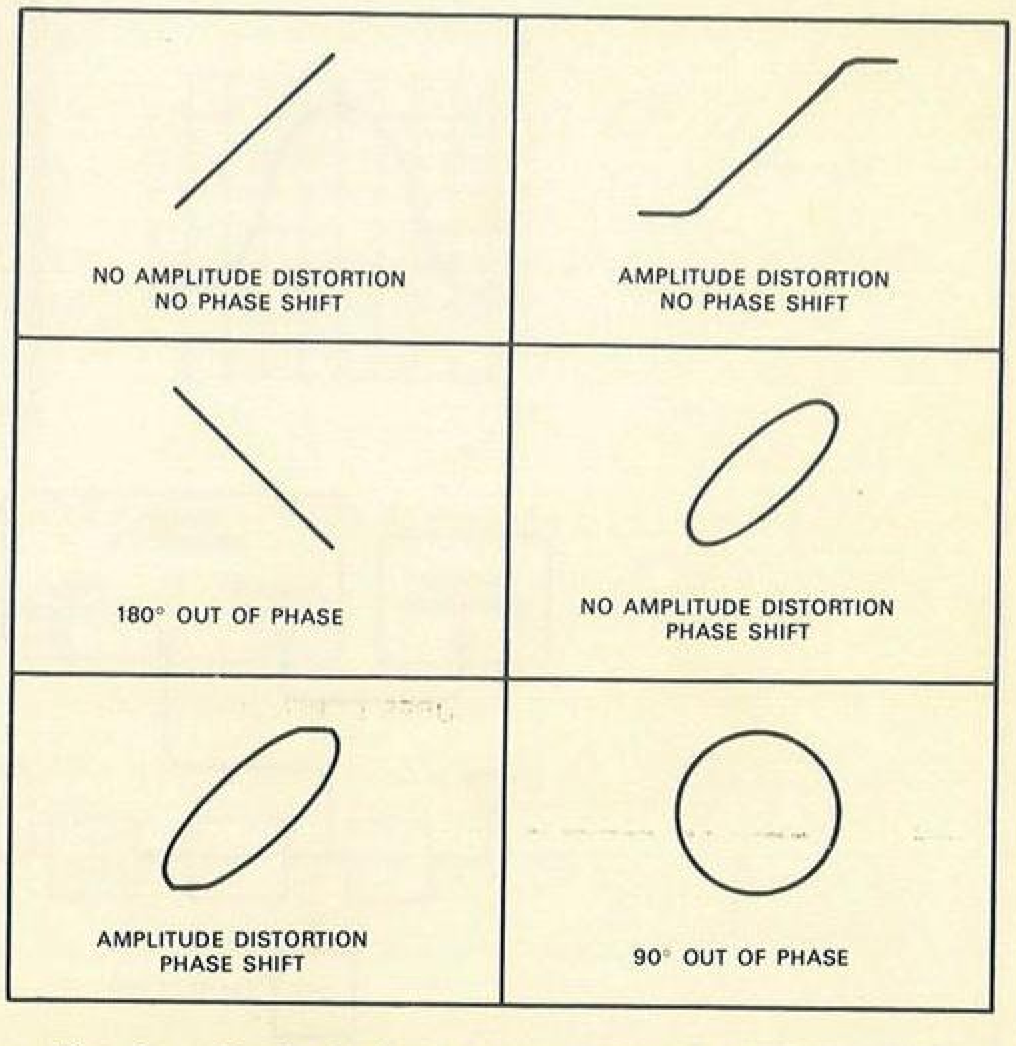


Fig. 9 Typical phase measurement oscilloscope displays

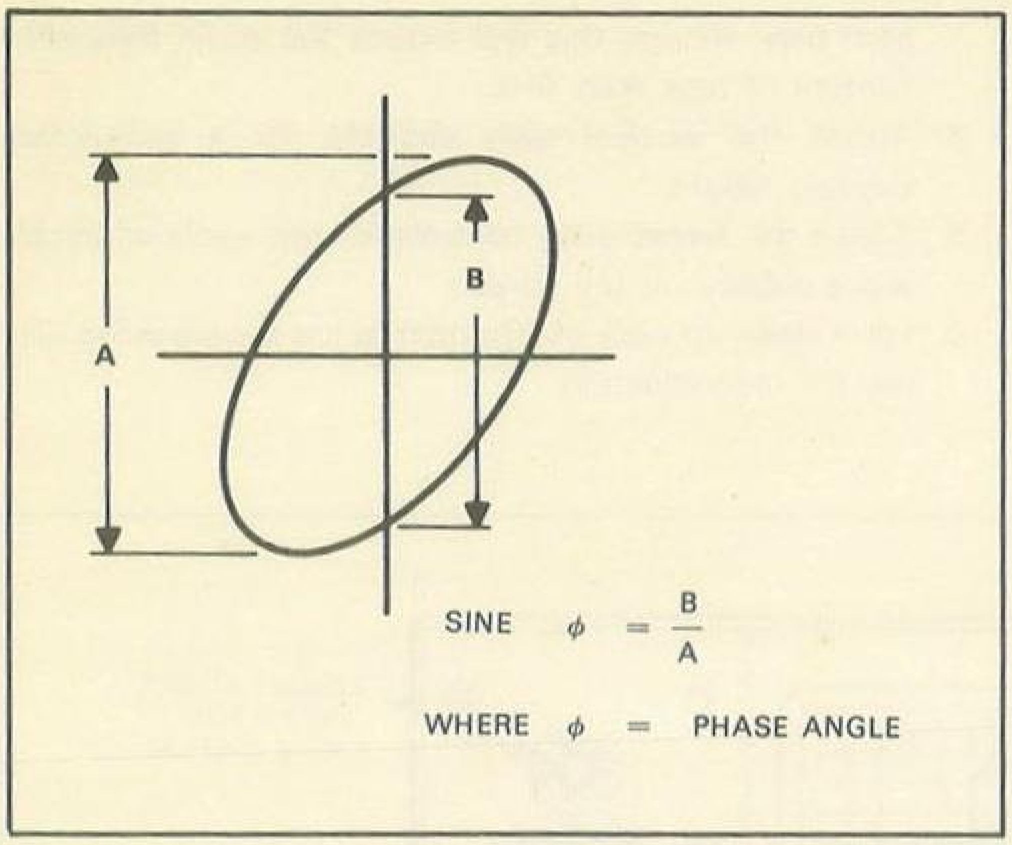


Fig. 10 Phase shift calculation

Frequency Measurement:

1. Connect the sine wave of known frequency to the vertical input of the oscilloscope and set the SWEEP TIME/DIV control to EXT H.
2. Connect the vertical input probe to the signal to be measured.
3. Adjust the vertical input and EXT H input for proper sizes.
4. The resulting Lissajous' pattern shows the ratio between the two frequencies (see Fig. 11).

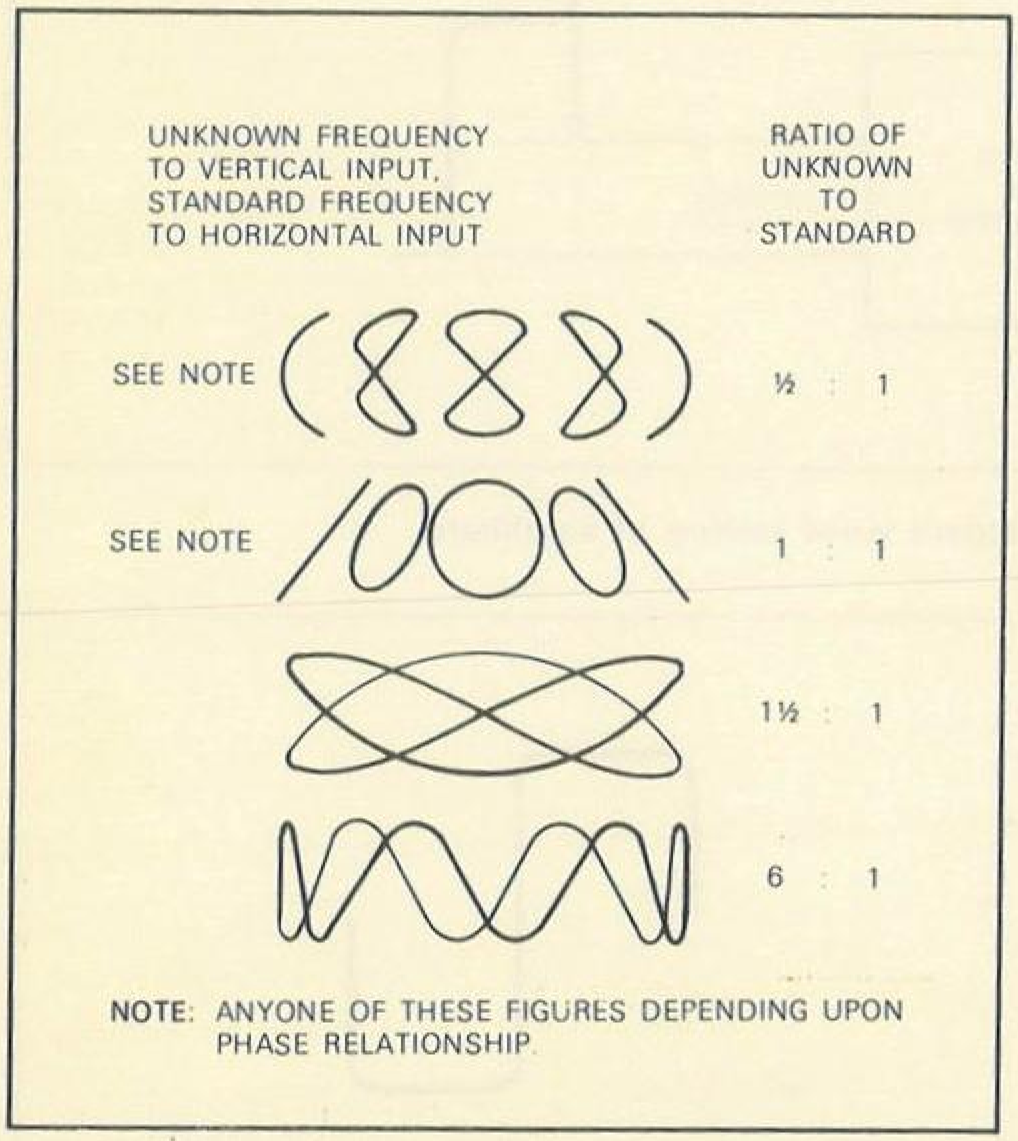


Fig. 11 Lissajous' waveforms used for frequency measurement

AMPLIFIER SQUARE WAVE TEST

Introduction

A square wave generator and the oscilloscope can be used to display various types of distortion present in electric circuits. A square wave of a given frequency contains a large number of odd harmonics of that frequency. If a 500Hz square wave is injected into a circuit, frequency components of 1.5kHz, 2.5kHz and 3.5kHz are also provided. Since vacuum tubes and transistors are non-linear, it is difficult to amplify and reproduce a square wave which is identical to the input signal. Interelectrode capacitances, junction capacitances, stray capacitances as well as narrow band devices and transformer response are the factors which prevent faithful response of a square wave signal. A welldesigned amplifier can minimize the distortion caused by these limitations. Poorly designed or defective amplifiers can introduce distortion to the point where their performance is unsatisfactory.

As stated before, a square wave contains a large number of odd harmonics. By injecting a 500Hz sine wave into an amplifier, we can evaluate amplifier response at 500Hz only, but by injecting a square wave of the same frequency we can determine how the amplifier would response to input signals from 500Hz up to the 15th or 21st harmonic.

The need for square wave evaluation becomes apparent if we realize that some audio amplifiers will be required during normal use to pass simultaneously a large number of different frequencies. With a square wave, we can evaluate the quality of input and output characteristics of a signal containing a large number of frequency components such as complex waveforms of musical instruments or voices.

The square wave output of the signal generator must be extremely flat. The oscilloscope vertical input should be set to DC as it will introduce the least distortion, especially at low frequencies. Because of the harmonic content of the square wave, distortion will occur before the upper end of the amplifier bandpass.

It should be noted that the actual response check of an amplifier should be made using a sine wave signal. This is especially important in an limited bandpass amplifier such as a voice amplifier.

The square wave signal provides a quick check of amplifier performance and will give an estimate of overall amplifier quality. The square wave also will reveal some deficiencies not readily apparent when using a sine wave signal. Whether a sine wave or square wave is used for testing the amplifier, it is important that the manufacturer's specifications on the amplifier be known in order to make a better judgement of its performance.

Testing Procedure (refer to Fig. 12):

1. Connect the output of the square wave generator to the input of the amplifier being tested.
2. Connect the vertical input probe of the oscilloscope to the output of the amplifier.
3. If the DC component of the amplifier output is low, set the AC-GND-DC switch to DC position to allow both the AC and DC components to be viewed. However, the AC position may be used to observe the AC component only, though this will reduce the audio frequency content of less than 5Hz.
4. Adjust the vertical gain controls for a convenient viewing height.
5. Adjust the sweep time controls for one cycle of square wave display on the screen.
6. For a close-up view of a portion of the square wave, use the 5X magnification.

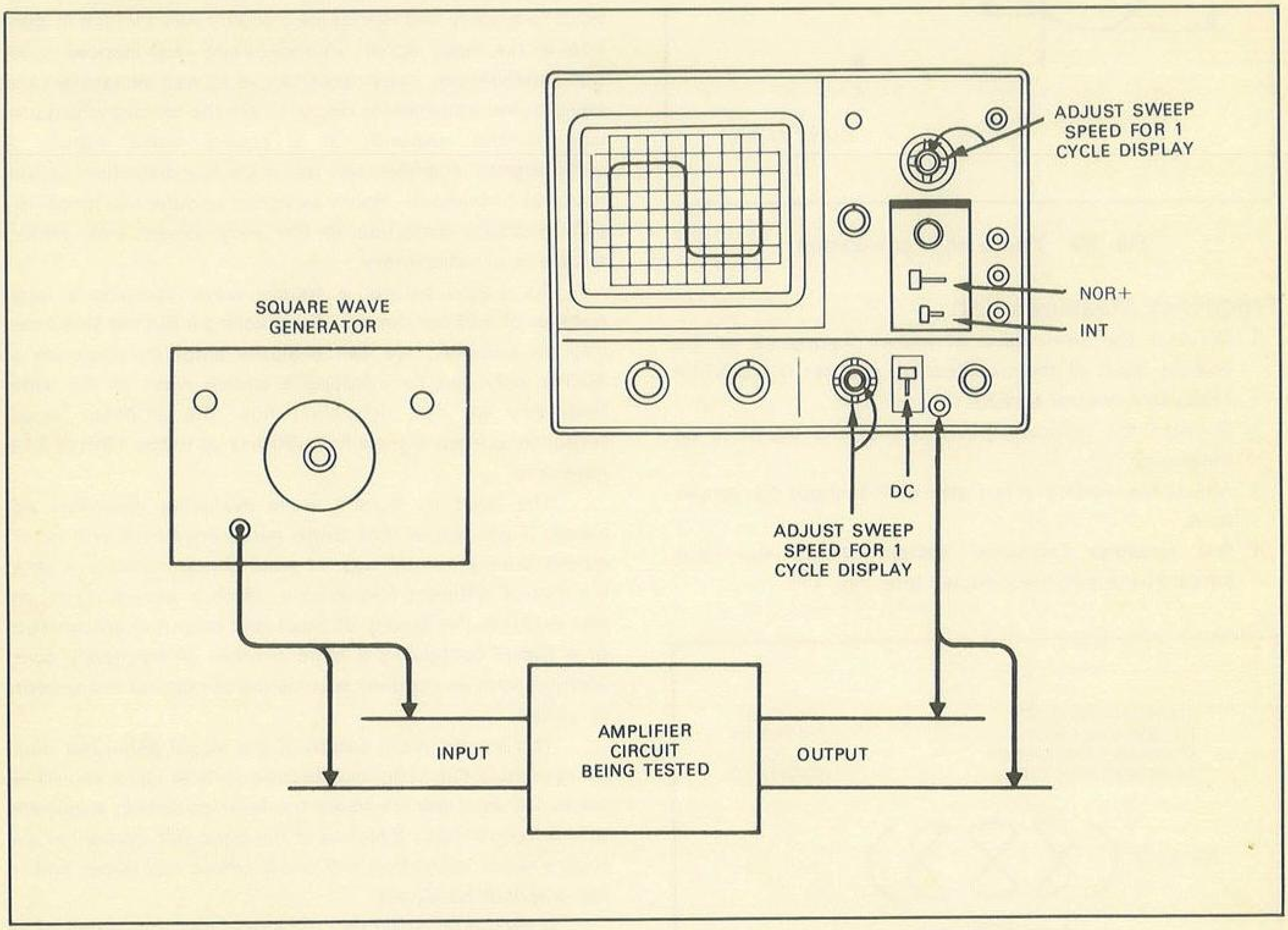


Fig. 12 Equipment set-up for square wave testing of amplifiers

Analysing the Waveforms:

The short rise time which occurs at the beginning of the half-cycle is created by the in-phase sum of the medium and high frequency sine wave components. The same holds true for the drop time. The reduction in high frequency components should produce a rounding of the square corners at all four points of one square wave cycle (see Fig. 13).

Distortion can be classified into the following three categories:

1. The first is frequency distortion and refers to the change in the amplitude of a complex waveform. In other words, the introduction in an amplifier circuit of resonant networks or selective filters created by combination of reactive components will create peaks or dips in an otherwise flat frequency response curve.

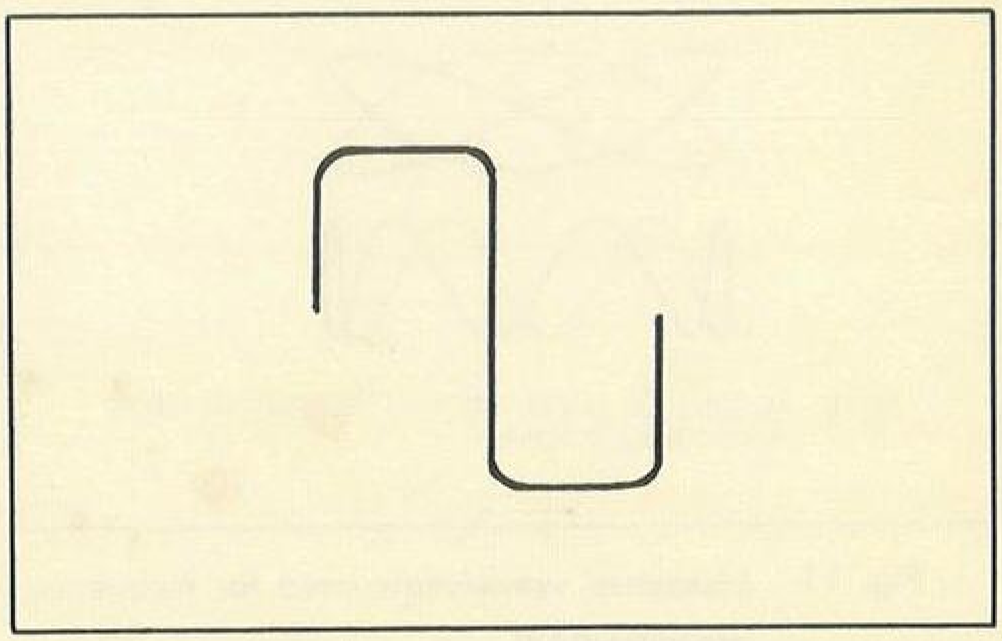


Fig. 13 Square wave response with high frequency loss

2. The second is non-linear distortion and refers to a change in wavehape produced by application of the waveshape to non-linear elements such as vacuum tubes, an iron core transformer or a clipper network.
3. The third is delay or phase distortion, which is distortion produced by a shift in phase between some components of a complex waveform.

In actual practice, a change in amplitude of a square wave component is usually caused by a frequency selective network which includes capacity, inductance or both. The presence of the C or L introduces a difference in phase angle between components, creating phase distortion or delay distortion. Therefore, in square wave testing of practical circuitry, we will usually find that the distorted square wave includes a combination of amplitude and phase distortions.

In a typical wide band amplifier, a square wave check reveals many distortion characteristics of the circuit. The response of an amplifier is indicated in Fig. 14, revealing poor low-frequency response along with the overcompensated high-frequency boost. The response of 100Hz square wave applied to the amplifier will appear as in Fig. 15A. The figure indicates satisfactory medium frequency response (approximately 1kHz to 2kHz) but shows poor low frequency response. Next, a 1kHz square wave applied to the input of the amplifier will appear as in Fig. 15B. This figure displays good frequency response in the region of 1000 to 4000Hz but reveals a sharp rise at the top of the leading edge of the square wave because of overcompensation at the frequencies of more than 10kHz.

As a rule of thumb, it can be safely said that a square wave can be used to reveal response and phase relationships up to the 15th or 20th odd harmonic or up to approximately 40 times the fundamental of the square wave. It is seen that wide-band circuitry will require at least two frequency check points to properly analyze the entire bandpass.

In the case illustrated by Fig. 14, a 100Hz square wave will encompass components up to about 4kHz. To analyze above 4kHz and beyond 10,000Hz, a 1kHz square wave should be used.

Now, the region between 100Hz and 4000Hz in Fig. 14 shows a rise from poor low-frequency (1000Hz to 1kHz) response to a flattening out from beyond 1000 and 4000Hz. Therefore, we can expect that the higher frequency components in the 100Hz square wave will be relatively normal in amplitude and phase but that the low-frequency components "B" in this same square wave will be modified by the poor low-frequency response of this amplifier (see Fig. 15A).

If the amplifier were such as to only depress the low frequency components in the square wave, a curve similar to Fig. 16 would be obtained. However, reduction in amplitude of the components is usually caused by a reactive element, causing, in turn, a phase shift of the components, producing the tilt as shown in Fig. 15A.

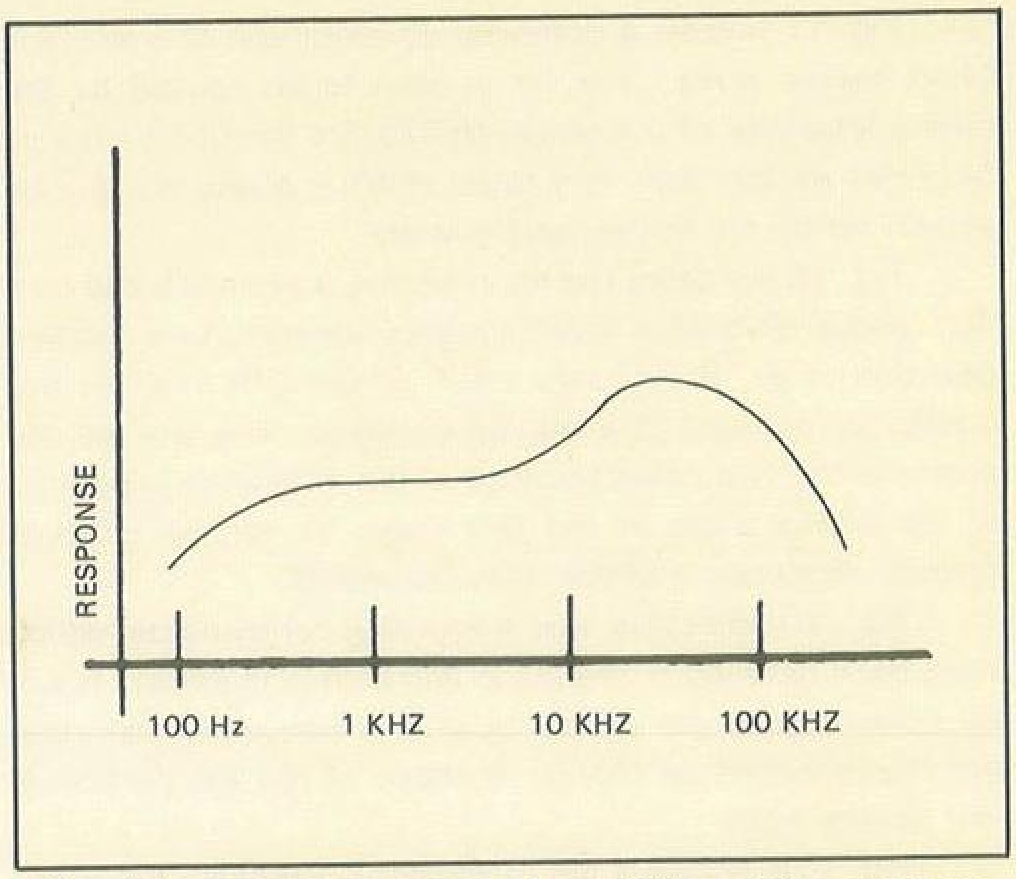


Fig. 14 Response curve of amplifier with poor low and high ends

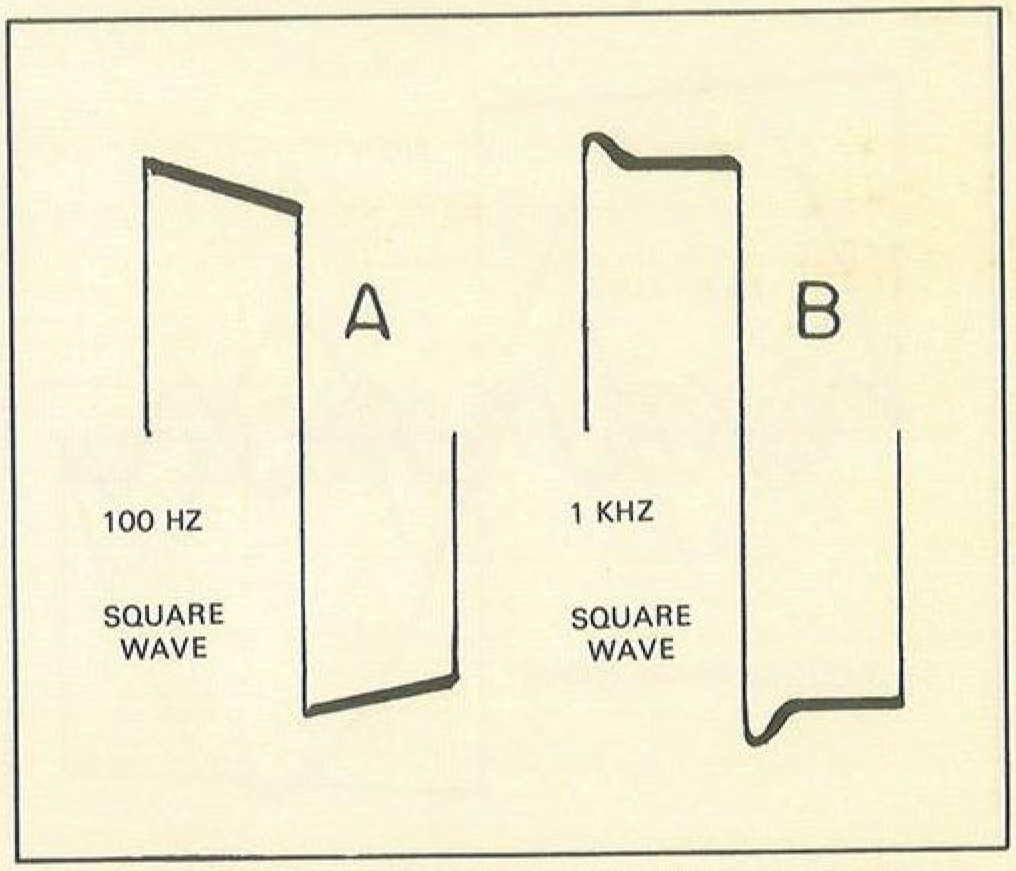


Fig. 15 Resultant 100 Hz and 1 kHz square waves from amplifier in Fig. 14.

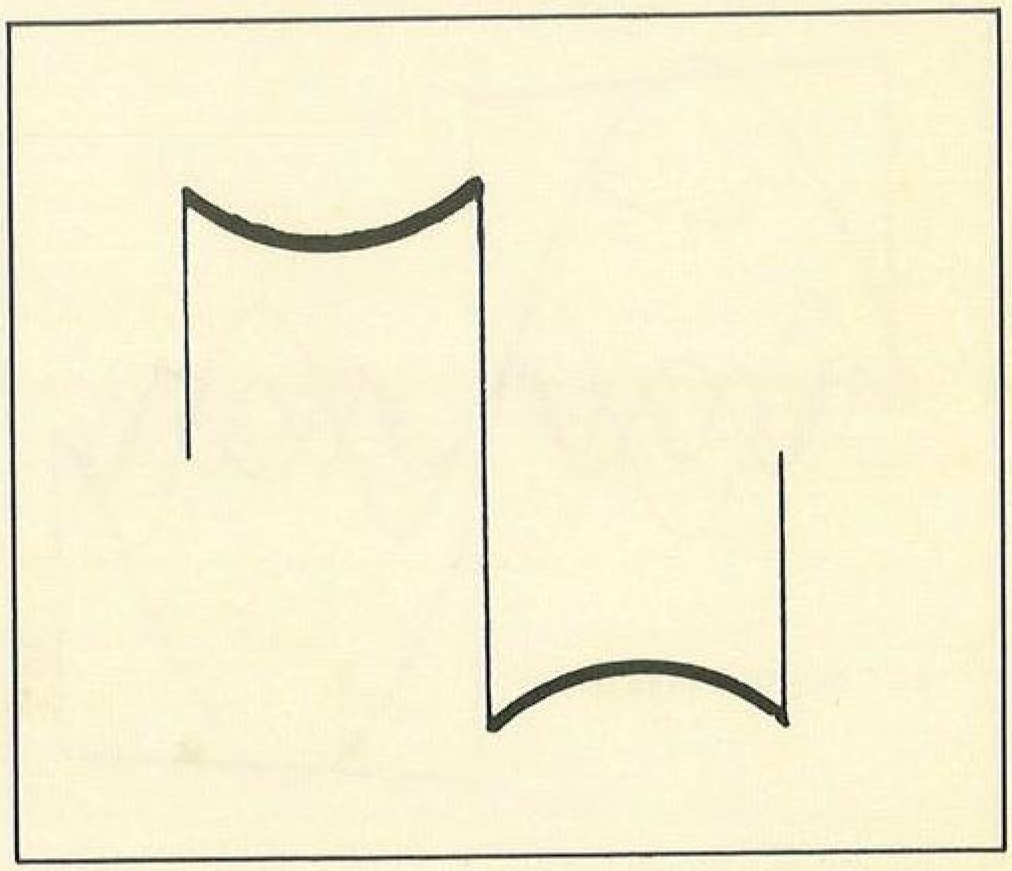


Fig. 16 Reduction of square wave fundamental frequency component in turned circuit

Fig. 17 reveals a graphical development of a similarly tilted square wave. The tilt is seen to be caused by the strong influence of the phase-shifted 3rd harmonic. It also becomes evident that very slight shifts in phase are quickly shown up by tilt in the square wave.

Fig. 18 indicates the tilt in square wave produced by a 10° phase shift of a low-frequency element in a leading direction. Fig. 19 indicates a 10° phase shift in a low frequency component in a lagging direction. The tilts are opposite in the two cases because of the difference in polarity of the phase angle in the two cases as can be checked through algebraic addition of components.

Fig. 20 indicates low-frequency components which have been reduced in amplitude and shifted in phase. It will be noted that these examples of low-frequency distortion are characterized by change in shape of the flat portion of the square wave.

Fig. 15B shows a high-frequency overshoot produced by rising amplifier response at the high frequencies. It should again be noted that this overshoot makes itself evident at the top of the leading edge of the square wave. The sharp rise of the leading edge is created by the summation of a large number of harmonic components. If an abnormal rise in amplifier response occurs at high frequencies, the high frequency components in the square wave will be amplified larger than the other components creating a higher algebraic sum along the leading edge.

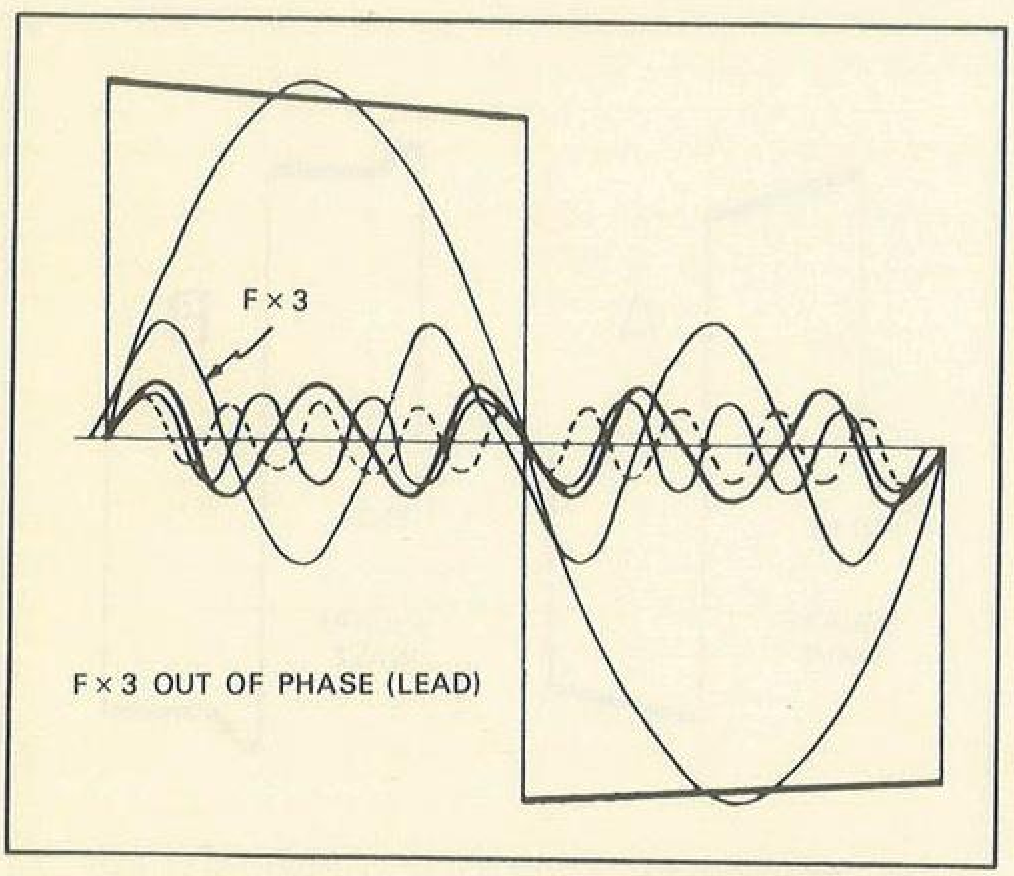


Fig. 17 Square wave tilt resulting from 3rd harmonic phase shift

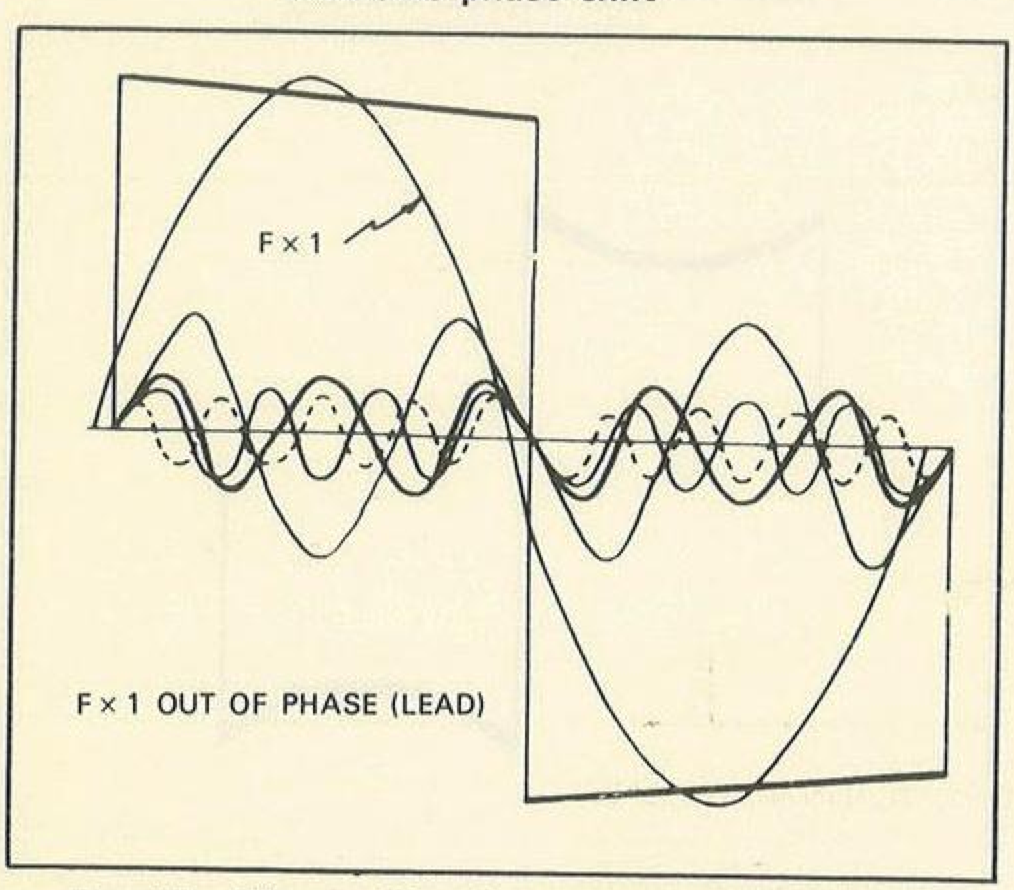


Fig. 18 Tilt resulting from phase shift of fundamental frequency in a leading direction

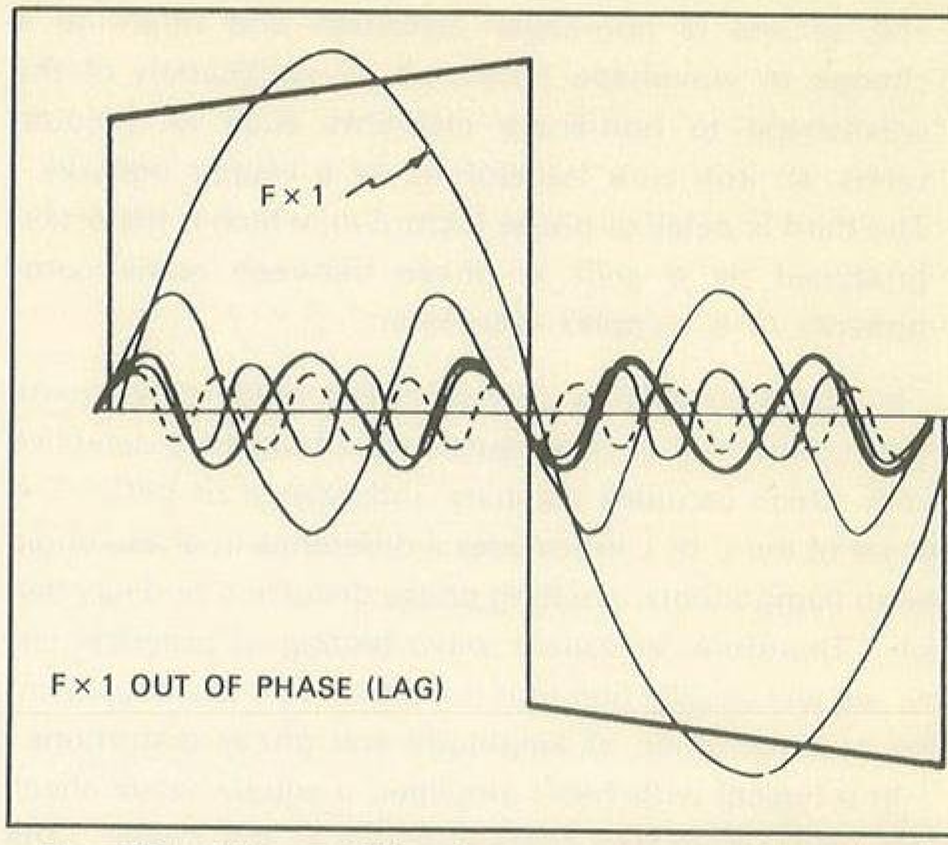


Fig. 19 Tilt resulting from a phase shift of fundamental frequency in a lagging direction.

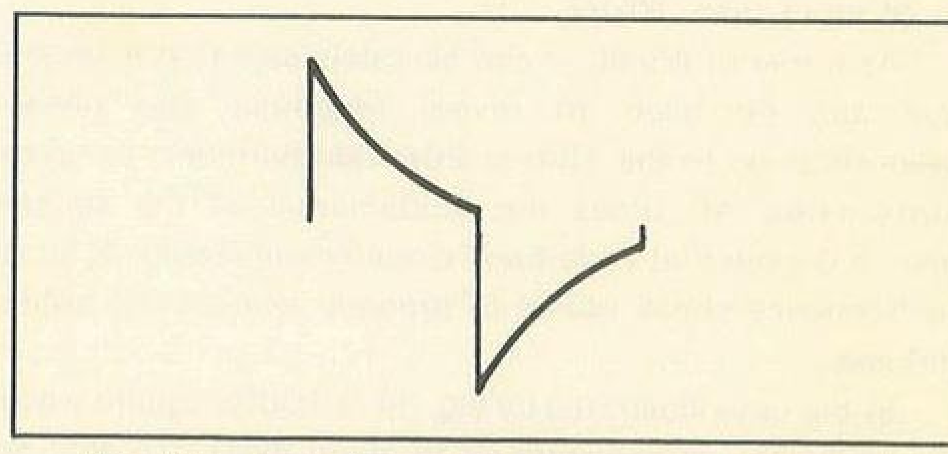


Fig. 20 Low frequency component loss and phase shift

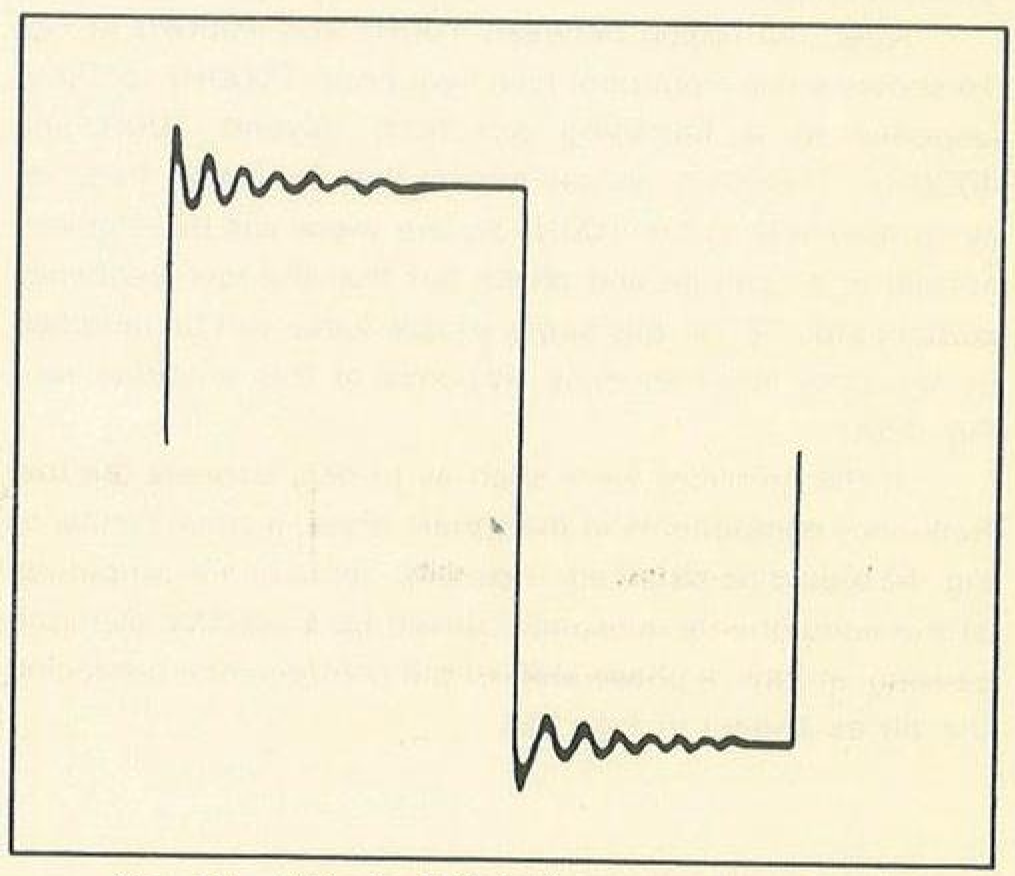


Fig. 21 Effect of high-frequency boost and poor damping

Fig. 21 indicates high-frequency boost in an amplifier accompanied by a lightly damped "shock" transient. In this case, the sudden transition in the square wave potential from a sharply rising, relatively high frequency voltage, to a level value of low frequency voltage, supplies the energy for oscillation in the resonant network. If this network in the amplifier is reasonably heavily damped, then a single cycle transient oscillation may be produced as indicated in Fig. 22.

Fig. 23 summarizes the preceding explanations and serves as handy reference.

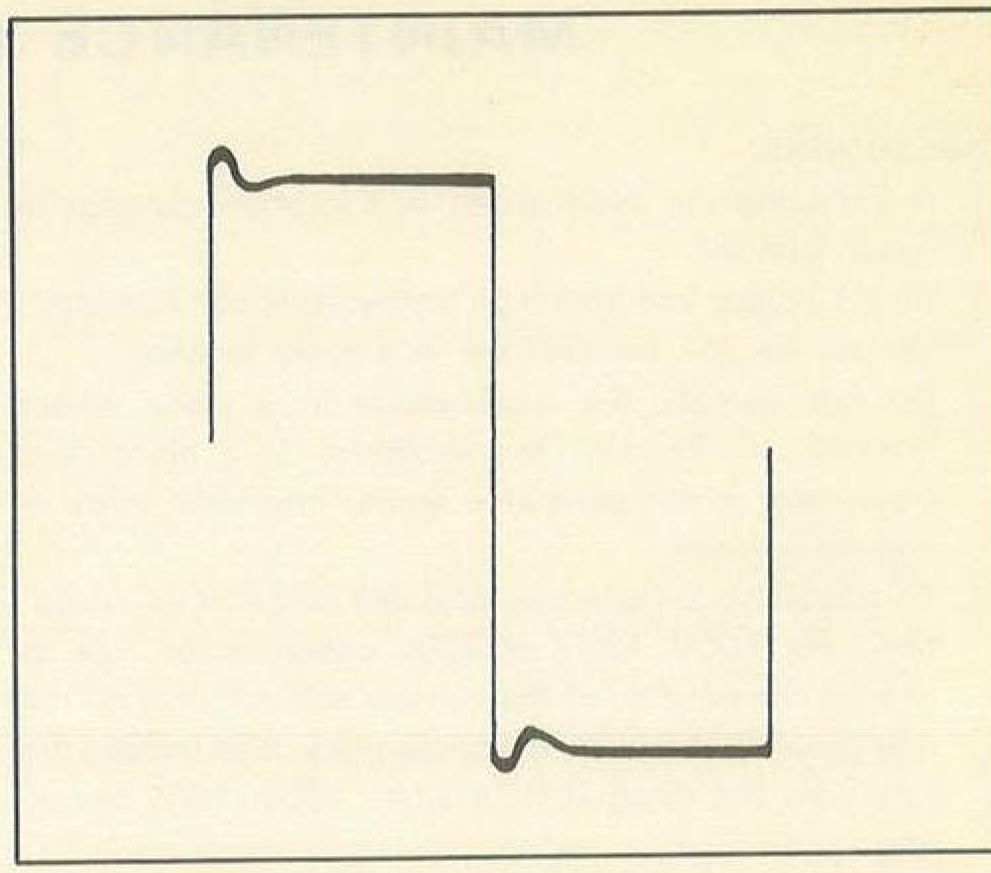


Fig. 22 Effect of high-frequency boost and good damping

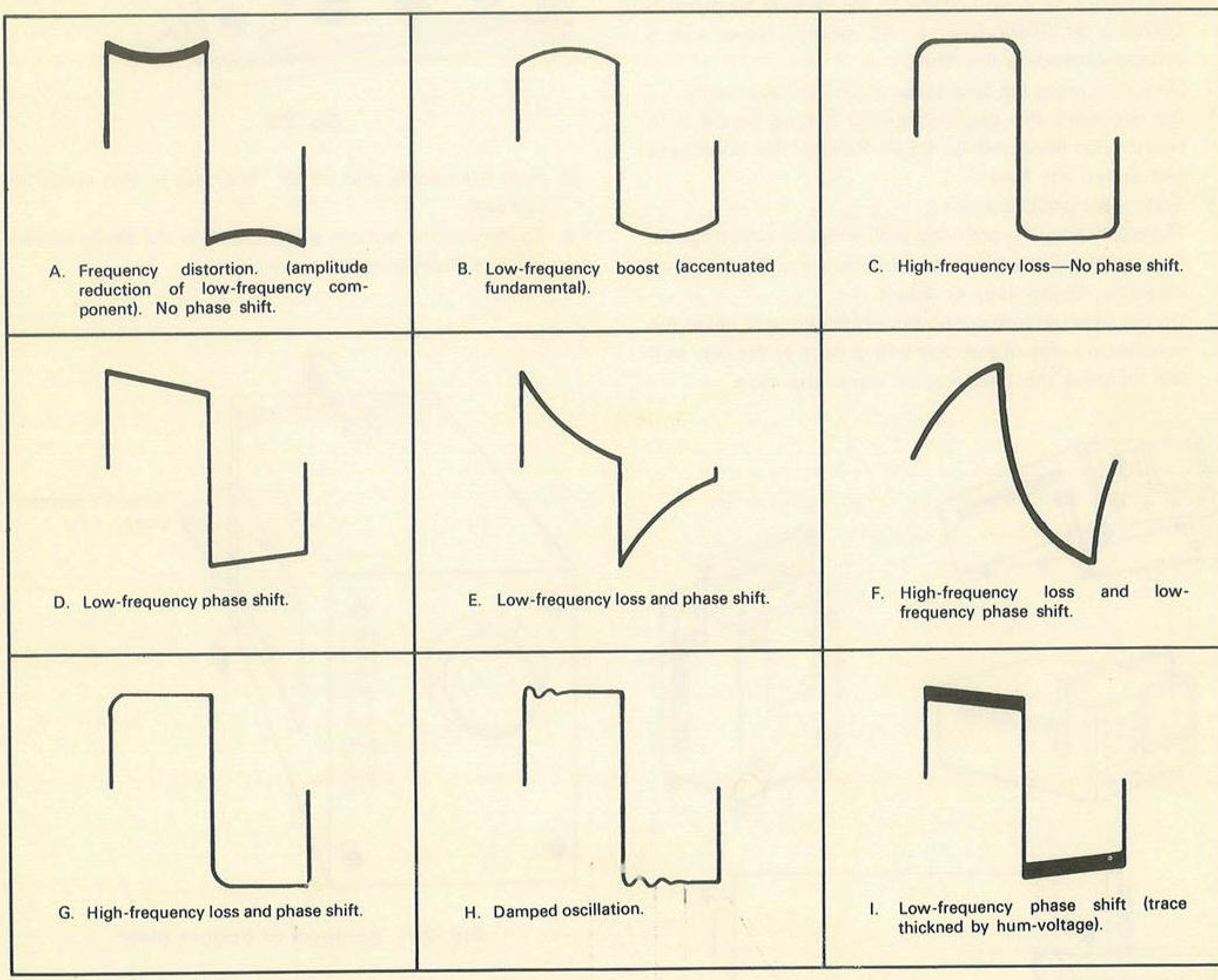


Fig. 23 Summary of waveform analysis for square wave testing amplifiers

MAINTENANCE AND ADJUSTMENT

Precautions:

1. Avoid using the oscilloscope in a location exposed to direct sunlight.
2. Select a place free from high temperature and humidity. Do not use the oscilloscope in a dusty location.
3. Do not operate the oscilloscope in a place where mechanical vibrations are excessive or a place near equipment which generates strong magnetic fields or impulse voltage.
4. This oscilloscope is factory adjusted for 240V AC operation. For 100V, 120V or 220V operation, be sure to change the position of the voltage selector plug on the rear panel as shown by the arrow mark, then replace the fuse with one rated at 0.7A when 100V, 120V operation.
5. The power fuse is mounted on the rear panel. Use a 0.7A fuse for 100, 120V AC operation or a 0.3A fuse for 220, 240V AC operation.
6. The maximum input voltage to the vertical amplifier is 600Vp-p or 300V (DC + AC peak). Never use a voltage exceeding this limit.
7. Do not increase the brightness of CRT unnecessarily.
8. Do not leave the oscilloscope for a long period with bright spot displayed on CRT. Reduce the brightness and soften the focus.
9. Setting the oscilloscope
   The oscilloscope is provided with a handle which can be fixed at 90° angle intervals, permitting it to be set either vertically, horizontally or aslant.
   Do not place any object on the oscilloscope or cover the ventilation holes of the case with a cloth or the like, as it will increase the temperature inside the case.

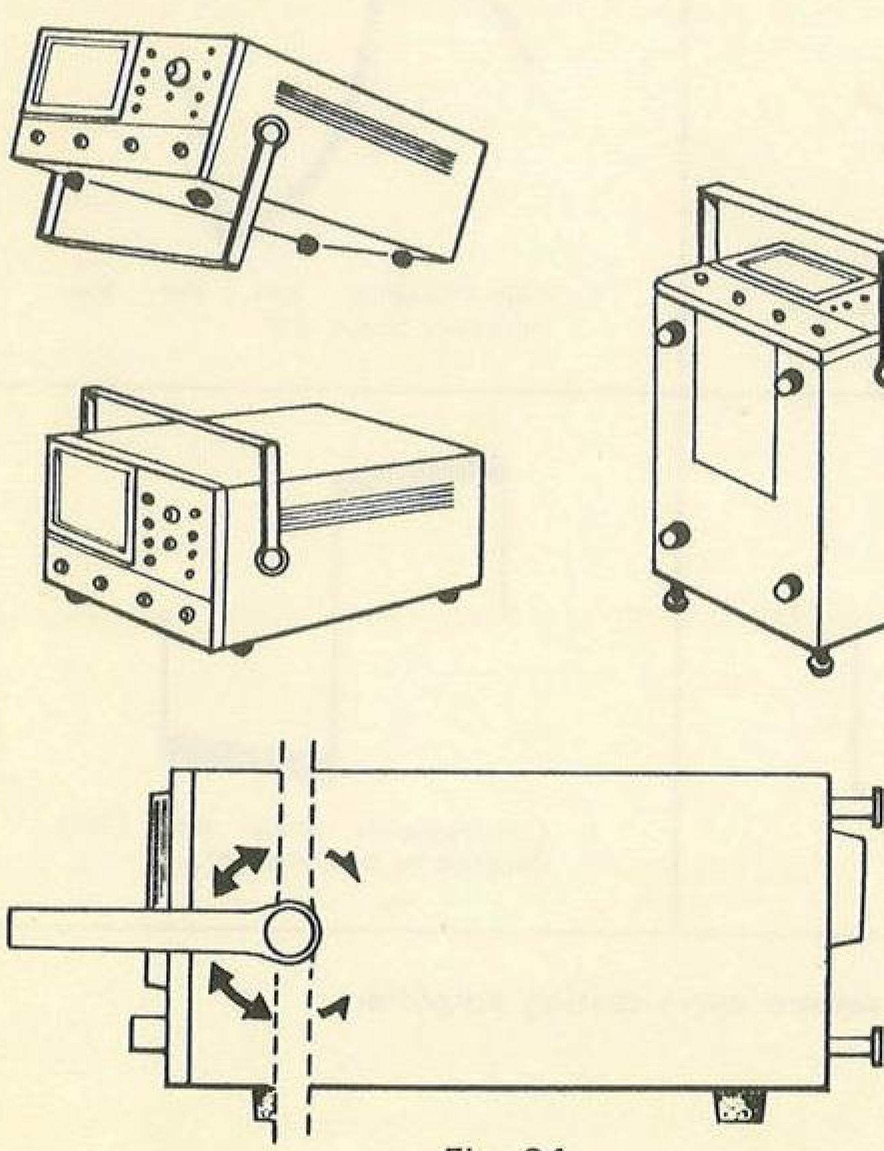


Fig. 24

MAINTENANCE

Removing the case:

1. Remove the six screws from the top and side walls of the case, using a Phillips head screwdriver.

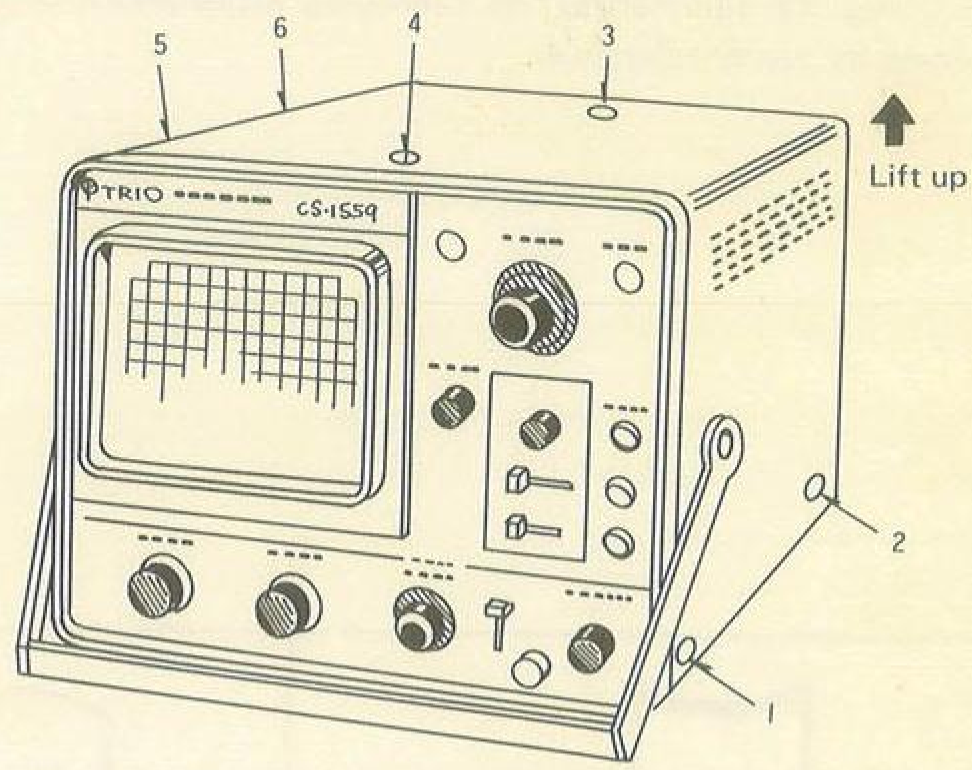


Fig. 25

2. Hold the handle and lift up. The case is now ready for removal.
3. To remove the bottom plate, unscrew the seven screws using a Phillips head screwdriver.

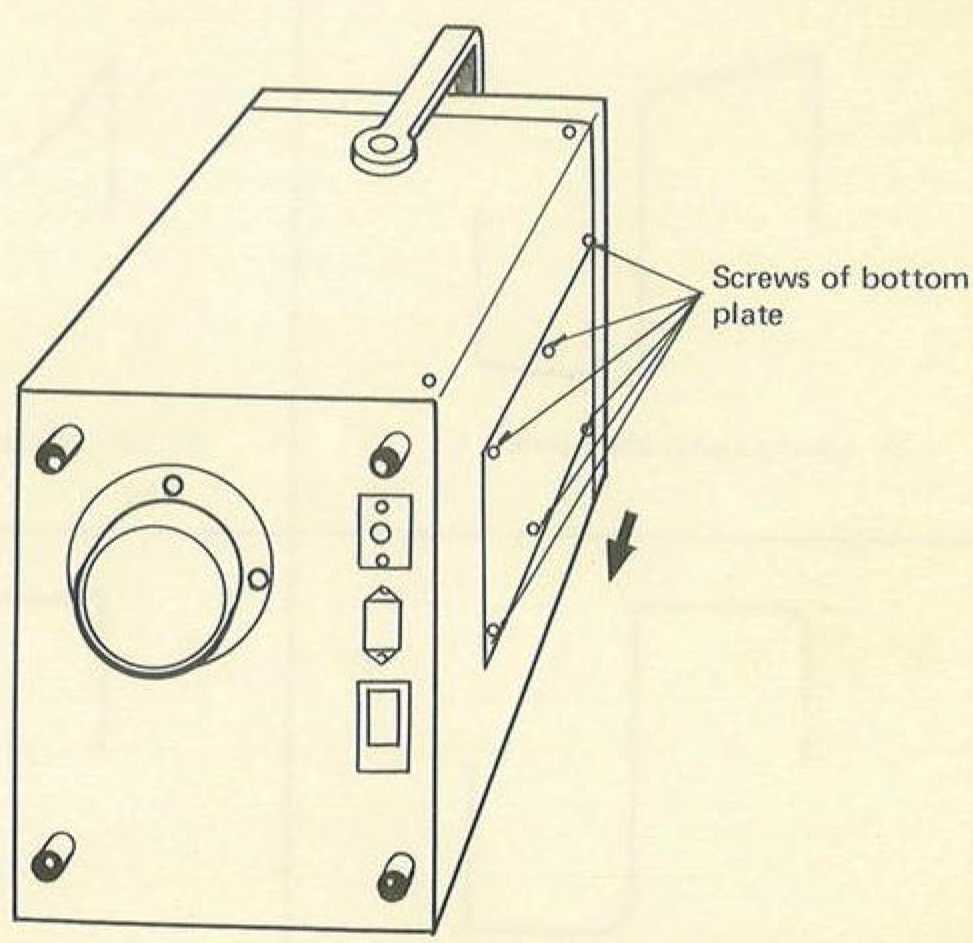


Fig. 26 Removal of bottom plate

Caution: A high voltage (2000V) is present on the CRT socket and the lower printed circuit board. Before removing the case, be sure to turn off the power, and do not touch these parts with hand or a screwdriver even after the case has been removed.

AC Voltage selector:

The oscilloscope may be operated from 100V, 120V, 220V, 240V, putting the AC voltage selector in place of another. (Refer to Fig. 27)

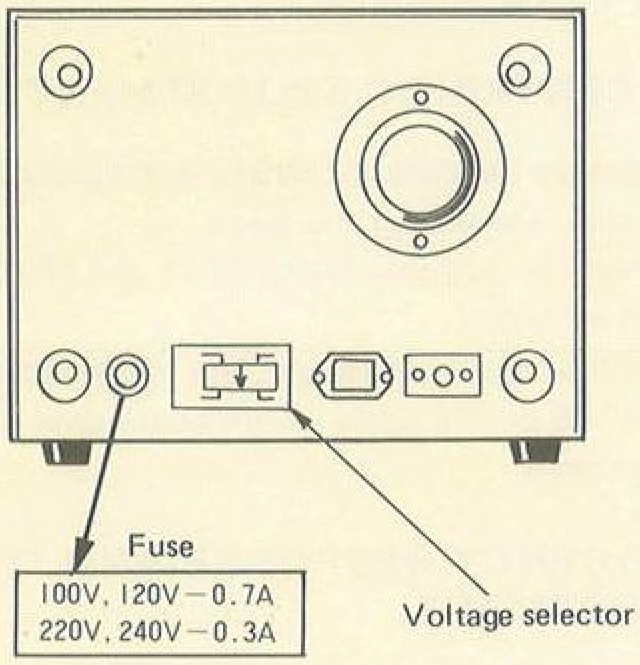


Fig. 27

Adjustment of CRT bright line azimuth:

1. Loosen the two screws holding the azimuth adjustment cover to the rear panel.
2. Turn the CRT cover to align the bright line of CRT with the horizontal line of the scale. The CRT turns together with the cover.
3. Retighten the screws making sure that the bright line is in the horizontal position.

Note: Do not remove the screws of the azimuth adjustment cover during adjustment.
The CRT shield mounting screws have no concern with the adjustment of bright line.

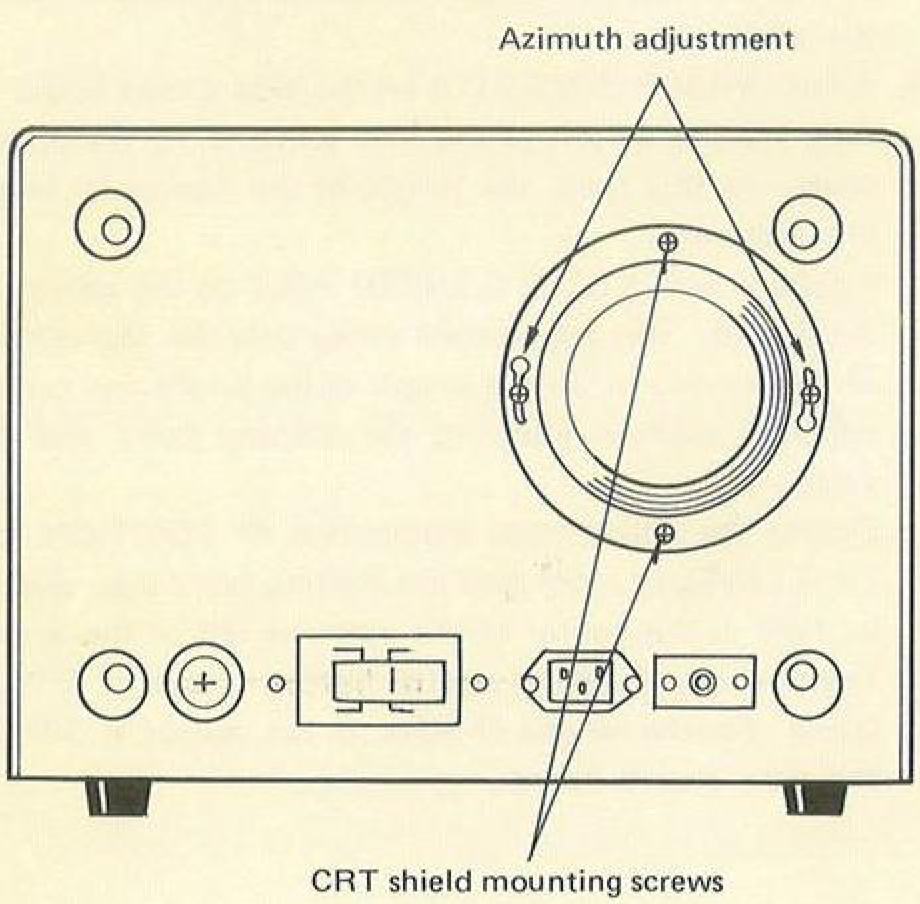


Fig. 28

ADJUSTMENT:

Observe the following before making adjustments:

1. The items given below are pre-adjusted at the factory before shipment. Should re-adjustment be required, it should be performed after calibrating the power source voltage (no adjustment is required on the probe).
2. All adjustments should be made with the semi-fixed resistors or the trimmers mounted on the printed circuit board. For adjustment, use a well insulated, flat blade screwdriver.
3. A high voltage (2000V) is present on the lower circuit board.
   Be sure to turn off the power before removing the bottom cover.
4. For optimum adjustment, turn on the power and warm up the oscilloscope sufficiently before starting.

DC BAL (1) Adjustment: (Refer to Fig. 29)

This adjustment is required when the bright line moves up and down by turning the vertical attenuator (VOLTS/DIV).

1. Set the vertical input selector switch (AC-GND-DC) to GND. Then center the bright line by pulling the PULL AUTO knob.
2. Turn the vertical attenuator (VARIABLE) fully counterclockwise. Adjust VR111 through the hole on the left side of the case so that the bright line is not deflected as the attenuator VOLTS/DIV is turned.

DC BAL (2) Adjustment: (Refer to Fig. 29)

This adjustment is required when the bright line moves up or down by turning the vertical attenuator VARIABLE.

1. Remove the case as described previously. For adjustment, use the auxiliary printed circuit board on the bottom.
   Adjust the VR402 from the top.
2. Turn the variable attenuator VARIABLE fully counterclockwise so that the bright line is centered on the scale. Then, turn the attenuator (VARIABLE(fully clockwise. If, at this time, the bright line shifts up or down, adjust the VR402 until it stays in the center position.
3. Repeat the above procedures until the bright line is stabilized when the attenuator (VARIABLE) is rotated.

Power Transformer

This oscilloscope is pre-adjusted for 240V AC operation (adjustable for 100V, 120V or 220V AC operation).

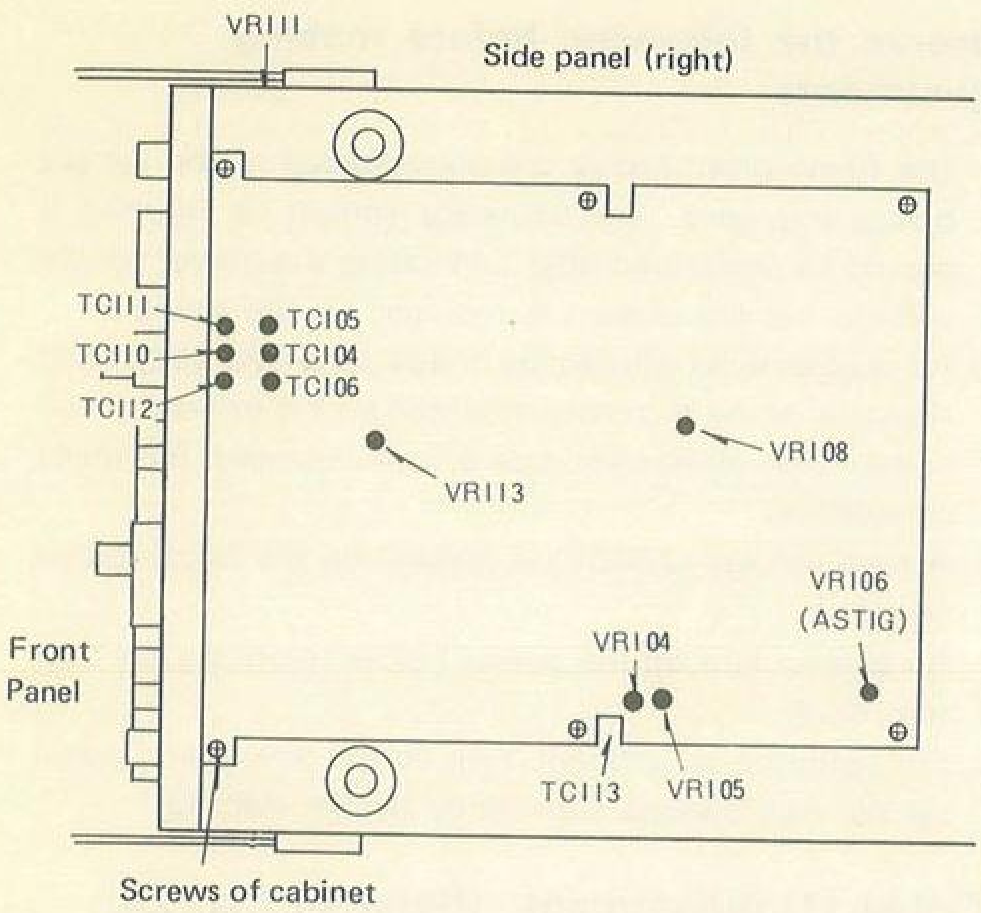


Fig. 29

VERTICAL ATTENUATOR ADJUSTMENT (VOLTS/DIV)

1. This adjustment should be made with the trimmer capacitor on the lower circuit board, which is accessible through the adjusting hole provided on the bottom cover.
2. Connect a 1kHz (output: 0.5V to 100Vp-p) square wave signal generator to the vertical input terminal.
3. With VOLTS/DIV set to 0.1V, adjust the trimmer TC104 until optimum square wave is obtained.
4. Next, change the range to 1V and 10V and adjust the trimmers in the same manner.

PROBE AND INPUT CAPACITANCE ADJUSTMENT

1. Set VOLTS to 0.1V.
2. Set the probe to 10:1 and connect it to INPUT terminal. Apply lkHz square wave signal to the probe and adjust its trimmer for optimum square wave. In this case, the input voltage is attenuated to 1/10 but the input resistance and input capacitance are reduced to less than 10M ohms and 18pF respectively.
3. Next, set VOLTS to 0.1V and adjust the trimmer. TC 110 on the lower circuit board through the adjusting hole provided on the bottom case so that optimum square wave can be obtained.
4. Finally adjust the trimmers TC111 and TC112 at 1V and 10V ranges respectively.

VERTICAL SENSITIVITY ADJUSTMENT

1. Set VOLTS/DIV to 0.01V and turn VARIABLE fully clockwise to CAL.
2. Apply 0.05Vp-p square wave signal to the vertical input.
3. Adjust VR113 (GAIN ADJ) on the lower circuit board through the adjusting hole in the bottom cover for 5 div of vertical amplitude.

CRT CENTERING ADJUSTMENT

1. Remove the case according to the procedures described under "Removing the Case".
2. Short the test terminals TP101 and TP102 on the lower circuit board.
3. With a horizontal bright line displayed on CRT, adjust VR105 on the same circuit board until the bright line is centered.

FREQUENCY RESPONSE AND OVERSHOOT ADJUSTMENT

1. Apply 100kHz square wave signal having a good rise characteristic to the input.
2. Adjust the middle range of the square wave (after rising) with TC113 on the lower circuit board through the adjusting hole in the bottom cover.
3. Adjust the high range of the square wave (rising portion) with VR104 on the same circuit board through the adjusting hole in the bottom cover.

SWEEP TIME (HORIZONTAL SENSITIVITY) AND BRIGHT LINE LENGTH ADJUSTMENT

1. Remove the case according to the procedures described under "Removing the Case".
2. Set SWEEP TIME/DIV to 0.lms and turn VARIABLE fully clockwise to CAL.
3. Apply 1kHz calibrated sine wave signal to the input and adjust each POSITION so that the waveform is centered and its starting point is positioned to the extreme left of the scale.
4. Adjust VR306 (TIME ADJ) on the side circuit board so that 1 wave length of the sine wave is 10 div on the scale. At this time, the length of the horizontal bright line will very.
   Adjust it with VR309 (LENGTH ADJ) on the same circuit board. This adjustment varies only the end portion of the waveform, so the length of the bright line can be adjusted without affecting the starting point and the sweep time.
   During the adjustment, manipulate ◄► POSITION and TRIG LEVEL in order that the starting point may always be held in the center of the extreme left of the scale.
5. The above adjustment applies to the ranges of 0.1s to 0.lms. For the ranges of 50μs to 1μs, adjust TC301 on the side circuit board .

X5 MAG ADJUSTMENT

1. Set SWEEP TIME/DIV switch to 1ms/div and apply 1kHz sine wave signal to the input.
2. Adjust the oscillator frequency and ◄► POSITION to obtain 11 peaks of waveforms. Each peak should be on the vertical line on the scale.
3. With MAG switch pulled toward you, adjust VR303 (MAG ADJ) on the side circuit board so that the spacing between peaks is 5 div.

MAG CENTER ADJUSTMENT

1. Set SWEEP TIME/DIV to 0.1ms and apply 1kHz square wave signal to the input. Adjust so that 1 wave length is spread over the entire scale.
2. Set ◄► POSITION to its mechanical center position (waveform may deviate in the horizontal direction).
3. With MAG switch pulled toward you, adjust VR304 (MAG CENT) on the side circuit board until the rising portion (or falling portion) in the center of the waveform comes to the point obtained at "X1" (MAG switch depressed).
4. Repeat this adjustment until the position of the rising portion (or falling portion) in the center of the waveform is not varied regardless of the position of the MAG switch.
5. Adjust VR305 (POS ADJ) on the side circuit board until the starting point of the waveform comes to the extreme left of the scale.

HORIZONTAL POSITION ADJUSTMENT

1. To adjust the horizontal position during sweep time, proceed as follows:
   Set ◄► POSITION to its mechanical center position and adjust VR305 (POS ADJ) on the side circuit board until the starting point of the waveform comes to the extreme left of the scale.
2. When SWEEP TIME/DIV is set to EXT H, adjust VR308 on the same circuit board so that the spot comes to the center of the scale.

SYNCHRONIZING LEVEL ADJUSTMENT

1. Apply 1kHz sine wave signal to the input. Set SYNC switch to NORM and SOURCE switch to INT.
2. Adjust VR311 (TRIG ADJ) on the side circuit board so that the waveform is started at the same position on the reverse slope when SLOPE is switched to "+" and "−".

CALIBRATING VOLTAGE ADJUSTMENT

Adjust VR301 on the side circuit board for 1Vp-p of square wave calibrating output voltage.

ASTIG ADJUSTMENT

Adjust VR106 on the lower circuit board through the adjusting hole in the bottom cover to uniform the width of the waveform bright line while adjusting FOCUS. Once adjusted, no readjustment is required because ASTIG is stabilized.

HIGH VOLTAGE ADJUSTMENT

1. Connect a DC voltmeter having high input impedance (more than 100M ohms) to CRT's socket terminal 1 or 3 and to the chassis.
2. Adjust VR107 on the lower circuit board for a reading of -1.9kV on the voltmeter.

BLANKING VOLTAGE ADJUSTMENT

1. By using PULL AUTO, display a bright line on the screen of CRT.
2. Adjust VR108 on the lower circuit board through the adjusting hole in the bottom cover so that the bright line disappears at 9 ~ 11 o'clock position of the brightness control knob.

180V ADJUSTMENT

Adjust VR109 on the lower circuit board until the voltage of No. 15 pin of the connector P109 on the same circuit board reaches 180V.

PARTS LIST

PARTS LIST OF CS-1559

Ref. No.	Parts No.	Description
		MISCELLANEOUS
—	A01-0802-02	Case
—	A10-1402-02	Chassis
—	A20-2701-05	Panel
—	A21-0804-02	Ornamental panel
—	A23-1601-12	Rear panel
—	A40-0701-13	Bottom plate
—	B20-0901-04	Graticule
—	B30-0110-05	Lamp mounting
—	B40-2706-04	Model name plate
—	B40-2703-04	Name plate
—	B41-0701-04	Name plate (power source)
—	B50-2806-00	Instruction manual
—	E01-1403-05	CRT socket
—	E03-0201-05	Power connector
—	E04-0002-05	Receptacle, type BNC × 2
—	E13-0104-05	Phone jack
—	E13-0111-05	Phone jack (black)
—	E14-0101-05	Phone plug
—	E18-0106-05	Banana jack
—	E18-0107-05	Banana jack (black)
—	E23-0501-04	Grounding plate
—	E30-0551-15	Lead wire w/1P connector
—	E30-0554-15	Lead wire w/3P connector
—	E30-0555-15	Lead wire w/4P connector
—	E31-0502-05	Lead wire w/3P connector
—	E31-0507-05	Lead wire w/4P connector
—	E31-0532-05	Lead wire w/1P connector
—	F05-3011-05	Fuse (0.3A) × 3
—	F05-7011-05	Fuse (0.7A) × 2
—	F07-0901-04	Cover
—	F10-1501-04	Shield plate
—	F11-0230-13	Shield case
—	F11-0902-03	CRT shield
—	F15-0816-04	Felt (170 × 10)
—	F15-0701-04	Felt (420 × 20 × 52)
—	G02-0601-04	Spring
—	G13-0090-04	CRT mounting rubber × 2
—	G53-0601-04	Bezel bush
—	H01-2802-04	Packing case
—	H10-2801-03	Packing material, foamed styrene
—	H20-2801-03	Protection cover
—	H25-0029-04	Polyethylene bag
—	J02-0501-05	Rubber leg × 4
—	J10-0026-02	Bezel
—	J10-0030-03	Bezel assembly
—	J13-0033-15	Fuse holder
—	J19-0387-05	Wire clipp
—	J19-0457-04	CRT band (1)
—	J19-0458-04	CRT band (2)
—	J21-2801-03	Power transformer mounting hardware
—	J21-2802-04	P.C. Board mounting hardware
—	J21-2805-05	Grip mounting hardware
—	J30-0601-04	Spacer (variable resistor)
—	J42-0501-04	Bush
—	J61-0049-05	Cable band × 5
—	J61-0501-05	Support × 3
—	K21-0259-14	Knob × 3
	K21-0283-04	Knob × 2
—	K21-0306-04	Knob × 7
—	K21-0801-04	Knob × 3
—	K29-0801-04	Knob × 5
—	K01-0501-05	GRIP ASSEMBLY
—	K01-0502-05	Grip (metalic)
—	K01-0503-05	Grip (molded)
—	L01-9006-15	Power transformer
L1,2	L40-3391-14	Ferri-inductor
VR3,VR3-2	R08-2501-05	Variable resistor
VR2,S1	R03-1021-05	Variable resistor
VR1	R05-9001-05	Variable resistor
S1	S59-2501-15	Power switch
—	X65-1150-00	Vertical, power unit (P.C. board)
—	X73-1190-01	Variable AMP (P.C. board)
—	X74-1060-01	Sweep circuit (P.C. board)
—	X77-1020-00	Voltage selector unit
—	X87-1180-01	Probe (PC-21)
—	W01-0058-04	Cord winder

PARTS LIST OF X73-1190-01

Ref. No.	Parts No.	Description
		RESISTOR
R421	PD14BY2E221J	Carbon 220Ω ±5% 1/4W
R422	PD14BY2E681J	Carbon 680Ω ±5% 1/4W
R424	RN14BK2E1820F	Metal film 182Ω ±1% 1/4W
R425	PD14BY2E100J	Carbon 10Ω ±5% 1/4W
R426	RN14BK2E1820F	Metal film 182Ω ±1% 1/4W
R427～429	PD14CY2E470J	Carbon 47Ω ±5% 1/4W
R430,431	PD14CY2E682J	Carbon 6.8kΩ ±5% 1/4W
R432	PD14BY2E561J	Carbon 560Ω ±5% 1/4W
		CAPACITOR
C421	CC45CH1H100D	Ceramic 10pF ±0.5pF
C422	CE04W1A470	Electrolytic 47μF 10WV
C423,424	C90-0298-05	Semiconductor ceramic 0.1μF +80% −20%
C425	CE04W1A470	Electrolytic 47μF 10WV
		SEMICONDUCTOR
Q403,404		Transistor 2SC535-C
		MISCELLANEOUS
—	E23-0046-04	Terminal × 18
—	E31-0504-05	1P connector with lead
—	E31-0505-05	1P connector with lead
—	J25-2802-03	Printed circuit board
—	R12-0056-05	Variable resistor 100Ω (B)

PARTS LIST

PARTS LIST OF X65-1150-00

Ref. No.	Parts No.	Description
RESISTOR		
R150,151	PD14BY2E470J	Carbon 47Ω ±5% 1/4W
R152	RN14BK2H9003F	Metal film 900kΩ ±1% 1/4W
R153	RN14BK2H9903F	Metal film 990kΩ ±1% 1/4W
R154	RN14BK2H9993F	Metal film 999kΩ ±1% 1/2W
R155	RN14BK2E1113F	Metal film 111kΩ ±1% 1/4W
R156	RN14BK2E1012F	Metal film 10.1kΩ ±1% 1/4W
R157	RN14BK2E1001F	Metal film 1kΩ ±1% 1/4W
R158	RN14BK2H1004F	Metal film 1MΩ ±1% 1/2W
R159	PD14BY2E104J	Carbon 100kΩ ±5% 1/4W
R160～165	PD14CY2E101J	Carbon 100Ω ±5% 1/4W
R166	PD14CY2E102J	Carbon 1kΩ ±5% 1/4W
R167,168	PD14CY2E153J	Carbon 15kΩ ±5% 1/4W
R169,170	RN14BK2E8201F	Metal film 8.2kΩ ±1% 1/4W
R171,172	RN14BK2E4701F	Metal film 4.7kΩ ±1% 1/4W
R173,174	R92-0704-05	Metal film 560Ω ±1% 1/4W
R175	RN14BK2E7680F	Metal film 768Ω ±1% 1/4W
R176	RN14BK2E4020F	Metal film 402Ω ±1% 1/4W
R177	RN14BK2E1200F	Metal film 120Ω ±1% 1/4W
R178	PD14BY2E4R7J	Carbon 4.7Ω ±5% 1/4W
R179	PD14BY2E100J	Carbon 10Ω ±5% 1/4W
R180,181	R92-0705-05	Metal film 3.3kΩ ±1% 1/4W
R182,183	PD14BY2E470J	Carbon 47Ω ±5% 1/4W
R184	PD14BY2E220J	Carbon 22Ω ±5% 1/4W
R185	PD14BY2E102J	Carbon 1kΩ ±5% 1/4W
R186	PD14BY2E103J	Carbon 10kΩ ±5% 1/4W
R187～191	PD14BY2E472J	Carbon 4.7kΩ ±5% 1/4W
R193～198	PD14BY2E470J	Carbon 47Ω ±5% 1/4W
R199	PD14BY2E221J	Carbon 220Ω ±5% 1/4W
R200	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R201	PD14BY2E331J	Carbon 330Ω ±5% 1/4W
R202,203	PD14BY2E102J	Carbon 1kΩ ±5% 1/4W
R204,205	PD14BY2E222J	Carbon 2.2kΩ ±5% 1/4W
R206～208	PD14BY2E470J	Carbon 47Ω ±5% 1/4W
R209	PD14BY2E471J	Carbon 470Ω ±5% 1/4W
R210	PD14BY2E474J	Carbon 470kΩ ±5% 1/4W
R212,213	PD14BY2E472J	Carbon 4.7kΩ ±5% 1/4W
R214,215	PD14BY2E473J	Carbon 47kΩ ±5% 1/4W
R216,217	PD14BY2E331J	Carbon 330Ω ±5% 1/4W
R218,219	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R220,221	PD14BY2E124J	Carbon 120kΩ ±5% 1/4W
R222	PD14BY2H683J	Carbon 68kΩ ±5% 1/2W
R223,224	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R225	PD14BY2E331J	Carbon 330Ω ±5% 1/4W
R226,227	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R228,229	PD14BY2E103J	Carbon 10kΩ ±5% 1/4W
R230	PD14BY2E224J	Carbon 220kΩ ±5% 1/4W
R231	PD14BY2E104J	Carbon 100kΩ ±5% 1/4W
R232～235	R92-0146-05	Carbon 2.2MΩ ±5% 1/4W
R236	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R237	RC05GF2H105J	Carbon 1MΩ ±5% 1/2W
R238	RC05GF2H473J	Carbon 47kΩ ±5% 1/2W
R239,240	RC05GF2H226K	Carbon 22MΩ ±10% 1/2W
R241	PD14BY2E473J	Carbon 47kΩ ±5% 1/4W
R242	PD14BY2E471J	Carbon 470Ω ±5% 1/4W
R243	PD14BY2E472J	Carbon 4.7kΩ ±5% 1/4W
R244	PD14BY2E104J	Carbon 100kΩ ±5% 1/4W
R245	PD14BY2E470J	Carbon 47Ω ±5% 1/4W
R246	PD14BY2E102J	Carbon 1kΩ ±5% 1/4W
R247	PD14BY2E224J	Carbon 220kΩ ±5% 1/4W
R248	PD14BY2E473J	Carbon 47kΩ ±5% 1/4W
R249	PD14BY2E223J	Carbon 22kΩ ±5% 1/4W
R250,251	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R252,253	PD14BY2E102J	Carbon 1kΩ ±5% 1/4W
R254	PD14BY2E154J	Carbon 150kΩ ±5% 1/4W

Ref. No.	Parts No.	Description
R255	PD14BY2E683J	Carbon 68kΩ ±5% 1/4W
R256	PD14BY2E103J	Carbon 10kΩ ±5% 1/4W
R257	PD14BY2E153J	Carbon 15kΩ ±5% 1/4W
R259	PD14BY2E682J	Carbon 6.8kΩ ±5% 1/4W
R260	PD14BY2E2R1J	Carbon 2.2Ω ±5% 1/4W
R261	RN14BK2E4301F	Metal film 4.3kΩ ±1% 1/4W
R262	RN14BK2E8201F	Metal film 8.2kΩ ±1% 1/4W
R263	PD14BY2E332J	Carbon 3.3kΩ ±5% 1/4W
R264	PD14BY2E2R2J	Carbon 2.2Ω ±5% 1/4W
R265	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R266	PD14BY2E332J	Carbon 3.3Ω ±5% 1/4W
R267	PD14BY2E2R2J	Carbon 2.2Ω ±5% 1/4W
R268	PD14BY2E472J	Carbon 4.7Ω ±5% 1/4W
R269	PD14BY2E123J	Carbon 12kΩ ±5% 1/4W
R270	RN14BK2E3003F	Metal film 300kΩ ±1% 1/4W
R271	PD14BY2E221J	Carbon 220Ω ±5% 1/4W
R272,273	PD14BY2E220J	Carbon 22Ω ±5% 1/4W
R274	PD14BY2E102J	Carbon 1kΩ ±5% 1/4W
R275	PD14BY2E104J	Carbon 100kΩ ±5% 1/4W
R276,277	PD14BY2E470J	Carbon 47Ω ±5% 1/4W
R278	RN14BK2E1332F	Metal film 13.3kΩ ±1% 1/4W
R279,280	PD14BY2E221J	Carbon 220Ω ±5% 1/4W
R281	PD14BY2E223J	Carbon 22kΩ ±5% 1/4W
CAPACITOR		
C112	CE04W1E470	Electrolytic 47μF 25WV
C113	CK45E1H103P	Ceramic 0.01μF +100% −0%
C114	CE04W1E330	Electrolytic 33μF 25WV
C115	CK45E1H103P	Ceramic 0.01μF +100% −0%
C116	CC45CH1H100D	Ceramic 10pF ±0.5pF
C117	C90-0298-05	Semiconductor ceramic 0.1μF +80% −20%
C118	CC45CH1H180J	Ceramic 18pF ±5%
C119	CK45E1H103P	Ceramic 0.01μF +100% −0%
C121	C90-0021-05	0.1μF
C122	CM93D1H470JSD	Mica 47pF ±5%
C123	CM93D1H471JSD	Mica 470pF ±5%
C124	CQ93M1H222K	Polystyrene 2200pF ±10%
C125	CK45D2H332M	Ceramic 3300pF ±20%
C126	CK45E1H103P	Ceramic 0.01μF +100% −0%
C127	CC45CH1H100D	Ceramic 10pF ±0.5pF
C128	CC45SL1H330J	Ceramic 33pF ±5%
C129	CE04W1A101	Electrolytic 100μF 10WV
C130	CK45E1H103P	Ceramic 0.01μF +100% −0%
C131	CC45SL1H220J	Ceramic 22pF ±5%
C132	CE04W1A101	Electrolytic 100μF 10WV
C134,135	C90-0231-05	0.5pF
C136	CK45D2H103M	Ceramic 0.01μF ±20%
C137,138	CK45D2H332M	Ceramic 3300pF ±20%
C139,140	CK45D2H103M	Ceramic 0.01μF ±20%
C141	CK45E3D102P	Ceramic 100pF +100% −0%
C142～145	CK45E3D103P	Ceramic 0.01μF +100% −0%
C146	C90-0298-05	Semiconductor ceramic 0.1μF +80% −20%
C147	CK45E1H103P	Ceramic 0.01μF +100% −0%
C148	CE04W1H471	Electrolytic 470μF 50WV
C149	CQ93M1H223K	Polystyrene 0.022μF ±10%
C150	CK45D2H203M	Ceramic 0.01μF ±20%
C151,152	C90-0298-05	Semiconductor ceramic 0.1μF +80% −20%
C153	C90-0231-05	0.5pF
C154,155	CC45CH1H050D	Ceramic 5pF ±0.5pF
C156	CE02W2E010	Electrolytic 1μF 250WV
C157	CE04W1E330	Electrolytic 33μF 25WV
C158,159	CE04W1A101	Electrolytic 100μF 10WV
C160	CE04W1C470	Electrolytic 47μF 16WV
C161	CK45D2H103M	Ceramic 0.01μF ±20%

PARTS LIST

Ref. No.	Parts No.	Description
C162	CE04W1E102	Electrolytic 1000μF 25WV
C163	CE04W1E330	Electrolytic 33μF 25WV
C164	CE02W2E470	Electrolytic 47μF 250WV
C165	CE04W1E101	Electrolytic 1000μF 25WV
C168,169	CC45SL1H221J	Ceramic 220pF ±5%
C171	CC45CH2H030D	Ceramic 3pF 0.5pF
SEMICONDUCTOR		
Q109～112		Transistor 2SC945-P
Q113,114		Transistor 2SC535-C
Q115,116		Transistor 2SC1628-Y
Q117,118		Transistor 2SA818-Y
Q119,120		Transistor 2SC945-P
Q121		Transistor E412S-B
Q122		Transistor 2SK30A-0
Q123,124		Transistor 2SC945-P
Q125,126		Transistor 2SC535-C
Q127～128		Transistor 2SA733-Q
Q130		Transistor 2SC945-P
Q131		Transistor 2SC535-C
Q132,133		Transistor 2SC945-P
Q134～137		Transistor 2SC983-Y
Q138		Transistor 2SC1213C
Q139		Transistor 2SC1419C
Q140		Transistor 2SA755-C
Q141		Transistor 2SB536 (2) LM
Q142		Transistor 2SD401
Q143,144		Transistor 2SC535-C
D105,106		Diode 1S1555
D107		Diode WZ100
D108		Diode Y16JA
D109～111		Diode W06C
D112		Diode 1S1705
D113		Diode WZ050
D114,115		Diode 1S1555
D116		Diode WZ100
D117		Diode WZ090
D118,119		Diode S1QB60
IC105		Integrated circuit RC4558T
MISCELLANEOUS		
L101,102	L40-4701-03	Ferri-inductor 47μH
L103,104	L40-6801-03	Ferri-inductor 47μH
L107	L40-4711-03	Ferri-inductor 470μH
L108	L40-4791-02	Ferri-inductor 4.7μH
POTENTIOMETER		
VR104	R12-1002-05	Semi-fixed resistor 1kΩ
VR105	R12-3004-05	Semi-fixed resistor 47kΩ
VR106	R12-6005-05	Semi-fixed resistor 330kΩ
VR107,108	R12-3004-05	Semi-fixed resistor 47kΩ
VR109	R12-1003-05	Semi-fixed resistor 2.2kΩ
VR111	R12-0050-05	Semi-fixed resistor 470Ω
VR112	R01-0502-05	Variable resistor 500ΩB
VR113	R12-0051-05	Semi-fixed resistor 150Ω
VR115	R03-1502-05	Variable resistor 5kΩA
TC104～106	C05-0065-05	Ceramic trimmer 6pF
TC110～113	C05-0066-05	Ceramic trimmer 10pF
N101		Neon lamp NE-2
N102		Neon lamp NE-2
S103	S32-4007-05	Rotary switch
S104	S29-2502-05	Rotary switch

Ref. No.	Parts No.	Description
T101	L19-0019-05	Transformer
P102	E40-0303-05	Connector 3P
P103	E40-0403-05	Connector 4P
P104	E40-0303-05	Connector 3P
P108	E40-0352-05	Connector 5P
P109	E40-0836-05	Connector 8P
P110	E40-0736-05	Connector 7P
	F01-0230-04	Heat sink
	F01-0231-04	Heat sink
	E23-0502-04	Grounding plate
	F11-0147-14	Shield case
	E23-0047-04	Terminal
	J25-2803-12	Printed circuit board

PARTS LIST OF X74-1060-01

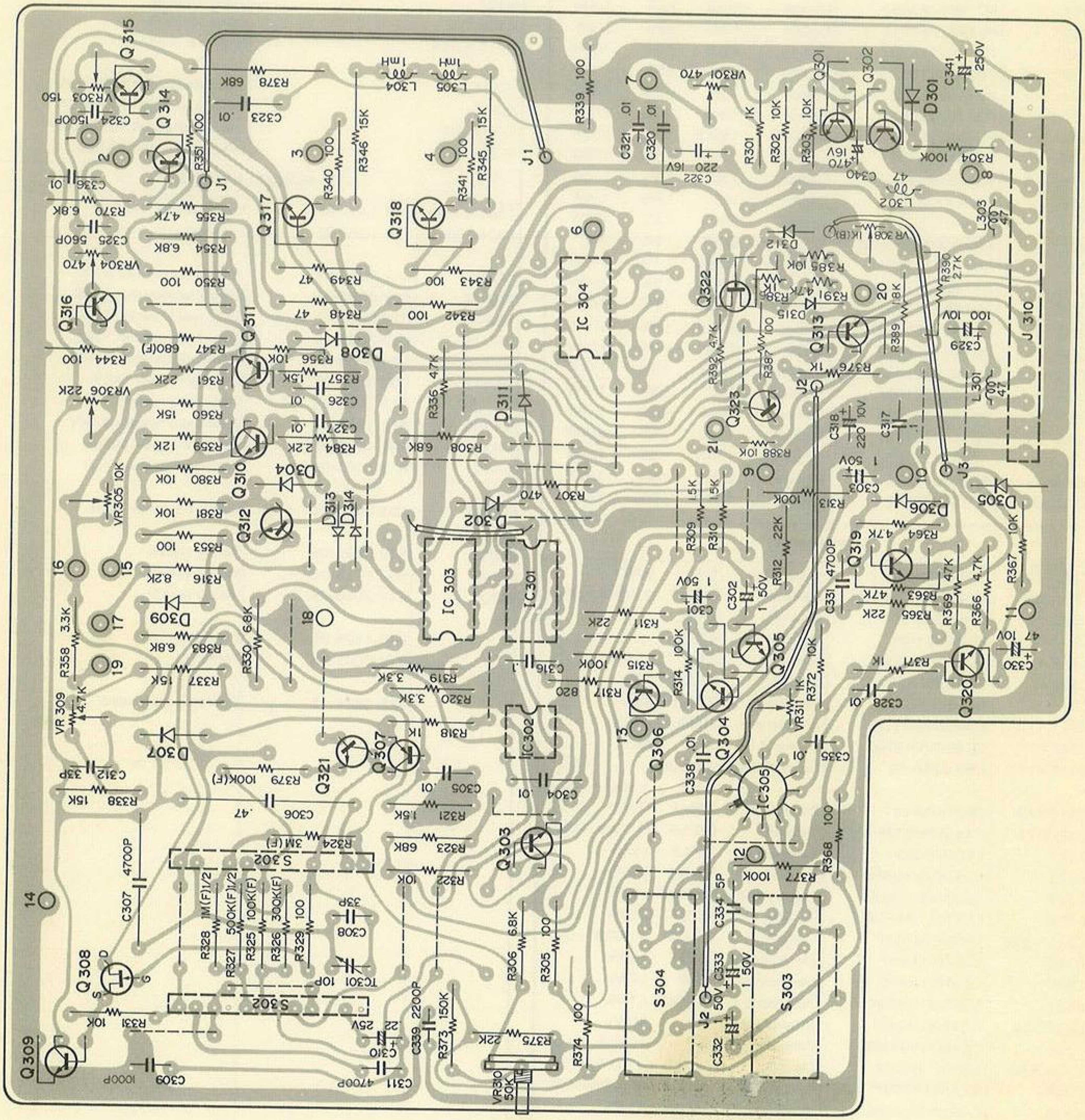
Ref. No.	Parts No.	Description			
RESISTOR					
R301	PD14BY2E102J	Carbon	1kΩ	±5%	1/4W
R302,303	PD14BY2E103J	Carbon	10kΩ	±5%	1/4W
R304	PD14BY2E104J	Carbon	100kΩ	±5%	1/4W
R305	PD14BY2E101J	Carbon	100Ω	±5%	1/4W
R306	PD14BY2E682J	Carbon	6.8kΩ	±5%	1/4W
R307	PD14BY2E471J	Carbon	470Ω	±5%	1/4W
R308	PD14BY2E682J	Carbon	6.8kΩ	±5%	1/4W
R309,310	PD14BY2E332J	Carbon	3.3kΩ	±5%	1/4W
R311,312	PD14BY2E223J	Carbon	22kΩ	±5%	1/4W
R313～315	PD14BY2E104J	Carbon	100kΩ	±5%	1/4W
R316	PD14BY2E822J	Carbon	8.2kΩ	±5%	1/4W
R317	PD14BY2E821J	Carbon	820Ω	±5%	1/4W
R318	PD14BY2E102J	Carbon	1kΩ	±5%	1/4W
R319,320	PD14BY2E332J	Carbon	3.3kΩ	±5%	1/4W
R321	PD14BY2E152J	Carbon	1.5kΩ	±5%	1/4W
R322	PD14BY2E103J	Carbon	10kΩ	±5%	1/4W
R323	PD14BY2E683J	Carbon	68kΩ	±5%	1/4W
R324	PD14BY2E305F	Carbon	3MΩ	±5%	1/4W
R325	RN14BK2E1003F	Metal film	100kΩ	±1%	1/4W
R326	RN14BK2E3003F	Metal film	300kΩ	±1%	1/4W
R327	RN14BK2H5003F	Metal film	500kΩ	±1%	1/4W
R328	RN14BK2H1004F	Metal film	100kΩ	±1%	1/2W
R329	PD14BY2E101J	Carbon	100Ω	±5%	1/4W
R330	PD14BY2E682J	Carbon	6.8kΩ	±5%	1/4W
R331	PD14BY2E103J	Carbon	10kΩ	±5%	1/4W
R336	PD14BY2E472J	Carbon	4.7kΩ	±5%	1/4W
R337,338	PD14BY2E153J	Carbon	15kΩ	±5%	1/4W
R339～344	PD14BY2E101J	Carbon	100Ω	±5%	1/4W
R345,346	RN14AB3D153G-B	Metal film	15kΩ	±1%	2W
R347	RN14BK2E6800F	Metal film	680Ω	±1%	1/4W
R348,349	PD14BY2E470J	Carbon	47Ω	±5%	1/4W
R350,351	PD14BY2E101J	Carbon	100Ω	±5%	1/4W
R353	PD14BY2E101J	Carbon	100Ω	±5%	1/4W
R354	PD14BY2E682J	Carbon	6.8kΩ	±5%	1/4W
R355	PD14BY2E472J	Carbon	4.7kΩ	±5%	1/4W
R356	PD14BY2E103J	Carbon	10kΩ	±5%	1/4W
R357	PD14BY2E152J	Carbon	1.5kΩ	±5%	1/4W
R358	PD14BY2E332J	Carbon	3.3kΩ	±5%	1/4W
R359	PD14BY2E123J	Carbon	12kΩ	±5%	1/4W
R360	PD14BY2E153J	Carbon	15kΩ	±5%	1/4W
R361	PD14BY2E223J	Carbon	22kΩ	±5%	1/4W
R363	PD14BY2E473J	Carbon	47kΩ	±5%	1/4W
R364	PD14BY2E472J	Carbon	4.7kΩ	±5%	1/4W

PARTS LIST

Ref. No.	Parts No.	Description
R365	PD14BY2E223J	Carbon 22kΩ ±5% 1/4W
R366	PD14BY2E472J	Carbon 4.7kΩ ±5% 1/4W
R367	PD14BY2E103J	Carbon 10kΩ ±5% 1/4W
R368	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R369	PD14BY2E473J	Carbon 47kΩ ±5% 1/4W
R370	PD14BY2E682J	Carbon 6.8kΩ ±5% 1/4W
R371	PD14BY2E102J	Carbon 1kΩ ±5% 1/4W
R372	PD14BY2E103J	Carbon 10kΩ ±5% 1/4W
R373	PD14BY2E154J	Carbon 150kΩ ±5% 1/4W
R374	PD14BY2E101J	Carbon 100Ω ±5% 1/4W
R375	PD14BY2E223J	Carbon 22kΩ ±5% 1/4W
R376	PD14BY2E102J	Carbon 1kΩ ±5% 1/4W
R377	PD14BY2E104J	Carbon 100k ±5% 1/4W
R378	RN14AB3D683J-B	Metal film 68kΩ ±5% 2W
R379	RN14BK2E1003F	Metal film 100kΩ ±1% 1/4W
R380	PD14BY2E103J	Metal film 10kΩ ±5% 1/4W
R381	PD14BY2E103J	Carbon 10kΩ ±5% 1/4W
R383	PD14BY2E682J	Carbon 6.8kΩ ±5% 1/4W
R384	PD14BY2E222J	Carbon 2.2kΩ ±5% 1/4W
R385	PD14CY2E103J	Carbon 10kΩ ±5% 1/4W
R386	PD14CY2E102J	Carbon 1kΩ ±5% 1/4W
R387	PD14CY2E101J	Carbon 100Ω ±5% 1/4W
R388	PD14CY2E103J	Carbon 10kΩ ±5% 1/4W
R389	PD14BY2E182J	Carbon 1.8kΩ ±5% 1/4W
R390	PD14BY2E182J	Carbon 2.7kΩ ±5% 1/4W
R391,392	PD14CY2E492J	Carbon 4.7kΩ ±5% 1/4W
	CAPACITOR	
C301~303	CE04W1H010	Electrolytic 1μF 50WV
C304,305	CK45E1H103P	Ceramic 0.01μF +100%−0%
C306	C90-0320-05	Ceramic 47μF
C307	C90-0321-05	Ceramic 4700pF
C308	CC45CH1H330J	Ceramic 33pF ±5%
C309	CC45CH1H221J	Ceramic 220pF ±5%
C310	CS15E1ER22M	Tantalum 0.22μF 25WV
C311	CQ93M1H222K	Polystyrene 2200pF ±10%
C312	CC45CH1H330J	Ceramic 33pF ±5%
C316,317	C90-0298-05	Semiconductor Ceramic 0.1μF +80%−20%
C318,319	CE04W1A221	Electrolytic 220μF 10WV
C320,321	CK45E1H103P	Ceramic 0.01μF +100%−0%
C322	CE04W1C221	Electrolytic 220μF 16WV
C323	CK45D2H103M	Ceramic 0.01μF ±20%
C324	CQ93M1H152K	Polystyrene 1500pF ±10%
C325	CC45SL1H561K	Ceramic 560pF ±10%
C326~328	CK45E1H103P	Ceramic 0.01μF +100%−0%
C329	CE04W1A101	Electrolytic 100μF 10WV
C330	CE04W1A470	Electrolytic 47μF 10WV
C331	CQ93M1H472K	Polystrene 4700pF ±10%
C332,333	CE04W1H010	Electrolytic 1μF 50WV
C334	CC45CH1H050D	Ceramic 5pF ±0.5pF
C335,336	CK45E1H103P	Ceramic 0.01μF +100%−0%
C338	CK45E1H103P	Ceramic 0.01μF +100%−0%
C339	CQ93M1H222K	Polystrene 2200pF ±10%
C340	CE04W1C471	Electrolytic 470μF 16WV
C341	CE04W2E010	Electrolytic 1μF 250WV
	SEMI-CONDUCTOR	
Q301~306		Transistor 2SC945P
Q307		Transistor 2SA733Q or R
Q308		Transistor 2SK30A-0
Q309~316		Transistor 2SC945P
Q317,318		Transistor 2SC1507
Q319~321		Transistor 2SC945P
Q322		FET, 2SK30A-0
Q323		Transistor 2SA733Q

Ref. No.	Parts No.	Description
D301,302		Diode 1S1555
D304~306		Diode 1S1555
D307		Diode 1S1587
D308,309		Diode 1S1555
D311~315		Diode 1S1555
IC301		Integrated circuit TD3472AP
IC302		Integrated circuit RC555DN
IC303,304		Integrated circuit TD3400AP
IC305		Integrated circuit AN606
	MISCELLANEOUS	
L301~304	L40-4701-03	Ferri-inductor 47μF
L304,305	L40-1092-03	Ferri-inductor 1mH
VR301	R12-0003-05	Semi-fixed resistor 470Ω
VR303	R12-0051-05	Semi-fixed resistor 150Ω
VR304	R12-0003-05	Semi-fixed resistor 470Ω
VR305	R12-3002-05	Semi-fixed resistor 10kΩ
VR306	R12-3005-05	Semi-fixed resistor 22kΩ
VR307	R08-9502-05	Variable resistor 5kΩB
VR308	R12-1002-05	Semi-fixed resistor 1kΩ
VR309	R12-1004-05	Semi-fixed resistor 4.7kΩ
VR310	R01-4024-05	Variable resistor 50kΩB
VR311	R12-1002-05	Semi-fixed resistor 1kΩ
TC301	C05-0066-05	Ceramic trimmer 10pF
S302	S29-2503-05	Rotary switch
S303	S32-2013-05	Rotary switch
S304	S37-2005-05	Rotary switch
	E40-1506-05	Connector 14P
	E23-0047-04	Terminal
	J25-2804-13	Printed circuit board

PC BOARD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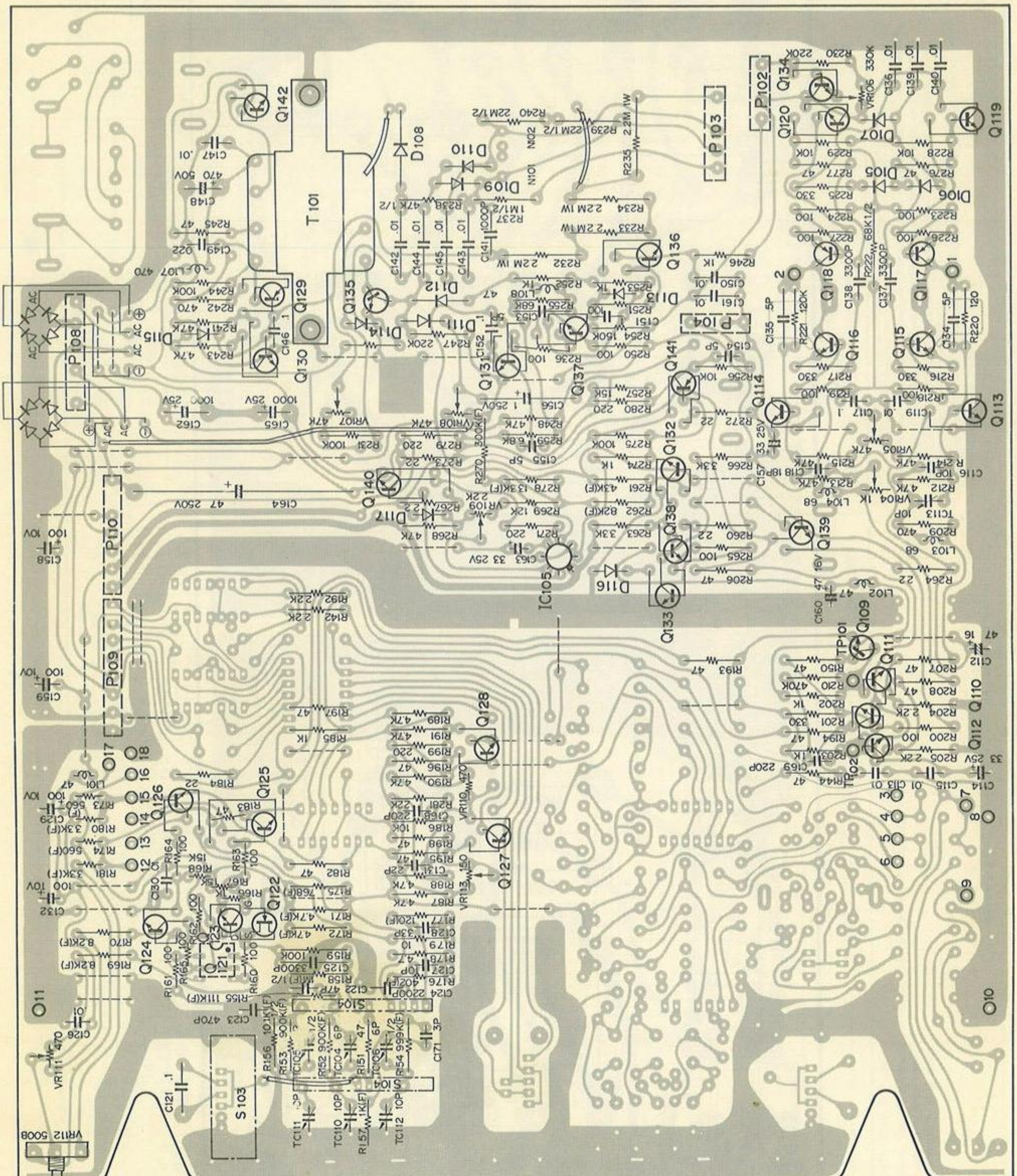
PC BOARD



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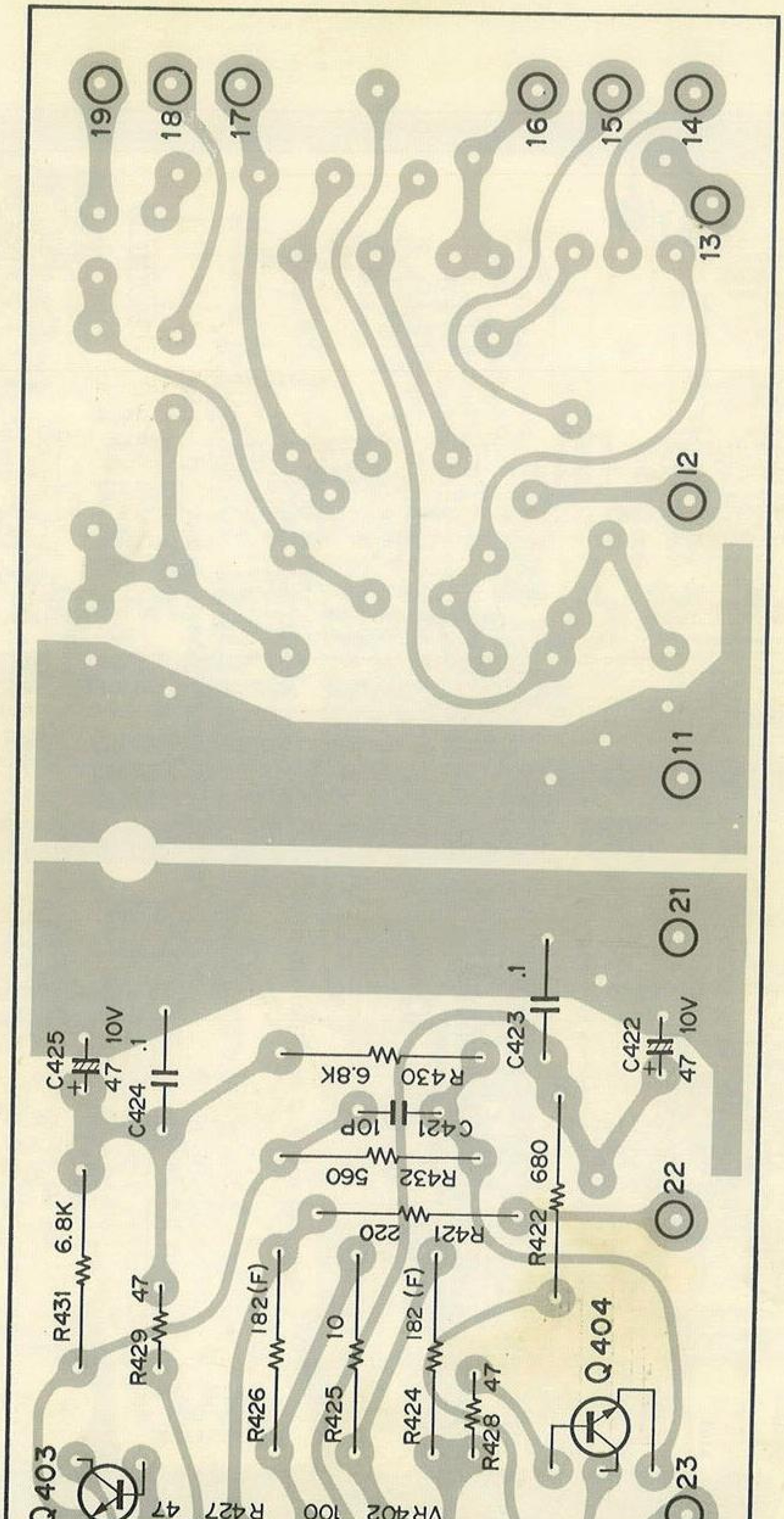
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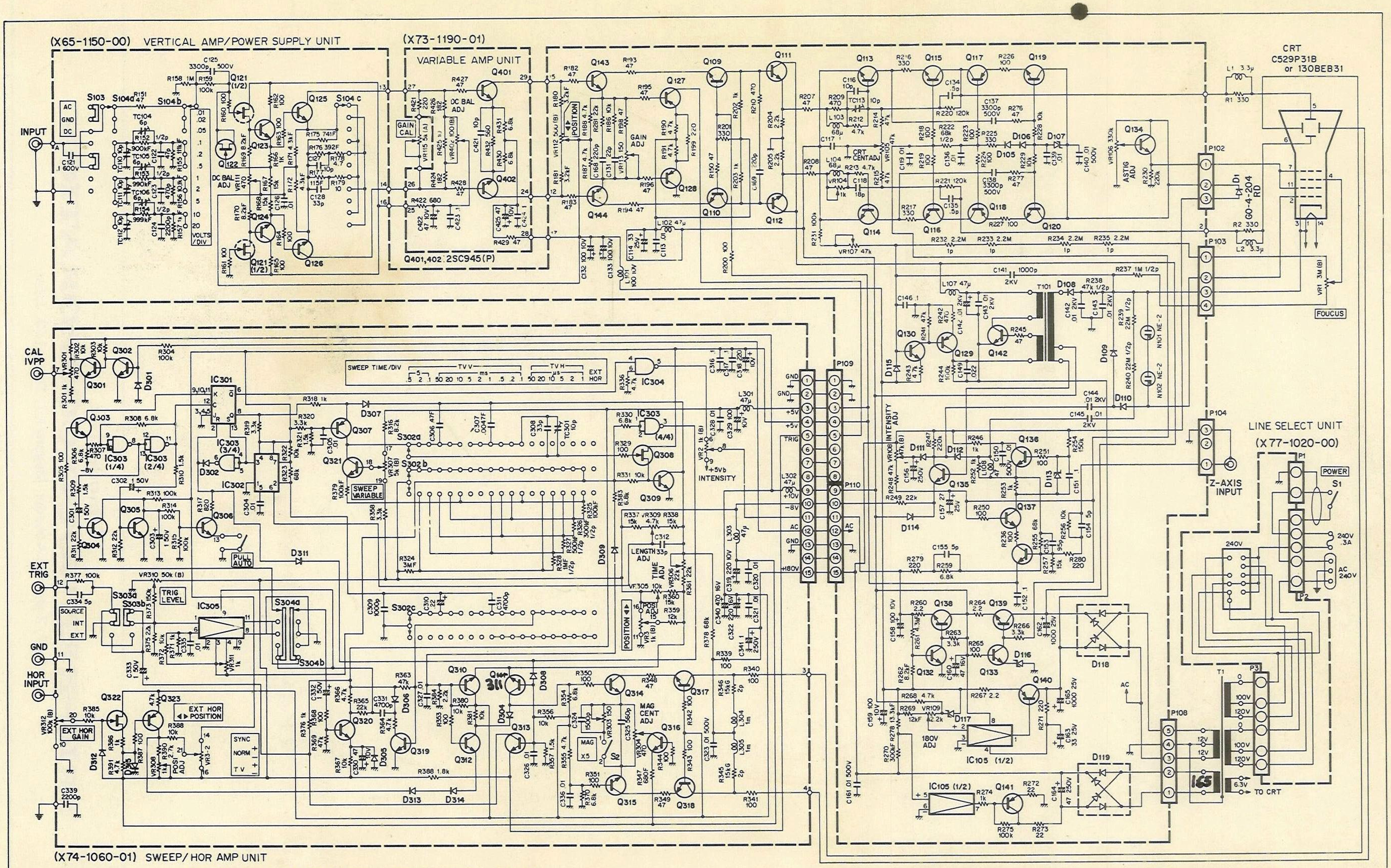
21
22
23
24
25
26
27
28
29
C425
47
10V
C424
.1
R431
6.8K
R429
47
Q403
R427
47
VR402
100
R426
182(F)
R425
10
R424
182(F)
R428
47
Q404
R430
6.8K
C421
10P
R432
560
R421
220
R422
680
C423
.1
C422
47
10V

SCHEMATIC DIAGRAM



Q301~306, 309~316, 319~321 : 2SC945(P), Q307, 323 : 2SA733(Q), Q308, 322 : 2SK30A(O), Q317, 318 : 2SC1507
D301~306, 308, 309, 311~315 : 1S1555, D307 : 1S1587
IC301 : TD3472AP, IC302 : RC555DN, IC305 : AN606

Q109~112, 119, 120, 123, 124, 130, 132, 133, 143, 144 : 2SC945(P), Q113, 114 : 2SC535(C), Q115, 116 : 2SC1628(Y)
Q117, 118 : 2SA818(Y), Q121 : E412S, Q122 : 2SK30A(O), Q125, 126 : 2SC535(C), Q127~129 : 2SA733(Q)
Q135~137 : 2SC983(Y), Q138 : 2SC1213(C), Q139 : 2SC1419(C), Q140 : 2SA755(C), Q141 : 2SB536(2)LM
Q142 : 2SD401(M), IC105 : RC4558T
D105, 106, 114, 115 : 1S1555, D107, 116 : WZ-100, D108 : Y16JA, D109~111 : W06C, D112 : 1S1705, D113 : WZ-050
D117 : WZ-090, D118, 119 : S1QB60

RESISTANSE VALUES IN Ω, 1/4W AND CAPACITANCE IN μF, F, UNLESS OTHERWISE SPECIFIED.

CS-1559

WE RESERVE THE RIGHT TO MAKE MODIFICATIONS IN THIS MODEL IN ACCORDANCE WITH TECHNICAL DEVELOPMENTS.

観測用ベーゼルの取りはずしに関する注意とお願い

このセットの観測用ベーゼルは，ベーゼルの裏側の４本のモールド脚によって，セット本体に取り付いておりますので，工具を使わないで直接取りはずすことができますが，力の方向によってはモールド脚が折れることがあります。

取りはずしの際は，Ｆｉｇ２のように先に下側の２本の脚をはずしてから（脚の先端のふくらみの部分Ｃのロックが Ｆｉｇ３のように少しはずれる程度），次に上側の２本の脚をはずして下さい。

取りはずしに当たっては，パネル面に対してできるだけ垂直に力を加えてください。

ベーゼルをセットに取り付ける場合にはＦｉｇ１のようにベーゼルの突起ＡＡ'と目盛板の穴ＢＢ'を合わせてからセットに取り付けてください。

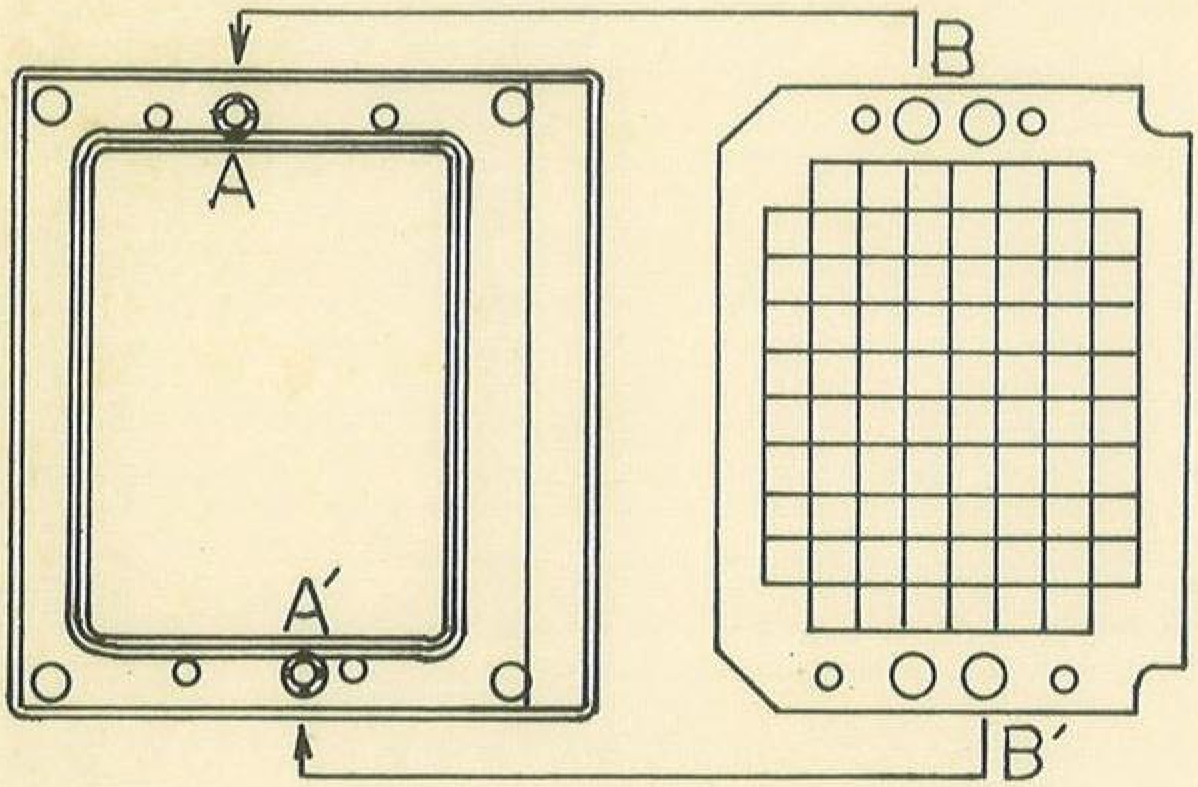


Fig 1

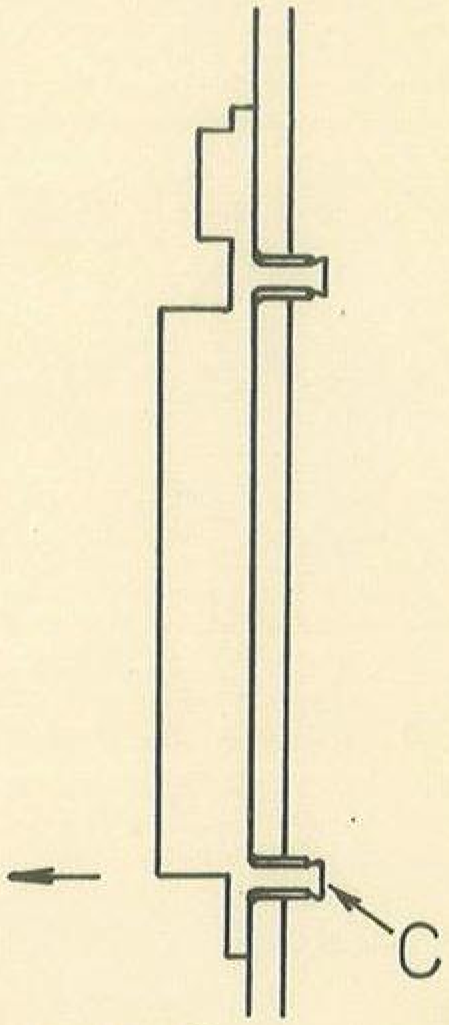


Fig 2

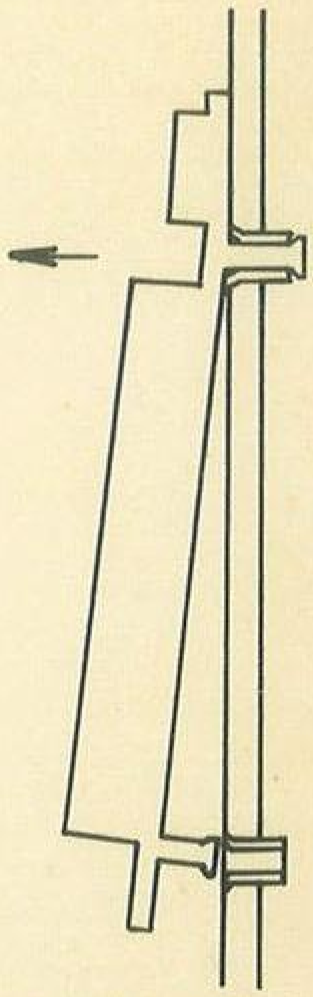


Fig 3

CAUTION

How to remove the bezel.

The bezel with 4 molded legs on back is removable by simply pulling with hands. No tools are required.
In removing the bezel it is required to pull toward the right-angle with fingers. Please pull the lower corners only a little bit (approx. 5 mm) to unlock the legs, then hold the upper corners and pull them.

NOTE: If lower corners are pulled too far from the front panel, upper corners' mold legs may be broken.

Before mounting bezel, please match the scale holes (B)(B') to holes (A)(A')

Scanned by: Jose Rojas
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A product of
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