PRECISION
TEST EQUIPMENT
Standard of Accuracy

OPERATING INSTRUCTIONS for

—PRECISION—

SERIES ES-500A

CATHODE RAY OSCILLOGRAPH

PRECISION APPARATUS COMPANY, INC.
92-27 HORACE HARDING BLVD. • ELMHURST, L. I., N. Y.
EXPORT DIVISION: 458 BROADWAY, NEW YORK CITY U.S.A. • CABLES - MORHANEX
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PREPARED BY

THE ENGINEERING DEPARTMENT

PRECISION APPARATUS COMPANY, INC.
ELMHURST, N.Y. U.S.A.

SERIES ES-500A

1. GENERAL SPECIFICATIONS

THE PRECISION SERIES ES-500A CATHODE-RAY OSCILLOGRAPH IS AN EXTENDED RANGE, EXTRA-HIGH SENSITIVITY INSTRUMENT, INTENDED FOR USE IN DESIGN, RESEARCH, AND SERVICE LABORATORIES FOR BOTH EXPERIMENTAL AND COMMERCIAL VISUAL CIRCUIT ANALYSIS.

THE CAREFULLY DESIGNED FUNCTIONS OF THE SERIES ES-500A, COUPLED WITH UNUSUALLY HIGH SENSITIVITY PUSH-PULL VERTICAL AND HORIZONTAL AMPLIFIER CIRCUITS AND LARGE CATHODE-RAY TUBE SCREEN AREA, PARTICULARLY ADAPT THE ES-500A TO RAPID AND EFFICIENT TELEVISION AND FREQUENCY-MODULATION ALIGNMENT PROCEDURES, AND PROVIDE VIRTUALLY DISTORTIONLESS DISPLAY OF NON-SINUSOIDAL WAVEFORMS ENCOUNTERED WHEN TROUBLE-SHOOTING TV SYNC AND SWEEP CIRCUITS.

PRECISION SERIES ES-500A PROVIDES THE LABORATORY ENGINEER AND THE MODERN SERVICE TECHNICIAN WITH AN INVALUABLE VISUAL-ANALYSIS TOOL COMBINING STREAMLINED MANIPULATION WITH AN UNUSUAL NUMBER OF VERSATILE, ADVANCED PERFORMANCE FEATURES, OUTLINED BELOW:

1. PUSH-PULL VERTICAL AMPLIFIER:- SINUSOIDAL FREQUENCY RANGE - 10 CYCLES TO 1 MEGACYCLE. RESPONSE IS FLAT UP TO 400KC WITHIN 1 DB; TO 600KC WITHIN 2 DB, AND TO 1000 KC BETTER THAN 6 DB. USEABLE SQUARE-WAVE RANGE IS 10 CYCLES TO 50 KILOCYCLES. INPUT IMPEDANCE IS 2 MEGOHMS, IN PARALLEL WITH APPROXIMATELY 22 MMFD.

2. VERTICAL SENSITIVITY:- BETTER THAN .020 (20 MILLIVOLTS) PER INCH. 20 MILLIVOLTS RMS WILL PRODUCE A DEFLECTION OF ONE INCH OR MORE ON THE CATHODE-RAY TUBE SCREEN WHEN THE VERTICAL-GAIN CONTROL IS SET AT MAXIMUM AND THE VERTICAL-SENSITIVITY SWITCH IS IN THE "X100" POSITION. THIS UNUSUALLY HIGH VERTICAL SENSITIVITY PERMITS DIRECT ALIGNMENT AND/OR ADJUSTMENT OF LOW-GAIN CIRCUITS AND PROVIDES FOR EXAMINATION OF MINUTE SIGNAL LEVELS.

3. VERTICAL-INPUT STEP ATTENUATOR:- CALIBRATED VERTICAL-SENSITIVITY ATTENUATOR SYSTEM, OF THE COMPENSATED RESISTANCE-CAPACITANCE WIDE-BAND TYPE. VIRTUALLY NO FREQUENCY OR PHASE DISTORTION. IN 3 STEPS (X1, X10, X100).

4. BUILT-IN PEAK-TO-PEAK VOLTAGE CALIBRATOR. A 1 VOLT PEAK-TO-PEAK REGULATED SEMI-SQUARE WAVE VOLTAGE SOURCE PERMITS THE USE OF THE SCOPE AS A DIRECT-READING PEAK AND P-P HIGH IMPEDANCE VOLTMETER.

5. CATHODE-FOLLOWER VERTICAL-INPUT CIRCUIT:- PERMITS USE OF LOW-IMPEDANCE VERNIER VERTICAL-GAIN CONTROL, ASSURING STATED VERTICAL-AMPLIFIER RESPONSE, REGARDLESS OF GAIN SETTINGS.

6. VERTICAL PHASE-REVERSING SWITCH:- PERMITS INVERSION OF PATTERNS. (PARTICULARLY USEFUL IN INTERPRETATION OF TV VIDEO-IF AND SIMILAR PATTERNS, WHEREIN MANUFACTURERS' SERVICE DATA ILLUSTRATE OSCILLOSCOPE FIGURES IN A PARTICULAR DIRECTION.) THE REVERSING CIRCUIT HELPS TO ELIMINATE CONFUSION BY DUPLICATING PUBLISHED POSITIONING OF RESPONSE CURVES. SEE FIG. 5 PAGE 6.

7. INTERNAL LINEAR SAWTOOTH HORIZONTAL SWEEP:- FROM 10 CYCLES PER SECOND TO 30 KILOCYCLES. A COMPENSATED MULTIVIBRATOR CIRCUIT AFFORDS UNUSUALLY LINEAR SAWTOOTH-SHAPED SWEEP-ACTUATING POTENTIALS. LINEAR WITHIN 10% ON ALL RANGES, EXCEPT HIGH-FREQUENCY END OF 5K TO 30K RANGE AT WHICH LINEARITY IS WITHIN 20% AT 2" DEFLECTION.

8. PUSH-PULL HORIZONTAL AMPLIFIER:- RESPONSE ALLOWS EFFECTIVE USE OF EXTERNAL HORIZONTAL SWEEP VOLTAGES FOR SWEEP-EXPANSION AND OTHER APPLICATIONS AT FREQUENCIES UP TO 1 MC. INPUT RESISTANCE - 500,000 OHMS. APPROXIMATELY 20 MMFD. INPUT CAPACITY. WITH HORIZONTAL-GAIN CONTROL AT MAXIMUM, THE SENSITIVITY OF THE HORIZONTAL AMPLIFIER IS .15 VOLT PER INCH, AND FREQUENCY RESPONSE IS FLAT WITHIN 1 DB TO 400 KC; 2 DB TO 600 KC, AND BETTER THAN 6 DB TO 1 MC.

9. WIDE-RANGE HORIZONTAL-PHASING CONTROL:- PERMITS SUPERPOSITION OF DUAL-TRACE PATTERNS IN FM, TV, OR SIMILAR RESPONSE PATTERN ANALYSIS.

10. QUADRUPLE SYNCHRONIZATION SELECTION:- PROVIDES FOR EXTERNAL, INTERNAL NEGATIVE, INTERNAL POSITIVE, AND LINE SYNCHRONIZATION. MAGNITUDE OF SYNC VOLTAGE CONTROLLABLE IN ALL 4 POSITIONS.

11. INTERNAL 60 CYCLE BEAM MODULATION:- A PHASE-CONTROLLED VOLTAGE IS AVAILABLE WITHIN THE INSTRUMENT. A SWITCH PERMITS THE BEAM-MODULATION VOLTAGE TO BE TURNED OFF. THE "BLANKING PHASE" CONTROL FACILITY ALSO PROVIDES FOR CLEAN DISPLAY OF HORIZONTAL OR VERTICAL SYNC PULSES.

12. EXTERNAL BEAM-MODULATION FACILITY:- PERMITS APPLICATION OF EXTERNAL VOLTAGES FOR MEASUREMENT OF PULSE DURATION, RISE TIME, OR SPECIAL BLANKING VOLTAGES.

13. TUBE COMPLEMENT AND APPLICATION:-

VERTICAL SECTION -

CATHODE FOLLOWER, COMPENSATED INPUT	6C4
FIRST VOLTAGE AMPLIFIER, WIDE BAND	6CB6
PHASE INVERTER	6C4
OUTPUT STAGE, PUSH-PULL	(6J6) (6J6)

HORIZONTAL SECTION

MULTIVIBRATOR SWEEP OSCILLATOR	6SN7 OR 7N7
LINEAR SWEEP RETRACE BLANKING AMP.	6C4
FIRST VOLTAGE AMPLIFIER, WIDE BAND	½6SN7 OR 7N7
PHASE INVERTER	½6SN7 OR 7N7
OUTPUT STAGE, PUSH-PULL	12AV7

POWER SUPPLY -

LOW-VOLTAGE RECTIFIER	5Y3
HIGH-VOLTAGE RECTIFIER	2X2
LOW-VOLTAGE REGULATOR	VR-150

CATHODE-RAY TUBE 5CP1A

FIGURE 1 BELOW ILLUSTRATES THE TUBE LOCATIONS AND THEIR SPECIFIC FUNCTIONS.

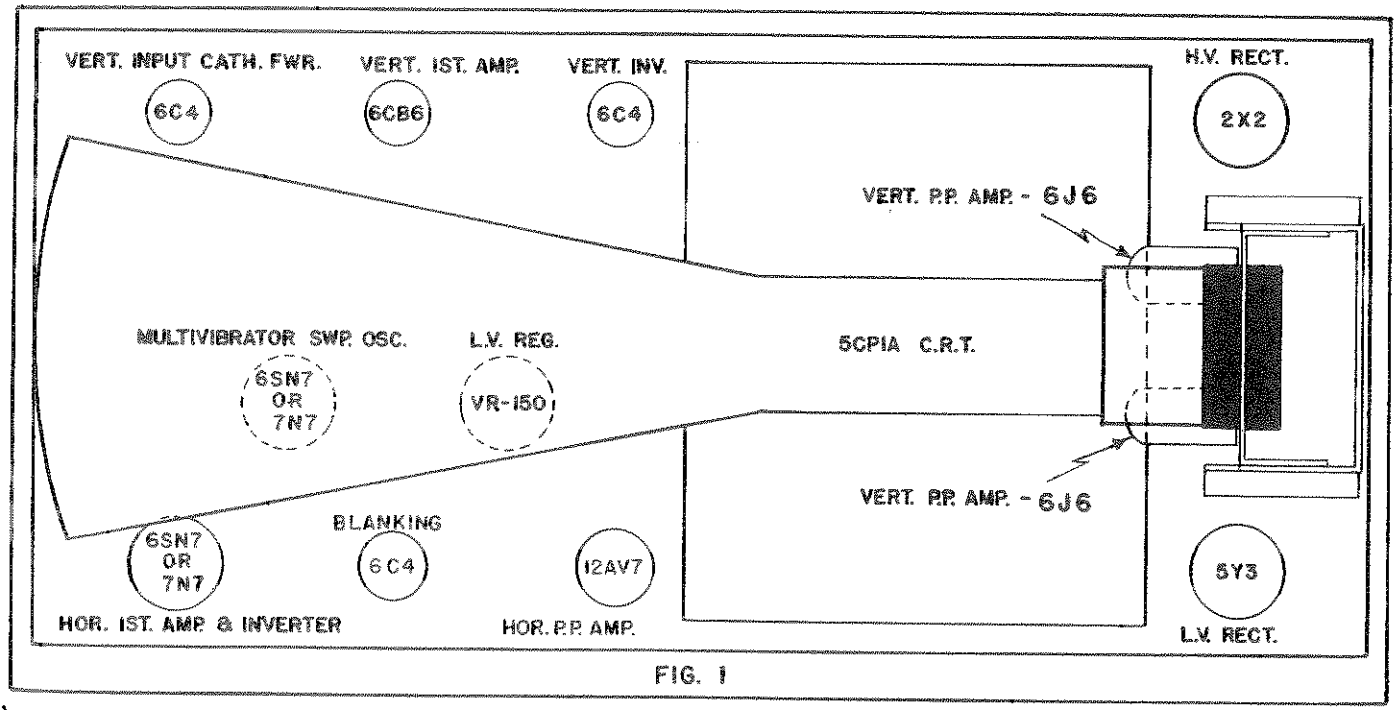


FIG. 1

14. DIRECT HORIZONTAL AND VERTICAL TERMINALS:- DIRECT ACCESS TO CATHODE-RAY TUBE DEFLECTION PLATES IS PROVIDED AT THE REAR OF THE OSCILLOGRAPH CABINET, FOR VERY-HIGH FREQUENCY APPLICATIONS, AND OTHER SIMILAR SPECIALIZED USAGES.

15. LARGE-SCREEN CATHODE-RAY TUBE PLUS HIGH-POTENTIAL C.R. SUPPLY PROVIDES MAXIMUM VISIBILITY AND EASE OF ANALYSIS.

16. REMOVABLE-ROTATABLE LIGHT SHIELD:- EXTRA-DEEP SHIELD PERMITS FULL USE OF THE INSTRUMENT UNDER ADVERSE LIGHTING CONDITIONS.

17. MULTIPLE-PURPOSE LABORATORY-TYPE INPUT TERMINALS ACCOMMODATE PHONE TIPS, BANANA-TYPE PLUGS, AND SPADE TERMINALS, AS WELL AS BARE-WIRE LEADS.

18. HIGH-INTENSITY CATHODE-RAY TUBE PATTERNS ASSURED THROUGH USE OF ADEQUATE HIGH-VOLTAGE SUPPLY, INCORPORATING TYPE 2X2 RECTIFIER.

19. LINE CIRCUIT FUSED FOR UTMOST INSTRUMENT PROTECTION.

20. EXTRA-HEAVY-DUTY, RUGGED CHASSIS CONSTRUCTION. CONSERVATIVELY RATED COMPONENTS.

21. HEAVY-GAUGE ROUND-CORNERED STEEL CABINET WITH FINE-GRAIN DULL BLACK WRINKLE FINISH. DIMENSIONS: 8 x 14 x 18".

22. DEEP-ETCHED AND ANODIZED, NON-GLARE, HEAVY-GAUGE ALUMINUM PANEL, RESISTANT TO MOISTURE AND WEAR.

23. AUDIO MONITORING FACILITIES.

24. FULLY LICENSED UNDER PATENTS OF A.T. AND T. AND W.E. CO'S.

II. INTRODUCTION

THE CATHODE-RAY OSCILLOGRAPH HAS LONG BEEN A VALUABLE TOOL TO THE ELECTRONIC CIRCUIT- DESIGN ENGINEER AND ADVANCED COMMERCIAL TECHNICIAN. HOWEVER, THE ADVENT OF THE BROAD-BAND CIRCUIT IN COMMERCIAL TELEVISION AND FM RECEIVERS HAS EMPHASIZED THE OSCILLOGRAPH AS A MOST IMPORTANT AND NECESSARY ADJUNCT TO THE MODERN RADIO SERVICE TECHNICIAN'S COMPLEMENT OF ELECTRONIC TEST INSTRUMENTS. FURTHERMORE, THE MODERN TV RECEIVER IS REPLETE WITH NON-SINUSOIDAL WAVEFORM GENERATORS, WAVE-SHAPING CIRCUITS, AND AMPLIFIERS. SUCH WAVEFORMS ARE CHARACTERIZED BY SHAPE AND BY POSITIVE PEAK, NEGATIVE PEAK, AND PEAK-TO-PEAK VOLTAGES. THE CATHODE-RAY OSCILLOGRAPH IS THE ONLY INSTRUMENT WHICH YIELDS COMPLETE WAVE FORM AND VOLTAGE ANALYSIS.

THE PRIMARY FUNCTION OF A CATHODE-RAY OSCILLOGRAPH IS TO PRODUCE A VISUAL REPRESENTATION OF APPLIED AC POTENTIALS WITH RESPECT TO A RELATED TIME BASE. THE TIME BASE MAY BE THE INTERNAL SWEEP CIRCUIT OF THE OSCILLOGRAPH OR SOME EXTERNAL SOURCE FED TO THE HORIZONTAL INPUT TERMINALS OR EVEN FED DIRECTLY TO THE HORIZONTAL DEFLECTION PLATES.

ENLARGING UPON THIS BASIC CONCEPT, IT CAN BE SEEN THAT A SIMPLE SINUSOIDAL ALTERNATING VOLTAGE (SUCH AS FROM THE AC POWER LINE) CAN BE REPRODUCED AS A CONVENTIONAL PICTORIAL REPRESENTATION ON THE SCREEN OF A CATHODE-RAY TUBE. SEE FIG. 24 PAGE 21. THIS FACT PERMITS THE TECHNICIAN TO OBSERVE AND ANALYZE WAVE SHAPE, HARMONIC CONTENT, PHASE RELATIONS, AND TO MEASURE VARIOUS TYPES OF VOLTAGES. ACCORDINGLY, THE OSCILLOGRAPH IS NOT ONLY A MONITOR OF WAVEFORM, BUT IT IS AT THE SAME TIME A SENSITIVE AC VACUUM-TUBE VOLTMETER, A HARMONIC ANALYZER, A FREQUENCY METER, A PHASE-ANGLE METER, AN IMPEDANCE METER, AND AN AUDIO-FREQUENCY MONITOR, PLUS NUMEROUS OTHER FUNCTIONS WHICH MAKE IT ONE OF THE MOST VALUABLE TROUBLE-SHOOTING INSTRUMENTS KNOWN TO TECHNOLOGY.

APPLICATIONS OF THE OSCILLOGRAPH ARE SO NUMEROUS THAT ONLY THE MOST COMMON CAN EVEN BE TOUCHED UPON FOR EXEMPLARY DISCUSSION. SEVERAL OF THE MOST IMPORTANT APPLICATIONS ARE CONSIDERED UNDER "APPLICATION NOTES", BEGINNING ON PAGE 10.

III. FUNCTIONS AND DESCRIPTION OF PANEL CONTROLS AND SWITCHES

1. "INTENSITY" CONTROL AND POWER ON-OFF.

INITIAL CLOCKWISE ROTATION OF THIS CONTROL ACTUATES THE POWER SWITCH AND TURNS THE INSTRUMENT ON. FURTHER ROTATION OF THE CONTROL (AFTER THE INSTRUMENT HAS HEATED) WILL CONTROL THE BRIGHTNESS OR "INTENSITY" OF THE CATHODE RAY TUBE TRACE

IMPORTANT NOTES:

A. ALWAYS ADJUST THE "INTENSITY" CONTROL TO MINIMUM BRIGHTNESS CONSISTENT WITH GOOD VISIBILITY IN ORDER TO EXTEND THE LIFE OF THE CATHODE-RAY TUBE.

B. NEVER ALLOW A SMALL SPOT OF HIGH INTENSITY TO REMAIN ON THE SCREEN MORE THAN MOMENTARILY; IF THIS PRECAUTION IS NOT OBSERVED, DISCOLORATION OR BURNING OF THE SCREEN WILL RESULT.

2. "FOCUS" CONTROL

THIS CONTROL ADJUSTS THE "SHARPNESS" OF FOCUS OF THE OSCILLOGRAPH TRACE. A NEW POSITION OF "FOCUS" MAY BE REQUIRED EACH TIME THE "INTENSITY" CONTROL IS READJUSTED. IT SHOULD ALWAYS BE REMEMBERED THAT THERE IS AN INVERSE RELATIONSHIP BETWEEN PATTERN INTENSITY AND FINENESS OF TRACE. ACCORDINGLY ALWAYS SET INTENSITY TO MINIMUM REQUIRED POSITION.

3. VERTICAL AND HORIZONTAL "CENTERING" CONTROLS

THESE CONTROLS PERMIT THE INITIAL LOCATION OF THE CATHODE-RAY BEAM TRACE AT A CENTRAL (OR ANY OTHER DESIRED) LOCATION ON THE FACE OF THE TUBE. THROUGH USE OF THESE CONTROLS THE BEAM MAY BE CENTERED ON THE SCREEN (USUAL PROCEDURE), OR THE OPERATOR MAY LOCATE THE BEAM AT PRACTICALLY ANY POINT ON THE SCREEN FACE AS MAY BE REQUIRED IN SPECIAL APPLICATIONS.

4. "SWEEP SELECTOR" (APPLIES TO HORIZONTAL DEFLECTION ONLY)

A. "LINE" POSITION:- WITH THE SWITCH SET TO "LINE" POSITION, A SMALL VOLTAGE OF THE SAME FREQUENCY AS THAT POWERING THE OSCILLOGRAPH IS APPLIED THROUGH THE HORIZONTAL AMPLIFIER TO THE HORIZONTAL DEFLECTION PLATES OF THE CATHODE-RAY TUBE, THUS SWEEPING THE BEAM BACK AND FORTH IN A HORIZONTAL DIRECTION AT THE SAME RATE AS THE POWER-LINE FREQUENCY.

B. "EXT. SW." POSITION:- WITH THE SWITCH SET TO "EXT. SW." POSITION, THE INTERNAL HORIZONTAL SWEEP SYSTEM IS DISCONNECTED, PERMITTING THE APPLICATION OF EXTERNAL HORIZONTAL SWEEP VOLTAGE THROUGH THE HORIZONTAL AMPLIFIER TO THE HORIZONTAL DEFLECTION PLATES OF THE CRT. USE THE "HOR." AND "GND" POSTS AT THE LOWER RIGHT CORNER OF THE ES-500A PANEL FOR INJECTION OF EXTERNAL SWEEP VOLTAGES.

C. THE REMAINING FOUR POSITIONS OF THE "SWEEP SELECTOR" SWITCH PERMIT THE OPERATOR TO SELECT INTERNAL LINEAR HORIZONTAL SWEEP VOLTAGES AT FREQUENCIES FROM APPROXIMATELY 10 CPS TO 30,000 CPS. THE FREQUENCIES INDICATED ON THE PANEL ARE INTENDED FOR USE AS A GUIDE ONLY: THEY DO NOT NECESSARILY REPRESENT EXACT FREQUENCY CALIBRATIONS.

NOTE: THE "VERNIER" CONTROL PERMITS THE OPERATOR TO ADJUST THE INTERNAL HORIZONTAL SWEEP VOLTAGE FREQUENCY TO POINTS WITHIN THE APPROXIMATE RANGES INDICATED ON THE "SWEEP SELECTOR" SWITCH.

SPECIAL NOTE: RE-USE OF SAWTOOTH SWEEP IN TV-FM ALIGNMENT

FIELD EXPERIENCE INDICATES THAT ALTHOUGH THE INTERNAL LINEAR SWEEP FUNCTION OF THE ES-500A CAN BE USED TO DISPLAY A VISUAL ALIGNMENT CURVE, THIS PROCEDURE IS NOT RECOMMENDED TO THE BEGINNER, INASMUCH AS CONFUSION FREQUENTLY ARISES FROM MULTIPLE PATTERNS AND SKIPPING OF SYNC LOCK.

SPECIAL NOTE: RE SELECTION OF HORIZONTAL SWEEP METHODS IN TV AND FM ALIGNMENT

IN THE ALIGNMENT OF FM AND TV RECEIVERS BY MEANS OF A WIDE-RANGE SWEEP-SIGNAL GENERATOR, TWO OPTIONAL METHODS ARE AVAILABLE FOR OBTAINING HORIZONTAL SWEEP.

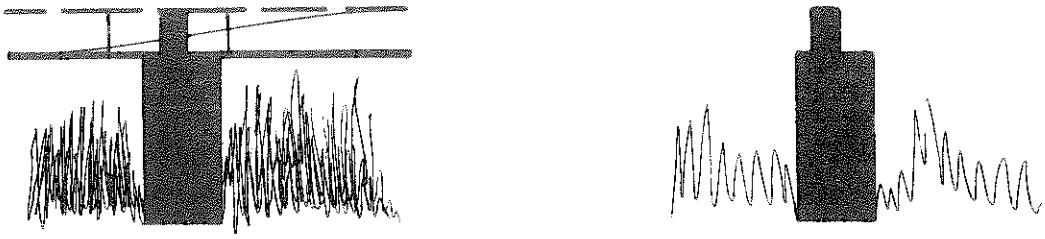
A. THE FIRST METHOD USES THE "LINE" POSITION OF THE SWEEP SELECTOR, AND THE "HORIZONTAL PHASE" CONTROL OF THE ES-500A TO OBTAIN A SUPERIMPOSED STATIONARY DOUBLE TRACE WAVE-SHAPE PATTERN.

B. THE SECOND METHOD USES THE "EXT. SW." POSITION OF THE "SWEEP SELECTOR" AND THE PHASING CONTROL OF THE SWEEP GENERATOR, THE HORIZONTAL SWEEP VOLTAGE BEING SUPPLIED BY THE SWEEP GENERATOR. A SUPERIMPOSED DOUBLE TRACE PATTERN WILL ALSO BE OBTAINED USING THIS METHOD; HOWEVER, FACILITIES FOR ELIMINATING ONE OF THE DUAL TRACES IS AVAILABLE IN THE VERSATILE ES-500A BY USE OF THE "BLANKING PHASE" CONTROL, DESCRIBED AS FOLLOWS:

5. 60 CYCLE "BLANKING PHASE" CONTROL

THIS CONTROL, WHEN TURNED FROM ITS "OFF" POSITION APPLIES AN INTERNALLY PHASEABLE, 60 CYCLE VOLTAGE TO THE CONTROL GRID OF THE CRT. THIS PROVIDES 60 CYCLE Z AXIS MODULATION OR "INTENSITY MODULATION". ROTATION OF THIS CONTROL ADJUSTS THE PHASE OF THE BLANKING VOLTAGE AS REQUIRED. A USEFUL SERVICE APPLICATION OF THIS FUNCTION IS THE BLANKING OR INTENSIFICATION OF TV SYNC SIGNALS TO OBTAIN A CLEAN DISPLAY OF COMPLEX PULSES - SEE FIG. 2. THIS FUNCTION CAN ALSO BE USED TO ELIMINATE ONE OF THE DUAL PATTERNS WHICH MAY BE OBTAINED IN THE ALIGNMENT OF TV AND FM RECEIVERS.

SEE FIG. 2 FOR ILLUSTRATION OF THE BLANKING EFFECT IN TV SYNC PULSE OBSERVATIONS.



TV SYNC PULSE DISPLAY WITHOUT BEAM BLANKING

TV SYNC PULSE DISPLAY WITH BEAM BLANKING

BEAM BLANKING CLEANS UP SYNC PULSE DISPLAYS

FIG. 2

6. "SYNCHRONIZATION"

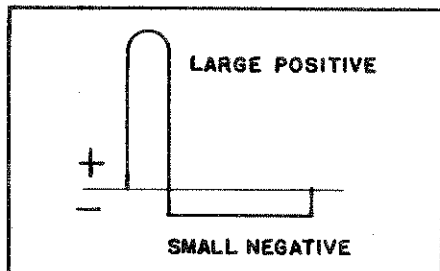
A. "EXT., INT. NEG., INT. POS., LINE" SWITCH

(1) WITH THIS SWITCH SET TO "EXT." POSITION, THE OSCILLOGRAPH PATTERN MAY BE "LOCKED" OR FIXED MOTIONLESS IN POSITION (STATIONARY PATTERN) BY MEANS OF AN EXTERNAL SYNC VOLTAGE APPLIED TO THE "EXT. SYNC." AND "GND." BINDING POSTS AT THE BOTTOM OF THE PANEL.

(2) WITH THIS SWITCH SET TO THE "INT. NEG." OR TO THE "INT. POS." POSITION, A PORTION OF THE SIGNAL OR VOLTAGE APPLIED TO THE VERTICAL DEFLECTION PLATES AUTOMATICALLY PROVIDES INTERNAL SYNCHRONIZATION OF THE OSCILLOGRAPH PATTERN.

NOTE:

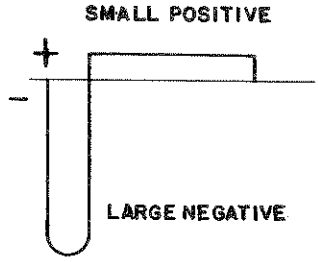
AS ILLUSTRATED IN FIGS. 3 AND 4, NON-SINUSOIDAL WAVEFORMS MAY OCCASIONALLY HAVE A LARGE NEGATIVE VOLTAGE AS COMPARED TO THE POSITIVE VOLTAGE (AND VICE VERSA). IF THE POLARITY OF THE SYNCHRONIZATION CIRCUITS IN THE SCOPE WAS NOT SELECTABLE FROM THE 'SCOPE PANEL, A WAVEFORM OF THE TYPE ILLUSTRATED IN FIG. 4 COULD BE SYNCHRONIZED ONLY BY ITS RELATIVELY SMALL POSITIVE PEAK. IN SUCH A CASE, INSUFFICIENT VOLTAGE WOULD BE AVAILABLE FOR SYNCHRONIZATION AND AN UNSTABLE PATTERN WOULD RESULT. THE ES-500A THEREFORE LOGICALLY PROVIDES SYNCHRONIZATION POLARITY SELECTION PERMITTING THE OPERATOR TO OBTAIN SYNC FROM EITHER THE POSITIVE OR NEGATIVE PEAK OF WAVEFORMS TO BE OBSERVED.



"INT POS" SYNCHRONIZATION WILL LOCK THIS WAVESHAPE

FIG. 3

FIG. 4



"INT NEG" SYNCHRONIZATION WILL LOCK THIS WAVESHAPE

(3) WITH THIS SWITCH SET TO THE "LINE" POSITION, A PORTION OF THE POWER-LINE VOLTAGE PROVIDES SYNCHRONIZING VOLTAGE. THE "LINE" SYNCHRONIZATION POSITION IS ADVANTAGEOUSLY USED IN MOST CASES WHEREIN THE REPETITION RATE OF THE SIGNAL IS INTEGRALLY RELATED TO THE POWER-LINE FREQUENCY. MORE STABLE PATTERNS ARE OBTAINED IN MANY CASES, BECAUSE OF THE SINE-WAVE SHAPE AND UNIFORMITY OF THE LINE-SYNC VOLTAGE.

B. "SYNC LOCK" CONTROL. THIS CONTROL REGULATES THE AMPLITUDE OF SYNC VOLTAGE APPLIED TO THE INTERNAL SAWTOOTH GENERATOR.

NOTE: THIS CONTROL SHOULD BE SET AS CLOSE TO THE COUNTERCLOCKWISE POSITION AS POSSIBLE, WITHOUT LOSING SYNC LOCK. EXCESSIVE SYNCHRONIZING VOLTAGE MAY CAUSE OBJECTIONABLE PATTERN DISTORTION.

7. "V. GAIN" AND "H. GAIN" CONTROLS

THESE CONTROLS VARY THE OVER-ALL GAIN OF THE "V" AND "H" AMPLIFIERS AND THEREBY PERMIT THE OPERATOR TO ADJUST THE VERTICAL AND HORIZONTAL SIZE (RESPECTIVELY) OF THE OSCILLOGRAPH PATTERN.

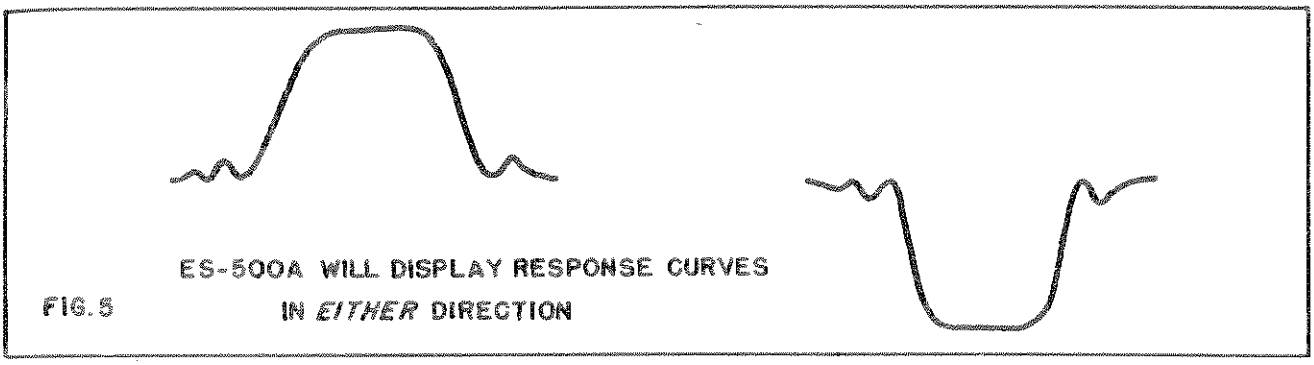
8. "V. SENSITIVITY" SWITCH

THIS 3-POSITION SWITCH PERMITS THE OPERATOR TO SELECT THE DESIRED VERTICAL SENSITIVITY (CONTINUOUSLY ADJUSTABLE THROUGH USE OF THE "V. GAIN" CONTROL). WITH THE "V. GAIN" CONTROL SET TO MAXIMUM, THE VERTICAL SENSITIVITY OF THE OSCILLOGRAPH IS:

X1 POSITION	2.0 VOLTS PER INCH.
X10 POSITION	0.20 VOLTS PER INCH.
X100 POSITION	0.020 VOLTS PER INCH, OR BETTER.

9. VERTICAL POLARITY REVERSING SWITCH

THIS SWITCH HAS TWO POSITIONS, MARKED "NORMAL" AND "REVERSE". THIS FEATURE IS VERY USEFUL IN INTERPRETATION OF TV VIDEO IF, AND SYNC OR SWEEP WAVEFORMS, WHEREIN MANUFACTURER'S SERVICE NOTES ILLUSTRATE PATTERNS IN A SPECIFIC DIRECTION. THE OPERATOR CAN DUPLICATE THE POSITIONING OF SERVICE DATA PATTERNS, THEREBY ELIMINATING A COMMON SOURCE OF CONFUSION. SEE FIG. 5.



ES-500A WILL DISPLAY RESPONSE CURVES IN *EITHER* DIRECTION

FIG. 5

10. "VERT." - "GND." TERMINALS

ALL SIGNALS OR A.C. VOLTAGES TO BE EXAMINED ON THE CRT SCREEN IN THE USUAL FASHION (USING THE INTERNAL VERTICAL AMPLIFIERS OF THE OSCILLOGRAPH) ARE CONNECTED TO THESE TERMINALS.

11. "HOR". - "GND." TERMINALS

IN THOSE CASES WHEREIN IT IS DESIRED TO USE AN EXTERNAL HORIZONTAL SWEEP VOLTAGE, THE "SWEEP SELECTOR" SWITCH IS SET TO "EXT. SW." AND THE EXTERNAL VOLTAGE IS APPLIED TO THE "HOR.-"GND." POSTS.

12. "PRESS TO CAL", 1 V P-P PUSH BUTTON

THIS PUSH BUTTON APPLIES A 1 VOLT PEAK-TO-PEAK, REGULATED SEMI-SQUARE WAVE, SCREEN CALIBRATING VOLTAGE TO THE "V" INPUT. SEE APPLICATION NOTES - PAGE 10.

13. "EXT. SYNC." POST

WHEN AN EXTERNAL SYNCHRONIZING VOLTAGE IS TO BE USED, THE "SYNCHRONIZATION" SWITCH IS SET TO "EXT." AND THE EXTERNAL SYNC VOLTAGE IS APPLIED TO THE "EXT.SYNC." POST.

14. "BEAM MOD." POST

APPLICATION OF EXTERNAL AC VOLTAGES TO THE "BEAM MODULATION" POST WILL INTENSITY-MODULATE THE CRT BEAM, RESULTING IN SEQUENTIAL BLANKING AND INTENSIFYING OF THE TRACE. THE NUMBER AND POSITION OF THE DISCONTINUITIES IN THE TRACE DEPEND UPON THE FREQUENCY AND PHASE OF THE BLANKING VOLTAGE. USES OF THIS FUNCTION INCLUDE THE MEASUREMENT OF UNKNOWN FREQUENCIES. OTHER APPLICATIONS INCLUDE MEASUREMENT OF PULSE DURATION, AND MEASUREMENT OF THE TIME OF RISE OF A WAVEFRONT.

15. "HORIZONTAL PHASE" CONTROL

THIS PHASING CONTROL OPERATES A BRIDGE-TYPE RESISTANCE-CAPACITANCE NETWORK WHICH PERMITS THE OPERATOR TO VARY THE PHASE OF THE SINE-WAVE SWEEP VOLTAGE INTERNALLY FED TO THE HORIZONTAL AMPLIFIER OF THE SCOPE (WHEN USING THE "LINE" POSITION OF THE "SWEEP SELECTOR" SWITCH). THE PHASE SHIFT IS ADJUSTED WITH RESPECT TO THE SIGNAL VOLTAGE BEING APPLIED TO THE "VERTICAL" POST OF THE INSTRUMENT. THE NATURE OF MANY SWEEP-SIGNAL GENERATORS AND INDEPENDENT FREQUENCY MODULATORS ARE SUCH THAT THEIR USE IN THE EXAMINATION OF RESPONSE-CURVE CHARACTERISTICS PRODUCES A DOUBLE-PATTERN ON THE SCREEN OF THE OSCILLOGRAPH. SHOULD THE PARTICULAR SWEEP GENERATOR BEING USED LACK PROVISIONS FOR ADJUSTMENT OF THE OUT-OF-PHASE PATTERNS WHICH USUALLY OCCUR, THE "PHASING" CONTROL USED IN CONJUNCTION WITH THE "LINE" POSITION OF "SWEEP SELECTOR" PERMITS SUPERIMPOSITION OF THE TWO OSCILLOGRAPH PATTERNS.

NOTE: IF THE "BLANKING PHASE" CONTROL IS TO BE USED TO ELIMINATE ONE OF THE AFOREMENTIONED TRACES, THE FOLLOWING PROCEDURE SHOULD BE USED: WITH THE "BLANKING PHASE" CONTROL IN THE "OFF" POSITION, SUPERIMPOSE THE TWO TRACES USING EITHER THE SWEEP GENERATOR'S PHASE CONTROL OR THE "HORIZONTAL PHASE" CONTROL OF THE ES-500A (DEPENDENT UPON WHICH HORIZONTAL SWEEP METHOD IS BEING USED). THEN ROTATE THE "BLANKING PHASE" CONTROL UNTIL ONLY ONE TRACE IS VISIBLE. (REDUCE "INTENSITY" CONTROL AS REQUIRED.)

UNLESS THE TWO TRACES ARE PROPERLY PHASED TOGETHER BEFORE THE RETRACE IS BLANKED, FREQUENCY DETERMINATIONS MADE ON THE BASIS OF SWEEP GENERATOR DIAL READINGS MAY BE IN ERROR.

16. DIRECT DEFLECTION PLATE CONNECTIONS TO THE 5CP1A CATHODE-RAY TUBE

DIRECT CONNECTIONS MAY BE MADE TO EITHER OR BOTH THE HORIZONTAL OR VERTICAL DEFLECTION PLATES OF THE CRT BY UTILIZING THE TERMINAL STRIP AT THE REAR OF THE INSTRUMENT. (FOR ACCESS TO THE DEFLECTION PLATES, LOOSEN THE TWO COVER-PLATE SCREWS AND ROTATE THE COVER PLATE TO ONE SIDE).

BEFORE MAKING CONNECTIONS, FIRST LOOSEN THE LINK SCREWS WHICH CONNECT TO THE APPLICABLE CRT DEFLECTION PLATES (AS INDICATED ON EXTERNAL ETCHED BACK SERIAL PLATE). ROTATE THE LINK UNTIL IT IS FREE OF ITS RESPECTIVE DEFLECTION-PLATE TERMINAL, AND TIGHTEN THE LINK RETAINING SCREW TO HOLD THE LINK IN PLACE. (LINK WILL NOW BE IN A HORIZONTAL POSITION.) ACCESS CAN NOW BE MADE TO THE HORIZONTAL OR VERTICAL PLATES FREE OF ANY INTERNAL CIRCUIT LOAD. (IN THIS POSITION, AMPLIFIER TUBES AND CENTERING CONTROLS ARE DISCONNECTED.)

NOTE: IF IT IS DESIRED TO OBTAIN DIRECT ACCESS TO THE DEFLECTION PLATES WITH THE INTERNAL CENTERING FACILITIES OPERATIVE, SUITABLE ISOLATING RESISTORS SHOULD BE INSERTED BETWEEN THE DEFLECTION PLATE AND THE LINK (A GOOD QUALITY CARBON OR METALLIZED RESISTOR OF APPROXIMATELY 0.5 TO 1 MEGOHM WILL BE SUITABLE). THIS RESISTOR WILL ISOLATE THE GIVEN AMPLIFIER OUTPUT FROM THE DEFLECTION PLATE, BUT ALLOWS THE DC CENTERING VOLTAGE TO CONTROL THE BEAM IN THE CRT, PROVIDED THE DEFLECTION PLATE IS AC COUPLED TO THE EXTERNAL SIGNAL SOURCE. WHEN OPERATING IN THIS MANNER, THE VERTICAL AND HORIZONTAL GAIN CONTROLS SHOULD BE SET TO ZERO.

DIRECT SIGNAL APPLICATION TO THE CRT DEFLECTION PLATES BECOMES USEFUL AND NECESSARY IN CASES WHEREIN THE SIGNALS OR VOLTAGES TO BE ANALYZED ARE BEYOND THE RANGE OF THE BUILT-IN AMPLIFIERS AND SWEEP CIRCUIT. FOR EXAMPLE, THE ENVELOPE OF A MODULATED RF CARRIER MAY BE EXAMINED BY APPLICATION OF THE RF SIGNAL TO THE VERTICAL PLATES, ETC.

17. PHONE JACKS

THE TWO TIP JACKS INDICATED ON THE REAR COVER PLATES AS "PHONES" PROVIDE FOR AUDIBLE CHECK OF THE VERTICAL PLATE SIGNAL, SIMULTANEOUSLY WITH VISUAL OBSERVATION. THIS FACILITY IS ALSO VERY USEFUL AS A HIGH-GAIN SIGNAL TRACER IN TROUBLE SHOOTING.
USE HIGH-IMPEDANCE PHONES ONLY!

IV. EXAMPLES OF APPLICATION

WITH THE "INTENSITY" CONTROL IN THE "LINE OFF" POSITION, INSERT THE LINE PLUG INTO A 110-120 V. 50-60 CYCLE AC OUTLET, UNLESS THIS INSTRUMENT HAS BEEN SPECIFICALLY FURNISHED FOR OTHER VOLTAGE AND/OR FREQUENCY.

CAUTION: DO NOT ATTEMPT TO OPERATE YOUR SERIES ES-500A WITH THE INSTRUMENT REMOVED FROM ITS METAL CASE, INASMUCH AS DANGEROUSLY HIGH VOLTAGE POINTS ARE EXPOSED UNDER THESE CONDITIONS.

ALWAYS DISCONNECT THE POWER CORD FROM THE AC OUTLET BEFORE REMOVING THE CHASSIS FROM THE METAL CASE.

(A) SET THE "BLANKING PHASE" CONTROL IN THE "OFF" POSITION.

(B) ROTATE THE "INTENSITY" CONTROL TO THE APPROXIMATE MID-POSITION.

(C) AFTER THE INSTRUMENT HAS WARMED UP, SET THE "SWEEP SELECTOR" TO "10 TO 90 CPS", THE "V GAIN" CONTROL TO 0 AND THE "H GAIN" CONTROL TO APPROXIMATELY #5.

(D) ADJUST THE "INTENSITY" AND "FOCUS" CONTROLS TO OBTAIN A SHARP MEDIUM-BRIGHTNESS HORIZONTAL TRACE.

(E) ADJUST THE "VERTICAL" AND "HORIZONTAL" CENTERING CONTROLS UNTIL THE TRACE LOCATES IN A CENTRAL POSITION.

(F) SET THE FOLLOWING CONTROLS AND SWITCHES AS FOLLOWS:

1. "SYNCHRONIZATION" SWITCH TO "INT" POSITION.
2. "SYNC LOCK" CONTROL TO EXTREME COUNTERCLOCKWISE POSITION.
3. "V. SENSITIVITY" SWITCH TO "X1".
4. "V. POLARITY" TO "NORM."

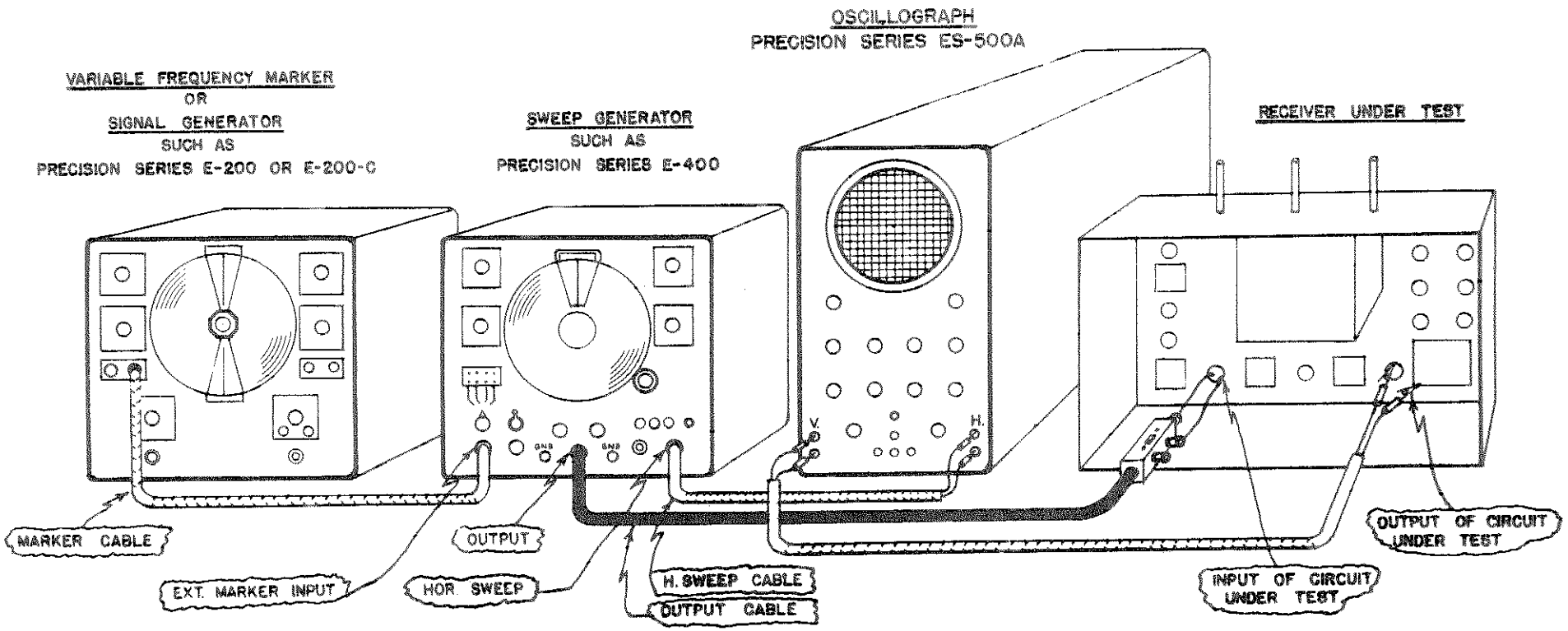
NEXT, TO OBSERVE A SIMPLE SINUSOIDAL WAVEFORM, APPLY 110-120 VOLT 50-60 CPS LINE VOLTAGE TO THE "V. TERMINALS".

ROTATE THE "V GAIN" CONTROL UNTIL THE SINUSOIDAL WAVE SHAPE OCCUPIES A REASONABLE HEIGHT ON THE 'SCOPE SCREEN.

ROTATE THE "SWEEP SELECTOR" VERNIER CONTROL UNTIL THE PATTERN BECOMES NEAR-STATIONARY. NOTE THAT THE NUMBER OF COMPLETE CYCLES TO BE OBSERVED DEPENDS UPON THE SETTING OF THE "VERNIER" CONTROL.

ROTATE THE "SYNC LOCK" CONTROL UNTIL THE PATTERN "LOCKS" IN POSITION.

FIG. 6 - TYPICAL SETUP FOR VISUAL ALIGNMENT WITH "PRECISION" SERIES ES-500A OSCILLOGRAPH



SUPPLEMENTARY NOTES

1. In all cases wherein the expected oscillograph pattern appears unduly distorted, insert a 25,000 to 250,000 ohms carbon isolating resistor in series with the "hot" lead which connects to the "Vert" terminal of the oscillograph. Connect this resistor at the oscillograph end of the connecting cable.

2. It is desirable to connect the "GND" terminal at the bottom center of the oscillograph panel to the Ground terminals of other interconnected test instruments and also to the Ground of the circuit under test. (Use Metallic braid for additional grounding connections wherever possible.) and through a 3-conductor cord to the building ground.

3. Do not attempt to operate the ES-500A with the instrument removed from its Metal case: the high voltage supply generates dangerously high potentials.

4. Bibliography

"Cathode Ray Tube at Work" by Rider
"Television Simplified", "FM Simplified" by Kiver
"Rider's Television Manual" by Rider
"Radio Data Book" by Boland and Boyce
Technical Trade Journals, such as
"Radio Maintenance","Radio Service Dealer", "Service",
"Successful Servicing", "Radio-Electronics","Radio News"
etc.

NOTE: IF THE "SYNCHRONIZATION" SWITCH IS NOW SWITCHED TO "INT. NEG." IT WILL BE NOTICED THAT THE PATTERN MOVES HORIZONTALLY 180 ELECTRICAL DEGREES, INDICATING THAT SYNCHRONIZATION IS BEING EFFECTED THRU USE OF THE NEGATIVE HALF CYCLE.

AN ANALYSIS OF THE DEVELOPMENT OF A SINUSOIDAL PATTERN IN AN CR OSCILLOGRAPH IS DETAILED ON PAGE 21.

OTHER VOLTAGES AT OTHER FREQUENCIES MAY NEXT BE APPLIED TO THE "VERT." TERMINALS OF THE ES-500A IN ORDER THAT THE OPERATOR MAY BECOME MORE FAMILIAR WITH THE MANIPULATION OF THE BASIC CONTROLS OF THE 'SCOPE.

A MORE COMPLETE APPLICATION OF THE ES-500A INVOLVES ITS USE IN THE ALIGNMENT OF TELEVISION RECEIVERS. A TYPICAL OPERATIONAL PROCEDURE IS DISCUSSED AS FOLLOWS:

METHOD A:- FOR EXAMINATION OF THE RESPONSE CURVE OF A WIDE-BAND RADIO-FREQUENCY AMPLIFIER (SUCH AS THE IF STAGES OF AN FM RECEIVER).

(A) THE OSCILLOGRAPH, SWEEP GENERATOR, AND OPTIONAL MARKER GENERATOR ARE SET UP AND INTERCONNECTED AS TYPICALLY ILLUSTRATED IN FIG. 6, PAGE 8.

1. THE OUTPUT OF THE CIRCUIT UNDER TEST (THE VOLTAGE DEVELOPED ACROSS THE RECEIVER LIMITER GRID RESISTOR IN THIS CASE) CONNECTS TO THE "VERT." AND "GND." POSTS ON THE OSCILLOGRAPH PANEL (USUALLY IN SERIES WITH A 25,000 TO 250,000 OHMS CARBON RESISTOR PLACED AT THE RECEIVER END OF THE CONNECTING CABLE.)

2. THE "HOR." AND "GND." POSTS OF THE OSCILLOGRAPH ARE CONNECTED TO THE "HORIZONTAL SWEEP" CONNECTIONS ON THE SWEEP GENERATOR PANEL. WHEN SUCH IS DONE, THE "SWEEP" SELECTOR SWITCH OF THE OSCILLOGRAPH MUST BE SET TO THE "EXT. SW." POSITION.

NOTE: THE ABOVE PROCEDURE (USING THE SINUSOIDAL HORIZONTAL SWEEP VOLTAGE PROVISIONS OF THE SWEEP GENERATOR TO HORIZONTALLY SWEEP THE OSCILLOGRAPH BEAM) WILL USUALLY PRODUCE A SUPERIMPOSED DOUBLE-TRACE PATTERN.

3. THE CONTROLS OF THE SWEEP GENERATOR AND OPTIONAL MARKER GENERATOR ARE ADJUSTED IN ACCORDANCE WITH THE SWEEP GENERATOR INSTRUCTION MANUAL.

4. THE OSCILLOGRAPHS'S "INTENSITY" CONTROL IS ADVANCED CLOCKWISE, TURNING THE INSTRUMENT ON.

5. THE "SWEEP SELECTOR" SWITCH IN THIS EXAMPLE IS SET TO "EXT. SW.".

6. THE "FOCUS" AND "INTENSITY" CONTROLS ARE ADJUSTED TO GIVE SHARPEST POSSIBLE TRACE ON THE OSCILLOGRAPH SCREEN, COMMENSURATE WITH LIGHTING CONDITIONS. USE SHIELD, IF REQUIRED.

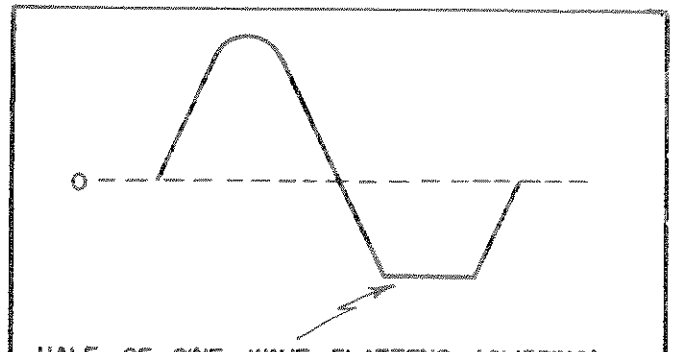
7. THE VERTICAL AND HORIZONTAL CENTERING CONTROLS ARE ADJUSTED TO LOCATE THE PATTERN AT THE CENTER OF THE SCREEN.

8. THE "V. GAIN" AND "H. GAIN" CONTROLS ARE ADJUSTED TO OBTAIN SUITABLE PATTERN HEIGHT AND WIDTH.

9. IF THE PATTERN IS INSUFFICIENTLY HIGH WHEN THE "V. SENSITIVITY" SWITCH IS SET TO THE "X1" POSITION, AND THE "V. GAIN" CONTROL SET TO MAXIMUM, THE "X10" OR THE "X100" SETTING OF THE "V. SENSITIVITY" SWITCH MAY BE USED.

NOTE: OPERATORS SOMETIMES ENCOUNTER OVERLOAD DIFFICULTIES BY ATTEMPTING TO DISPLAY HIGH-LEVEL SIGNALS WITH THE "V. SENSITIVITY" SWITCH IN THE "X100" POSITION, AND THE "V. GAIN" CONTROL NEAR ZERO. NEVER SET THE "V. SENSITIVITY" SWITCH TO A HIGHER POSITION THAN ACTUALLY NEEDED. FIG. 7 ILLUSTRATES THE SHAPE THAT A SINE WAVE ASSUMES WHEN EXCESSIVE VOLTAGE IS APPLIED TO THE VERTICAL AMPLIFIER IN THE "X100" POSITION. THIS IS DUE TO OVERLOADING IN THE CATHODE FOLLOWER STAGE, THE RESULT OF WHICH IS CLIPPING. IT IS RECOMMENDED THAT THE FOLLOWING APPROXIMATE VOLTAGE LIMITS BE USED IN ORDER TO PREVENT THIS CONDITION FROM OCCURRING.

IN THE:-
X100 POSITION 4V. R.M.S. MAX.
X10 POSITION 40V. R.M.S. MAX.
X1 POSITION 400V. R.M.S. MAX.



EFFECT PRODUCED BY OVERLOADING CATHODE FOLLOWER STAGE

FIG. 7

SPECIAL NOTE: IF THE OPERATOR SO CHOOSES, HE MAY DISPENSE WITH THE USE OF THE SWEEP GENERATOR "H SWEEP CABLE" NOTED IN FIG. 6, BY USING THE "LINE" POSITION OF THE OSCILLOGRAPH "SWEEP SELECTOR" SWITCH AND "HOR. PHASE" CONTROL. THIS PROCEDURE PRODUCES THE SAME RESULTS AS OBTAINED USING THE AFOREMENTIONED "H SWEEP CABLE" AND THE PHASING CONTROL ON THE SWEEP GENERATOR.

10. AFTER HAVING OBTAINED THE OSCILLOGRAPH PATTERN AS DESCRIBED ABOVE, SWITCH IN THE "BLANKING PHASE" CONTROL. ADJUST THIS CONTROL TO OBTAIN A SINGLE TRACE OF UNIFORM BRIGHTNESS. IT MAY BE NECESSARY TO REDUCE THE "INTENSITY" CONTROL SETTING TO OBTAIN A MEDIUM-INTENSITY PATTERN UNDER THESE CONDITIONS. THIS ADJUSTMENT ALSO PERMITS REDUCTION OF ANY RESIDUAL "BLANKED" TRACE. THE "FOCUS" CONTROL MAY REQUIRE MINOR READJUSTMENT TO PRODUCE MAXIMUM SHARPNESS OF TRACE.

METHOD B

THIS METHOD ELIMINATES THE USE OF THE CONNECTING CABLE BETWEEN "HORIZONTAL SWEEP" CONNECTOR ON THE SWEEP GENERATOR AND THE "HOR.-GND." POSTS OF THE OSCILLOGRAPH. IT ALSO ELIMINATES THE USE OF PHASING CONTROLS. HOWEVER, IT CAN LEAD TO MULTIPLE PATTERNS AND OTHER DIFFICULTIES, IN THE HANDS OF INEXPERIENCED OPERATORS.

1. ROTATE THE "SWEEP SELECTOR" SWITCH OF THE OSCILLOGRAPH TO THE "10-90" CYCLES POSITION, AND THE "SYNCHRONIZATION" SWITCH TO THE "LINE" POSITION. A STATIONARY SINGLE-TRACE PATTERN CAN BE THEN OBTAINED BY PROPER ADJUSTMENT OF THE "SWEEP VERNIER CONTROL, AND THE "SYNCHRONIZATION LOCK" CONTROL.

V. APPLICATION NOTES

SERIES ES-500A HAS BEEN CAREFULLY ENGINEERED NOT ONLY TO REPRODUCE WAVE PATTERNS UP TO 1 MEGACYCLE BUT FURTHERMORE HAS BEEN SPECIFICALLY DESIGNED TO MINIMIZE RECTANGULAR PATTERN DISTORTION AND PHASE SHIFT AT THE IMPORTANT LOWER FREQUENCIES AS WELL.

IN TELEVISION SERVICE APPLICATIONS, FOR EXAMPLE, THE 'SCOPE IS EXTENSIVELY USED BOTH FOR VISUAL ALIGNMENT PROCEDURES (A LOW FREQUENCY APPLICATION), AND FOR SIGNAL TRACING AND SIGNAL ANALYSIS (HIGHER FREQUENCY). FOR THE LOW FREQUENCY ALIGNMENT APPLICATIONS THE EXCELLENT LOW FREQUENCY CHARACTERISITCS OF THE ES-500A INSURE FAITHFUL REPRODUCTION OF THE SEMI-RECTANGULAR WAVE SHAPES ENCOUNTERED IN VIDEO IF AND OVERALL TV ALIGNMENT. HOWEVER IN THE EQUALLY IMPORTANT TECHNIQUE OF SIGNAL TRACING IN TV ANALYSIS, NUMEROUS WAVESHAPES ARE ENCOUNTERED WITH HARMONIC CONTENT APPROACHING 1 MEGACYCLE IN FREQUENCY. IF THESE HARMONIC COMPONENTS ARE NOT PROPERLY AMPLIFIED BY THE 'SCOPE, NUMEROUS PULSE WAVE-SHAPES (SUCH AS HORIZONTAL SYNC PULSES) WILL BE DISTORTED AND IMPROPERLY DISPLAYED. THE CAREFULLY ENGINEERED HIGHER FREQUENCY AMPLIFICATION CHARACTERISTICS OF THE ES-500A MINIMIZE PULSE DISTORTION WHEN THE 'SCOPE IS PROPERLY EMPLOYED AND APPLIED TO THE TEST CIRCUIT.

IN THIS CONNECTION IT IS EXTREMELY IMPORTANT TO REALIZE THAT SELECTION AND USE OF TEST LEADS OR PROBES BETWEEN THE VERTICAL INPUT OF THE 'SCOPE AND THE CIRCUIT UNDER TEST CAN SIGNIFICANTLY AFFECT THE TEST RESULTS OBTAINED. FOUR MOST USEFUL TYPES OF OSCILLOSCOPE PROBES HAVE BEEN DEVELOPED AND MADE AVAILABLE AS A COMPLETE SET DESIGNATED AS "PRECISION SERIES SP-5 OSCILLOSCOPE TEST PROBE SET.

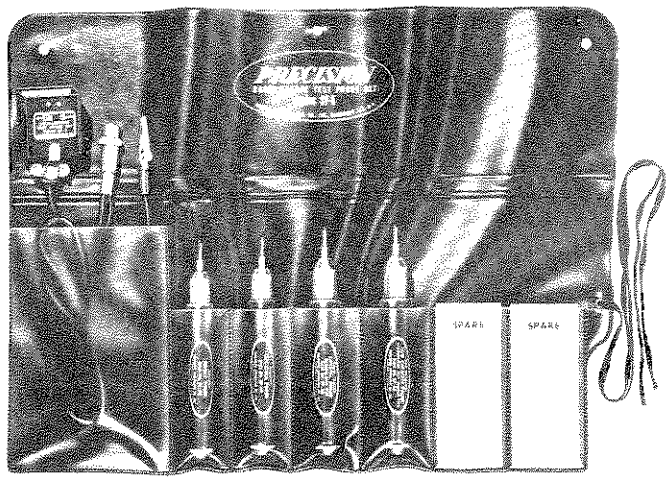


FIG. 8

A. OSCILLOSCOPE TEST PROBE SET: THIS SET CONTAINS THE FOLLOWING FOUR PROBES:-

THE HIGH-IMPEDANCE-LOW CAPACITY PROBE (TYPE SP-5A) IS REQUIRED FOR TESTS IN RELATIVELY HIGH IMPEDANCE CIRCUITS BEING ANALYZED THEREBY EFFECTIVELY CONVERTING THE INPUT OF THE 'SCOPE FOR GENERAL PURPOSE HIGH IMPEDANCE TESTING. IT IS FREQUENCY-COMPENSATED TO PERMIT FAITHFUL SCOPE REPRODUCTIONS OF HIGH-HARMONIC-CONTENT PULSES SUCH AS TV HORIZONTAL AND VERTICAL SYNC PULSES. THE PROBE IS ALSO DESIGNED TO BLOCK DC COMPONENTS FROM REACHING THE INPUT OF THE SCOPE.

THE CRYSTAL-DEMODULATOR PROBE (TYPE SP-5B) PERMITS THE SCOPE TO BE USED TO EXAMINE THE MODULATION COMPONENTS OF AN OVERALL RF SIGNAL. FOR EXAMPLE, THE TV STATION TRANSMITS A COMPOSITE TV VIDEO SIGNAL WHICH CONSISTS OF AN RF CARRIER MODULATED BY PICTURE INFORMATION PLUS BLANKING AND ASSOCIATED SYNC PULSES. THE MODULATED RF MUST BE RECTIFIED (DEMODULATED), BEFORE APPLICATION TO THE OSCILLOSCOPE, SO THAT THE INFORMATION CONTENT MAY BE VIEWED.

THIS PROBE CAN ALSO BE GENERALLY EMPLOYED TO TRACE MODULATED CARRIERS IN MOST COMMUNICATION CIRCUITS AND SYSTEMS.

THE RESISTIVE-ISOLATING PROBE (TYPE SP-5C) FINDS USEFUL APPLICATION IN VISUAL ALIGNMENT PROCEDURES. THE NAME OF THE PROBE INDICATES ONE OF ITS ESSENTIAL FUNCTIONS, NAMELY, TO ISOLATE THE CIRCUIT UNDER TEST FROM THE OSCILLOSCOPE CABLE AND SCOPE INPUT CIRCUIT.

IN ADDITION, THIS PROBE ALSO SERVES AS A SHIELDED LOW-PASS FILTER TO SHARPEN BROAD MARKER PIPS WHICH MIGHT OTHERWISE MASK IMPORTANT PORTIONS OF RESPONSE TRACES.

THE SHIELDED DIRECT PROBE (TYPE SP-5D) PROVIDES CONVENIENT DIRECT TEST FACILITIES, NOT ASSOCIATED WITH ANY INTERVENING CIRCUIT COMPONENTS. THIS DIRECT PROBE IS TO BE EMPLOYED IN SUCH CIRCUITS WHEREIN THE CABLE CAPACITY IS NOT IMPORTANT. SUCH CIRCUITS USUALLY ARE RELATIVELY LOW IN IMPEDANCE AND/OR ARE INVOLVED WITH LOW FREQUENCIES.

THIS TEST PROBE SET FINDS CHIEF APPLICATION IN TV TESTING AND ANALYSIS AND IS AVAILABLE AS A SEPARATE ACCESSORY TEST SET AT YOUR FAVORITE RADIO AND TV DEALER OR DISTRIBUTOR.

SPECIFIC APPLICATION INSTRUCTIONS FOR USE OF EACH PROBE ARE INCLUDED IN THE INSTRUCTION BOOK ACCOMPANYING EACH SP-5 TEST SET.

B. CALIBRATION OF THE OSCILLOGRAPH AS AN AC, PEAK-TO-PEAK, HIGH IMPEDANCE VOLTMETER:

IN THE ANALYSIS OF BOTH SINUSOIDAL AND NON-SINUSOIDAL VOLTAGES IT IS IMPORTANT TO KNOW BOTH MAGNITUDE AND WAVEFORM OF THE UNKNOWN VOLTAGES. THE OSCILLOSCOPE IS OF COURSE INVARIABLY USED TO DETERMINE WAVE SHAPE; YET IN MANY APPLICATIONS, (PARTICULARLY TELEVISION), - MANY PEOPLE ATTEMPT TO USE A VTVM WITH A PEAK-TO-PEAK INDICATING PROBE TO OBTAIN VOLTAGE READINGS, INSTEAD OF AN OSCILLOSCOPE.

THE OSCILLOSCOPE IS HOWEVER INHERENTLY FAR SUPERIOR TO THE PEAK-TO-PEAK VTVM FOR RELIABLE MEASUREMENT OF MANY NON-SINUSOIDAL VOLTAGES ENCOUNTERED IN TELEVISION ANALYSIS. AN APPRECIABLE NUMBER OF TV VOLTAGES INCLUDE VERY NARROW PULSE COMPONENTS (OF LOW ENERGY CONTENT) TO WHICH THE USUAL PEAK-TO-PEAK VTVM WILL NOT RESPOND PROPERLY. THE 'SCOPE HOWEVER CAN DISPLAY SUCH COMPONENTS, YIELDING TRUE PEAK AND PEAK-TO-PEAK VOLTAGE READINGS.

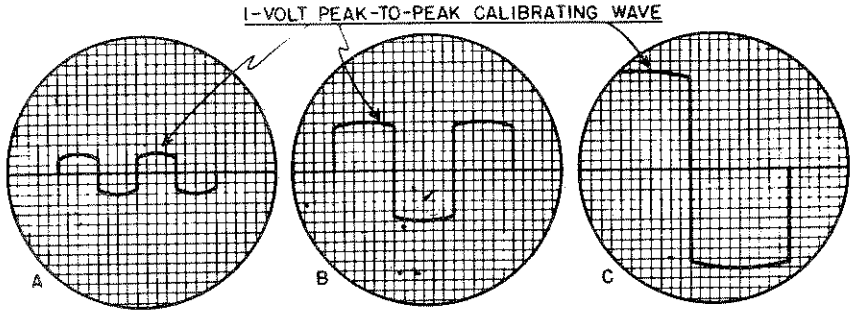
IN ORDER TO USE THE OSCILLOSCOPE AS A DIRECT READING HIGH IMPEDANCE VOLTMETER IT IS MERELY NECESSARY TO CALIBRATE THE SQUARES ON THE CROSS-HATCH MASK IN TERMS OF VOLTAGE.

THE "1 V P-P" PUSH-BUTTON ON THE PANEL OF ES-500A ACTUATES A REGULATED ONE VOLT PEAK TO PEAK SCREEN CALIBRATING VOLTAGE.

THE FACT THAT THIS VOLTAGE IS FIXED AND REGULATED PERMITS IT TO BE USED AS A SCREEN-CALIBRATING SOURCE AS FOLLOWS:

1. WITH NO SIGNAL APPLIED TO THE 'SCOPE: ADJUST THE HORIZONTAL 'SCOPE TRACE TO COINCIDE WITH THE MIDDLE HORIZONTAL LINE OF THE CROSS-HATCH MASK.
2. DEPRESS THE "PRESS TO CAL" PUSH-BUTTON. - USE 60 CYCLE INTERNAL SWEEP.
3. WITH THIS BUTTON DEPRESSED, THE MAGNITUDE OF THE SEMI-SQUARE WAVE PATTERN OBTAINED ON THE 'SCOPE SCREEN IS ONE PEAK-TO-PEAK VOLT.
4. TO CALIBRATE THE CROSS HATCH MASK OF THE 'SCOPE AS A DIRECT-READING, HIGH IMPEDANCE A.C. VOLTMETER IT IS MERELY NECESSARY TO ADJUST THE "V GAIN" CONTROL (WITH THE "VERT" SENSITIVITY SWITCH SET TO "X10") UNTIL THE SQUARE WAVE PATTERN ASSUMES A HEIGHT OF 10 SQUARES. AFTER THIS IS DONE DO NOT DISTURB THIS SETTING OF THE "V GAIN" CONTROL.

SEE FIG. 9, MIDDLE ILLUSTRATION.



EXAMPLES OF PEAK-TO-PEAK CALIBRATION OF OSCILLOSCOPE

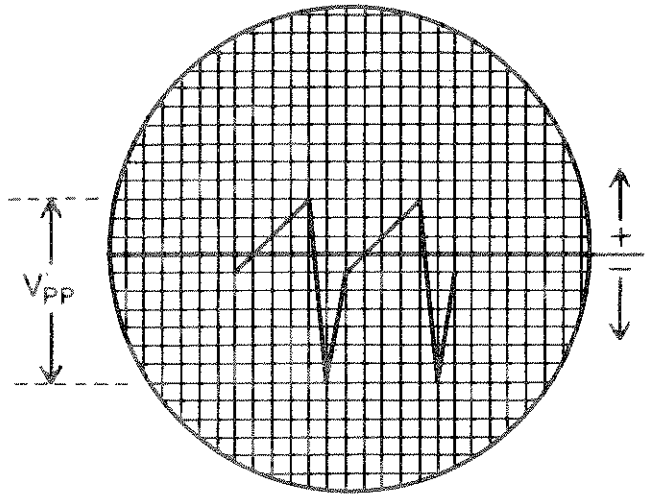
A - GAIN CONTROLS SET TO PROVIDE A SENSITIVITY OF 0.25 V. P-P PER SQUARE

B - " " " " " " " " 0.10 " " " "

C - " " " " " " " " 0.05 " " " "

FIG. 9

ONCE THIS SETTING IS MADE, (RELEASE THE PUSH BUTTON), THE 'SCOPE IS AUTOMATICALLY CALIBRATED SUCH THAT EACH VERTICAL BOX OR SQUARE = .1 VOLT P-P. AN EXTERNAL A.C. VOLTAGE WHOSE TOTAL PEAK-TO-PEAK HEIGHT ON THE SCREEN EQUALS, FOR EXAMPLE, 10 SQUARES, IS A 1.0 VOLT PEAK-TO-PEAK VOLTAGE (10 x .1 = 1.0 VOLTS).



SCOPE HAS BEEN CALIBRATED FOR 0.1 PEAK-TO-PEAK VOLT PER SQUARE.

WAVEFORM MEASURES 1 PEAK-TO-PEAK VOLT.

POSITIVE PEAK MEASURES 0.3 PEAK VOLT.

NEGATIVE PEAK MEASURES 0.7 PEAK VOLT.

SAWTOOTH COMPONENT MEASURES 0.4 PEAK-TO-PEAK VOLT.

PULSE COMPONENT MEASURES 0.6 PEAK-TO-PEAK VOLT.

FIG. 10

THE "V SENSITIVITY" SWITCH FUNCTIONS AS A X10 MULTIPLIER OR DIVIDER AS FOLLOWS:

FOR EXAMPLE: WITH THE SCREEN CALIBRATED AS DETAILED ABOVE (VERT. SENSITIVITY AT "X10", "PRESS TO CAL" BUTTON DEPRESSED, "V GAIN" CONTROL ADJUSTED SUCH THAT THE SQUARE WAVE OCCUPIES 10 VERTICAL SQUARES) THE 'SCOPE SCREEN IS CALIBRATED TO READ .1 PEAK-TO-PEAK VOLT PER SQUARE.

IF THE "VERT. SENSITIVITY" SWITCH IS NOW SWITCHED TO THE "X1" POSITION, THE SCREEN NOW INDICATES 1 PEAK-TO-PEAK VOLT PER SQUARE.

IF THE "VERT. SENSITIVITY" SWITCH IS NEXT SWITCHED TO THE "X100" POSITION, THE SCREEN INDICATES .01 PEAK-TO-PEAK VOLT PER SQUARE.

INASMUCH AS THERE ARE 40 SQUARES ON THE USEABLE PORTION OF THE SCREEN, THE ABOVE METHOD OF CALIBRATION PROVIDES ACCURATE READINGS FROM .01 VOLT TO 40 VOLTS, PEAK-TO-PEAK.

IF IT IS DESIRED TO DIRECTLY MEASURE VOLTAGES ABOVE 40 VOLTS AND UP TO 400 VOLTS, THE FOLLOWING METHOD OF CALIBRATION SHOULD BE USED:

1. PRESS THE "PRESS TO CAL." BUTTON.
2. SET THE "VERT. SENSITIVITY" SWITCH TO X100.
3. ADJUST THE SQUARE WAVE TO A HEIGHT OF 10 SQUARES BY ADJUSTING THE "V GAIN" CONTROL.
4. RELEASE THE PUSH BUTTON.
5. EACH SQUARE NOW REPRESENTS .1 PEAK-TO-PEAK VOLT.
6. SWITCH THE "VERT. SENSITIVITY" SWITCH TO "X1" POSITION. DO NOT DISTURB THE SETTING OF THE "V GAIN " CONTROL!
7. EACH SQUARE OF THE SCREEN NOW REPRESENT 10 PEAK-TO-PEAK VOLTS - THE TOTAL OF 40 SQUARES ON THE SCREEN NOW REPRESENTS 400 PEAK-TO-PEAK VOLTS.

TO READ VOLTAGES ABOVE 400 PEAK-TO-PEAK VOLTS THE LOW CAPACITY SP-5A 10 TO 1 PROBE SHOULD BE USED.

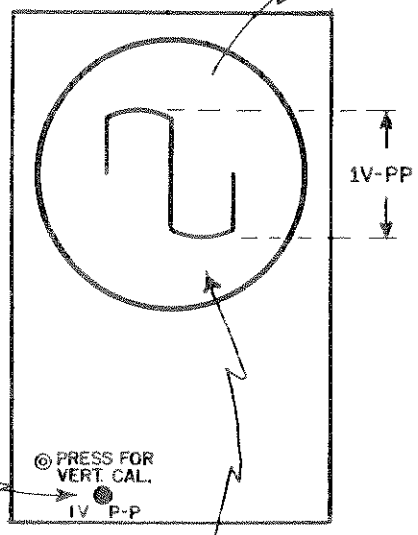
FOR EXAMPLE IF A POTENTIAL OF 800 PEAK-TO-PEAK VOLTS IS TO BE MEASURED, THE SCREEN IS CALIBRATED FOR 10 PEAK-TO-PEAK VOLTS PER SQUARE AS DESCRIBED ABOVE. USING THE SP-5A PROBE EACH SQUARE NOW REPRESENT 100 PEAK-TO-PEAK VOLTS.

CALIBRATION OF THE ES-500A OSCILLOSCOPE AS A PEAK TO PEAK HIGH IMPEDANCE VOLTMETER

FIG. 11

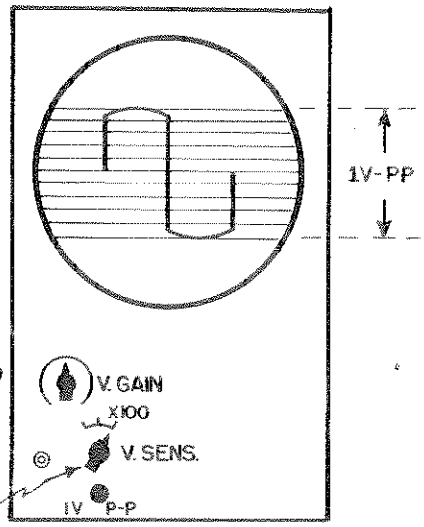
① DEPRESS "PRESS FOR VERT. CAL." BUTTON. (THIS CONNECTS INTERNAL 1V. P-P TO VERTICAL INPUT OF SCOPE.)

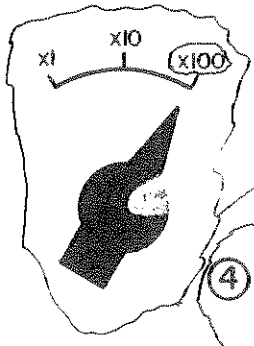
KEEP THIS BUTTON DEPRESSED THROUGHOUT THE CALIBRATION PROCEDURE.



② THIS PRODUCES A SCREEN PATTERN OF THE 1V. P-P WAVE.

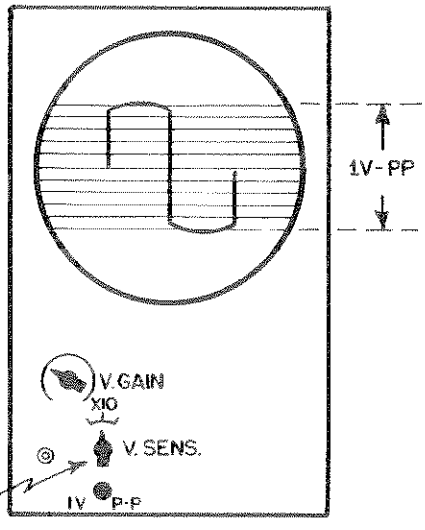
③ THE HEIGHT OF THE 1V. P-P WAVE DEPENDS UPON THE SETTING OF THE "V. GAIN" CONTROL AND THE "V. SENSITIVITY" SWITCH.

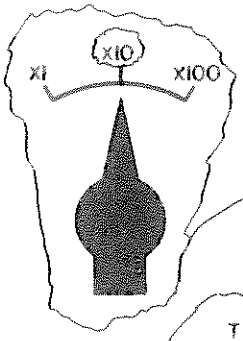




④ FOR EXAMPLE, WITH THE "V. SENSITIVITY" SWITCH SET TO X100 POSITION, ADJUST "V. SENSITIVITY" CONTROL UNTIL 1V. P-P PATTERN OCCUPIES A TOTAL OF 10 VERTICAL SQUARES.

⑤ RELEASE BUTTON: NOW, AS LONG AS THE "V. SENSITIVITY" CONTROL IS LEFT UNTOUCHED THE SCOPE IS CALIBRATED SO THAT EACH SQUARE EQUALS .1 VOLT.





⑥ THE SAME PROCEDURE COULD HAVE BEEN USED EXCEPT WITH THE "V. SENSITIVITY" SWITCH SET TO "X10" POSITION. ("V GAIN" CONTROL AT A HIGHER SETTING.)

⑦ THE OPERATOR MAY CHOOSE ANY ONE OF THE "V. SENSITIVITY" SWITCH POSITIONS ("X1", "X10" OR "X100") TO CALIBRATE.

IF THE OPERATOR USES THE "X100" POSITION FOR CALIBRATION, THEN THE SCOPE WILL READ .1 VOLT PER SQUARE IN THE "X100" POSITION, 1.0 VOLT PER SQUARE IN THE "X10" POSITION, AND 10 VOLTS PER SQUARE IN THE "X1" POSITION.

IF THE OPERATOR USES THE "X10" POSITION FOR CALIBRATION THEN THE SCOPE WILL READ .1 VOLT PER SQUARE IN THE "X10" POSITION, 1 VOLT PER SQUARE IN THE "X1" POSITION, AND .01 VOLT PER SQUARE IN THE "X100" POSITION.

IF THE "X1" POSITION IS USED, ADJUST THE "V. SENSITIVITY" CONTROL SO THAT PATTERN OCCUPIES ONE SQUARE. THEN THE VOLTAGE RANGE OF THE SCOPE WILL BE 1 VOLT PER SQUARE IN THE "X1" POSITION, .1 VOLT PER SQUARE IN THE "X10" POSITION AND .01 VOLT PER SQUARE IN THE "X100" POSITION.

ATTACHMENT OF THE LOW CAPACITY 10-1 PROBE (PRECISION SP-5A) AFTER CALIBRATION, AUTOMATICALLY EXTENDS THE CALIBRATED RANGE BY A FACTOR OF 10 (A CALIBRATED RANGE OF 10 VOLTS PER SQUARE BECOMES 100 VOLTS PER SQUARE WHEN THE SP-5A PROBE IS ATTACHED TO THE 'SCOPE).

NOTE: IN SOME ES-500A MODELS WHERE A 1V. P-P TERMINAL POST APPEARED INSTEAD OF THE "PRESS FOR VERT. CAL." 1 V P-P BUTTON, CONNECT A JUMPER FROM THE 1V-PP POST TO THE VERT. INPUT POST AND FOLLOW THE SAME PROCEDURE AS OUTLINED ABOVE.

C. COMPOSITE DC AND AC VOLTAGES: THE MOST IMPORTANT FUNCTION OF A COMMERCIAL CATHODE RAY OSCILLOSCOPE IS THE ANALYSIS OF AC WAVE-SHAPES. HOWEVER CERTAIN AC POTENTIALS MAY BE A PART OF A COMPOSITE AC AND DC POTENTIAL. AS A SIMPLE EXAMPLE, THE VOLTAGE ACROSS THE INPUT FILTER CONDENSER OF A POWER SUPPLY WILL BE A DC VOLTAGE UPON WHICH IS SUPER-IMPOSED AN AC RIPPLE. SEE FIG. 12.

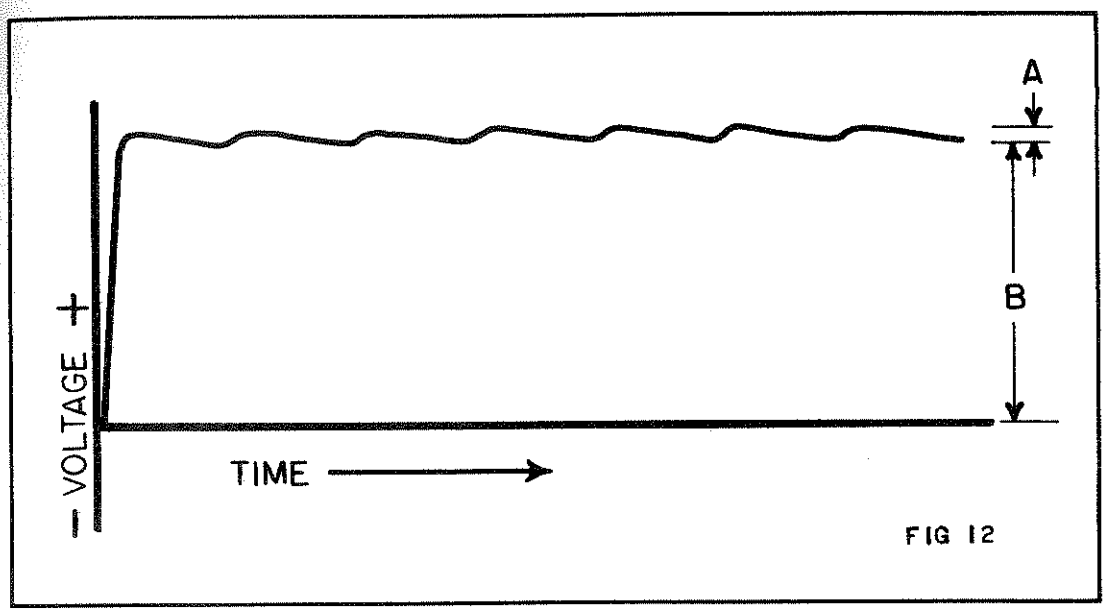


FIG 12

THE VOLTAGE IS ACTUALLY A DC VOLTAGE WHICH IS VARYING IN MAGNITUDE AS A RESULT OF THE CHARGE AND DISCHARGE ACTION OF THE FILTER. THE RIPPLE POTENTIAL "A" IS HOWEVER AN ALTERNATING VOLTAGE IN ITSELF AND WILL AFFECT THE RECEIVER CIRCUITS AS AN ALTERNATING VOLTAGE. IF THIS D.C. POTENTIAL WITH ITS SUPERIMPOSED RIPPLE IS APPLIED TO THE INPUT TERMINALS OF THE 'SCOPE THE PATTERN OBTAINED WILL APPEAR AS IN FIG. 13.

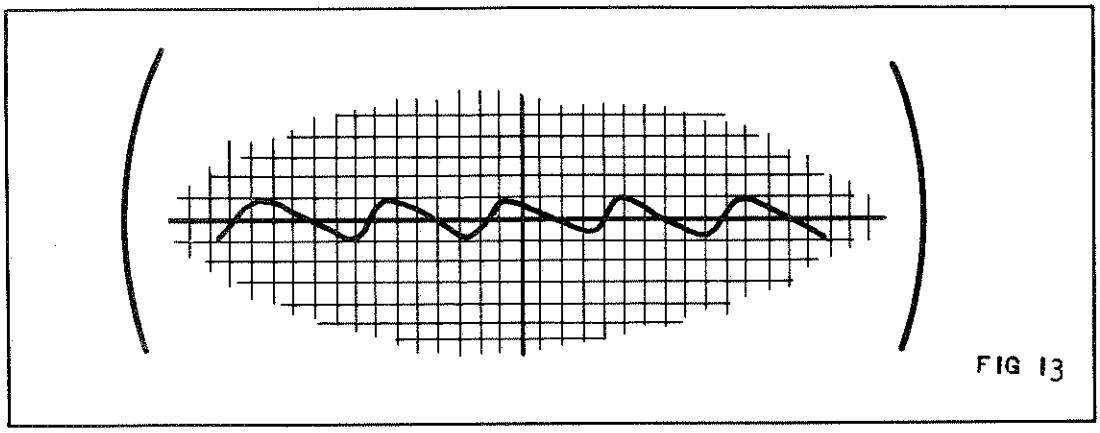


FIG 13

IT IS IMPORTANT TO NOTE THAT THE DC PORTION OF THE TOTAL POTENTIAL IS NOT DISPLAYED BY THE 'SCOPE. DC POTENTIALS ARE BLOCKED BY THE SERIES INPUT CAPACITOR OF THE 'SCOPE AND BY THE CAPACITY COUPLING EMPLOYED BETWEEN THE AMPLIFIER STAGES OF THE 'SCOPE.

D. OBSERVATION OF AC AND DC COMPONENTS

IF IT IS DESIRED TO OBSERVE BOTH THE DC AND ITS SUPERIMPOSED AC COMPONENT, (WITH THE PROPER RELATION TO THE ZERO VOLTAGE AXIS), THE VOLTAGE SHOULD BE CONNECTED DIRECTLY TO THE DEFLECTION PLATES OF THE CR TUBE (SEE PAGE 6).

THE DC BLOCKING OF THE AMPLIFIER STAGES IS THUS ELIMINATED, AND THE AC COMPONENT WILL APPEAR ABOVE THE HORIZONTAL BASE-LINE OF THE CROSS HATCH MASK TO AN EXTENT DETERMINED BY THE MAGNITUDE OF THE DC COMPONENT. SEE FIG. 15.

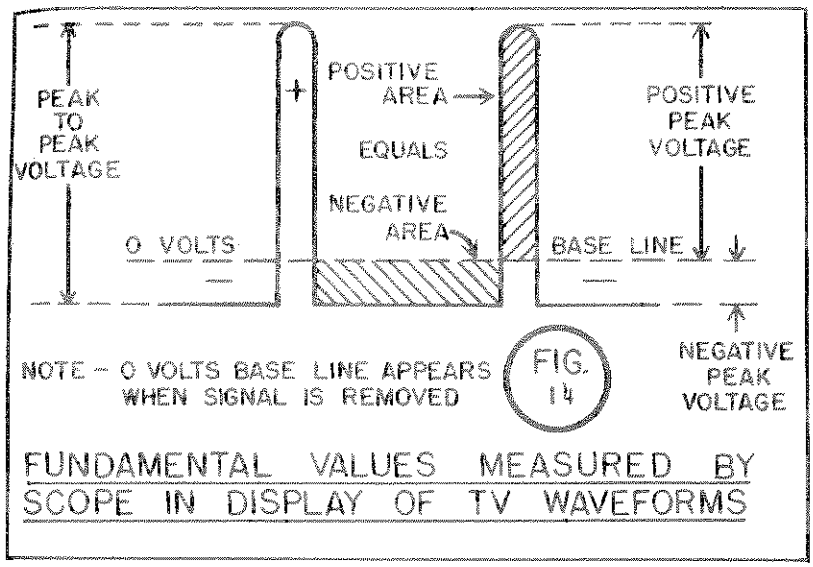


FIG. 14

FUNDAMENTAL VALUES MEASURED BY SCOPE IN DISPLAY OF TV WAVEFORMS

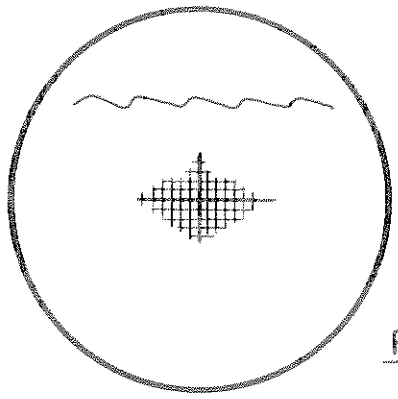


FIG. 15

DC WITH RIPPLE APPLIED DIRECTLY TO CR TUBE DEFLECTION PLATES

THE RELATIVE MAGNITUDE OF THE POSITIVE AND NEGATIVE CYCLES OF A NON SINUSOIDAL VOLTAGE WAVEFORM DEPENDS UPON THE SHAPE AND PROPORTIONS OF THE WAVEFORM.

AS AN EXAMPLE:- WITH NO SIGNAL APPLIED TO THE 'SCOPE, ADJUST THE HORIZONTAL 'SCOPE TRACE TO COINCIDE WITH THE MIDDLE HORIZONTAL LINE OF THE CROSS HATCH MASK.

IF A SINUSOIDAL VOLTAGE IS NOW APPLIED TO THE 'SCOPE, THE POSITIVE PORTION OF THE SINE WAVE WILL EQUAL THE NEGATIVE PORTION.

IF, HOWEVER A NON-SINUSOIDAL VOLTAGE OF THE SHAPE INDICATED IN FIG. 14 IS NEXT APPLIED, THE POSITIVE AND NEGATIVE PORTIONS WILL BE REVEALED AS STRIKINGLY UNEQUAL.

THE CONCLUSION TO BE DRAWN FROM THIS DISCUSSION IS AS FOLLOWS:

"THE AC OSCILLOSCOPE ALWAYS PORTRAYS A NON-SINUSOIDAL VOLTAGE AS IT WILL BE TRANSMITTED THROUGH AC COUPLED CIRCUITS IN ACTUAL EQUIPMENT."

E. DISPLAY OF CLEAN SYNC PULSES

IT SHOULD BE OBSERVED THAT THE "BLANKING PHASE" CONTROL PERMITS THE OPERATOR TO OBTAIN A CLEAN HORIZONTAL SYNC PULSE, OR A CLEAN VERTICAL SYNC PULSE, AS ILLUSTRATED IN FIG. 2 PG. 4. IN THIS APPLICATION, THE SYNC PULSE IS DISPLAYED IN THE NORMAL MANNER, AND THE "BLANKING PHASE" CONTROL IS THEN ROTATED AS REQUIRED TO DISPLAY THE PULSE WITHOUT INTERFERENCE.

F. RETRACE MINIMIZATION

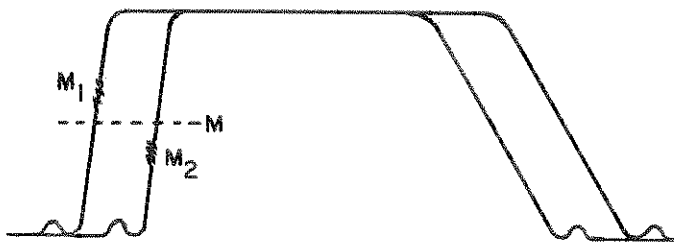
THE RETRACE MAY BE VISIBLE WHEN HIGH-FREQUENCY SWEEP IS BEING USED TO DISPLAY HORIZONTAL SWEEP OR SYNC WAVEFORMS. IN SUCH CASE, THE RETRACE CAN BE MINIMIZED BY USE OF A LOWER FREQUENCY SWEEP RATE. TO EXPAND THE WAVEFORM TO ITS FORMER WIDTH, ADVANCE THE "HORIZONTAL GAIN" CONTROL AS REQUIRED.

G. APPARENT DISPLACEMENT OF MARKER PIPS OBTAINED IN VISUAL ALIGNMENT

UNDER SOME CONDITIONS, THE OPERATOR MAY OBSERVE THAT THE MARKER APPEARS HIGHER UP ON THE TRACE THAN ON THE RETRACE, AS SHOWN IN FIG. 16 WHEN USING 60-CYCLE SINE-WAVE SWEEP IN ALIGNMENT WORK.

IT WILL BE OBSERVED THAT THE MARKER "DISPLACEMENT" APPEARS GREATER ON THE STEEPER PORTION OF THE CURVE, AND BECOMES LESS AS THE SWEEP WIDTH IS REDUCED. FURTHERMORE, THE "DISPLACEMENT" BECOMES GREATER AS THE EXTERNAL INPUT CAPACITANCE TO THE 'SCOPE IS INCREASED.

THIS "DISPLACEMENT" APPEARS BECAUSE EXCESSIVE INPUT CAPACITANCE INCREASES THE DECAY TIME FOR STEEP WAVEFRONTS BEYOND PERMISSIBLE LIMITS. AS A RESULT, THE ELECTRON BEAM IN THE CRT LAGS THE DETECTOR VOLTAGE, AND FALSE INDICATION IS OBTAINED ON THE 'SCOPE SCREEN.



MARKERS, NORMALLY APPEARING AT LEVEL "M", APPEAR AT M_1 AND M_2 WHEN INPUT CAPACITY OF SCOPE IS EXCESSIVELY HIGH

MARKER DISPLACEMENT IS CAUSED BY INCORRECT TEST CONDITIONS

SEE TEXT

FIG. 16

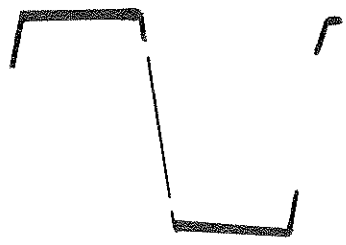
H. HORIZONTAL SPREAD OF MARKER PIPS OBTAINED IN FM AND TV VISUAL ALIGNMENT

IF THE EXTERNAL INPUT CAPACITY TO THE 'SCOPE IS QUITE LOW, MARKER PIPS ON FM OR TV RESPONSE CURVES MAY APPEAR QUITE BROAD, PARTICULARLY ON HORIZONTALLY FLAT PORTIONS OF THE WAVESHAPE. SUCH PIPS MAY BE "SHARPENED" BY SHUNTING THE VERTICAL INPUT TERMINALS WITH A LOW CAPACITY CONDENSER.

NOTE: USE THE LOWEST VALUE CONDENSER THAT WILL SATISFACTORILY SHARPEN THE MARKER: EXCESSIVELY HIGH CONDENSER VALUES MAY GIVE RISE TO DISPLACEMENT OF MARKER PIPS ALREADY DISCUSSED IN "G" ABOVE.

I. ADJUSTMENT OF POWER-SUPPLY VIBRATORS:

DURING OPERATION IN THE RADIO RECEIVER, OR IN A SUITABLE TEST JIG, AN OSCILLOGRAPHIC TEST OF THE WAVEFORM ACROSS THE PRIMARY OF THE VIBRATOR TRANSFORMER SHOULD DISPLAY A SHAPE SIMILAR TO THAT OF FIG. 17. BREAKS, PIPS, AND DIPS IN THE WAVESHAPE INDICATE VARIOUS CONTACT TROUBLES WHICH SHOULD BE CORRECTED AS REQUIRED.



TYPICAL VIBRATOR WAVE

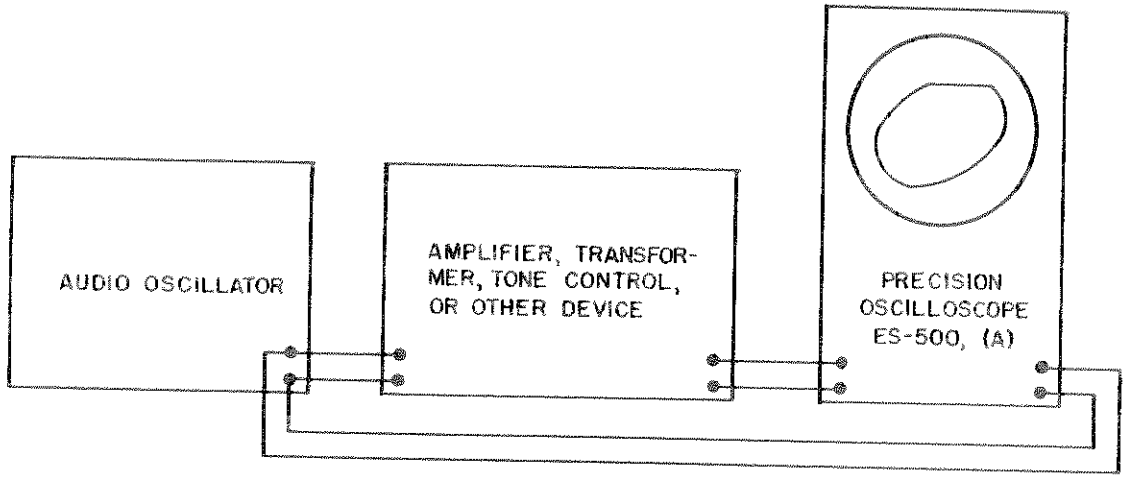
FIG. 17

J. AUDIO AMPLIFIER AND COMPONENT ANALYSIS

THE ES-500A IS ALSO VALUABLE IN CHECKING THE PERFORMANCE OF THE AUDIO SECTION OF A RECEIVER. FOR THIS PURPOSE, AN AUDIO OSCILLATOR IS USED IN A TEST SET-UP, AS SHOWN IN FIG. 18. THE WAVEFORMS SHOWN IN FIG. 19, NEXT PAGE, ILLUSTRATE:

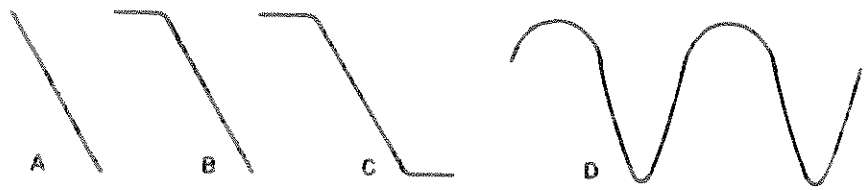
(A) NO DISTORTION AT THE FREQUENCY OF TEST, AND NO PHASE SHIFT; (B) OVERLOAD DISTORTION DUE TO LIMITING OR DRIVING BEYOND CUT-OFF; (C) OVERLOAD DISTORTION DUE TO LIMITING ACTION AND DRIVING BEYOND CUT-OFF; (E) PHASE SHIFT; (G,F) PHASE SHIFT PLUS OVERLOAD DISTORTION, (D) SHOWS THE SAWTOOTH-SWEPT DISPLAY OF "B", WHICH IS OBTAINED BY SINE WAVE SWEEP.

(SEE NEXT PAGE)



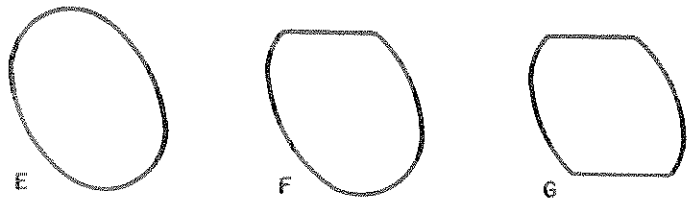
TEST SET-UP FOR DETERMINATION OF FREQUENCY RESPONSE, DISTORTION, PHASE SHIFT, AND HARMONIC GENERATION

FIG. 18



A, B, C, E, F, G, DISPLAYED WITH SINE-WAVE SWEEP

D - DISPLAY OBTAINED WITH SAWTOOTH SWEEP



APPLY SINE-WAVE SIGNAL TO HORIZONTAL INPUT OF SCOPE, AND TO INPUT OF AMPLIFIER UNDER TEST. APPLY OUTPUT OF AMPLIFIER TO VERTICAL INPUT OF SCOPE.

A - NO OVERLOAD DISTORTION, NO PHASE SHIFT
B - OVERLOAD DISTORTION, NO PHASE SHIFT
C - DRIVING INTO GRID CURRENT, AND PAST CUT-OFF, NO PHASE SHIFT
D - OVERLOAD DISTORTION
E - PHASE SHIFT
F - PHASE SHIFT, OVERLOAD DISTORTION
G - PHASE SHIFT, DRIVING INTO GRID CURRENT, AND PAST CUT-OFF

TYPICAL AMPLIFIER ANALYSES SHOWING GENERATION OF HARMONICS, AMPLITUDE DISTORTION, AND PHASE SHIFT

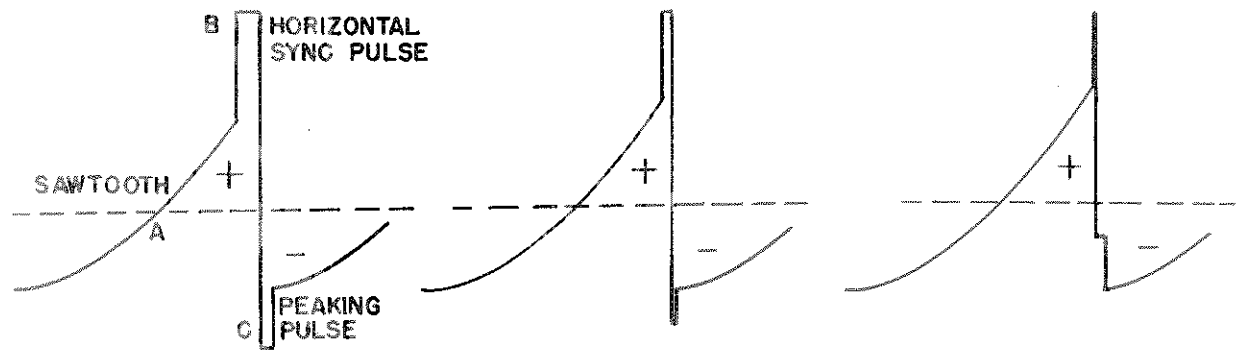
FIG. 19

K. ADJUSTMENT OF SYNC CIRCUITS

PROPER ADJUSTMENT OF THE THREE MAIN TYPES OF SYNC CIRCUITS IS GREATLY FACILITATED BY USE OF THE OSCILLOGRAPH. THESE ARE BRIEFLY REVIEWED IN ORDER:

1. PULSE-WIDTH TYPE OF SYNC-CONTROL CIRCUIT: AS SHOWN IN FIG. 20 THIS TYPE OF AFC SYSTEM UTILIZES THREE SIGNAL COMPONENTS COMPRISING THE "SAWTOOTH" A, THE POSITIVE SYNC PULSE B, AND A NEGATIVE PEAKING PULSE C. AS THE ADJUSTMENTS OF THE CIRCUIT ARE CHANGED, IT WILL BE OBSERVED THAT THE POSITIVE PEAK OF THE WAVE IS ABOUT 50% MAXIMUM.

SPECIAL NOTE: A TV STATION MUST BE TUNED IN DURING THE TIME THIS ADJUSTMENT IS MADE.



PULSE-WIDTH TYPE OF AFC PATTERNS, SHOWING OPERATION
FIG. 20

2. PULSE-AND-SAWTOOTH TYPE OF SYNC-CONTROL CIRCUIT: FIG. 21, PAGE 19, ILLUSTRATES TYPICAL CONTROL CIRCUIT WAVEFORMS. THE ADJUSTMENTS ARE MADE TO EQUALIZE THE PULSES AT THE POSITIVE AND NEGATIVE PEAKS OF THE SAWTOOTH WAVE.

3. SINE-WAVE AND PULSE TYPE OF SYNC-CONTROL CIRCUIT: TYPICAL WAVEFORMS ARE SHOWN IN FIG. 22, PAGE 19. THE SYNC TRANSFORMER IS ADJUSTED TO PHASE THE PULSES ON THE SINE WAVES AS SHOWN IN THE INSET.

THERE ARE ALSO LESS-COMMON TYPES OF AFC CIRCUITS FOR HORIZONTAL SYNC STABILIZATION; IN THESE CIRCUITS THE OPERATOR WILL ALSO FIND THE 'SCOPE A MOST VALUABLE TOOL. THE MANUFACTURER'S SERVICE DATA SHOULD BE CONSULTED TO DETERMINE THE PROPER WAVEFORM INDICATION.

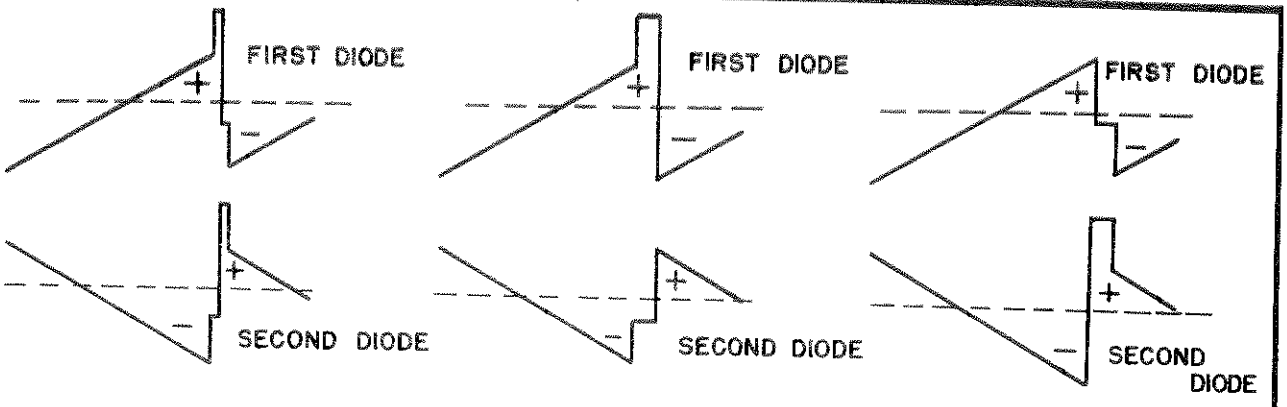
L. TROUBLESHOOTING BUZZ AND HUM:

BECAUSE 60-CYCLE BUZZ IN THE SOUND IS A COMMON TROUBLE COMPLAINT, THE OPERATOR CANNOT AFFORD TO OVERLOOK THE UTILITY OF THE 'SCOPE IN THIS APPLICATION.

REMEMBER THAT IN THE AUDIO SECTION, YOU WILL USE A DIRECT CABLE TO THE 'SCOPE, OR PERHAPS THE 10-TO-1 PROBE. HOWEVER, IN THE HIGH-FREQUENCY SECTIONS OF THE RECEIVER, YOU WILL USE A SIGNAL-TRACING PROBE. (SP-5B).

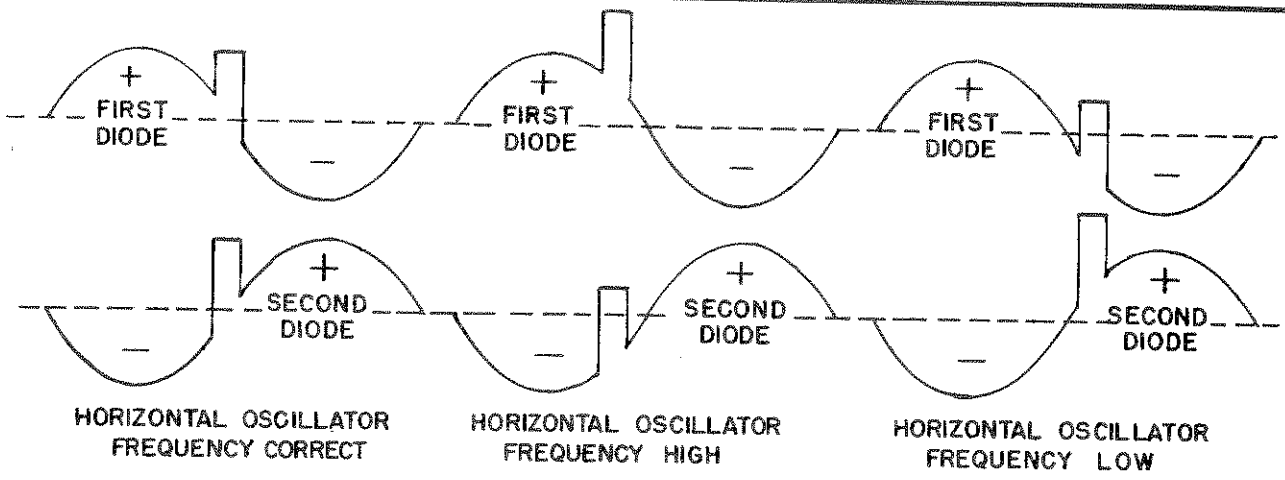
USE 60 CYCLE LINE SWEEP FOR THIS ANALYSIS, AND FAMILIARIZE YOURSELF WITH THE DISPLAY OF HUM AND PULSES: HUM DUE TO SINE-WAVE VOLTAGES WILL APPEAR AS AN ELLIPSE ON THE SCREEN. THE WIDER THE ELLIPSE, THE GREATER THE HUM. BUZZ WILL APPEAR AS DISCONTINUITY IN THE BASE LINE (OR ELLIPSE IF HUM IS ALSO PRESENT). BUZZ MAY APPEAR AS A SAWTOOTH OR TRIANGLE, OR AS A PIP.

TRACE THE SPURIOUS SIGNAL OR SIGNALS BACK TO THEIR SOURCE, USING SUITABLE PROBES. IF THE BUZZ IS WEAK, USE FULL GAIN ON THE 'SCOPE. NOTE THAT THE PHASE CONTROL OF THE 'SCOPE CAN BE USED TO OBTAIN THE MOST FAVORABLE DISPLAY OF THE SIGNAL.



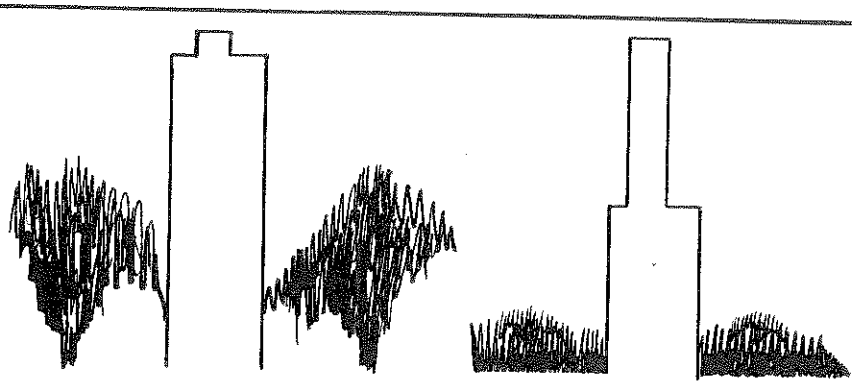
TYPICAL WAVEFORMS OF PULSE-SAWTOOTH AFC SYNC SYSTEM

FIG. 21



TYPICAL WAVEFORMS IN PULSE-SINEWAVE DISCRIMINATOR AFC SYNC SYSTEM

FIG. 22



LIMITING OF VIDEO-AMPLIFIER SIGNAL DUE TO INCORRECT BIASING

FIG. 23

BUZZ IS SOMETIMES CAUSED BY RECEIVER OVERLOADING. TO CHECK THIS POSSIBILITY, OBSERVE THE COMPOSITE VIDEO WAVEFORM AT THE SOUND-TAKEOFF POINT, USING THE 10-TO-1 PROBE. HORIZONTAL SYNC PULSES, SEEN WHEN USING A 15,750-CYCLE SAWTOOTH SWEEP, SHOULD APPEAR UNDISTORTED AS IN FIG. 2, AND NOT LIMITED OR CLIPPED, AS SHOWN IN FIG. 23A. LIKEWISE, THE CAMERA SIGNAL SHOULD NOT SHOW EVIDENCE OF LIMITING, AS SHOWN IN FIG. 23B.

VI. MAINTENANCE NOTES

THE HIGH VOLTAGE POWER SUPPLY IN YOUR ES-500A IS A SOURCE OF DANGEROUSLY HIGH POTENTIALS. NEVER ATTEMPT INDISCRIMINATE ADJUSTMENTS OR REPAIRS TO THE CHASSIS OF THE SERIES ES-500A WITH THE LINE CORD CONNECTED TO THE POWER SOURCE.

IN CASES WHEREIN THE INSTRUMENT DOES NOT APPEAR TO BE ENERGIZED OR POWERED WHEN THE LINE CORD IS INSERTED INTO THE POWER LINES (AND WITH THE "INTENSITY" CONTROL ADVANCED CLOCKWISE), THE 2 AMPERE TYPE 3AG FUSE SHOULD BE EXAMINED FOR BURN-OUT. THE FUSE IS MOUNTED BEHIND THE ETCHED BACK SERIAL PLATE AS INDICATED.

NEVER REPLACE A BURNED FUSE UNTIL THE CONDITION WHICH CAUSED THE FUSE BURN-OUT HAS BEEN CORRECTED. IF IT BECOMES NECESSARY TO REMOVE THE INSTRUMENT FROM THE CASE, THIS CAN BE DONE BY REMOVING THE PANEL SCREWS, AND THE CHASSIS-HOLDING SCREWS AT THE REAR OF THE CASE.

NOTE 1: TEST LEADS OR CABLES ARE NOT FURNISHED WITH THE SERIES ES-500A. THERE ARE SO MANY DIVERSIFIED APPLICATIONS FOR A CATHODE-RAY OSCILLOGRAPH THAT IT WOULD BE ESSENTIALLY IMPOSSIBLE TO SUPPLY ANY ONE SET OF LEADS OR CABLES THAT WOULD BE UNIVERSALLY USEABLE.

HOWEVER FOR THE SPECIALIZED FIELDS OF TV AND RADIO IT IS ADVANTAGEOUS TO USE SPECIFIC TYPES OF PROBES SUCH AS IMCLUDED IN THE SP-5 PROBE SET. THIS ACCESSORY TEST SET MAY BE PURCHASED FROM THE SAME SUPPLY HOUSE THAT SUPPLIED YOU WITH YOUR ES-500A!

NOTE 2: NEVER APPLY VOLTAGES HIGHER THAN 600 VOLTS PEAK TO ANY OF THE ES-500A INPUT CONNECTING TERMINALS WITHOUT USING AN ADDITIONAL EXTERNAL SERIES ISOLATING CAPACITOR. (APPROXIMATELY .5 MFD. CAPACITY AND OF PROPER VOLTAGE RATING).

THE CIRCULAR LIGHT SHIELD PROVIDED WITH SERIES ES-500A PERMITS EFFECTIVE USE OF THE INSTRUMENT IN BRIGHTLY LIGHTED LOCATIONS. THE SHIELD IS OF SNAP-ON ROTATABLE TYPE AND IS EASILY REMOVED AND RE-INSERTED AS DESIRED. A SLOT IN THE SHIELD PERMITS THE CROSS-SECTION MASK TO BE INSERTED WITHOUT REMOVING THE SHIELD.

THE CROSS-SECTION TRANSPARENT MASK PROVIDES DESIRED COMPARISON-CALIBRATION FACILITIES. THE MASK MAY BE ROTATED SLIGHTLY, IF NECESSARY, TO COMPENSATE FOR ANY SLIGHT DEVIATION OF THE C.R. TRACE FROM A HORIZONTAL PLANE. (MASK ORIENTATION IS USUALLY PERFORMED WITH THE INTERNAL SWEEP OPERATING AND NO VOLTAGE APPLIED TO THE "VERT." TERMINALS).

IN ALL CASES WHERE FAULTY OPERATION OF THE INSTRUMENT IS SUSPECTED THE SERVICE DEPARTMENT OF PRECISION APPARATUS COMPANY, INC., SHOULD FIRST BE CONSULTED. SHOULD THE SERVICE DEPT. RECOMMEND RETURN OF THE INSTRUMENT TO THE FACTORY, THE COMPLETE INSTRUMENT SHOULD BE CAREFULLY PACKED IN A WELL PADDED, STRONG CORRUGATED SHIPPING CARTON AND ADDRESSED TO PRECISION'S SERVICE DEPT.

IMPORTANT NOTE: THE ORIGINAL PACKING OF THE SERIES ES-500A IS ADMIRABLY SUITED FOR THIS PURPOSE.

IMPORTANT: IF AT ANY TIME THE SERIES ES-500A IS TO BE RETURNED TO THE FACTORY FOR REPAIR, A COMPLETE DESCRIPTION OF SUSPECTED FAULTY OPERATION, AS NOTED BY THE OPERATOR, MUST ACCOMPANY THE INSTRUMENT. THE MORE DETAILS SUBMITTED TO THE SERVICE DEPARTMENT OF PRECISION, THE MORE QUICKLY AND EFFICIENTLY THE INSTRUMENT CAN BE REPAIRED AND RETURNED. IT IS VERY IMPORTANT THAT THIS DESCRIPTION OF SUSPECTED FAULTY OPERATION BE GIVEN IN UNUSUALLY EXACT DETAIL DUE TO THE FACT THAT IN MANY CASES, FAULTY OPERATION CAN BE TRACED TO DIFFICULTIES IN OTHER ITEMS OF TEST EQUIPMENT AND/OR IMPROPER ANALYSIS OF RESULTS OBTAINED.

YOUR SERIES ES-500A OSCILLOGRAPH IS A RELATIVELY CRITICAL AND DELICATE INSTRUMENT, DO NOT ATTEMPT ANY MAJOR REPAIRS BEFORE CONSULTING THE SERVICE DEPARTMENT OF PRECISION APPARATUS COMPANY, INC.

PRECISION APPARATUS COMPANY, INC.
92-27 HORACE HARDING BLVD.
ELMHURST, L.I., N.Y.

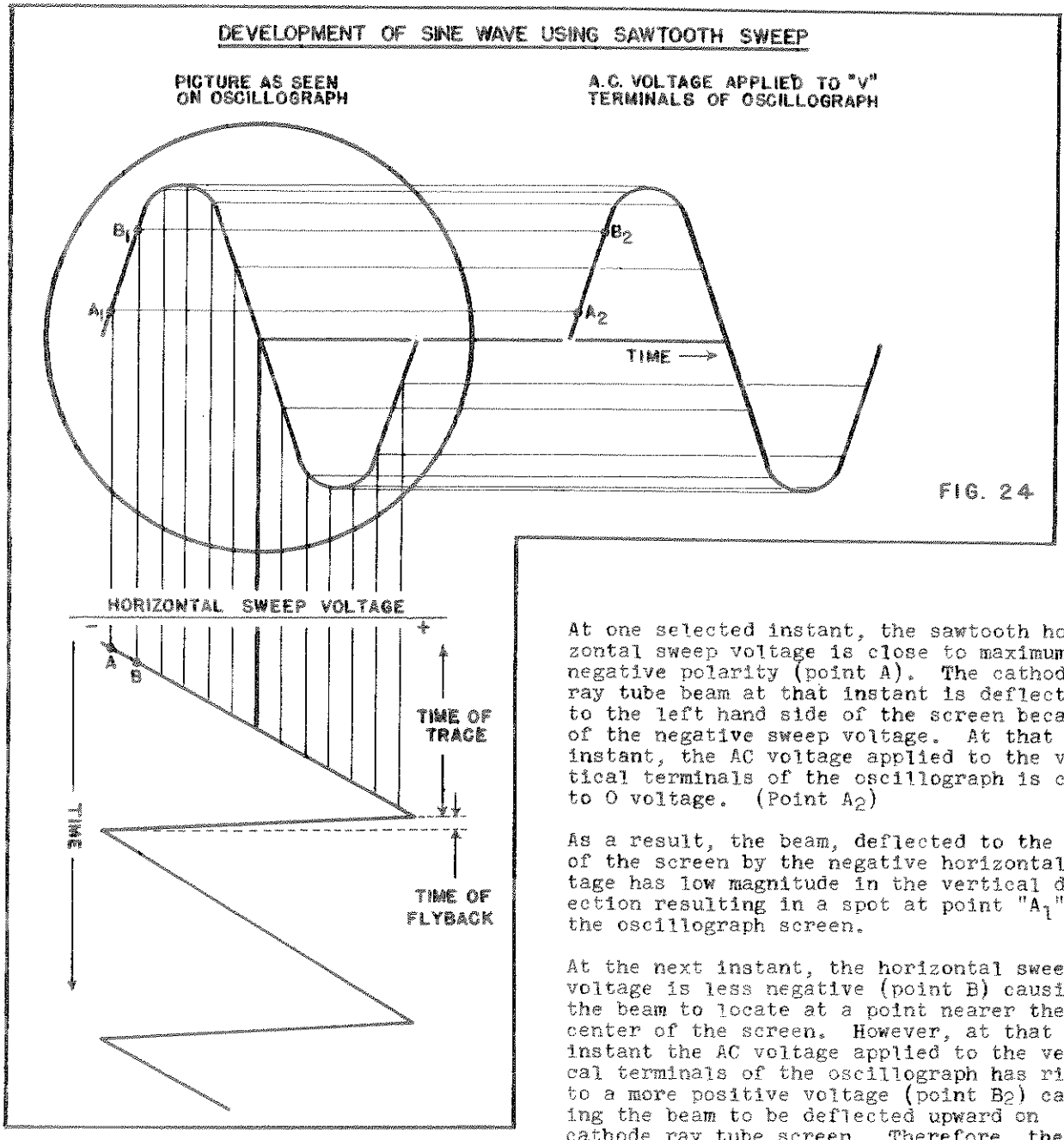


FIG. 24

At one selected instant, the sawtooth horizontal sweep voltage is close to maximum negative polarity (point A). The cathode ray tube beam at that instant is deflected to the left hand side of the screen because of the negative sweep voltage. At that same instant, the AC voltage applied to the vertical terminals of the oscillograph is close to 0 voltage. (Point A_2)

As a result, the beam, deflected to the left of the screen by the negative horizontal voltage has low magnitude in the vertical direction resulting in a spot at point "A_1" on the oscillograph screen.

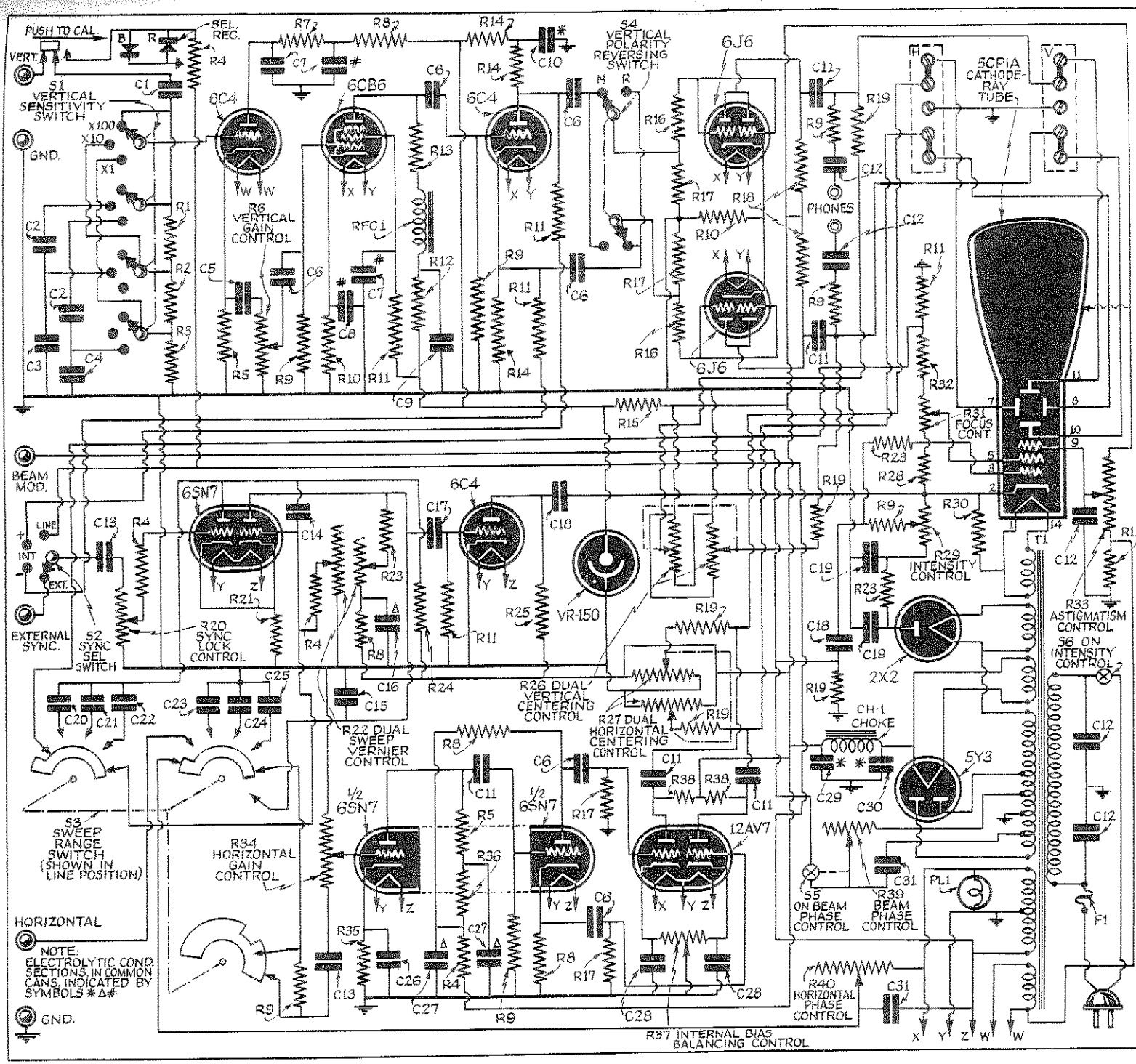
At the next instant, the horizontal sweep voltage is less negative (point B) causing the beam to locate at a point nearer the center of the screen. However, at that same instant the AC voltage applied to the vertical terminals of the oscillograph has risen to a more positive voltage (point B_2) causing the beam to be deflected upward on the cathode ray tube screen. Therefore, the beam has now moved to the right and upward on the screen now locating at point "B_1".

This process continues, i.e., the beam moves horizontally towards the right side of the CR tube screen while its position as regards vertical location is governed by the polarity and magnitude at individual points along one cycle of the AC voltage applied to the "V" terminals.

In conclusion, it can therefore be stated that as a result of the simultaneous application of a linear time base to the horizontal axis plus the unknown voltage to the vertical axis, the cathode ray tube graphically reproduces the character and shape of the unknown voltage. This is very much the same as a hand plotted graph with which we are all familiar, except that a cathode ray oscillograph does the job much faster via electronic means.

PRECISION APPARATUS COMPANY, INC.
92-27 Horace Harding Blvd.,
Elmhurst, L.I., N.Y.
U.S.A.

DWG. № 1055c



ITEM	PART NO.	SPECIFICATION
81	C31	0.1 MFD.
80	C30	20 MFD.
79	C29	30 MFD.
78	C28	.0018 MFD.
77	C27	10 MFD. EACH
76	C26	340 MMFD.
75	C25	.04 MFD.
74	C24	0.4 MFD.
73	C23	1 MFD.
72	C22	1250 MMFD.
71	C21	.012 MFD.
70	C20	0.1 MFD.
69	C19	0.4 MFD. EACH
68	C18	.006 MFD. EACH
67	C17	56 MMFD.
66	C16	5 MFD.
65	C15	.01 MFD.
64	C14	240 MMFD.
63	C13	0.5 MFD. EACH
62	C12	.02 MFD. EACH
61	C11	0.25 MFD. EACH
60	C10	40 MFD.
59	C9	3 MFD.
58	C8	500 MFD.
57	C7	15 MFD. EACH
56	C6	0.5 MFD. EACH
55	C5	25 MFD.
54	C4	1000 MMFD.
53	C3	.82 MMFD.
52	C2	4-30 MMFD. EACH
51	C1	0.25 MFD.
50	R40	200K Ω HORIZONTAL PHASE CONT.
49	R39	200K Ω BEAM PHASE CONT.
48	R38	15K Ω
47	R37	600 Ω INTERNAL BIAS BAL. CONT.
46	R36	22K Ω
45	R35	820 Ω
44	R34	500K Ω HORIZONTAL GAIN CONT.
43	R33	500K Ω ASTIGMATISM CONT.
42	R32	680K Ω
41	R31	500K Ω FOCUS CONTROL
40	R30	10 MEG. Ω
39	R29	100 K Ω INTENSITY CONTROL
38	R28	220K Ω
37	R27	DUAL 1 MEG Ω HOR. CENT. CONT.
36	R26	DUAL 1 MEG Ω VERT. CENT. CONT.
35	R25	100K Ω
34	R24	30K Ω
33	R23	100K Ω EACH
32	R22	DUAL 1/2 MEG Ω SWEEP VERNIER CONT.
31	R21	200 Ω
30	R20	10K Ω SYNC. LOCK CONT.
29	R19	3.3 MEG. Ω EACH
28	R18	15K Ω EACH
27	R17	560K Ω EACH
26	R16	91 Ω EACH
25	R15	10K Ω
24	R14	1000 Ω EACH
23	R13	12K Ω
22	R12	4700 Ω
21	R11	56K Ω EACH
20	R10	150 Ω EACH
19	R9	1 MEG. Ω EACH
18	R8	4700 Ω EACH
17	R7	1500 Ω
16	R6	10K Ω VERTICAL GAIN CONT.
15	R5	10K Ω EACH
14	R4	33K Ω EACH
13	R3	20K Ω
12	R2	180K Ω
11	R1	1.8 MEG. Ω
10	S6	SW. ON INTENSITY CONTROL
9	S5	SW. ON BEAM PHASE CONTROL
8	S4	VERTICAL POLARITY REV. SW.
7	S3	SWEEP RANGE SWITCH
6	S2	SYNCHRONIZATION SELECTOR SW.
5	S1	VERTICAL SENSITIVITY SW.
4	T1	POWER TRANSFORMER
3	RFC1	1.3 M.H. R.F.C.
2	PL1	№47 PILOT LAMP
1	F1	2 AMP. FUSE

PRECISION APPARATUS CO. INC.
ELMHURST, L.I., N.Y.

TITLE: OSCILLOSCOPE SERIES ES-500A Starting with Serial # 1306

DRAWN BY: Wm Radlick DATE: 4-22-53

CHECKED BY: [illegible] DATE: 4-27-53

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