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DU MONT

CATHODE-RAY OSCILLOGRAPH TYPE 224-A

OPERATING INSTRUCTIONS

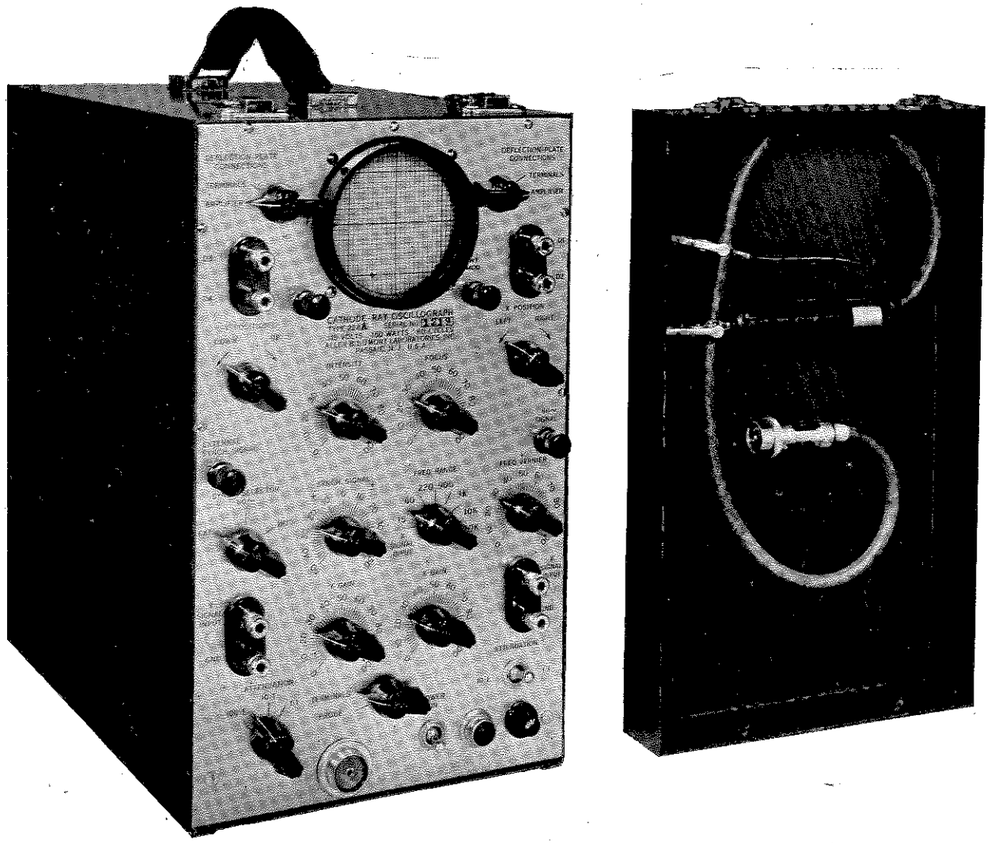
ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
CLIFTON, NEW JERSEY
U. S. A.

Obviously, the design of any piece of electrical indicating equipment resolves from a series of compromises which represent the designer's opinion of an ideal instrument consistent with contemporary engineering techniques and present-day production possibilities.

In developing this instrument, an attempt has been made to incorporate circuits the characteristic of which, we believe, will satisfy the greatest number of applications, and to this end many circuit combinations have been included to extend its flexibility and versatility.

We feel, however, that the real test of any instrument is the opinion of the man who uses it. This day-to-day test of the instrument's advantages and limitations will prove, more than any other method, just what characteristics are desirable, why the range of any given component or function of the equipment should be extended, and how important such modification is.

Because of the nature of the equipment manufactured by Allen B. Du Mont Laboratories, Inc., it is only by complete cooperation between the customer and our Engineering Department that satisfactory design can be achieved. In an attempt to continually extend the applicability of our equipment to the problems of the engineer, we sincerely request suggestions advising in what manner the design of this equipment may be further extended to include these problems.



CATHODE-RAY OSCILLOGRAPH
Type 224-A

Operating Instructions

For

DU MONT TYPE 224-A CATHODE-RAY OSCILLOGRAPH

ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
Clifton, N. J., U. S. A.

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Part No. 67001721

PRINTED IN U.S.A.

TYPE 224-A CATHODE-RAY OSCILLOGRAPH

OPERATING INSTRUCTIONS

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OPERATING INSTRUCTIONS

1.00 INTRODUCTION

1.10—GENERAL SPECIFICATIONS:

Cathode-ray Tube:

Type 3GP1
Accelerating Potential ..... 1000 volts

Input Impedance:

	TERMINALS	PROBE	DIRECT (BALANCED)	DIRECT (UNBALANCED)
a. Y-Axis	2 meg. 30 uuf.	1 meg. 20 uuf.	10 meg. 20 uuf.	5 meg. 25 uuf.
b. X-Axis	2 meg. 30 uuf.		10 meg. 20 uuf.	5 meg. 25 uuf.

Maximum Input Potential:

Y-Axis through amplifier ..... 600 volts maximum signal and d. c. or peak signal
Y-Axis direct to plates ..... 600 volts maximum signal and d. c. or peak signal
Y-Axis through probe ..... 400 volts maximum signal and d. c. or peak signal
X-Axis through amplifier ..... 200 volts maximum d. c.
50 volts peak signal
X-Axis direct to plates ..... 600 volts maximum signal and d. c. or peak signal
Z-Axis ..... 400 volts maximum signal and d. c.
Peak signal should never drive grid positive

Amplifier Frequency Response:

Y-Axis ..... Sinewave response uniform within 3 db. from 20 cycles to 2 megacycles at any attenuator setting. Square wave response at 50 cycles, 500 cycles, 25 kilocycles, 100 kilocycles to be equal to those shown in Figure 2.

X-Axis ..... Uniform within 3 db. from 10 cycles to 100 kilocycles at any attenuator setting.

Deflection Factor:

a. With Amplifier
Y-Axis Terminals ..... 0.1 volts r.m.s./inch deflection
Y-Axis with Probe ..... 0.4 volts r.m.s./inch deflection
X-Axis Terminals ..... 0.7 volts r.m.s./inch deflection

b. To Deflection Plates
Y-Axis ..... 25 volts r.m.s./inch deflection
X-Axis ..... 28 volts r.m.s./inch deflection

Intensity Modulation ..... 15 volts peak is sufficient to bring beam from just extinguished condition to normal brilliance

Linear Time-base:

Frequency Range ..... 15 to 30,000 c.p.s.
Direction of Sweep ..... Left to right
Synchronizing Signal Sources ..... Internal (Y Signal) 60 cycles
External
Synchronizing Polarity ..... Either polarity of sync. signal
Synchronizing Signal Amplitude .... 1 volt at external sync. terminal is sufficient to synchronize. Internal synchronism will hold for ½ inch vertical deflection.

Power Supply Source:

Potential ..... 115 volts
Frequency ..... 60 cycles
Power Consumption ..... 150 watts
Fuse Protection ..... 3 amps.

Physical Specifications:

Height ..... 14¼ inches overall
Width ..... 8⅜ inches overall
Depth ..... 15⅛ inches overall
Weight ..... 50 pounds

1.20 DESCRIPTION

The Type 224-A Cathode-ray Oscillograph is an instrument for plotting a visual curve of one electrical quantity as a function of another on the screen of a cathode-ray tube.

It consists of a cathode-ray tube, amplifiers for producing the deflection voltages, a linear-time-base generator or sweep circuit, a means for intensity modulation of the beam, and associated power supplies.

Provision is made to connect signals directly to the deflection plates when frequencies to be observed are above the useful limits of the amplifiers.

The Y-axis or vertical deflection amplifier has uniform frequency response within 3 d.b. from 20 c.p.s. to 2 megacycles. The X-axis or horizontal deflection amplifier has uniform response within 3 d.b. from 10 c.p.s. to 100 kilocycles. Both amplifiers have input attenuators and distortionless gain controls. The Y-amplifier has an input connection for a test probe which reduces the input capacitance, with a loss of gain, but which provides freedom from stray pickup. The X-axis amplifier can be used to amplify the linear time-base or an external signal.

The unit is housed in a case wth a removable front cover which serves to protect the front panel when the unit is not in use. The test probe is held inside the front cover by clips.

2.00 OPERATING INSTRUCTIONS

2.10 INSTALLATION

The Type 224-A Cathode-ray Oscillograph is shipped with all tubes in place and ready for operation. The chassis can be removed by first removing the seven round head retaining screws on the panel and two located at the rear of the cabinet. (**Caution**—Do not remove the four flat-head screws which are flush with the panel.) All tube locations are marked on the chassis label. The Type 991 ¼ watt neon bulb fits into a socket mounting under the chassis.

2.110 Power Supply

The Type 224-A Cathode-ray Oscillograph is designed to operate on 115 volts, 60 cycles only. For operation on other supply voltages a suitable voltage-changing transformer is necessary.

When external voltage- or frequency-changing or regulating devices are used in connection with the oscillograph, such devices should be located at least six feet from the oscillograph to avoid magnetic deflection distortion as discussed in Section 3.10.

The high-voltage section of the power supply delivers approximately 1000 volts negative with respect to ground. The low-voltage supply delivers approximately 400 volts positive with respect to ground for the amplifiers and sweep oscillator.

In addition, an electronic voltage regulator delivers 190 volts positive for the operation of all low-level stages. Its regulation and output voltage are determined by a factory adjustment of a potentiometer R69 mounted on the side of the chassis.

The regulated voltage has been factory adjusted to a value of 190 volts and its adjustment should not be changed except to compensate for variations in regulator tubes. A voltmeter should always be used when this adjustment is made to return the output to 190 volts.

2.20 CONTROLS

All controls and terminals of the Type 224-A are located on the front panel. Related controls are grouped together where possible. In general, the X-axis controls occupy the right side of the panel and the Y-axis the left side. Each group of controls will be considered separately.

2.210 Beam Controls

The Beam Controls comprise those which adjust the intensity, focus, and position of the

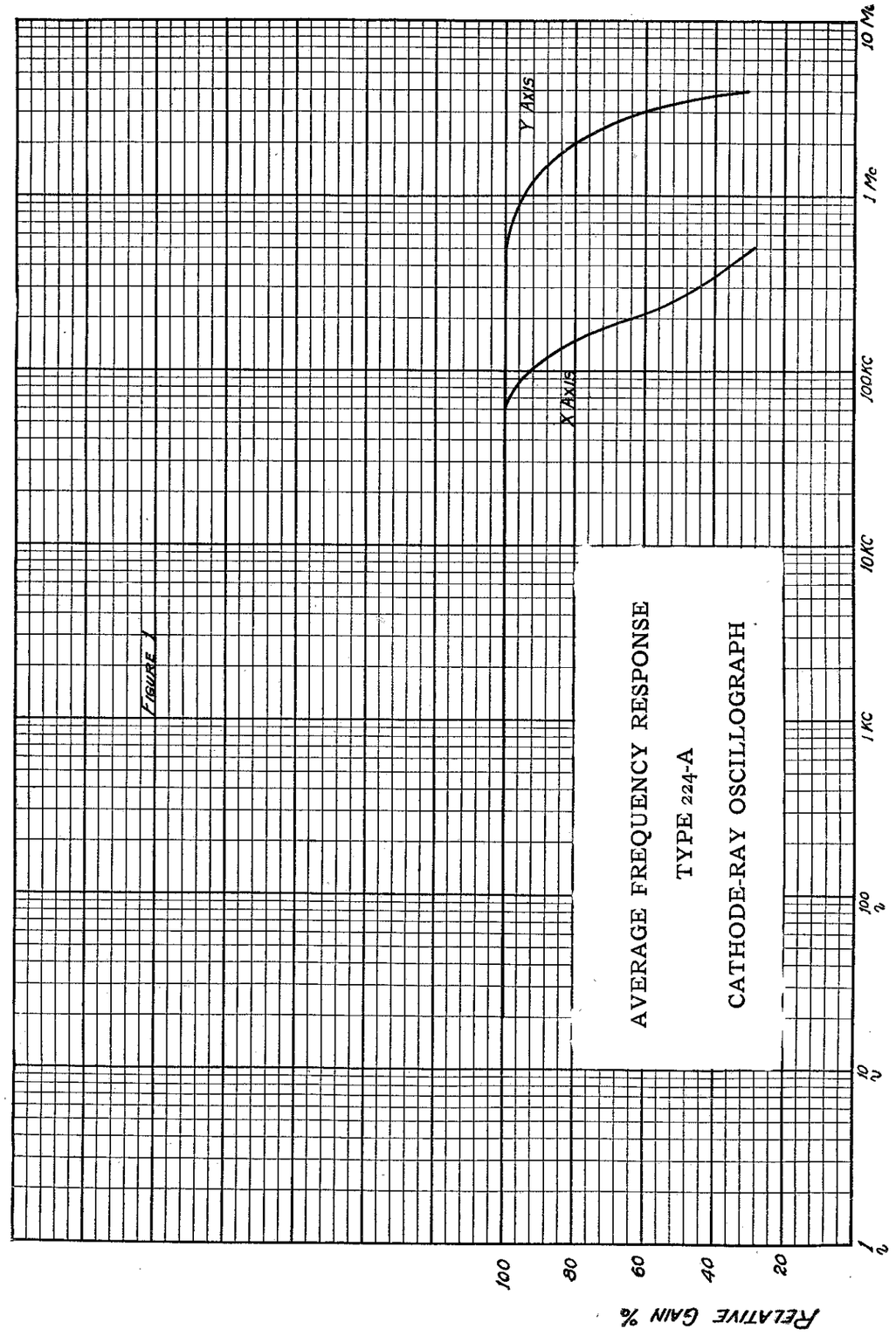


FIGURE 1

fluorescent spot on the screen of the cathode-ray tube.

2.211 Power Switch

The Power Switch is located on the front panel to control the power supply to the instrument. When thrown to the "power on" position, the pilot light should light. This switch should always be thrown to the off position before the instrument is removed from the cabinet.

2.212 Intensity Control

The Intensity Control sets the bias between control electrode or grid and cathode of the cathode-ray tube and thus determines the beam current. In general, it is desirable to keep the intensity of the trace as low as is consistent with convenience in use in order to conserve tube life. A sharply focused line or spot of high intensity should never be permitted to remain stationary on the screen for any considerable period. (See Section 3.30).

2.213 Focus Control

The Focus Control serves to set the potential of the focusing electrode of the cathode-ray tube. In general, there will be a setting for optimum focus at each intensity level.

2.214 X- and Y-Positioning Controls

The X- and Y-positioning Controls adjust the location of the spot or trace on the screen in the horizontal and vertical directions, respectively. Each control is marked with the direction of motion of the spot it produces.

2.220 Linear Time-Base Controls

The Linear Time-base or Sweep Oscillator Controls include the Frequency Range and Frequency Vernier Controls, Synchronizing Signal Selector, Synchronizing Signal Amplitude Control, and an External Synchronizing Signal Terminal.

2.221 Frequency Range Control

The setting of the Frequency Range Selector determines the range of time-base frequencies which operation of the Frequency Vernier Control will produce. The limits of each of the six ranges are given by the numbers at either side of the dial pointer and are as follows: 15, 60, 220, 900, 3K, 10K, 30K. The letter "K" represents kilo or one thousand; thus 30K represents 30,000 cycles per second.

When the control is in the extreme counter-clockwise position marked "X-signal Input," the sweep circuit is prevented from oscillating, and the input of the X-axis amplifier is connected to the "X-signal Input" terminals.

2.222 Frequency Vernier Control

When the proper frequency range has been selected with the frequency range control (Section 2.221), the exact frequency necessary to stabilize the pattern on the screen can be obtained by means of the Frequency Vernier Control.

2.223 Synchronizing Selector Switch

The source of signal to which the linear time-base may be synchronized is selected by the setting of the synchronizing selector. The following sources of synchronization are available: external signal, 60 cycles, and internal.

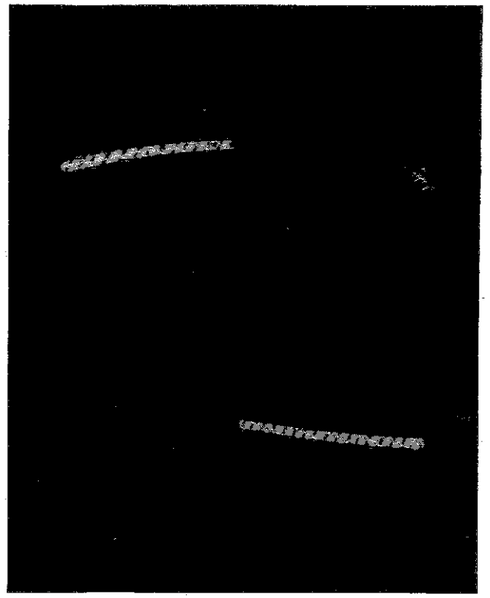
In the external position the switch permits synchronization of the time-base oscillations with a signal connected between ground and the "External Synchronizing Signal" input post. The amount of signal necessary is discussed in Section 2.225.

When the switch is thrown to the 60 cycle position, the sweep may be synchronized to the frequency of the power line supplying the instrument.

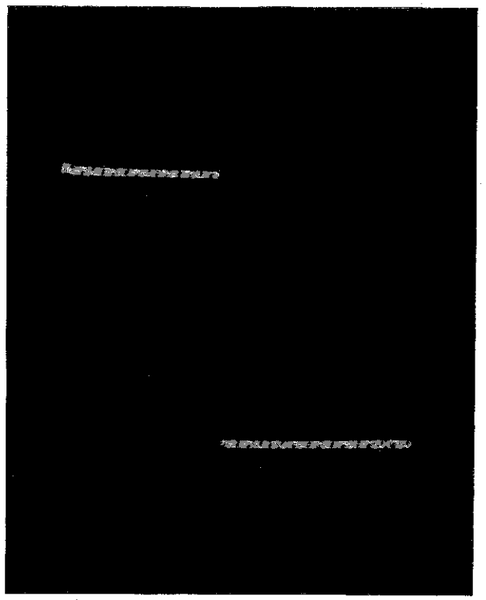
When the selector is in the "Int." position, a signal is picked off from a suitable point in the Y-axis amplifier and used to synchronize the sweep.

2.224 Synchronizing Signal Amplitude Control

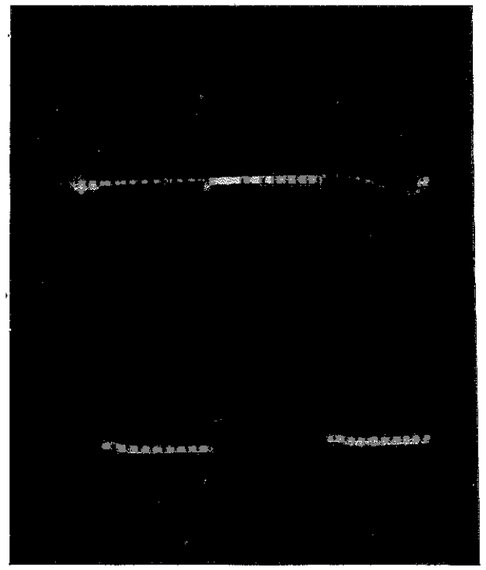
This control allows the amount of synchronizing voltage applied to the grid of the gas triode to be adjusted to the optimum value to insure good synchronization. In addition, the polarity of the synchronizing signal upon which the synchronization occurs may be selected. In the sector of the synchronizing signal control



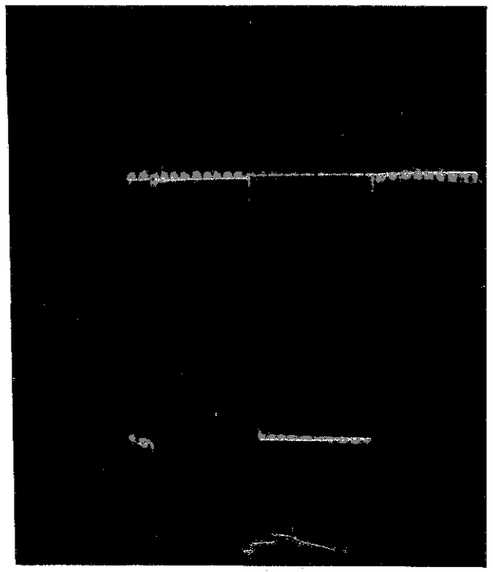
(a) 50 Cycles per Second



(b) 500 Cycles per Second



(c) 25 Kilocycles per Second



(d) 100 Kilocycles per Second

Figure 2

TYPICAL SQUARE-WAVE RESPONSE

marked $\pm$, the sweep synchronizes on the negative half cycle of an external synchronizing signal or the positive half cycle of an internal synchronizing signal. In the sector of the control marked $\mp$, the reverse is true. Thus, synchronization from non-symmetrical wave forms such as short pulses, etc., is assured.

The minimum amount of synchronizing voltage which gives good synchronization should always be used. Excess synchronizing voltage at the grid of the gas triode may introduce nonlinearity in the sweep.

2.225 External Synchronizing Signal Input

When synchronization is desired from a signal other than the power line or that amplified by the Y-axis amplifier, that signal-voltage should be connected to the terminal marked "Ext. Synch. Signal." Under such conditions, the synchronizing selector (Section 2.223) should be thrown to the "External" position.

Excessive synchronizing voltages fed to this terminal may be coupled into the X- or Y-amplifiers and cause distortion. Ten volts (peak to peak) should be the maximum external synchronizing signal ever employed. The impedance of the External Synchronizing Signal Input Circuit is 500,000 ohms. If large values of external synchronizing voltage are available, a suitable series resistor should be connected to the External Synchronizing Signal Input terminal to reduce this to the maximum value given above.

2.230 Y-Axis Amplifier

The Y-axis amplifier consists of an input attenuator, a cathode-loaded input stage (6J5), a stage of amplification, and a balanced phase-inverter deflection amplifier. The amplifier has essentially uniform frequency response in the range of 20 c.p.s. to more than 2 mc. This frequency response is maintained for any setting of the gain control or input attenuator. The overall gain of the amplifier is more than 300 times. A typical response curve is shown in Figure 1. Figure 2 shows typical square-wave response at 50 cycles, 500 cycles, 25 kilocycles, 100 kilocycles.

The Y-axis Amplifier Controls consist of the Y-signal Input Terminal Post, the Test Probe Terminal, the Y-attenuation Control, and the Y-gain Control.

2.231 Y-Signal Input Terminals

The signal used to provide Y-axis or vertical deflection should be connected to either the Y-signal input terminals or the test probe, depending on the setting of the Y-axis probe switch.

2.232 Y-Attenuation Control

A high-impedance attenuator of the compensated resistance-capacitance type is provided at the input of the Y-amplifier to reduce the input signal voltage, if necessary, to a value that will not overload the amplifier. The attenuation ratios provided are 100:1, 10:1, and 1:1.

2.233 Y-Gain Control

A low-impedance continuously variable attenuator supplies a continuous adjustment of the amplitude or deflection. The operator will notice that the signal amplitude can never be reduced to zero with this control, but that the amplitude in the extreme counter-clockwise position is about 10 per cent of that for the "full gain" position. This feature in conjunction with the use of the Y-attenuator prevents overloading of the input stage of the amplifier as long as the pattern is no larger than full screen. Thus, the operator will not be deceived by distortion caused by overload in the amplifier so long as the pattern is kept entirely on the screen.

2.234 Test Probe Terminal

The Test Probe Terminal provides a means for connecting a test probe such as the Du Mont Type 242-A to the input circuit of the Y-amplifier.

2.235 Test Probe

One Du Mont Type 242-A Test Probe is supplied with every Type 224-A Cathode-ray Oscillograph. The Type 242-A Test Probe consists of a compensated 4:1 attenuator in an insulated probe supplied with a length of coaxial cable and a connector. The input capacitance of the test probe is less than 20 uuf. This makes it possible to connect it to relatively high-impedance points without serious loading effects on these circuits.

2.240 X-Axis Amplifier

The X-axis amplifier consists of an input attenuator, a cathode-loaded input stage, and a phase-inverter deflection amplifier. The X-axis amplifier controls consist of the X-signal Input

Terminal, the X-gain Control, and the X-attenuation Control.

2.241 X-Signal Input Terminal

An external signal to be amplified along the X- or horizontal axis should be connected between the X-signal Input Terminal and ground. This terminal is connected to the input of the amplifier only when the frequency range switch is in the "X-signal Input" position (See Section 2.221).

2.242 X-Amplifier Gain Control

The X-amplifier Gain Control is a continuously variable low-impedance attenuator which operates in conjunction with the X-attenuation Control to determine the amount of deflection along the X-axis.

2.243 X-Attenuation Control

The input circuit of the X-axis Amplifier incorporates a two position high-impedance attenuator with attenuation ratios of 10:1 and 1:1. If the input voltage is over 5 volts r.m.s., the attenuator should be set in the 10:1 position. For input voltage over 50 r.m.s. an external attenuator should be used, since voltages in excess of this value will overload the input stage.

2.250 Direct Deflection Controls

When frequencies above the useful limits of the amplifiers are to be observed (about 5 megacycles and 500 kilocycles for the Y- and X-amplifiers respectively), direct connections to the deflection plates are available to extend this range.

The Direct Deflection Controls consist of the X- and Y-deflection Plate Switches and the X- and Y-deflection Plate Terminals. Since the action of these controls is the same for either X- or Y-axis, they will be considered together.

2.251 X- and Y-Deflection Plate Switches

These switches allow the selection of connections to deflection plates either directly, with a deflection factor of approximately 75 d.c. volts/inch, or through the amplifiers. The deflection plates can be directly connected to the front panel terminal posts, but position voltages are always applied through 5 megohm resistors. It is therefore possible to examine still larger signals by a.c. coupling and positioning either up or down. When an unbalanced signal source is used, the deflection-plate terminal to which signal voltage is not applied should be connected to ground by means of a separate lead wire.

2.260 Z-Axis

2.261 Intensity Modulation Input Terminals

Signals for intensity modulation are connected between the input post marked "INT. MOD." and ground. The d. c. resistance is 1 megohm, and the input capacitance is 20 uuf.

The response of the beam to modulation is uniform within 3 db. from 30 cycles per second to 3 megacycles.

A signal within this frequency range having a peak value of 15 volts will bring the beam from a just extinguished condition to normal brilliance on its positive phase.

2.262 Precautions

Care should be taken never to apply a modulating signal which swings the grid positive with respect to the cathode. This condition is indicated on the cathode-ray tube screen by marked defocusing during the positive phase of the modulating signal and it may cause a serious shortening of the cathode-ray tube life. No more than 400 volts d. c. should ever be applied to the "INT. MOD." post.

2.270 60 Cycle Test Signal Terminal Post

A signal of power line frequency having an amplitude of approximately 2.2 volts peak to peak is provided at front panel as a source of test signal.

3.00 PRECAUTIONS

WARNING: It is inadvisable to operate this cathode-ray oscillograph with the case removed. There are potential differences as high as 1500 volts in this instrument, and it should be treated with proper caution.

3.10 MAGNETIC AND ELECTRIC FIELDS

Magnetic and electrostatic shielding have been provided for in the design of this instrument. However, operation of the instrument in strong fields such as are found near transmitters, transformers, etc., may introduce spurious deflection.

Electrostatic pickup by the wide range amplifiers may be minimized by the use of shielded input cables and connections with a good electrical ground. Magnetic deflection may be eliminated by removing the instrument from the immediate vicinity of the source of the magnetic field, or by orienting the instrument in the field so that the deflection is at a minimum.

3.20 POWER LINE REGULATION

Variations of ± 10 per cent from the nominal value 115 volts should cause little change in the operating characteristics of the instrument. Greater changes than the above may cause the regulated power supply to cease regulating and the operation of the instrument to become erratic.

If a primary voltage regulator is employed, the precautions of Section 3.10 should be employed.

3.30 SCREEN BURNING

A fine trace or spot of high intensity should not be allowed to remain stationary on the screen for long periods. Burning or discoloration of the screen may result from concentrating the entire energy of the beam to a small area for a considerable period.

4.00 MAINTENANCE

The components of the Type 224-A Cathode-ray Oscillograph have been selected and tested to provide long, trouble-free operating life, and the only service necessary should be the replacement of vacuum tubes; the locations of the vacuum tubes are marked on the chassis label.

4.10 WARRANTY

4.11 Du Mont Instruments

All instruments manufactured by Allen B. Du Mont Laboratories, Inc., are guaranteed to equal or exceed all specifications for that particular instrument as published by the company. They are further guaranteed against defective materials and workmanship for a period of one year from date of sale, and we will promptly repair the instrument or replace it, at our discretion, at any time within the guarantee period should any defect develop from these causes or the instrument be not as represented, upon our inspection of the equipment.

In order that this guarantee be effective, it is necessary that the enclosed guarantee card be properly filled out and mailed to the factory immediately upon receipt of the equipment. Complete information should be given, since a record of every instrument is maintained at our office. This record constitutes our source of information when any correspondence is necessary. Both the *type number and the serial number* of the instrument must be given on this card in order that the information be complete.

4.12 Du Mont Cathode-Ray Tubes

All industrial cathode-ray tubes manufactured and sold by Allen B. Du Mont Laboratories are guaranteed for a life of 1,000 hours or for six months, depending upon which expires first. The only exceptions to this guarantee are burned-out heaters and broken glass. Cathode-ray tubes will be promptly replaced within the guarantee period if, upon our inspection, the tube has failed within less than its normal expected life.

In order that this guarantee be effective, it is necessary that the enclosed guarantee card be properly filled out and mailed to the factory immediately upon receipt of the equipment. Complete information should be given in order that the records which we maintain on your particular tube will be accurate. When correspondence is necessary, both *type number and serial number* of the tube should be mentioned. The serial number of Du Mont cathode-ray tubes will be found on the glass stem of the electron gun.

4.20 SERVICE

Du Mont equipment is designed and manufactured in accordance with the best practices of modern engineering, and it is fully inspected before it leaves our factory. Under normal operation it may be expected to give long, trouble-free service. In order to insure factory service and proper consideration within the guarantee period, the enclosed guarantee card should be properly filled out and mailed to the

factory immediately upon receipt of the equipment.

In many cases, equipment has been returned to us, without authorization, and without any need for our examination, resulting in unnecessary shipping costs. In the event that you feel you have not received satisfactory operation from this equipment, you should immediately contact our Instrument Service Department, mentioning the *type number and serial number,* completely outlining all characteristics of the failure, and describing the method in which the equipment has been used.

It is important that such information be given, since much time often can be saved when all operating conditions are known. With such information, we often are able to make decisions and suggestions which will avoid returning it to our plant. The foregoing applies also to Du Mont cathode-ray tubes.

All equipment returned to our plant should be shipped, carefully packed, via express prepaid. Cathode-ray tubes larger than five inches screen diameter should be shipped separately and should not be left mounted in their socket within the instrument. In addition, all equipment should be properly identified either by a packing slip or, preferably, by a suitable tag affixed to it. Unidentified equipment which has been returned to us is a serious source of needless errors and delays.

4.30 REPLACEMENT PARTS

When ordering replacement parts, always give the type number and serial number of the instrument and refer to the part by its symbol designation and its description on the schematic.

4.40 SPECIFICATIONS

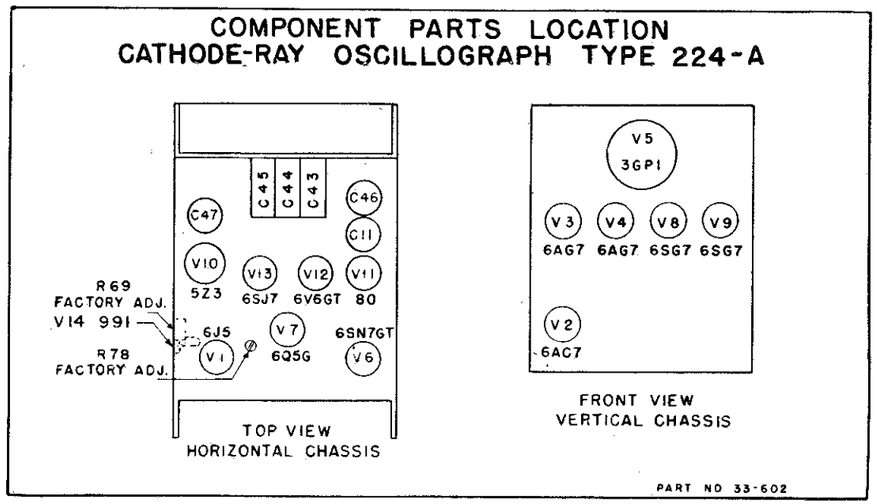
The right is reserved to change the specifications of any equipment, without notice, at any time. This right shall not incur any liability to Allen B. Du Mont Laboratories, Inc., to change equipment previously sold, or to supply new equipment in accordance with earlier specifications.

4.50 THE DU MONT OSCILLOGRAPHER

The Du Mont *Oscillographer,* a quarterly publication, is published regularly by the Allen B. Du Mont Laboratories. It is sent free of charge to engineers, research workers, and those engaged in the use and application of cathode-ray equipment. When sending requests for subscriptions and address-change notice, please supply the following: name, company name, company address, type of business, and title of individual.

4.20 EMERGENCY TUBE REPLACEMENT DATA

Type Used in 224-A	*Emergency Replacement*
6J5	6C5, 6P5-G
6AC7	6AB7, 6SJ7, 6SG7
6AG7	No replacement
6SN7GT	6SL7
6Q5G	884
6SG7	6AC7, 6AB7, 6SJ7
6SJ7	6AB7, 6AC7, 6SG7
6V6GT/G	6V6, 6L6, 6Y6, 6F6
5Z3	80, 83
80	5Z3
991	¼ W. Neon
3GP1	1806/3EP1



PATENT NOTICE

Manufactured under one or more of the following U. S. Patents:

1,844,117	1,960,333	1,999,407	2,000,014	2,014,106
2,067,382	2,082,327	2,085,576	2,087,280	2,098,231
2,153,800	2,157,749	2,162,009	2,163,256	2,164,176
2,185,705	2,186,634	2,186,635	2,190,020	RE. 21,326
2,201,309	2,207,048	2,208,254	2,209,507	2,221,398
2,225,099	2,227,822	2,229,556	2,245,409	2,245,428
2,249,942	2,249,943	2,269,115	2,269,129	2,280,700
2,280,738	2,290,592	2,297,742	2,297,752	2,299,471
2,299,510	2,315,848	2,319,691	2,321,149	2,328,259
2,331,401	2,337,980	2,338,336	2,338,646	2,343,630
2,345,549	2,346,509	2,347,933	2,355,363	2,356,733
2,364,687	2,365,476	2,372,455	2,372,901	2,373,114
2,379,488	2,384,931	2,389,025	2,391,082	2,391,090
2,391,273	DES. 143,796	2,396,014	2,398,535	2,398,959
2,404,185	2,408,193	2,409,419	2,410,920	2,414,319
2,414,634				

Other Patents Pending

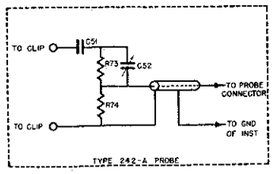
ALLEN B. DU MONT LABORATORIES, INC.
CLIFTON, N. J., U. S. A.

COMPONENT PARTS LIST

C1	0.2 μf. 400V.
C2	3-12 μμf. 500V.
C3	3-12 μμf. 500V.
C4	.001 μf. 500V.
C5	68 μμf. 500V.
C6	0.2 μf. 400V.
C7	100 μf. 50V. elec.
C8	0.1 μf. 600V.
C9	0.5 μf. 600V.
C10	0.5 μf. 600V.
C11	4 μf. 600V.
C12	0.5 μf. 200V.
C13	0.5 μf. 600V.
C14	25 μf. 50V. elec.
C15	0.1 μf. 600V.
C16	0.1 μf. 600V.
C17	0.25 μf. 400V.
C18	.05 μf. 400V.
C19	0.1 μf. 600V.
C20	0.1 μf. 600V.
C21	0.5 μf. 600V.
C22	0.25 μf. 400V.
C23	68 μμf. 500V.
C24	3-12 μμf. 500V.
C25	100 μf. 50V. elec.
C26	0.2 μf. 400V.
C27	0.5 μf. 600V.
C28	3-12 μμf. 500V.
C29	0.15 μf. 400V.
C30	.04 μf. 400V.
C31	.01 μf. 400V.
C32	2400 μμf. 500V
C33	620 μμf. 500V.
C34	150 μμf. 500V.
C35	25 μf. 50V. elec.
C36	0.5 μf. 600V.
C37	0.1 μf. 600V.
C38	0.1 μf. 600V.
C39	Deleted
C40	Deleted
C41	Deleted
C42	Deleted
C43	4 μf. 600V.
C44	4 μf. 600V.
C45	4 μf. 600V.
C46	0.5 μf. 1500V.
C47	0.5 μf. 1500V.
C48	0.5 μf. 600V.
C49	0.5 μf. 600V.
C50	0.5 μf. 600V.
C51	.05 μf. 400V.
C52	4-30 μμf. 500V.
C53	.05 μf. 1600V.
F1	3 amp. fuse
L1	70-250 μh.
L2	170 μh.
L3	170 μh.
L4	8.5 mh.
L5	8.5 mh.
L6	19h-150 ma.
R1	2 meg. ½W.±5%
R2	2 meg. ½W.±5%
R3	20 K ½W.±5%
R4	240 K ½W.±5%
R5	2 meg. ½W.±5%
R6	47 ohm ½W.
R7	1 K ½W.
R8	1 K pot.
R9	100 ohm ½W.
R10	18 meg. ½W.
R11	75 K 1W.±5%
R12	100 K ½W.
R13	2.4 K 1W.±5%
R14	10 K 3W.
R15	47 ohm ½W.
R16	82 K ½W.
R17	100 K 1W.
R18	15 K ½W.
R19	470 ohm 3W.
R20	47 ohm ½W.
R21	3.5 K 10W. non-inductive ±5%
R22	15 K 10W.±5%
R23	3.5 K 10W. non-inductive ±5%
R24	33 K ½W.
R25	470 K ½W.
R26	1.5 K ½W.
R27	8.2 K ½W.
R28	200 K C.T. pot.
R29	22 K ½W.
R30	10 K 1W.
R31	10 K 1W.
R32	1 K ½W.
R33	470 K 1W.
R34	4 meg. pot.
R35	240 K ½W.±5%
R36	2 meg. ½W.±5%
R37	2.2 meg.½W.
R38	10 K ½W.
R39	10 K pot.
R40	Deleted
R41	3.3 meg.½W.
R42	82 K 1W.
R43	100 K 1W. ±5%
R44	47 ohm ½W.
R45	15 K ½W. ±5%
R46	2 K 1W±5%
R47	2.2 meg.½W.
R48	47 ohm ½W.
R49	68K 2W.
*R50	37.5 K 2W.
R51	20 K ½W.±5%
R52	20 K ½W.±5%
*R53	37.5 K 2W.
R54	4.7 meg. ½W.
R55	4 meg. dual pot.
R56	4.7 meg. ½W.
R57	4.7 meg. ½W.
R58	4.7 meg. ½W.
R59	100 K 1W.
R60	100 K 1W.
R61	4 meg. dual pot.
R62	10 K 1W.
R63	100 K. 1W.
R64	100 K pot.
R65	150 K 1W.
R66	500 K pot.
R67	820 K 1W.
R68	220 K 1W.
R69	500 K pot.
R70	470 K 1W.
R71	470 K 1W.
R72	82 K 1W. ±5%
R73	680 K ½W.±5%
R74	240 K ½W.±5%
R75	Deleted
R76	1 meg. 1W.
R77	470 K 1W.
R78	1K pot.
R79	330 ohms 1W.
R80	330 ohms 1W.
S1	D.P. 3.T.
S2	S.P. D.T.
S3	D.P. D.T.
S4	S.P. 3.T.
S5	D.P. 7.T.
S6	D.P. D.T.
S7	S.P. D.T.
S8	S.P. S.T.
T1	Power Transformer Part No. 20-177
V1	6J5
V2	6AC7
V3	6AG7
V4	6AG7
V5	3GP1
V6	6SN7GT
V7	6Q5G
V8	6SG7
V9	6SG7
V10	5Z3
V11	80
V12	6V6GT/G
V13	6SJ7
V14	TYPE 991
V15	6.3 V. .15 amp.

*2 75 K 1W. in parallel

K = ohms × 1000 (example 15K = 15000 ohms)



SCHEMATIC OF CIRCUIT
TYPE 224-A
CATHODE-RAY OSCILLOGRAPH
DD-840-D-6