MODEL 568

OSCILLOSCOPE

OPERATION MANUAL

KIKUSUI ELECTRONICS CORP.

CONTENTS

1. INTRODUCTION

The Model 568 oscilloscope designed and manufactured by Kikusui Electronics Corp., is of the trigger sweep type, employing a square-shaped cathode-ray tube with an interior scale 155 mm calibrated. It is an all-purpose high-grade oscilloscope, featuring two phenomena of the vertical axis by the electronic change-over system, coverage of the frequency band DC~20 MHz, and maximum sensitivity of 5 mV/cm.

All the circuits, except a part thereof, are semiconductorized, and field effect transistors are used for the input circuit of the vertical axis, giving superb stability and being completely ready for regular operation within approximately 15 seconds from being switched on.

The horizontal axis can be triggered for any frequency in the DC–20 MHz band. The Model 568 has a time-base oscillator of the range 5 sec/cm ~ 0.1 μS/cm, and is capable of measuring down to 0.02 μS/cm by means of a 5-times magnifier.

The cathode-ray tube has an effective tube surface of 80 mm x 110 mm and being furnished with an interior scale, is capable of measuring over a wide range free from parallex.

Construction

This model comprises a main body and accessories as enumerated below below :

Main body

Accessories

Probe	2
BNC cable	1
BNC cable terminal adapter	1
Hexagonal Wrench (4 mm)	1
Hexagonal Wrench (3 mm)	1
Fuse	1 set
Dust cover	1
Accessory case	1
Operation manual	1
Test data	1

2. SPECIFICATIONS

VERTICAL DEFLECTION SYSTEM

Characteristic	Performance Requirement	Operational Information
Sensitivity	5mV/cm ~ 10V/cm, 11 steps	Steps in 1, 2 & 5 sequence
Sensitivity error	± 3% or less of the indicated value on the panel if VARIABLE is set at CAL'D	Calibrate sensitivity correctly in 5 mV/cm range
Continuous change in sensitivity	Can be attenuated to 2. 5 times or more the indicated value on the panel. Can be changed to 25V/cm (uncalibrated) in 10V/cm range.	
Frequency bandwidth	At DC connection - DC~20MHz At AC connection - 3Hz ~ 20 MHz	-3dB or less
Rise time	17. 5nS	
Square wave characteristic	Overshoot 3% or less Ringing 1. 5% or less Sagging (at 200kHz) 1% Sagging (at 60Hz) 1%	Measured at DC connection
Signal time delay	Approx. 150nS	
Input impedance	1MΩ± 2%, 38pF± 2pF, parallel	
Input terminal	BNC type receptacle	
Maximum allowable input voltage	In 5mV/ cm range, 400Vp-p Other range than 5mV 600 Vp-p	Value of voltage, DC+ACp-p; AC, at 1 kHz frequency or less
Input connection system	AC and DC	

VERTICAL DEFLECTION SYSTEM (Cont'd)

Characteristic	Performance Requirement		Operational Information
Move of luminant line by DC offset	2 mm or less at 5 mV/cm in sensitivity		
Mode of vertical action	Ch. 1	Single	
	Ch. 2	Single	
	AL T	2 phenomena, Ch 1 and Ch 2 to be swept alternately	To be switched over by synchronization of sweep
	CHOP	2 phenomena, Ch 1 and Ch 2 to be swept by switching-over	To be switched over by constant repetition, irrespective of sweep
	ADD	Ch 2 ± Ch 1	
CHOP change-over frequency	150 kHz ±20%		
Polarity	Only Ch 1 is inversible		
Linearity	Elongation or contraction is ±1.2 mm (±3%) or less if 4 cm signal at the center of CRT surface is moved to the full extent of the vertical effective area.		Linearity of CRT at frequency of 100 kHz or less is included.
In-phase signal elimination ratio	More than 20 : 1 at 200kHz frequency		If Ch 1 and Ch 2 are equalized in sensitivity
Adjacent-channel interference	1, 000:1 or over, 100 kHz 70:1 or over, 20 MHz		Apply signals in the CRT surface effective area on one input under ALT operation, and terminate the other input at 50Ω, in the range of 5 mV/cm for both Ch 1 and Ch 2.

HORIZONTAL DEFLECTION SYSTEM

Characteristic	Performance Requirement	Operational Information
Sweep time	0. 1μS/cm - 5Sec/cm, 24 steps	Steps in 1, 2 and 5 sequence
Continuous change in sweep time -	Can be regulated up to 2. 5 times the indicated value on the panel. The longest sweep time is up to 2. 5 Sec/cm (uncalibrated).	
Sweep time error	± 3% or less of the value indicated on the panel	Set VARIABLE at CAL'D.
Linearity of sweep	± 3% or less	
Sweep multiplication	5 times	
Multiplication error	± 2% of sweep time error ± 5% only in the case of 0. 5, 0. 2 and 0. 1μS/cm	
Linearity by multiplication	± 2% of sweep linearity ± 5% only in the case of 0. 5, 0. 2 and 0. 1 μS/cm	
Change in position by multiplication	5 mm or less at the center	

TRIGGERING

Characteristic	Performance Requirement	Operational Information
Trigger source	NORM, waveform on picture tube CH 2 ONLY, CH 2 only LINE, waveform of power source EXT., external	
Trigger coupling	AC, HF REJ, LF REJ, and DC	
Polarity	Positive or negative	

TRIGGERING (Cont'd)

Characteristic	Performance Requirement	Operational Information
Internal trigger sensitivity		To be shown by amplitude on CRT surface
AC	50Hz ~ 8 MHz 2 mm 50Hz ~ 20 MHz 5 mm	
HF REJ	50Hz ~ 50 kHz 2 mm	
LF REJ	30kHz ~ 8 MHz 2 mm 30kHz ~ 20 MHz 5 mm	
DC	dc ~ 8 MHz 2 mm dc ~ 20 MHz 5 mm	
External trigger sensitivity		
AC	50Hz ~ 20 MHz 100mVp-p	
HF REJ	50Hz ~ 50kHz 100mVp-p	
LF REJ	30kHz ~ 20 MHz 100mVp-p	
DC	dc ~ 20 MHz 100mVp-p	
Triggering level control range	2Vp-p or over at EXT; however, in case the knob is pulled out, TRIG SIG 1/10 is set, thus extending the range up to approx. 10 times the rated voltage	
AUTO	Satisfies the item of trigger sensitivity to signals of 50 Hz or over	
Single sweep	Same as the item of trigger sensitivity	
External trigger input impedance	Approx. 1MΩ 40pF or less, parallel	
Max. allowable input voltage	400Vp-p (DC + ACp-p)	AC - 1 kHz or less
Input terminal	BNC type receptacle	

EXTERNAL SWEEP AMPLIFIER SYSTEM

Characteristic	Performance Requirement	Operational Information
Deflection sensitivity	100mV/cm or over; to be reduced to 1/10 by step attenuator, and controlled continuously down to 1/10 approximately by HOR GAIN knob	Sensitivity is improved by 5 times by setting at 5 x MAG, hence 20mV/cm or over
Frequency bandwidth	DC - 2 MHz, -3dB or less	
Input impedance	1 MΩ ± 5%, 20pF or less, parallel	
Max. allowable input voltage	400Vp-p (DC + ACp-p)	AC - 1 kHz or less
Input terminal	BNC type receptacle	

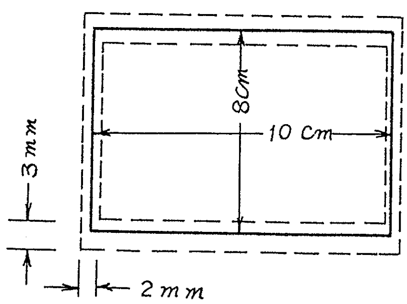
Z AXIS

Characteristic	Performance Requirement	Operational Information
Sensitivity	Modulation can be observed at the input of +2.5V.	
Frequency range	DC - 10 MHz	
Input DC resistance	Approx. 47 kΩ	
Polarity	Luminance is reduced by signals of positive polarity	
Input terminal	Terminal of 19 mm spacing, furnished with short bar	

CALIBRATION VOLTAGE

Characteristic	Performance requirement	Operational Information
Waveform	Square wave	
Polarity	Positive polarity, 0V in standard level	
Output voltage	5mVp-p - 10Vp-p, 11 steps	Steps in 1,2 and 5 sequence
Output voltage error	±3% or less	
Frequency	1 kHz ±20% or less	
Duty ratio	48:52 or less	
Rise time	$1\mu S$ or less	
Output terminal	BNC type receptacle	

CATHODE-RAY TUBE (CRT)

Characteristic	Performance Requirement	Operational Information
Tube type	150W, 6" square, with inteior scale calibrated	
Phosphor	B31 (P31)	
Accelerating voltage	Approx. 5, 500 V	
Effective area	8 cm (V) x 10cm (H)	
Distortion	 Within the range marked by the dotted lines around the peripheral section shown by 8 cm x 10 cm above	

CATHODE-RAY TUBE (CRT) (Cont'd)

Characteristic	Performance Requirement	Operational Information
Conformity between luminant line and graticule	Conformity can be obtained by adjusting the rotator	
Unblanking	DC coupling	
Illumination	Keep luminance over the graticule continuously variable	

POWER SUPPLY

Characteristic	Performance Requirement	Operational Information
Line voltage	-----------V	Built-in power source is stabilized in this range.
Line frequency	50 Hz - 60 Hz	
Power consumption	Approx. 160 VA	
Max. operational temperature range	0° C - +40° C	
Temperature range satisfying the specifications	+15° C - +35° C	

MECHANICAL CHARACTERISTICS

Characteristic	Performance Requirement	Operational Information
Dimensions	332(H) x 236 (W) x 540 (D) mm 315(H) x 235 (W) x 480 (D) mm	Maximum Cabinet only
Weight	Approx. 17.5 kg	Main body only

ACCESSORIES SUPPLIED

Item	Quantity
955 type lower capacitance probe (with BNC connector)	2
Cable, with BNC terminal (0.5 m in length)	1
BNC terminal adapter	1
Power source cord (approx. 2 m in length)	1
Short bar	1
Time lag fuse, 2A	1
Lead-in type time lag fuse, 3A	1
Fast blow fuse, 0.1A	1
Fast blow fuse, 0.2A	1
Hexagonal wrench, for 3 mm	1
Hexagonal wrench, for 4 mm	1
Dust cover	1
Accessory case	1
Operation manual	1
Test data	1

3. OPERATION

3.1 FRONT PANEL

The explanation of the knobs and the terminals on the front panel and the rear panel will be given below. Concering the double knobs, the grey ones are indicated with black letters, and the red ones are indicated with red letters.

INTENSITY knob	This knob is for regulation of luminance of the CRT. Luminance is intensified by turning this knob clockwise, while it is reduced by turning this knob counterclockwise.
FOCUS knob	This knob is employed along with the ASTIG knob for the purpose of clarifying a luminant point or trace occurring on the surface of the CRT (hereinafter called CRT surface).
ASTIG knob	This knob is used along with the FOCUS knob as indicated above.
SCALE ILLUM knob	This knob is for regulating the luminance over the CRT scale. Luminance is intensified by turning thing knob clockwise, while it is reduced by turning this knob counterclockwise.
POWER ON knob	This is a power source switch. Power source is switched on by pushing it up, and a lamp is lit thereby.
CALIBRATOR knob	This is for a square wave oscillator for sensitivity calibration. The waveform is a positively going square wave. The frequency is approx. 1 kHz. The knob is capable of selecting 11 steps in 1, 2.5 sequences from 5 mVp-p up to 10 Vp-p, and output can be taken from the BNC receptacle for CAL OUT.
CAL OUT	This is the output terminal for the CALIBRATOR above.

Vertical deflection system (CH 1)	The CH 1 and CH 2 knobs and terminals are the same in function. The explanation given for the CH 1 knobs and terminals is applicable to the CH 2 knobs and terminals.
INPUT	This is an input terminal for the vertical axis. The terminal is a BNC type receptacle for input signals or for connection with a probe.
AC-DC-GND	This is a switch for selecting the connection of the input. When this is set at AC, the input section of the vertical amplifier forms AC coupling, until DC is cut-off even when input signals have DC, thus enabling only AC signals to be observed. If this is set at DC, the input section of the vertical amplifier forms DC coupling, thus enabling the input signals to be observed together with DC signals. When this switch is set at GND, input signals and the vertical amplifier disconnected, and the input side of the vertical amplifier grounded. Grounding potential can be confirmed readily enough.
VOLTS/CM	(Grey knob) This is a switch for switching over vertical axis deflection sensitivity to any of the 11 steps in the range 5 mV/cm to 10 V/cm. The indicated value at each step represents the value of voltage for every 1 cm of vertical amplitude on the tube surface, obtained when the VARIABLE knob is turned clockwise to the end and set at the CAL'D position. This switch is put in to operation on at the CAL'D position and the lamp of UNCAL'D is switched off.
VARIABLE	(Red knob) This is a control for continuously attenuating the input signals. The attenuation factor is approximately 1/2.5 if this knob is turned counterclockwise to the extreme end. Therefore, each and every interspace between steps of VOLTS/CM can be made continuously variable.

UNCLA'D	This is a switch for an uncalibrated pilot lamp, which is switched on if the VARIABLE is set at any position other than CAL'D, thus indicating that vertical axis deflection sensitivity is uncalibrated.
POSITION	This is a vertical position control for the luminant point or trace.
DC BAL -	This is a semifixed variable resistor for regulating DC balance of the vertical axis by a minus-shaped shaft arranged at the center of the POSITION knob. If DC of the vertical axis is not balanced, vertical position moved irregularly when the VARIABLE knob is turned. Once DC balance is regulated correctly, it is subjected to virtually no fluctuation; however, it sometimes cannot escape fluctuation due to ambient temperature variation.
CAL	This is a semifixed resistor for calibrating sensitivity. This serves to calibrate so that the amplitude on the CRT surface can be reduced to 1 cm when the voltage indicated by the VOLTS/CM is applied thereto.
GND	This is a terminal connected to the panel and the chassis.
CH 1 INV	This is a push-pull switch for switching the polarity of CH 1. The polarity remains normal when this switch is set at the push position and the polarity is reversed when it is set at the pull position.
(CH 2)	This CH 2 knob has the same function as the Ch 1 knob and terminal, except in the case set forth in CH 1 INV above.
MODE	This is a switch for selecting one of the following functions of the 2-phenomena amplifier.
CH 1	If the switch is set at CH 1, the amplifier of the Ch. 1 alone is put into operation, thus constituting a single phenomenon oscilloscope.

CH 2

If the switch is set at CH 2, the amplifier of the Ch. 2 alone is put into operation, thus constituting a phenomenon oscilloscope.

ALTER

This switch changes over the functions of Ch 1 and Ch 2 alternately at each termination of the sweep of the time axis, thus reproducing on the tube surface the two phenomena one following the other. If sweep time is delayed (to lower than above 2mS/cm), two phenomena cannot be observed at the same time by this method. The two-phenomena observation by ALTER is suitable for observation in a comparatively high frequency range.

CHOP

This switch changes over the functions of Ch 1 and Ch 2 alternately at the frequency of approximately 100 kHz, more than thus reproducing on the tube surface two phenomena one following the other. In this function the traces of Ch 1 and Ch 2 are connected with each other by dots, and the waveforms become hard to observe if sweep time is cut short (to 10μS/cm or quicker). The two-phenomena observation by CHOP is suitable for observation in a comparatively low frequency range.

ADD

This switch puts Ch 1 and Ch 2 in operation concurrently, thus permitting observation of a signal equivalent to the algebraic sum or balance of the input signals of Ch 1 and Ch 2 as reproduced on the tube surface. For obtaining the algebraic sum or balance, the push-pull switch, set forth in CH 1 INV above, is used.

HORIZONTAL DEFLECTION SYSTEM

HORIZONTAL POSITION	(Grey knob) This switch is the horizontal position regulator of the luminant point or trace.
FINE	(Red knob) This is the fine regulator of the horizontal position knob.
PULL 5 x MAG	By pulling out this knob, an image is multiplied 5 times in the direction of the horizontal run.
HORIZ DISPLAY	This switch that changes over the function of the horizontal deflection system, and either of the following functions can be selected.
EXT. HOR. 1	The sweep oscillator suspends its function, and the horizontal amplifier is connected to the EXT. HOR. IN terminal.
EXT. HOR. 1/10	Attenuation by 1/10 is arranged between the input of the horizontal amplifier and the EXT. HOR. IN terminal.
AUTO	The time axis oscillator starts functioning as a self-excited sweep. A luminant line appears on the tube surface even when it is devoid of signals for observation, and the oscillator triggers when the signals to be observed are 50 Hz or over.
NORM	The time axis oscillator is put acts as a triggering sweep. In this condition, the time axis oscillator stops sweeping if no signals are present for observation, and only remains in standby condition. As soon as signals are present for observation, the oscillator starts sweeping.
SINGLE	The time axis oscillator is put into the condition of a single sweep. If the RESET switch is pushed when there are no signals to be observ-ed, the READY lamp is switched on, thus indicating that the oscillator is in standby condition for single sweep. If a triggering signal is applied to the oscillator in standby condition, sweep is conducted only once, and the READY lamp is switched off.

Single sweep is conducted for observation of a single phenomenon among the waveforms observed and for photographing.

TIME/CM

(Grey knob) This is a sweep-time change-over switch. Concerning the indicated value at each step, the sweep time for every cm of the horizontal amplitude on the tube surface is indicated on the tube surface, when the VARIABLE knob is turned clockwise to the CAL'D position.

VARIABLE

(Red knob) This is a continuously variable regulator for sweep time. At the extreme clockwise position of CAL'D, the TIME/CM is calibrated, meanwhile if this VARIABLE knob is turned counterclockwise to the extreme, the lamp on UNCAL'D is switched on.

TRIGGERING

LEVEL

This knob is the triggering level regulator. This is for regulating the step for starting the sweep of the triggering signal waveform. By pulling out this knob, an attenuation by 1/10 is arranged in the pass of the triggering signal.

SLOPE

This is for selecting the slope of the triggering signal waveform, determines triggering point on the upward slope of the waveform (+ setting) while triggering on the downward slope of the waveform (- setting)

COUPLE

This is a change-over switch for coupling of the triggering signal, and it is capable of selecting one of the following functions.

AC

This is for AC coupling, and is suitable for cutting off the DC of the triggering signal and having only the AC conponent triggering. However, triggering is hard to conduct with triggering signals of less than 50 Hz.

HF REJ	This is suitable for observing 2-phenomenon signals by the CHOP, or for the observation of a waveform including high frequency noise.
LF REJ	This is suitable for cutting off a low frequency and triggering only in the high frequency range. Accordingly, triggering in the low frequency range of approx. 30 kHz or less is difficult to conduct.
DC	This is for DC coupling, and triggering is conducted by direct current. This is suitable for triggering in low frequency range among others.
SOURCE	This is for changing over the kind of the triggering signal, and selects the following functions.
NORM	The observed waveform reproduced on the tube surface becomes a triggering signal source.
CH 2 ONLY	The observed waveform applied on Ch 2 alone becomes a triggering signal source.
LINE	The primary supply power source becomes a triggering signal source.
EXT	The external signal applied on the EXT TRIG IN terminal is made a triggering signal.
EXT TRIG IN	This is an input terminal for external triggering.
EXT HOR GAIN	This is a sensitivity regulator for external sweep of the horizontal axis. If the HORIZ DISPLAY switch is set at the position of the EXT HOR, sensitivity of the horizontal amplifier can be regulated continuously.
EXT HORIZ IN	This is an input terminal for external sweep of the horizontal axis.

3.2 REAR PANEL

Arranged on the rear panel are a Z-axis input terminal, a trace rotator, a fuse and a connector for the power source.

These items have no specifically marked indications, therefore reference should be made to the diagram of the rear panel.

Z AXIS	This is a Z-axis input terminal for modulating external luminance. External luminance can be modulated by an input signal of 2.5 V, and the luminance is reduced by an input of positive polarity.
TRACE ROTATOR	This is a semifixed resistor that conforms the horizontal luminant line of time axis sweep with the scale on the tube surface.
FUSE	This is a time-lag fuse of 2A enclosed in a holder.

3.3 CAUTIONS TO BE EXERCISED IN HANDLING

Primary supply voltage

This model can be operated with complete safety as long as the primary supply voltage is in the range rated voltage ±10%; however, if this range is exceeded it may cause irregularity, therefore it is recommended to operate this model in the range rated voltage ±10% devising a suitable system.

Ambient temperature

The suitable ambient functioning temperature for this model is in the range 0° ~ +40° C. And the ambient temperature for it to have the specified performance is in the range +15℃~ +35° C.

Permissible voltage of each input terminal

The following allowable maximum input voltages are specified for each input terminal and the accessory probe. Care should be taken not to apply higher voltage than the specified level, since the model might function irregulatly.

Input terminals of Ch 1 and Ch 2	400Vp-p if VOLTS/CM is 5mV/cm, 600Vp-p for ranges other than 5mV/cm.
Accessory probe	600Vp-p
EXT HORIZ IN terminal	400Vp-p
EXT TRIG IN terminal	400Vp-p
Z AXIS terminal	100Vp-p

Concerning luminance of cathode-ray tube

It is recommended that luminance should not be intensified too much, or left intact with only a luminant spot remaining on the cathode-ray tube for a long time. Since the phosphor of the cathode-ray tube might be damaged by heat.

3.4 FIRST-TIME OPERATION

Before supplying power, set up the knobs on the front panel as indicated below.

INTENSITY	Clockwise to the extreme end
FOCUS	Around the center
ASTIG	Ditto
MODE	Ch 1

HORIZ DISPLAY	AUTO
TRIGGERING SOURCE	NORM
COUPLE	AC
SLOPE	+

Connect the power source cord to AC source, and set the POWER switch at ON. After a bright luminant line is produced on the tube surface in approx. 15 seconds, turn the INTENSITY knob counterclockwise a little and regulate the luminance to a proper level.

Focus correctly.

Turn the VERT POSITION and HORIZ POSITION knobs properly until the luminant line is set at the center of the tube surface, then turn the FOCUS and ASTIG knobs until the most clear-cut focus is obtained.

Feed signals and produce waveforms on the tube surface.

Apply the calibration voltage of this model, and produce the waveform of the calibration voltage on the tube surface.

Connect the CAL OUT and the INPUT terminal of CH 1 to each other by the lead-in wire furnished with a BNC connector accessory and set the knobs as indicated below.

AC DC GND (CH 1)	DC
VOLTS/CM (CH 1)	5 mV
VARIABLE (CH 1)	CAL'D
CALIBRATOR (CH 1)	20 mV
TIME/CM	0. 5 mS

VARIABLE	CAL'D
TRIGGERING LEVEL	Around the center

With the knobs set as indicated above, a square wave of 4 cm vertical amplitude can be observed.

Now turn the VOLTS/CM knob counterclockwise step by step, and the vertical amplitude begins to attenuate. Then turn the VARIABLE knob counterclockwise, and the amplitude attenuates continuously.

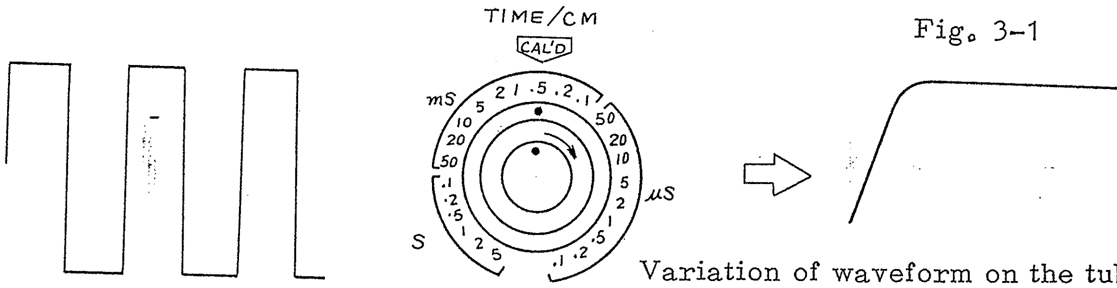
The above-mentioned operation serves an operator to show clearly the relation between the input signals, the VOLTS/CM knob and the VARIABLE knob.

Time base and triggering

Now that the calibration voltage is for a square wave of approximately 1 kHz, repetition of one of the square waves can be observed to the length of approximately 2 cm in the direction of the horizontal level. If the TIME/CM knob is set at 0.5 mS range. The sweep time of the time axis is cut short by turning the TIME/CM knob clockwise step by step; and the sweep time can be made variable continuously by turning the VARIABLE knob. Therefore, a part of the waveform from the total quantity of the square wave of the calibration voltage under observation, can readily be observed.

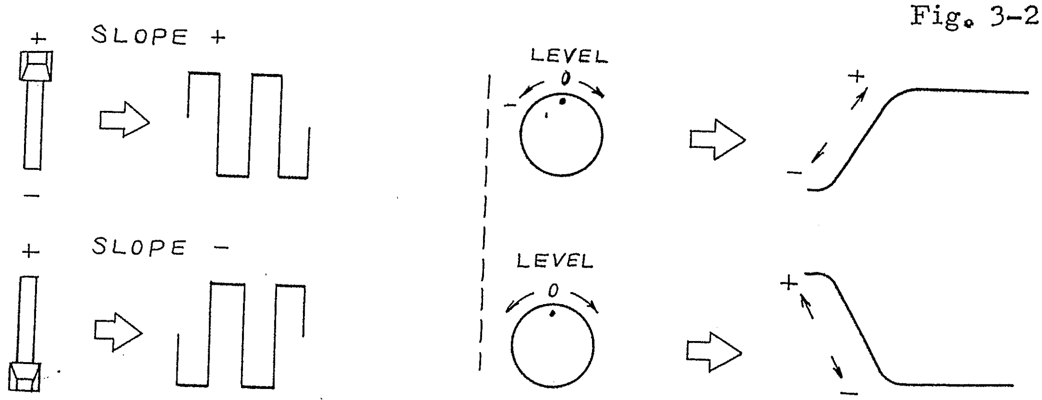
Turn the TIME/CM knob clockwise step by step, and the rise section of the square wave can be observed in its enlarged view as shown in Fig. 3-1. For proper operation, reference should be made to Fig. 3-2 concerning the variation of the triggering point when the SLOPE is set at + or -, and when the LEVEL knob is turned. Sweep can be made to start from any optional point of the rise or the fall of the square wave, by proper turn of the LEVEL knob.

Fig. 3-1



Variation of waveform on the tube surface by turning the TIME/CM knob.

Fig. 3-2



Setting the SLOPE knob at + and -, and the waveform produced on the tube surface

Direction of revolution of the LEVEL knob, and change in triggering point of the waveform on the tube surface

Classification of trigger signal source

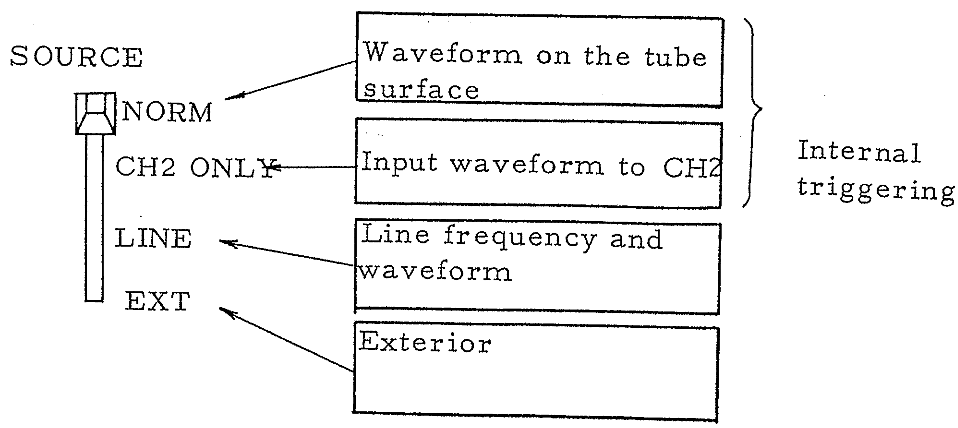
In order to observe the waveform of an input signal in its standstill condition on the tube surface, it is necessary to apply to the trigger circuit of the time axis either the waveform of the input signal or some other signal having a certain relation to the input signal in time, thus putting the trigger circuit in regular operation.

1. Set the TRIGGERING SOURCE switch at either NORM (the signal of the waveform on the tube surface) or CH2-ONLY (the input waveform to CH2), and apply the input signal to the trigger circuit through the interior of the oscilloscope. This method is called internal triggering.

2. Set the TRIGGERING SOURCE switch over to EXT, and apply to the trigger circuit from exterior either a signal equivalent to the input signal or a signal having a certain time relation to the input signal. This method is called external triggering.

3. Set the TRIGGERING SOURCE switch over to LINE, and the waveform of the line frequency of the power source becomes a triggering signal in the oscilloscope set and is applied to the trigger circuit. This method is called line triggering.

Selection of trigger signal source by change-over of the SOURCE switch



Internal triggering (NORM, CH2 ONLY)

In the case of the internal triggering, an input signal is internally connected the trigger circuit from an intermediate portion of the vertical axis amplifier. If the TRIGGERING SOURCE switch is set a NORM, the waveform on the tube surface makes a trigger signal; while if the SOURCE switch is set at the position CH2 ONLY, only an input signal of CH2 makes a trigger signal. Even if these input signals are of low voltage, they are amplified to a proper voltage level and applied to the trigger circuit. Therefore, operation is quite simple.

External triggering (EXT)

In the case of the external triggering, the trigger circuit can be put in operation without being affected by the vertical deflection system. In the case of the internal triggering mentioned above, for instance, switching-over of the VOLTS/CM or a turn of the VERTICAL POSITION knob results in fluctuations in the voltage applied to the trigger circuit. Therefore, it is necessary to manipulate the TRIGGER LEVEL knob in some cases in conformity with the waveform of an input signal on each occasion. In such a case, triggering can be kept secure and correct by selecting this external triggering, no matter how freely the knob of the vertical deflection system is turned, in so far as the waveform of the external triggering signal remains free from fluctuations.

If the external trigger signal is too intense, the trigger point cannot be thoroughly regulated by use of the LEVEL knob. In such a case, pull out the LEVEL knob, and the trigger signal is attenuated to approximately 1/10 (PULL ÷ 10 TRIG SIG), and the regulation range of the trigger point is thus extended.

Line triggering

Now that a trigger signal of the line frequency is connected directly to a trigger circuit from the secondary side of the power source transformer by this line triggering, it proves quite convenient for observation of the waveform of the line frequency free from being affected by the vertical deflection system.

Triggering operation

This model is kept in a triggering condition by simple manipulation of the LEVEL knob as indicated on Pages 14 through 16. Now turn the LEVEL knob slowly on. Triggering is accomplished at about the center, and the waveform on the tube surface stops moving. Then set the VOLTS/CM knob of CH 1 to turn counterclockwise, and set the amplitude of the waveform on the tube surface at 5 mm. If the LEVEL knob is not set at a correct position, it might possibly result in a deviation of triggering, hence to the condition of self-excited sweeping on some occasion. In such a case, a position for stabilized triggering can be located by turning the LEVEL knob once more either clockwise or counterclockwise.

The methods indicated above are applicable to operation in the AUTO state. In the AUTO state, the time axis oscillator automatically start self-excited sweep if no trigger signal is present or if the LEVEL knob is set at a position over the triggering point, until a horizontal luminant line occurs on the tube surface. However, in AUTOmatic operation, an input signal must be triggered as described below, if the input signal is 50 Hz or less, since such an input signal cannot be triggered by AUTOmatic operation.

Turn the HORIZ DISPLAY switch from AUTO to NORM. Conduct triggering as desired by turning the LEVEL knob in the same manner as in the case of AUTO. In this method, triggering can be conducted from DC after setting the TRIGGERING COUPLE switch at DC. If no trigger signal occurs, however, sweep stops and the tube surface is cleared. The same occurs if the LEVEL knob is turned over the triggering point.

Operation for enlarging the input signal for sweep

A part of an input signal can be enlarged for better observation by cutting short the sweep time; however, if a delayed part of an input signal is an object of observation by enlargement from the start of the sweep, reduction of the sweep time may sometimes result in driving an object of observation off the tube surface.

In such a case, pull the PULL 5xMAG knob, and the part of wanted observation is enlarged by 5 times to the right and to the left of the center of the tube surface, as shown in Fig. 3-4 below.

(The red knob of the HORIZ POSITION has the double function of POSITION FINE and PULL 5xMAG.)

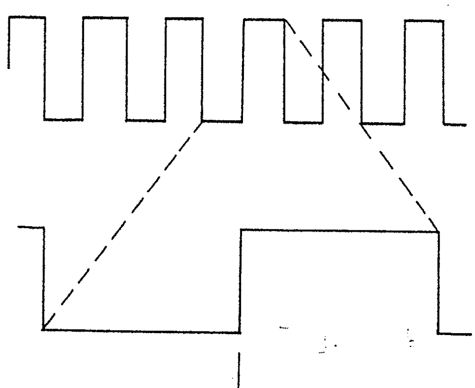


Fig. 3-4

Centerline of tube surface

The sweep time for an enlarged input signal is equivalent to 1/5 the indicated value of TIME/CM. Therefore, the maximum sweep time for an enlarged input signal is $0.1\mu S/cm \times 1/5 = 0.02\mu S/cm$, compared with that for an unenlarged input signal, i. e. $0.1\mu S/cm$.

The maximum sweep time can thus be cut short by enlarging the sweep as set forth above; however, since enlargement of sweep time might possibly result in deterioration of luminance, also the said multiplication by 1/5 might slip off memory in some cases, it is recommended not to enlarge an input signal except in the following cases:

(1) If futher from the starting point of sweep is required to be enlarged for better observation.

(2) If a signal should be swept more quickly than 0. 1μS/cm

Operation for single sweep

In the case of observing a discharge waveform or a transient phenomenon, two or more phenomena are overlapped if a conventional method of repetitive sweep is used. In such a case, a signal can be observed more accurately by following the method of single sweep, that sweeps only once.

Given below is an explanation of basic operation for single sweep, with calibration voltage taken as an input signal.

Apply the calibration voltage to Ch 1.

HORIZ DISPLAY	AUTO
TRIGGERING SOURCE	NORM
COUPLE	AC
SLOPE	+
VOLTS/CM	Position for ready observation
TIME/CM	Ditto

After setting the knobs as indicated above, adjust the TRIGGERING LEVEL knob to have it conduct regular triggering sweep.

Then disconnect the calibration voltage from the input Ch 1, in the same conditions.

Set the HORIZ DISPLAY switch at SINGLE.

Push the RESET button. By pushing this button, the READY lamp located next to the button is switched on, thus indicating that the model is in standby condition for single sweep. Should the READY lamp not be switched on, push the button again.

(If the trigger circuit has a trigger input, single sweep starts immediately as soon as the RESET button is pushed. Therefore, this model cannot be put in standby condition, no matter how often the RESET button is pushed. Hence it is imperative to keep the input to the vertical axis and the input to the EXT TRIG IN terminal disconnected.)

If calibration voltage is applied to Ch 1 after the model has been put in standby condition, sweep is conducted only once. For conducting sweep again in the same conditions, disconnect the input of the calibration voltage from Ch 1, and push the RESET button again, thus putting the model in the standby condition.

The explanation of operation for single sweep is for internal triggering, and it is applicable in the case of external triggering also.

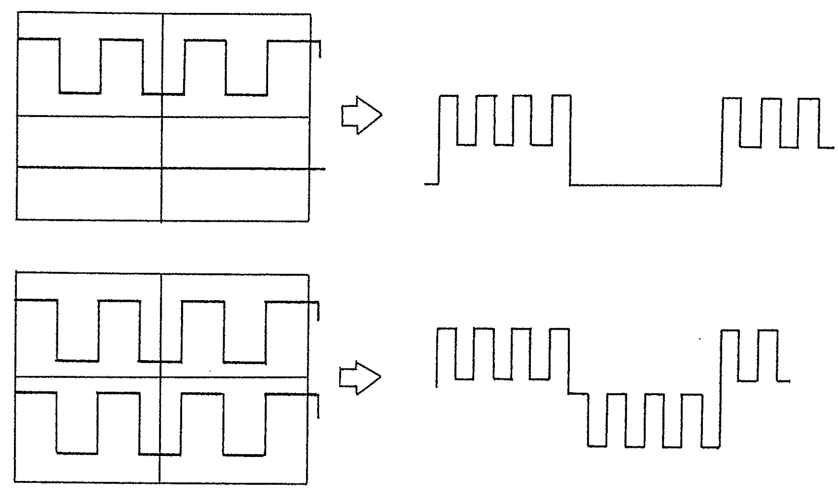
(Note) Single sweep cannot be carried out with two phenomena (ALTER or CHOP). It is recommended to carry out single sweep with single phenomenon operation of either Ch 1 or Ch 2.

-- 2-phenomena operation, and operation for sum or balance --

2-phenomena operation

First, set the MODE switch at ALT. By the operation described in the preceding paragraph, the calibration voltage can be observed on Ch 1, and a horizontal luminant line on Ch 2, respectively. Now that since triggering in this case has been conducted under NORM, the waveform on the tube surface has constituted a trigger signal source. The trigger signal is not a continuous square wave of 1 kHz, and it becomes zero for each sweep time. Accordingly, triggering is in an unstable condition. Now, apply calibration voltage to Ch 1 and Ch 2 simultaneously. Two square waves of the calibration voltage will appear on the tube surface. Then handle the POSITION knob so that the side of Ch 1 appears in the upper half of the tube surface and the side of Ch 2 appears in the lower half of the tube surface, for instance. In this case, too, the trigger signal has the same form as the waveform on the tube surface, since triggering is in the NORM condition. Therefore, the trigger signal has a waveform such as that shown in Fig. 3-5, and triggering becomes unstable.

In these circumstances, a stabilized triggering condition can be restored, irrespective of the condition of the tube surface, by taking the trigger signal source from Ch 2. This switchover can be obtained by setting the TRIGGERING SOURCE switch at CH 2 ONLY.



Waveform on the tube surface

Waveform of trigger signal in the case of TRIGGERING SOURCE NORM

Fig. 3-5

Next, turn the TIME/CM knob counterclockwise step by step. At the position of ALT, Ch 1 and Ch 2 are swept alternately, hence it is impossible to observe both of them at the same time. For the observation of input signals of low frequencies on the two-phenomena operation select the CHOP, set forth below for the purpose. Set the MODE switch at CHOP. In this case, the trace can be observed in the shape of a dotted line by cutting short the sweep time, in the reverse manner of ALT. If triggering is not stabilized, set the COUPLE switch over at HF REJ.

The two-phenomena observation can be conducted over the whole range of the TIME/CM by correctly selecting either ALT or CHOP.

Observation of sum or balance

Set the MODE switch at ADD. Now the sum or the balance of the input signals of Ch 1 and Ch 2 can be observed.

Then push the button switch located at the center of the MODE switch. The height of the button changes every time the button is pushed, and the polarity of Ch 1 is kept inversed as long as yellow mark is seen. This condition is called CH 1 INV.

When the button is pushed, Ch 1 + Ch 2 results, and the sum can be observed. Meanwhile, at the time of CH 1 INV, (-Ch 1) + CH 2 results, and the balance can be observed.

-- Operation as an XY-scope --

Set the knobs as indicated below.

HORIZ DISPLAY	EXT HOR 1 or 1/10
MODE	CH 1

By the above-mentioned setting, the model is now ready for the operation as an XY-scope. Next, apply calibration voltage to Ch 1 and the EXT HORIZ IN terminal, then adjust the VOLTS/CM of Ch 1 and the HOR GAIN knob in such a manner that proper amplitude can be maintained. A couple of spots will appear on the diagonal lines on the tube surface. This is a Lissajous figure of 1:1 in frequency ratio and 0° in phase difference.

4. MAINTENANCE

4.1 Connection of input signals

The input impedance of this model as seen from the signal input terminal is 1 MΩ in resistance and 38pF in parallel capacitance; and if a probe accessory is employed, the resistance will be 10 MΩ and the parallel capacitance will be 13pF or less.

The methods of connecting this model to the signal source for observation are various, and include the use of a conventional sheathed wire, a shielded wire, a probe, a coaxial cable etc. The appropriate method should be followed to meet best the conditions indicated below.

Degree of output impedance of input signal source

Intensity and frequency of input signal

Induction from exterior

Distance between input signal source and oscilloscope

The methods of connection classified according to the kinds of input signal are as shown in Table 4-1 below.

Table 4-1

Classification of input signals \ Methods of connection			Sheathed wire	Shielded wire	Probe	Co-axial cable	Miscellaneous
Low frequency	Low impedance	Near	O	O	O	O	
		Far		O		O	
	High impedance	Near		O	O		
		Far		O			
High frequency	Low impedance	Near			O	O	
		Far				O	
	High impedance	Near			O	O	
		Far					

Method of employing sheathed wire

Connect the accessory BNC terminal adapter to the input terminal of the vertical axis, using a sheathed wire. This method features simplicity and has the advantage that the input signal does not attenuate. However, if the sheathed wire is comparatively long and the output impedance of the input signal source is high, it is subjected to an exterior induction adversely affecting observation. Also the stray capacitance between this sheathed wire and the grounding wire is large, and its effect on the object circuit for measurement is higher than when an accessory prove of 10:1 attenuation factor is employed.

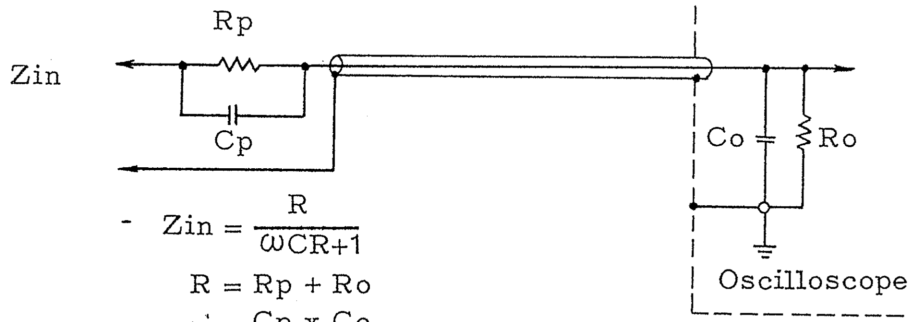
Method of employing shielded wire

Employment of a shielded wire serves to prevent external induction from occurring. However, now that the capacitance of the shielded wire is as high as 50pF/m - 100pF/m, this method is not suitable if the output impedance of the input signal source is high. Therefore this method is not suitable for a high frequency, either.

Method of emplying a probe

An accessory probe of 10:1 in attenuation factor is employed for this model. A lead-in wire itself has been shielded as shown in Fig. 5, and an attenuator for a wide band has been constituted by a resistor Rp for attenuation and a parallel capacitor Cp; therefore, this method is suitable for use if the output impedance is high or in the case of a high frequency.

Input impedance if a probe is employed



$$Zin = \frac{R}{\omega CR+1}$$

$$R = Rp + Ro$$

$$C = \frac{Cp \times Co}{Cp + Co}$$

$$Cp = \frac{Co \times Ro}{Rp}$$

(Co includes the capacitance of the cable)

Fig. 4-1

Method of employing a co-axial cable

If the output impedance of the input signal source is 50Ω or 75Ω, use a co-axial cable of the same impedance, and signals up to a high frequency can be transmitted without attenuation, by proper matching. In the case of matching, it is advisable to carry it out on the side of the input of the oscilloscope as shown in Fig. 4-2.

Circuit to be measured

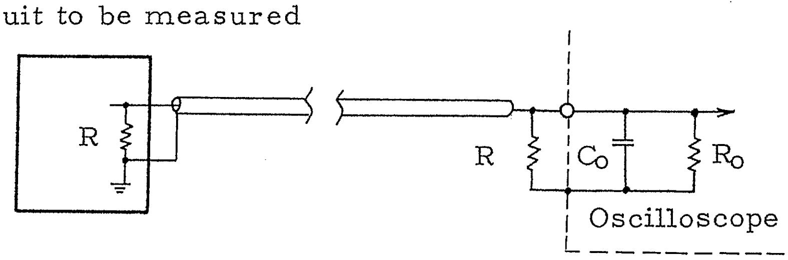


Fig. 4-2

4.2 Measurement of voltage

Measurement of DC voltage

Set the HORIZ DISPLAY switch to AUTO, set the TIME/CM at approximately 1mS/cm, and produce a sweep line on the tube surface.

Then set the AC-DC-GND of the vertical axis input at GND. Now that the vertical position of the sweep line is set at the 0 V position of the vertical input, as shown in Fig. 4-3, select a setting position on the tube surface for ready measurement. Then set the AC-DC-GND switch at DC, apply the voltage at the point to be measured on the input of the vertical axis, and read out the move of the sweep line at that time using the scale on the tube surface.

If the sweep line moves off the tube surface when the point to be measured is touched upon, turn the VOLTS/CM switch counterclockwise, until the sweep line moves to a position ready for measurement. If the direction of the move is upward from the position before measurement, polarity of the voltage is +; whereas, if the direction of the move is downward from the position before measurement, polarity of the voltage is -.

The voltage can be measured by the employment of either of the following equations, (4-1) and (4-2) below, after taking the vertical amplitude in cm using the scale on the tube surface as a standard.

If a probe of 10:1 in attenuation factor is employed

Voltage = Indicated value of VOLTS/CM
x amplitude (cm) x 10 .... (4-1)

If the voltage is applied to the input terminal directly

Voltage = Indicated value of VOLTS/CM
x amplitude .... (4-2)

Measurement of AC voltage

If AC voltage is lapped on DC voltage as shown in Fig. 4-3, and if the AC-DC-GND switch is set at DC, the DC voltage pushes the sweep line off the tube surface, since the DC voltage is higher than the AC voltage, thus making it impossible for the section of the AC voltage to be observed properly.

In such a case, the section of the AC voltage may be moved to the outside the tube surface by operation of the VERTICAL POSITION knob, but it is advisable to avoid this kind of operation, since it often results in an error of measurement.

The section of the AC voltage can also be moved to the outside of the tube surface by switching over the VOLTS/CM, but it is also advisable to avoid this operation, since the amplitude is reduced, thus making it difficult to conduct accurate measurement.

In such a case, set the AC-DC-GND switch at AC. Thereby a capacitor is connected in series with the vertical input, thus cutting off the DC voltage. Then only the AC voltage can be suitably enlarged for ready measurement. By taking measurement of the amplitude in cm at this time, the AC voltage can be calculated through the application of the (4-1) and (4-2) equations.

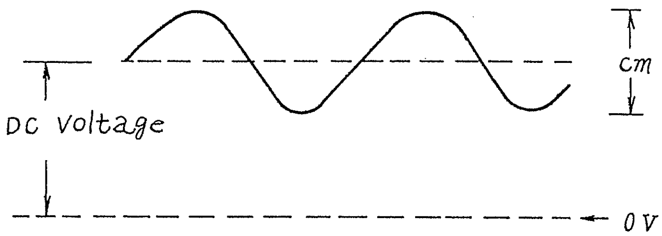


Fig. 4-3

(Observed at AC, attenuation by -3dB results for approx. 3 Hz in the case of a low frequency signal.)

The AC voltage calculated by equations (4-1) and (4-2) constitutes the peak value thereof (Vp-p). The effective value (Vrms) of a sinusoidal wave can be obtained by the application of the equation of (4-3) below.

$$\text{Voltage (Vrms)} = \frac{\text{Voltage (Vp-p)}}{2\sqrt{2}} \quad \ldots\ldots\ldots (4\text{-}3)$$

4.3 Measurement of time

Measurement of time interval

Measurement of the time interval between any two points optionally selected on a waveform can be read out directly from the indicated value of the TIME/CM, by setting the VARIABLE of the TIME/CM at CAL'D.

First, set the HORIZ DISPLAY at AUTO, and control triggering level.

Then turn the TIME/CM switch so that a space between two points of the waveform can be measured easily, as shown in Fig. 4-4.

Time (T) = TIME/CM (sec) x length of tube surface (cm) x reciprocal number of multiplication factor of magnifier ..... (4-4)

The reciprocal number of the multiplication factor of a magnifier in the equation (4-4) above is 1 in the case of no magnification, and 0.2 in the case of magnification.

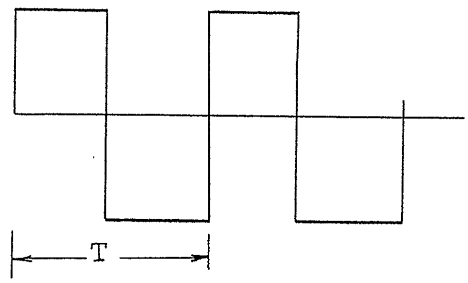


Fig. 4-4

Measurement of time balance

The time balance between two signals having the same frequency can be measured by two phenomena of either ALT or CHOP.

Now, set the TRIGGERING SOURCE switch at CH 2 ONLY, then apply a quick signal to Ch 2 and a slow signal to Ch. 1. When a waveform as shown in Fig. 4-5 appears on the tube surface, read out T and calculate the time balance by the application of equation (4-4).

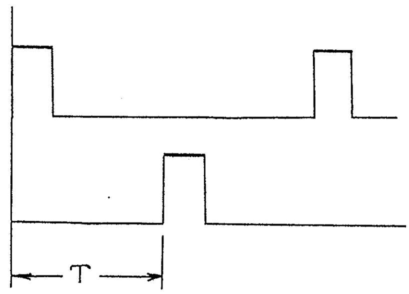


Fig. 4-5

Measurement of pulse width

Move the pulse vertically by 2 cm or 4 cm from the horizontal center-line of the scale on the tube surface selected as the center. Next, set the VARIABLE of the TIME/CM at CAL'D, and turn the TIME/CM switch until the pulse width is reduced to such a level that it can be readily measured in the horizontal direction. Read out the width T of the center of the rise and the fall of the pulse as shown in Fig. 4-6, and calculate the pulse width by application of equation (4-4). If the pulse width is narrow, magnify it.

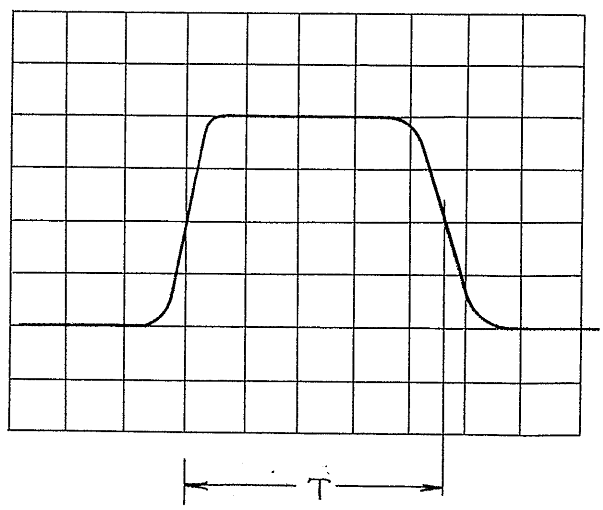


Fig. 4-6

Measurement of rise time and fall time of pulse

Operate this model in the same manner as in the case of measuring the pulse width. In other words, read out T as shown in Fig. 4-7, and calculate the pulse width by application of the equation of (4-4).

In this case, the pulse width can be read out directly, since the rise or fall time of the pulse is slow enough, compared with the rise time of this model itself, which is 17.5nS; however, if the rise or fall time of the pulse is quicker, the value obtained by reading-out must be corrected by application of the equation of (4-5) below.

To: Rise time of this model (17.5nS)

T : Value obtained by actual measurement

Tu: Real value

$$Tu = \sqrt{T^2 - To^2} \quad \cdots\cdots (4\text{-}5)$$

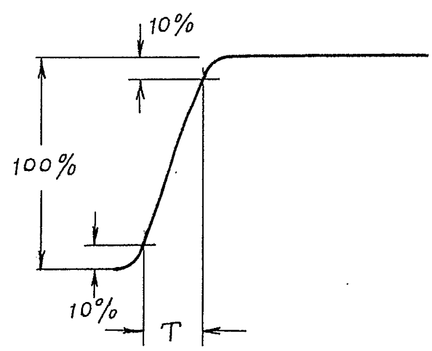


Fig. 4-7

Measurement of frequency

For the measurement of a frequency, there are the following three methods. The first method involves calculating the time for 1 cycle by the application of the equation of (4-4) above, and then calculating the frequency by the application of equation (4-6) below.

$$\text{Frequency (f) (Hz)} = \frac{1}{\text{Cycle T (Sec)}} \quad \ldots\ldots\ldots\ldots \quad (4\text{-}6)$$

The second method involves calculating the time for certain cycles in the 10-20 range, determining the number N of the cycles included in 10 cm of the horizontal scale, and calculating the frequency by application of equation (4-7) below.

$$\text{Frequency (f) (Hz)} = \frac{N}{\text{Indicated value (Sec) of TIME/CM} \times 10} \quad \ldots \quad (4\text{-}7)$$

Compared with the preceding method (4-6), this method reduces measurement error when the value of N is large.

The two methods indicated above measure frequency by the time measurement method; however, if a frequency is 10 kHz or less, and the waveform is as simple as a sinusoidal wave, this model can be utilized as an XY-scope, and can be operated so as to draw a Lissajous figure for the measurement of a frequency. For utilizing this model as an XY-scope, set the HORIZ DISPLAY switch at EXT HOR. Then apply an unknown signal to Ch 1, and a known signal to the EXT HORIZ IN terminal, then adjust the VOLTS/CM and the HOR GAIN that the vertical and horizontal amplitudes are both 4 cm.

Now vary the frequency of the known signal, and Lissajous figures of 1:1 will be drawn up as shown in Fig. 4-8 below.

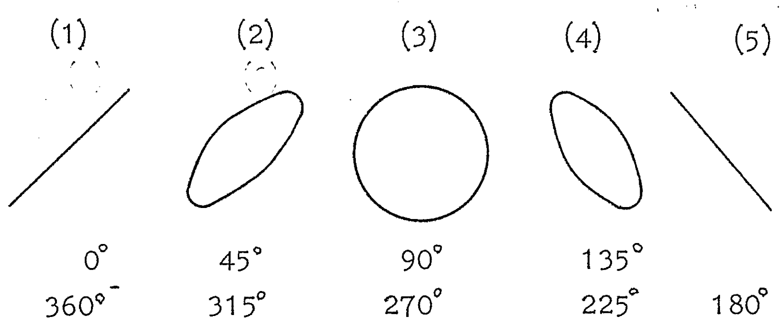


Fig. 4-8

The Lissajous figure is one of a circle, an ellipse or a straight line, and as the proportion approaches 1:1, the figure continuously repeats the trace in the sequency of (1)⟶ (5)⟶(1). And as the proportion approaches 1:1 the variation slows down, and the figure remains still in either shape when the proportion reaches 1:1.
The known frequency at this time is equivalent to the frequency required.
Any unknown frequency can be located from this figure, no matter what the frequency ratio is; however, the simplest and surest method is to employ an oscillator capable of varying the frequency continuously and in a wide range, thus allowing one to obtain a figure of 1:1 in frequency ratio.
Measurement of phase difference
Measurement by means of a Lissajous figure (between two signals of equivalent frequency).

Make the model operate as an XY-cope as described in the explanation of measurement of frequency above, and have it drown up a Lissajous figure. The phase angle will be obtained by application of the following equation. See Fig. 9.

$$\text{Phase angle } \sin\theta = \frac{A}{B} \quad \ldots\ldots\ldots\ldots \quad (4\text{-}8)$$

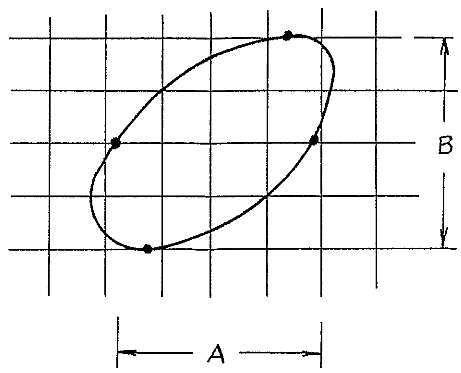


Fig. 4-9

Measurement by two-phenomena operation (the case of two signals of equivalent frequency).

Conduct triggering at CH 2 ONLY, in the same manner as when measuring time balance. Fig. 4-10 illustrates measurement of phases of two sine waves.

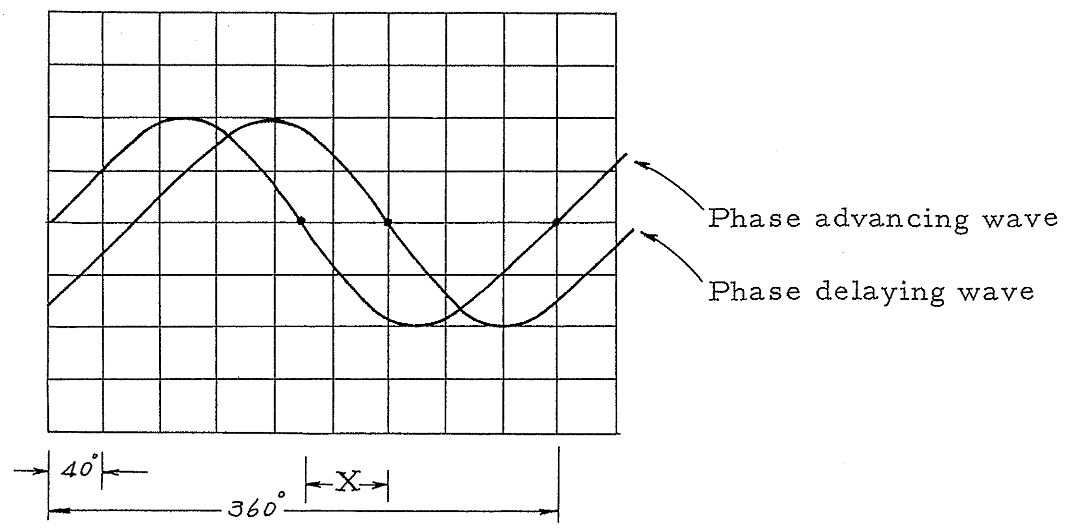


Fig. 4-10

First adjust the TIME/CM and the VARIABLE, and set 1 cycle at 9 cm of the horizontal scale. Handle the TRIGGERING LEVEL concurrently, and set the triggering point precisely at the center-line of the horizontal scale. Fig. 14 shows a correctly set state. Now the 1 cycle is 360°, 1 cm in the horizontal direction represents 40°. Since X in Fig. 14 is 1.5 cm,

Phase difference (degree) = X (space in the horizontal direction between phase advancing wave and phase delaying wave) x 40° ..... (4-9)

Measurement by two-phenomena operation (the case of two signals of different frequency).

If two signals are different in frequency (but the two frequencies are in a relation of integral ratio), it is necessary to conduct triggering with a signal of lower frequency. Therefore, if is advisable to apply a signal of lower frequency to Ch 2, and the model is put in operation only at CH 2 ONLY as far as triggering is concerned. Should triggering be conducted in a reverse manner, the other signal of a lower frequency cannot be triggered.

5. CALIBRATION

5.1 Outline

It is advisable to carry out calibration of this model at regular intervals. Whether over-all calibration is needed or a partial calibration is enough can easily be judged by conducting daily inspection of its vertical deflection sensitivity, its accuracy of sweep time, and various other functions.

Even after repair of an irregular section, calibration is needed in some cases depending upon the nature of the repair.

Partial calibration may sometimes affect other sections. For instance, low voltage power sources, often affect virtually all the circuits, and a high voltage power source often affects vertical and horizontal deflection sensitivity.

Low voltage power source

In carrying out calibration of the model, be sure to check the low voltage power source first of all. In this check, it is recommended to employ a digital voltmeter and conduct precise measurement.

The low voltage power sources consist of some stablized power sources and an unstabilized power source, as shown in Table 5-1 below.

Table 5-1

Low voltage power source	Classification	Specification	Remark
-45 V	Stabilized	-44.9 ~ -45.1 V	Semifixed
+15 V	Ditto	14.9 ~ 15.1 V	Ditto
+22 V	Unstabilized		
+45 V	Stabilized	44.9 ~ 45.1 V	Semifixed
+100 V	Stabilized	95 ~ 105 V	Fixed
+200 V	Ditto	197 ~ 203 V	Semifixed
+300 V	Ditto	290 ~ 310 V	Fixed

The voltage check points are as shown in Fig. 5-1. Measure the voltage between each check point and the ground, and if the value thus obtained does not meet the specified one in Table 5-1 above, carry out necessary calibration in the following order.

First +45 V, Second -45 V, Third +15 V, Fourth +200 V

The positions of the semifixed variable resistors for regulation will be also shown in Fig. 5-1.

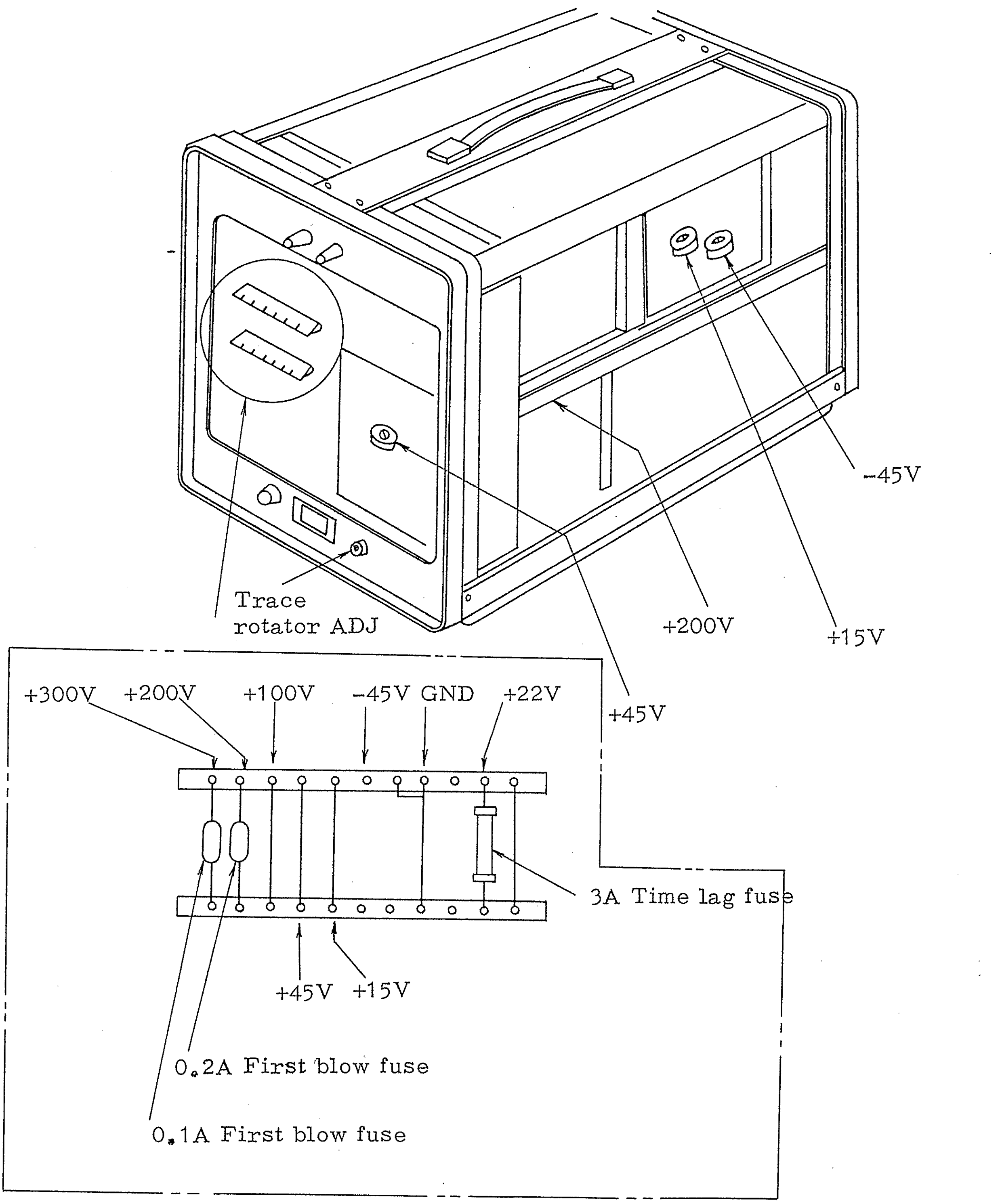


Fig. 5-1

For the measurement of voltage, select a primary voltage of rated voltage ± 5% or less.

High voltage power source

A fluctuation in the high voltage power source results in fluctuation in the vertical and, horizontal deflection sensitivity of the cathode-ray tube. The voltage of the high voltage power source will be as shown in Table 5-2, and the check points and the sections to be adjusted will be as shown in Fig. 5-2.

Table 5-2

Classification	Specifications	
CRT cathode voltage	-1, 500 V	
CRT anode voltage	Approx. +3. 6 V	

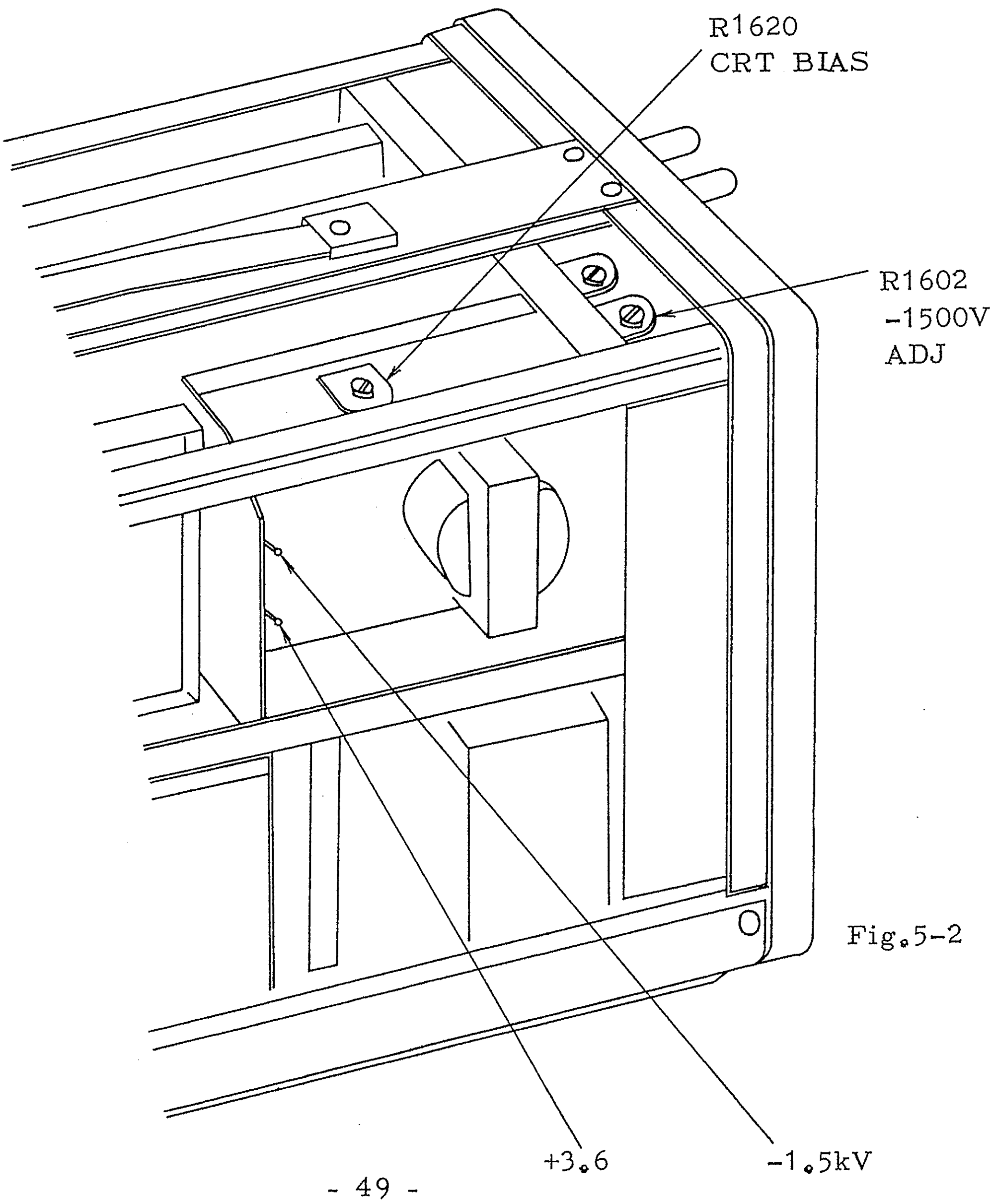


Fig.5-2

The specified voltages have been set by means of an electrostatic voltmeter of high precision. It is inadvisable to employ other voltmeters for the measurement specified herein, since this model would be adversely affected by the internal resistance of such a voltmeter.

Measurement of anode voltage among others will result in gross error.

Luminance

Luminance is regulated by the R1620 CRT BIAS semifixed resistor shown in Fig. 5-2. Set the HORIZ DISPLAY switch at EXT HOR before regulating luminance. Adjust the CRT BIAS so that a luminant point on the CRT surface disappears when the INTENSITY knob is turned virtually to the center.

Trace rotator

Matching of the horizontal sweep line and the horizontal scale of the CRT is sometimes made to fluctuate by the influence of terrestrial magnetism. In such a case, adjust the trace rotator ADJ knob located on the rear panel of the cabinet until proper matching is obtained.

Vertical axis deflection sensitivity

Set the output of the 1 kHz square wave oscillator, whose output voltage fluctuates by 0.5% or less, at 20 mVp-p, and apply its output voltage to the vertical input terminal. Adjust the semifixed resistor CAL located on the front panel, so that the amplitude on the tube surface is precisely 4 cm when the VOLTS/CM is 5 mV. Conduct calibration of the vertical deflection sensitivity for each of Ch 1 and Ch 2, since each channel has its CAL arranged for that. Then apply voltage twice as high the indicated values on each range of the VOLTS/CM, and check the amplitude on the tube surface. The specified allowance of the indicated value for each range is ±3%; however, in the case of an excess over the allowable range, it is possible that the resistance value of the resistor for attenuation for the range has been made to fluctuate.

Phase of VOLTS/CM switch

If there is deviation of the phase of the VOLTS/CM switch, a waveform on the CRT surface for observation is distorted, and the frequency characteristics of the model become abnormal also.

Regulation of a phase is carried out by adjusting the corrective capacitors for input capacitance and high frequency. In other words, a capacitance meter capable of measuring the input capacitance of 38pF and a 1 kHz square wave oscillator of high performance are employed in this method.

A capacitance meter of the bridge type is not suitable for measuring input capacitance in this case. A type that can measure feeble voltage is necessary. Recommended for the measurement is an LC meter, Model 231A, of our company's make.

For the 1 kHz square wave oscillator, the square wave oscillator for calibration previously described is recommended. If some other type of oscillator is employed for this purpose, care should be taken to select a model that generates waveforms free from sagging or overshoot and is 0.1μS or less in rise time. The square wave characteristics of ranges that cannot be regulated pursuant to Table 5-3 below, should be checked with the sideboard kept fixed.

Table 5-3 (Ch 1 only)

Range of VOLTS/CM	Variable capacitor for calibration	
	Input capacitance	HF correction
5 mV	C419	
10 mV	C414	C415
20 mV	C417	C418
50 mV	C402	C403
0.1 V		
0.2 V		
0.5 V	C406	C407
1 V		
2 V		
5 V	C410	C411
10 V		

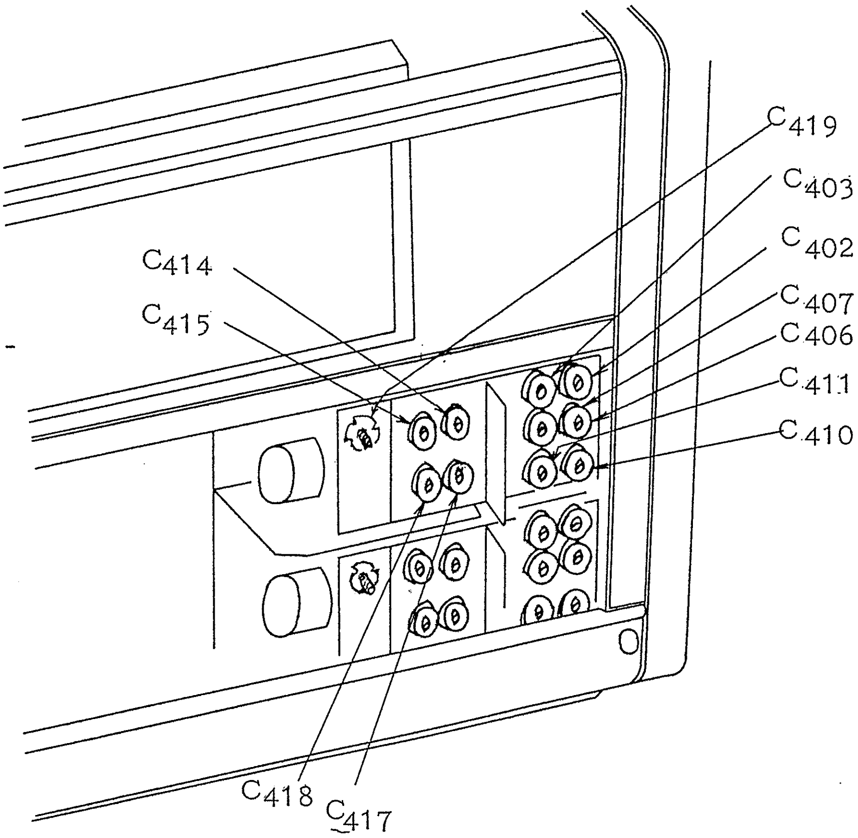


Fig. 5-3

Sweep time

Conduct calibration in the order given below.

Set the knobs in the following manner.

HORIZ DISPLAY	AUTO
TIME/CM	1mS

Then apply to the vertical input the signals with precisely 1mS time intervals. An oscillator capable of checking the whole range (5 sec ~ 0. 1μS) of the TIME/CM and that can change time intervals over an extensive range is necessary.

The specified allowance of the sweep time is ±3% of the indicated value. However, since 1mS must be calibrated as precisely as possible, it is recommended that this time be calibrated by means of the SWP CAL semifixed resistor shown in Fig. 5-4, so that the said allowance is ±1% or less. Then adjust the 5 x MAG ADJ semifixed resistor so that the sweep can be magnified correctly 5 times, and calibrate error to ±1% or less.

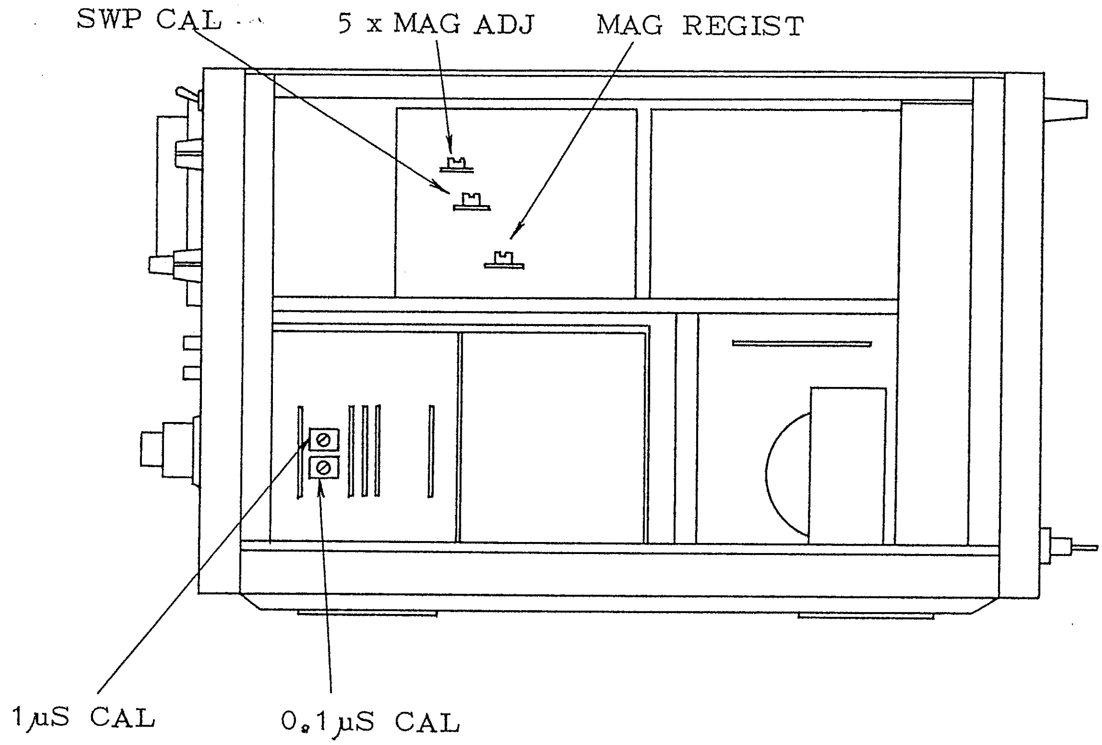


Fig. 5-4

MAG REGIST

Adjust the MAG REGIST so that magnification of sweep can be conducted at the center of the CRT surface.

NORM TRIG 0V ADJ and CH 2 TRIG 0V ADJ

Now that all the stages, from the trigger pick-off to the trigger circuit, are DC connected, each DC output of the pick-off amplifier should be set at 0V when the sweep line is set at the center of the CRT surface. If this is subjected to fluctuation, the range of adjustment of the LEVEL knob is altered when triggering is conducted with DC connection.

Conduct the adjustment in the following order.

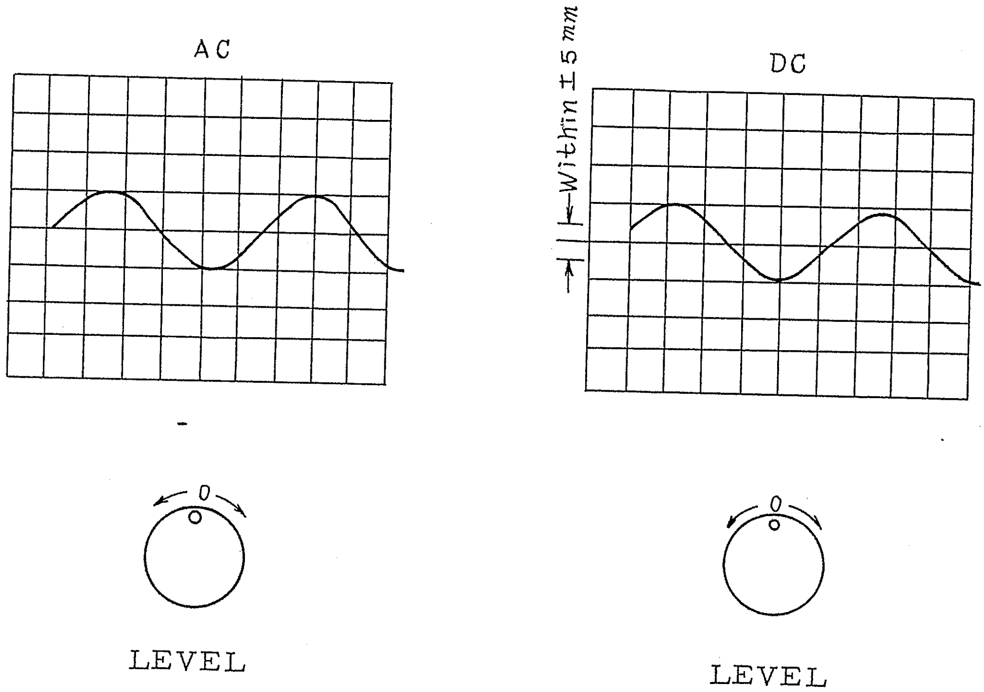
TRIGGERING SOURCE set at	NORM
TRIGGERING COUPLE set at	AC

Produce a sine wave of 1 kHz of 1 cm in amplitude on the CRT surface. Match the waveform in the center on the CRT surface.

Adjust the LEVEL knob to set the trigger point in the center of the CRT surface.

Switch over the TRIGGERING COUPLE to DC.

After operating as described above, check fluctuation of the triggering point when the COUPLE is switched over to DC. If the fluctuation is more than ± 5mm as shown in Fig. 5-4, adjust the 0V ADJ in Fig. 5-5. Concerning the CH 2, also, switch over the TRIGGERING SOURCE to CH 2 ONLY, and check in the same manner as described in the case of NORM.



The LEVEL knob matches the trigger point at the center of the scale.

Keep the LEVEL knob as it is

Fig. 5-5

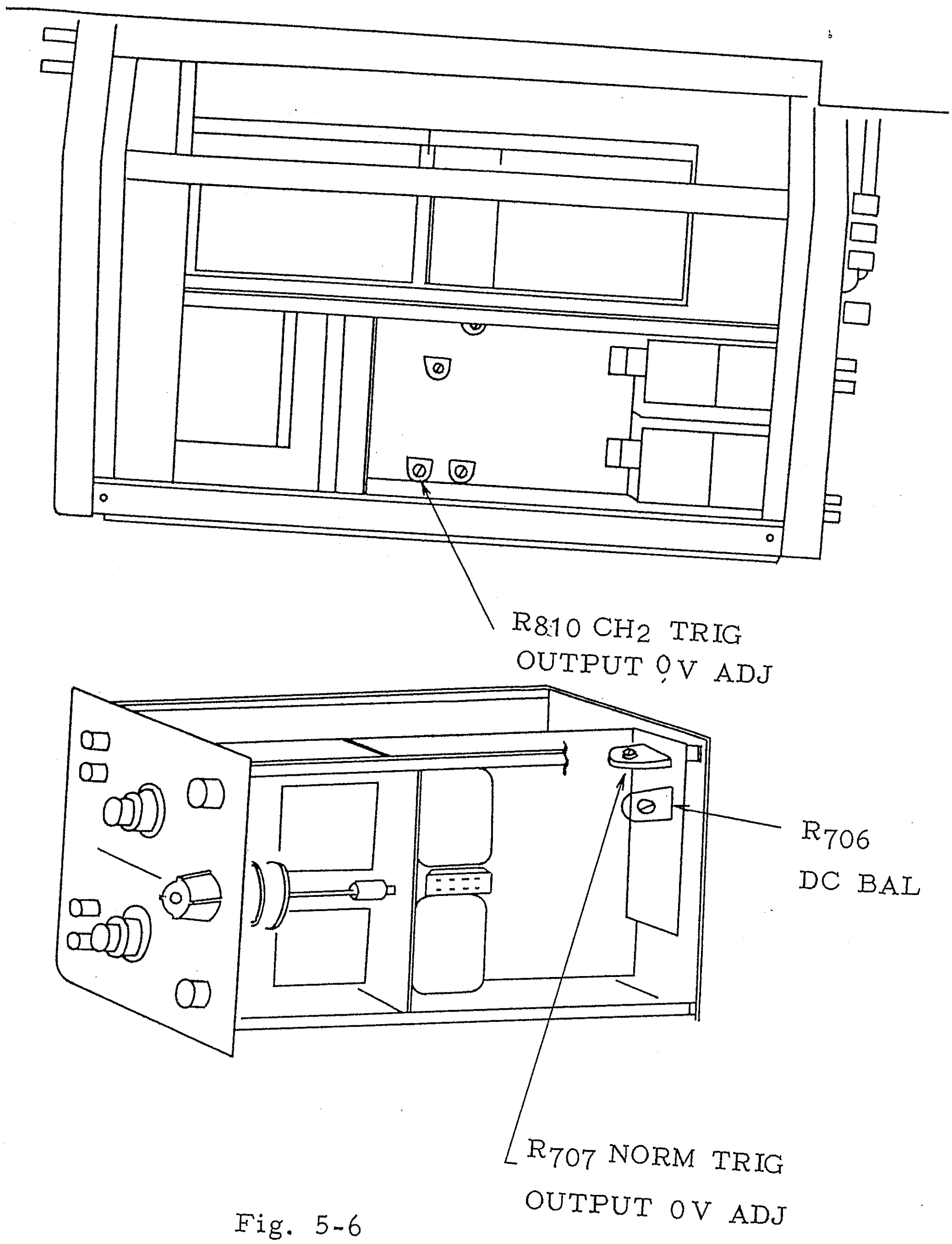


Fig. 5-6

For adjusting the NORM TRIG 0V ADJ knob, draw out the vertical axis unit, connect the model and the unit by a thin coaxial cable, [illegible] to the adjustment.