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DIRECT AMPLITUDE MEASUREMENT

SEE PAGE 2

American Optical Company Rapid-scanning Spectrophotometer

THE
OSCILLOGRAPHER

A publication devoted exclusively to the cathode-ray oscillograph, providing the latest information on developments in equipment, applications, and techniques. Permission for reprinting any material contained herein may be obtained by writing to the Editor at address below.

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Neil Uptegrove, — Editor

ON THE COVER

The calibrating feature of the new Du Mont Type 304-A Cathode-ray Oscillograph is displayed fully in this oscillogram which shows the ionization and de-ionization potentials of a gas tube. Reading directly from the scale, the ionization potential is seen to be 85 volts while the de-ionization potential is 35 volts with the VOLTS FULL SCALE switch on the 100 volts range, and the MULTIPLIER set on 1.0. The oscillogram was taken with the Du Mont Type 296 Oscillograph-record Camera. For details on the new Type 304-A Oscillograph, see the article, "A True Electronic Voltmeter — the new Du Mont Type 304-A Cathode-ray Oscillograph," on Page 11.

To meet industry's need for an instrument capable of indicating rapid color changes or for monitoring a flowing liquid, the American Optical Company and the Allen B. Du Mont Laboratories, Inc., have developed the American Optical Company Rapid-scanning Spectrophotometer.

The new instrument is the result of a joint effort of the two companies — American Optical Company having designed the optical system and the Du Mont Laboratories, Inc. the oscillograph and electronic circuits. This unique com-

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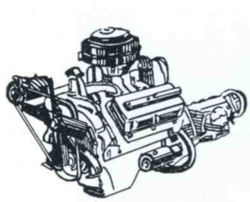
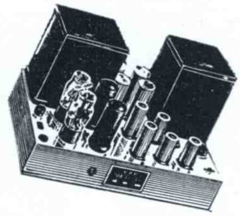
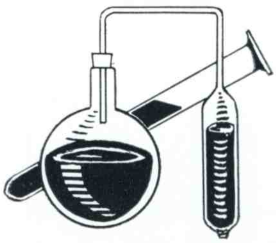






By
Mark T. Nadir

(Part 3 of a 3-part article. Mr. Nadir describes a new phosphor method of detecting temperature differences and variable capacitor transducer elements.)

Phosphors

A paper, "The Observations of Temperature Distributions and of Thermal Radiation by Means of Non-linear Phosphors," by F. Urbach, N. R. Nail and D. Pearlman appeared in *The Journal of the Optical Society of America,* December, 1949. In this paper a method of utilizing phosphors for the measurement of radiation is described.

It was observed that ultraviolet light is converted to visible light by phosphors. The efficiency of this process may vary considerably with the temperature of the phosphor. Two methods are described by the authors — "contact thermography" and "projection thermography." The former is accomplished by coating or spraying a surface with a suitably poisoned phosphor. An ultraviolet lamp of unvarying light output radiates the surface of the phosphor, causing the phosphor to fluoresce. If the temperature of the phosphor is raised or lowered by heating it with infrared radiation or by placing it in contact with a heated body, the light output in the visible region will vary with the temperature of the phosphor. The visible radiation may be measured visually or by means of a suitably situated phototube.

In "projection thermography" the infrared radiation of a body is focused by means of a parabolic mirror upon a screen

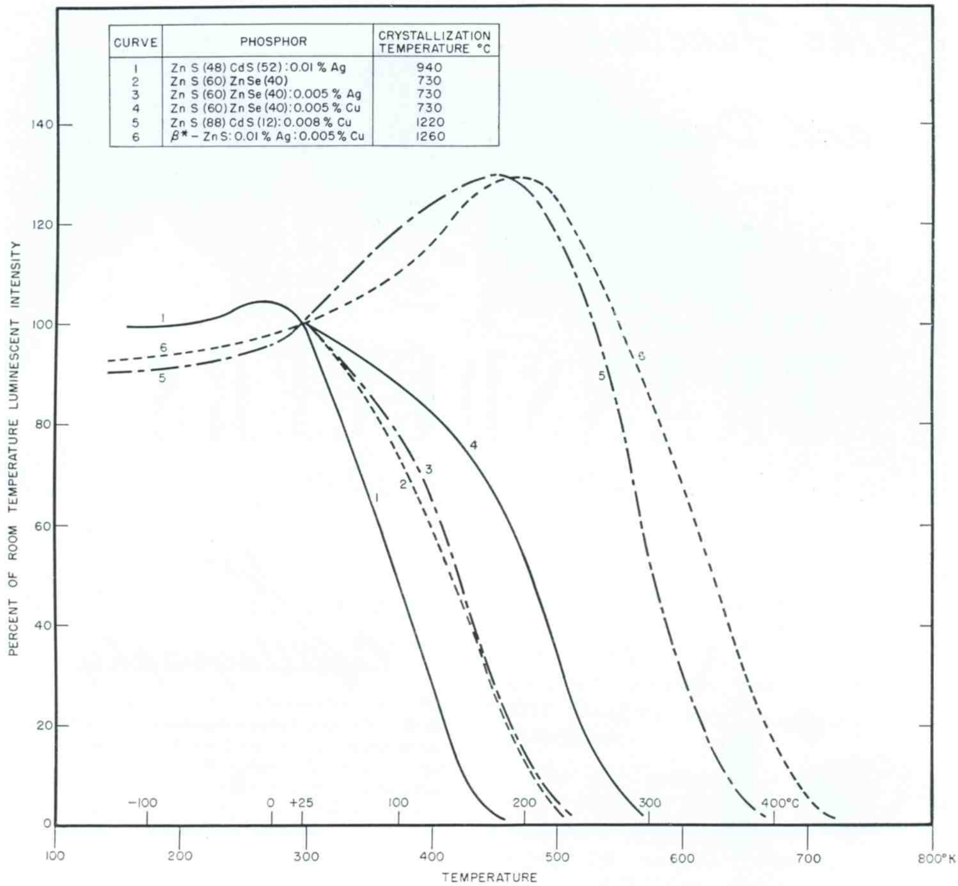


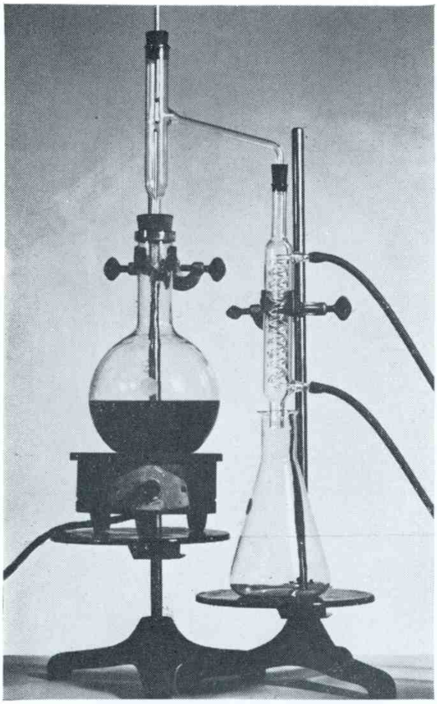
Figure 43. Dependence of luminous intensity on temperature of phosphor. (Courtesy of the Radio Corporation of America)

whose surface is a phosphor and the infrared radiation intensity determined.

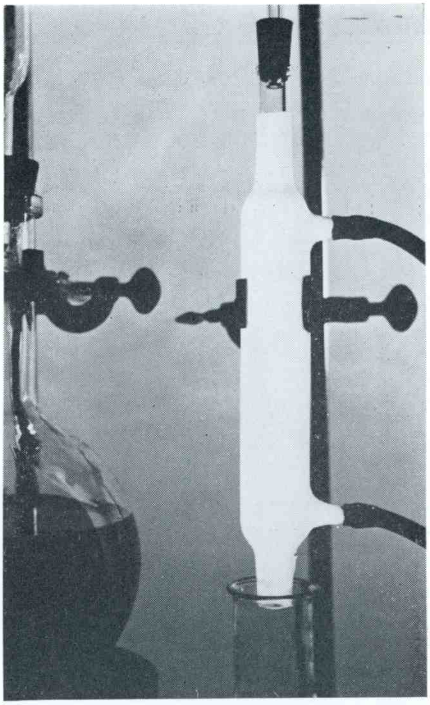
The importance of this process lies in the very large temperature sensitivity that exists in the material. The intensity may fall from a maximum to zero over a region as little as 175° approximately. Each phosphor has a region of its own where this may occur. The six phosphors reported show characteristics differing from each other in such a manner that the region between 30°C and 700°C could be covered in steps, as may be seen in Figure 43. Because of their high sensitivities to temperature, accurate measurements can be made to a few degrees, and the process readily lends itself to the measurement of small temperature differentials.

Figure 44 shows a glass still which has been coated with a temperature sensitive phosphor, or a "contact-thermograph." As the temperature of the still varies under working conditions, the temperature differential on the surface can be readily observed. In these pictures note how the fluorescence increases (the lighter portion of the picture) as the cooling water is applied.

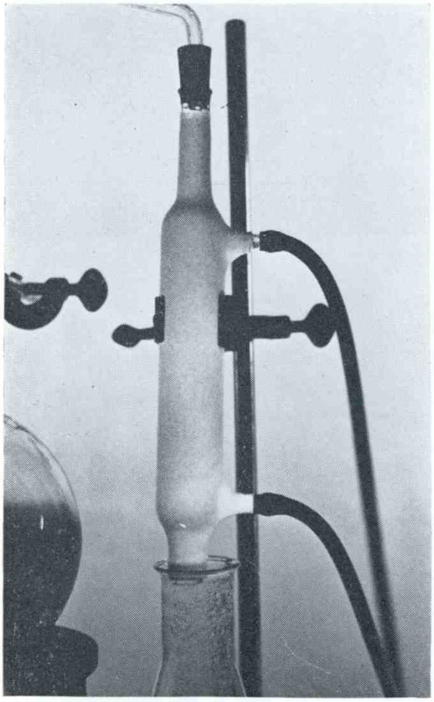
Figure 45 shows the setup for "thermoradiography" (a method of "projection thermography") using a parabolic mirror to focus the image upon a phosphor screen. Similar results can be obtained by



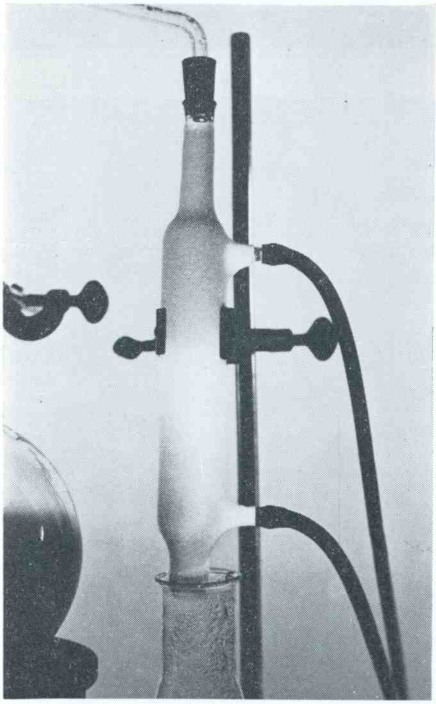
(a) As seen in room light



(b) Condenser coated with phosphor seen under ultra-violet illumination

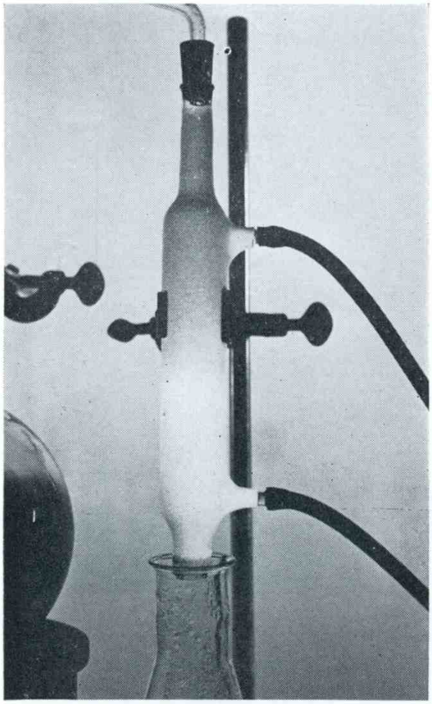


(c) Still in operation with no cooling water applied



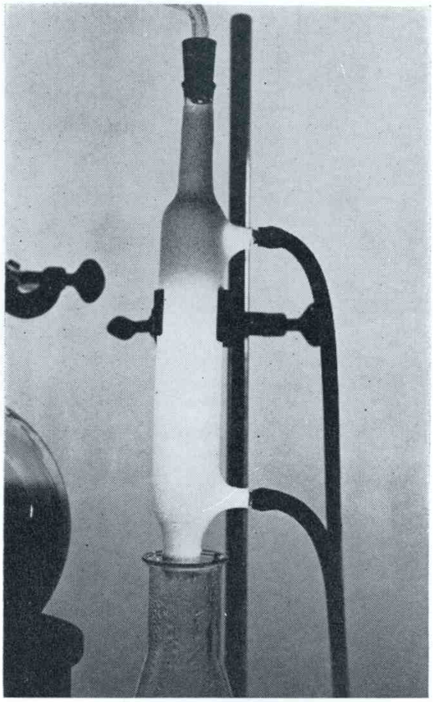
(d) Still in operation with cooling water applied and condenser beginning to function

Figure 44. Glass still coated with phosphor under various operating conditions. (Courtesy of F. Urbach, N. R. Nail, D. Pearlman and the Eastman Kodak Company)



(e)

(e-f) Same as (d), but successively later stages



(f)

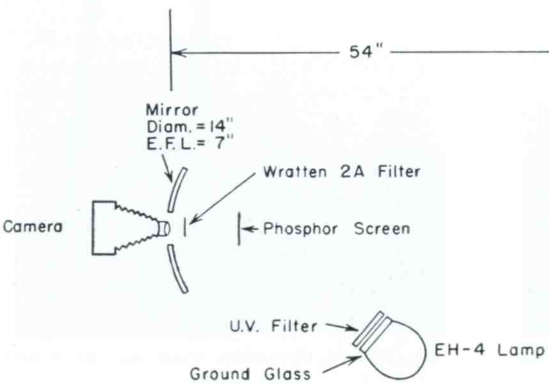
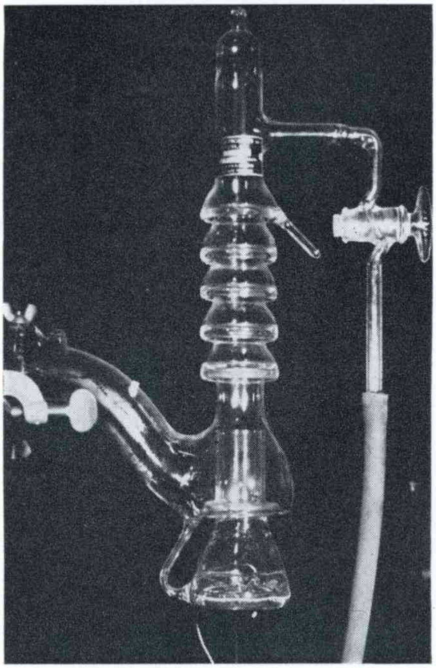
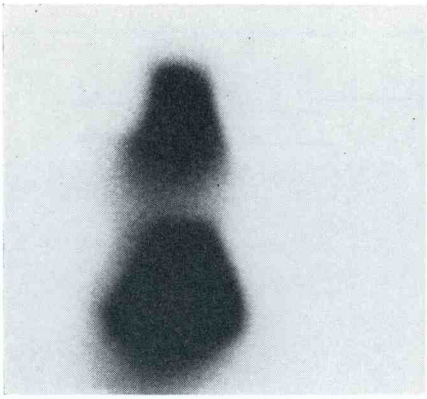


Figure 45. Setup for "thermoradiography." (Courtesy of F. Urbach, N. R. Nail, D. Pearlman and the Eastman Kodak Company)



(a)



(b)

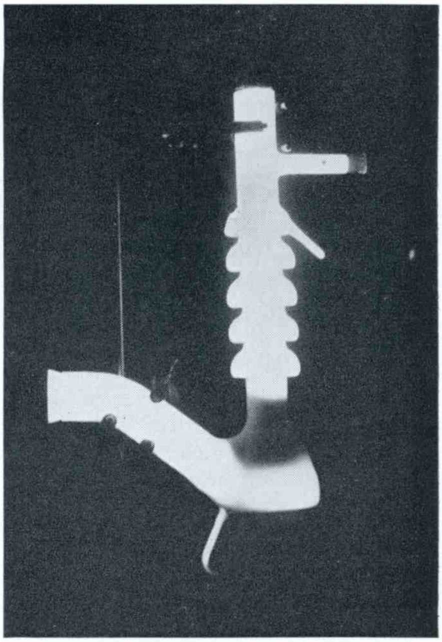
Figure 46. Glass diffusion pump. (a) In room light; (b) Thermoradiograph of pump in operation; (c) Contact-thermograph of pump in operation. (Courtesy of F. Urbach, N. R. Nail, D. Pearlman and the Eastman Kodak Company)

scanning the object or its image by means of a photocell and an oscillograph.

Also in the article cited quantitative results were obtained of photographic densities. It might be pointed out that the same results are readily accomplished by oscillography without the delay of processing photographic film.

TABLE 4
Capacitive Transducer Elements
1. Variable capacitors 2. Electrets

A capacitor is any two surfaces between which a potential difference exists. Ideally, the capacitor has neither inductance nor resistance. The inductance can be minimized by keeping the leads short and employing configurations for the capacitive elements which expose the maximum surface to each other, such as a pair of parallel plates. The resistance can be minimized by insulating the surfaces from each other with materials that have high internal and surface resistances and pro-



(c)

tecting their surfaces from dirt to prevent leakage across the surface of the insulators.

Variable Capacitors

The capacity between a pair of parallel plates is given by:

$$\mu\mu f = .08842 \frac{KA}{d} \text{ where,}$$

A = area of active surface in sq. cm
d = distance between plate surfaces
K = dielectric constant

From this it follows that the capacity can be varied in three ways: (1) by varying the active area; (2) by varying distance between plates; and (3) by varying the dielectric constant.

The active area can be varied by moving the plates in their planes so their centers approach and recede from each other, all the while maintaining them parallel. (See Figure 47.) This is the principle employed in the construction of the air-variable capacitor shown in Figure 48. These are available in various types, varying linearily, logarithmically sinusoidally, etc., with rotation. Specially shaped plates can be designed so that the capacity will vary in any desired manner with rotation.

The capacity may be varied by altering the spacing between the plates, the method used to construct condenser microphones. The condenser microphone employs a rigid plate and a flexible diaphragm of thin, stretched metal as the other plate. The diaphragm is made to vary its spacing with respect to the rigid plate by the variation of air pressure which occurs when sound waves are present.

If the dielectric constant of the medium separating the plates is varied, the capacity will also be varied. This can be done by moving a dielectric in and out of the electrostatic field existing between the capacitor plates as shown in Figure 49. This method is sometimes employed for measuring the thickness of material when the materials have a large dielectric constant.

The use of a capacitive element requires that a potential known as the polar-

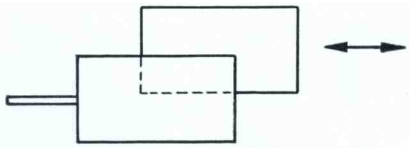


Figure 47. Capacity varied by moving plates in their planes

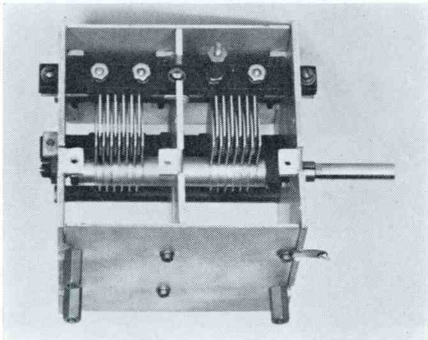


Figure 48. Air-variable capacitor

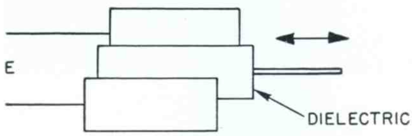


Figure 49. Dielectric capacitor employing varying dielectric

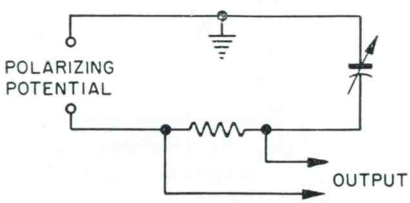


Figure 50. Method of connecting capacitive element as a thermistor

izing potential exists across the plate. The polarizing potential may be either d-c or a-c. When an unvarying polarizing potential is employed, the output signal is a faithful copy of variations in capacity. When an alternating polarizing potential is employed, the output signal is a modulated envelope with the polarizing frequency acting as the carrier frequency.

The usual method of using a capacitive element is shown in Figure 50. When the capacity is varied, a current flows $\left(E \frac{dC}{dt}\right)$. This current flowing through the resistor appears as a voltage drop and is the output signal.

Electrets

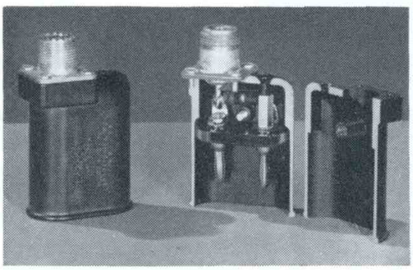
The electret is a device which maintains a potential difference across it and is the electrostatic equivalent of a permanent magnet. It differs from a battery insofar as no current can be drawn from it.

An electret can be formed by permitting molten wax to cool between a pair of charged plates. The voltage on the plates should be the highest which may be applied without causing arcing. When the wax has cooled to room temperature, the potential may be removed from the plates and the wax separated from them. The wax is now an electret. An electret may be employed between the plates of a capacitor in which case no polarizing potential will be necessary.

With the capacitive elements this discussion of transducer elements ends. We have covered the most commonly encountered transducer elements; undoubtedly there are others which do not use these principles, but these are comparatively rare and not of general interest. For our part we refuse "to mount our horse and ride off in all directions."

Throughout the article a conscious attempt has been made to confine the scope of the piece to basic electronic principles involved in the transducer elements themselves, and thus avoid getting lost in the practically limitless jungle of their combinations. It is hoped that the reader has been given a clearer conception of the function and basic uses of these increasingly important devices. Further articles on the general subject of transducers will appear in future issues of the Oscillographer.

Du Mont Type 2592 Terminal Adapter



The Du Mont Type 2592 Terminal Adapter fulfills a dual function. It permits the use of coaxial cables for carrying the input signal to the banana-jack type terminals of an oscillograph, and it also provides the correct impedance-matching termination for the coaxial cable.

The Type 2592 may be employed on any instrument having banana-jack type terminals spaced ¾″ on centers. The input signal to the Terminal Adapter is fed through a standard coaxial connector which fits Amphenol plugs, Types 83-1SP, 83-1PN, and 83-776.

An impedance-matching resistor is built into the Adapter. The last two digits of the type number, shown on one side of the Adapter, give the impedance of the cable with which it is to be used.

The terminating resistors furnished in these Adapters are the nearest 5% RMA value to the surge impedance of the cable. If a very low standing-wave ratio is desired at the termination, a special low-tolerance resistor may readily be installed.

(*Continued on Next Page*)

Cat. No.	*Type No.*	*Amphenol Plug Type No.*	*Description*
1600-A	2592-52	83-1SP, 83-1SPN, 83-776	52-ohm Terminal Adapter for use with UHF coaxial connector
1601-A	2592-75	"	75-ohm Terminal Adapter for use with UHF coaxial connector
1602-A	2592-93	"	93-ohm Terminal Adapter for use with UHF coaxial connector
1607-A	2592-N52	UG-18B/U, UG-21B/U	52-ohm Terminal Adapter for use with Type N coaxial connector
1608-A	2592-N75	UG-94A/U	75-ohm Terminal Adapter for use with Type N coaxial connector
1618-A	2592-B52	UG-88/U, UG-260/U	52-ohm Terminal Adapter for use with Type BNC coaxial connector
1619-A	2592-B75	"	75-ohm Terminal Adapter for use with Type BNC coaxial connector
1620-A	2592-B93	"	93-ohm Terminal Adapter for use with Type BNC coaxial connector

A. O. Spectrophotometer (Con't)

bination of optical spectrophotometer and cathode-ray oscillograph produces spectrophotometric curves instantaneously on the cathode-ray screen.

The rapid operation of this Spectrophotometer is accomplished by the use of an oscillating mirror which scans the image of the spectrum across a slit placed in front of a photocell. The result is a curve on the cathode-ray screen in which the amplitude of the trace at any instant is proportional to the intensity of a paricular wave length of light. Both coordinates of the curve are linear and either or both may be expanded.

The indicator unit of the Rapid-scanning Spectrophotometer contains a cathode-ray tube with a long persistence screen for visual observation. However, the spectrophotometric curves may also be photo-recorded with an oscillograph-record camera, available from Du Mont.

The Rapid-scanning Spectrophotometer will handle transparent, solid, or liquid samples up to 100 millimeters thick. By means of a separate reflection attachment, the instrument will produce data from opaque solids or powders.

The portion of the spectrum covered by the instrument ranges from 400 to 700 millimicrons. This range is scanned at an interval of 1/180 of a second, at a repetition rate of 60 times per second. Because of this high scanning rate, the Rapid-scanning Spectrophotometer is particularly adaptable to the investigation of rapidly changing spectra, problems which require telemetering or simultaneous transmission of spectrophotometric data to several points, or to production control where continuous monitoring is desired.

The A.O. Rapid-scanning Spectrophotometer is another example of the manner in which cathode-ray oscillographs can greatly increase the utility of mechanical or optical equipment. The oscillograph furnished by Du Mont for this application is but one example of specialized designs available from the Special Products Section of Du Mont Laboratories.

For further information concerning the new Rapid-scanning Spectrophotometer, write Optical Measuring Department, American Optical Company, Instrument Division, Buffalo 15, New York. For information concerning standard or special oscillographic equipment, write to Instrument Division, Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Avenue, Clifton, N. J.

A True Electronic Voltmeter . . .

The New Du Mont Type 304-A

Cathode-ray Oscillograph

The new Du Mont Type 304-A Cathode-ray Oscillograph is a true electronic voltmeter which retains all the popular features of its predecessor, the general-purpose Type 304-H. The new Type 304-A enables rapid, accurate amplitude measurements directly from the face of the cathode-ray tube of any portion of a signal up to 1000 volts, within the frequency range of the instrument. Thus, peak-to-peak measurements may be readily obtained without disturbing any of the leads.

A wholly new cathode-ray tube, designated the Type 5ADP-, is incorporated in the Type 304-A. (See Figure 1.) Features of the new precision-built tube include a deflection plate alignment tolerance of $\pm$ 1°, a new electron-gun design that provides a brilliant trace with excellent resolution, a sensitivity almost twice that of conventional tube designs, and a flat face to minimize errors of measurement owing to parallax. An auxiliary focus system reduces astigmatism to negligible proportions.

A comparison of the Type 5ADP- Cathode-ray Tube with the tube it replaces, the Type 5CP-A, is given in Table 1.

High-gain a-c or d-c amplification is featured in the Type 304-A. Specifications call for a sensitivity of 100 millivolts d-c full scale, equivalent to a deflection factor of 25 peak-to-peak millivolts per inch (10 peak-to-peak millivolts/cm). Sinusoidal frequency response, with any setting of attenuator and gain controls, is flat to zero cps and down not more than 10% at 100,000 cps with direct coupling; with capacitive coupling, down not more than 10% at 10 cps and 100,000 cps. Frequency response is down not more than 50% at 300,000 cps with either a-c or d-c coupling.

Other features of the Type 304-A include a new illuminated scale, calibrated to read directly in volts, driven and recurrent sweeps variable from 2 to 30,000 cps with sweep expansion up to 6 times useful screen diameter, provision for extra-low-frequency sweeps by means of external capacitors, stabilized synchronization for presentations without jitter and for reliable sweep operation by sync limiting on both driven and recurrent sweeps, and provision for intensity modulation of the electron beam. In addition, an astigmatism control assures a very small, uniform spot size under all normal conditions. Excellent stability is assured by the regulation of the heaters of the Y-amplifier input stages.

For those who desire the features of the Type 304-A in a cathode-ray oscillograph designed for mounting in a standard 19-inch relay rack, Du Mont has designed the Type 304-AR. The two oscillographs are identical electrically.

The input attenuator, vertical deflection, sync and sweep, horizontal deflection, cathode-ray tube, and power supply circuits of the Type 304-A are basically the same as the Du Mont Types 304 and 304-H, which are described in detail in the Oscillographer, Vol. 11, No. 4. However, in addition, the Type 304-A contains a voltage calibrator circuit, shown in Figure 4. A description of the operation of this circuit follows.

Referring to Figure 4, the power frequency voltage from the 375-volt winding on T601 is applied to V602 through limiting resistor R603. On the positive half-cycle the voltage build-up across the divider (R607 and R602) is limited to

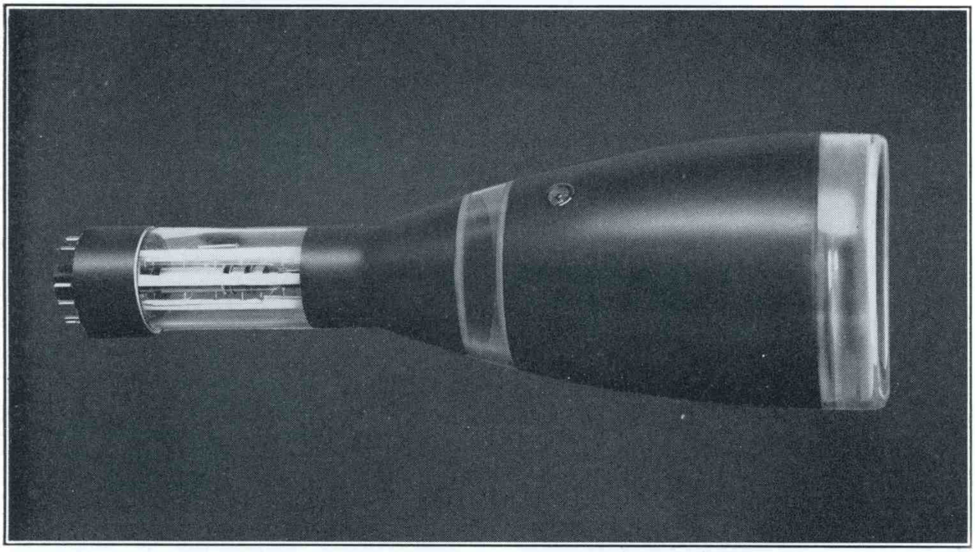


Figure 1. The new Du Mont Type 5ADP- Cathode-ray Tube employed in the Type 304-A. Tight tolerances of this flat-faced tube enable a precision of measurement impossible with more conventional tubes

TABLE I

COMPARISON OF TYPES 5CP-A AND 5ADP- CATHODE-RAY TUBES

	5CP-A	5ADP-
Angular Alignment	90°±3°	90°±1°
Grid Cutoff per KV of Eb2	30V ±50%	30V ±25%
Deflection Factor DCV/In/KV of Eb2 D1D2 D3D4	 46V ±15% 39V ±15%	 30V ±10% 23V ±10%
Line Width	No spec	.03" max.
P1 Light Output	No spec	15 ft. L. min.
Modulation[1]	No spec	45V max.
Deflection Factor Uniformity	No spec	2% max.
Pattern Distortion at 75% of Useful Scan[2]	No spec	2½% max.
Minimum Useful Scan D1D2 D3D4	 ±2¼" from center ±2¼" from center	 ±2" from center ±2" from center

[1]The amount of grid voltage required to drive tube from cut-off to minimum specified light output. (Measured in accordance with JAN-1A specification at post accelerator current = 25 Ma.)

[2]The edges of a raster pattern, whose mean dimensions are the indicated percentage of useful scan, shall not deviate from the mean dimension rectangle by more than the specified amount.

slightly greater than +110 volts peak due to conduction through V602 from cathode (pin 1) to plate (pin 7) when the applied voltage exceeds the ±110 volts regulated bias on the cathode (pin 1). The other half of V602 conducts on the negative half-cycle, thus clamping the top of R607 to essentially ground potential during this time. The result is a square-wave voltage at power-line frequency ±110 volts peak-to-peak appearing across the divider network (R607 and R602). The attenuated output is coupled from the junction of R607 and R602 to the CALIBRATOR switch (S102). R602 (CALIBRATOR ADJ) provides a means of varying the calibration voltage to provide exactly 0.1 volt (100 mv) peak-to-peak. This voltage is coupled to the input cathode follower by the CALIBRATOR switch (S102).

Amplitude measurements of even the most complex waveforms are simple with the Type 304-A, as shown in Figures 5a and b. Once the CALIBRATOR push button (S102) is depressed, a square-wave standardizing voltage is applied which may be adjusted by means of the MULTIPLIER control (R112) to produce, for example, 50 units deflection on the screen. The reading of the VOLTS FULL SCALE switch multiplied by that of the MULTIPLIER control converts these units to volts full scale. By depressing the

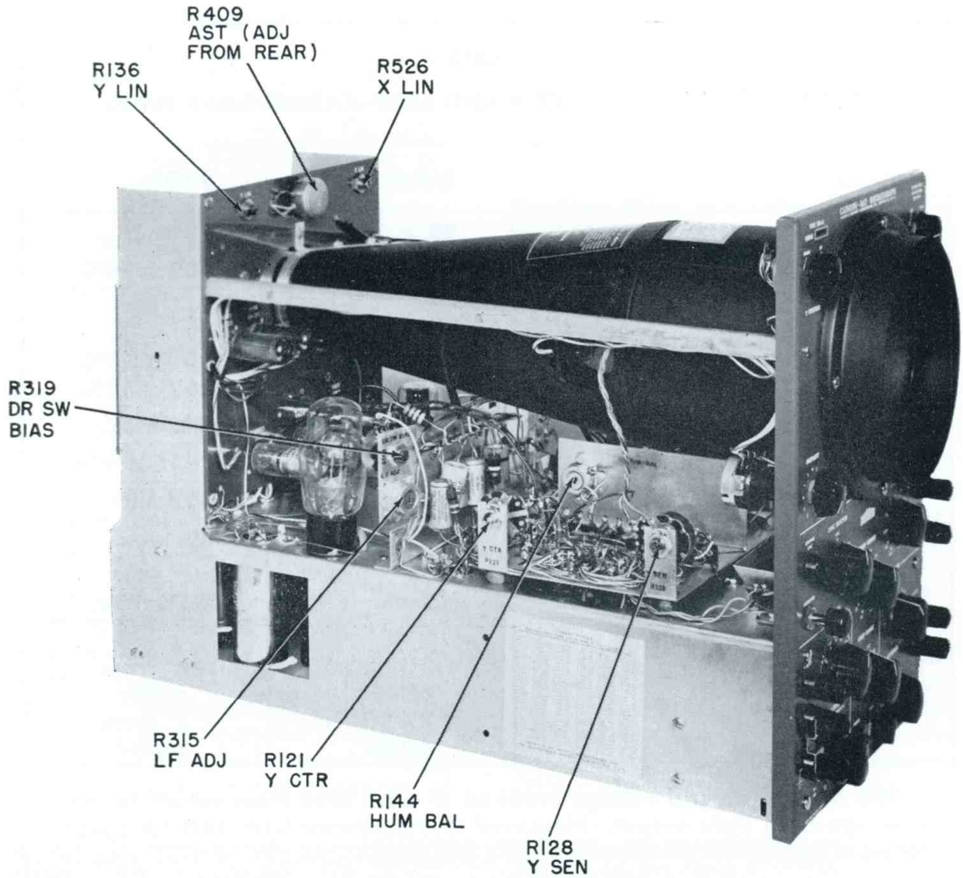


Figure 2. Identification of back-of-panel controls, left side

ASTigmatism control (R409) — Adjusted to produce small spot, uniform in size across screen

Y-LINearity (R136) — Adjusted to produce no change in size with vertical positioning

X-LINearity (R526) — Adjusted to produce no change in size with horizontal positioning

DRiven SWeep BIAS (R319) — Adjusts level of input voltage needed to initiate driven sweep

Sweep Low-frequency ADJustment (R315) — Fine adjustment for low-frequency sweeps

Position Centering Adjustment (Y CTR) — R121 — Adjustment to center trace vertically with no signal input and Y POSITION control at its mechanical center

Y SENsitivity (R128) — Sets sensitivity of the Y Axis at 25 millivolts d-c per inch at full gain

CALIBRATOR push button again, the signal under study is returned to the screen, where any amplitude portion of the signal may be read directly in volts from the calibrated scale.

With this system of amplifier standardization, the VOLTS FULL SCALE switch can be operated at will, without necessitating recalibration, provided only that precision resistors are used in this scale selector. Actually, the 1% resistors used, insure the overall specified accuracy of 5%.

Stability

To assure stability, the heaters of the Y-amplifier input stages are regulated. A series-connected thermal regulator controls the heater temperature to stabilize

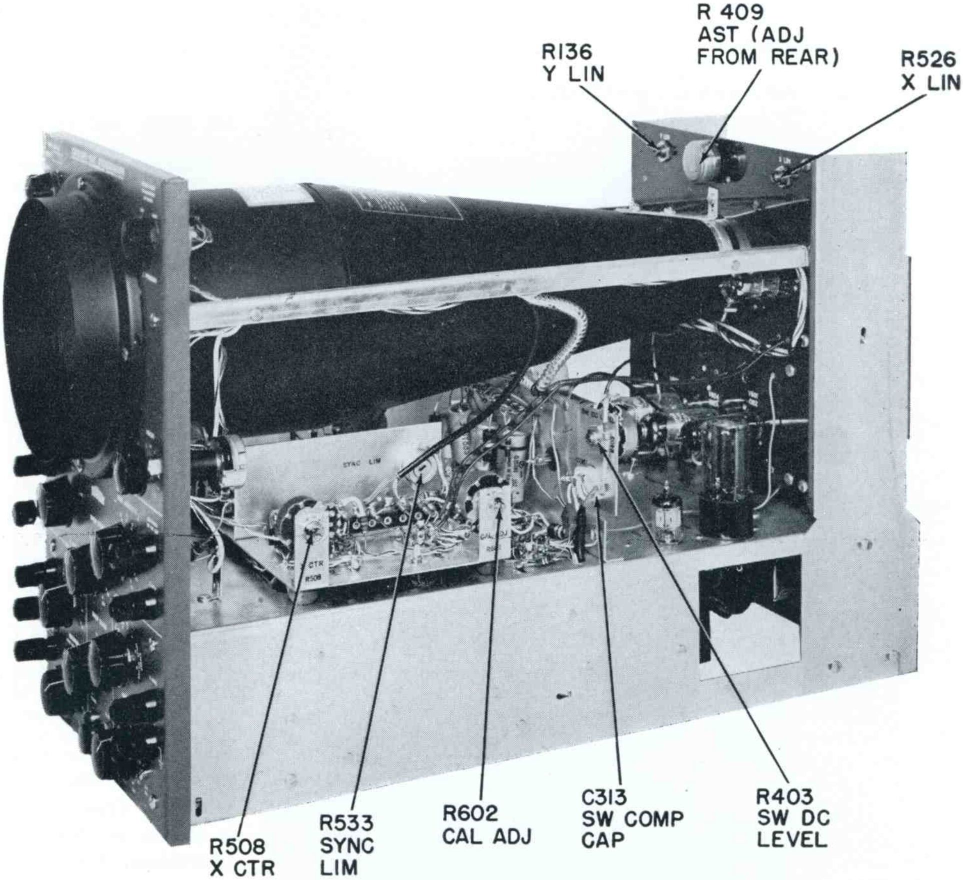


Figure 3. Identification of back-of-panel controls, right side

SYNC LIMiter (R533) — Adjusts bias level of sync limiter diode (V302). V302 prevents erratic operation of sweep generator (V303)

Y-LINearity (R136) — See Figure 2

ASTigmatism control (R409) — See Figure 2

X-LINearity (R526) — See Figure 2

Position Centering Adjustment (X CTR) — R508 Adjustment to center trace horizontally with no signal input and X Position control at its mechanical center

CALibrator ADJustment (R602) — Adjusted to produce identical deflection (CALIBRATOR switch pushed in) compared with a 0.1-volt signal from a standard voltage calibrator (CALIBRATOR switch released)

Sweep-output Attenuator Trimmer (SW COMP CAP) — C313 — Adjusted to produce optimum linearity and minimum "tail" of the sawtooth waveform

SWeep DC LEVEL (R403) — Adjusted to allow sweep to expand equally in both directions as the (X) AMPLITUDE control is advanced

cathode emission over a $\pm 10\%$ range of variation in supply potential. In addition, a HUM BALance potentiometer is included in the filament circuit of these two stages to reduce line-frequency modulation to a minimum.

Stability is also gained by the d-c balance arrangement of the vertical deflection push-pull amplifiers. Also, the screen grid potentials of the last push-pull stage are obtained from an unregulated source to allow the gain of the circuit to rise

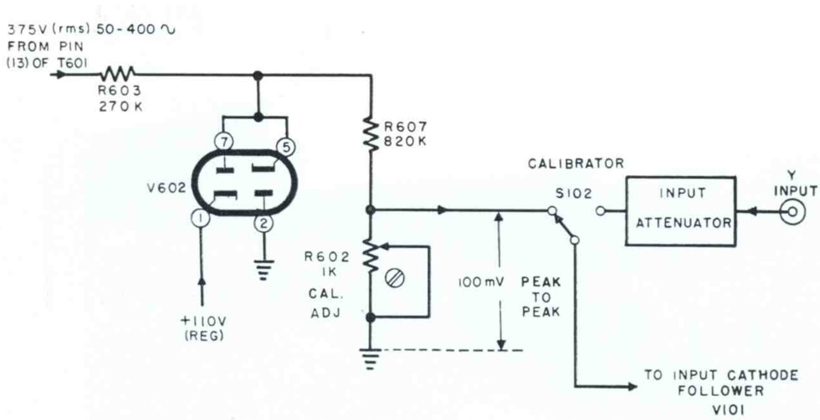


Figure 4. Voltage calibrator circuit (simplified schematic)

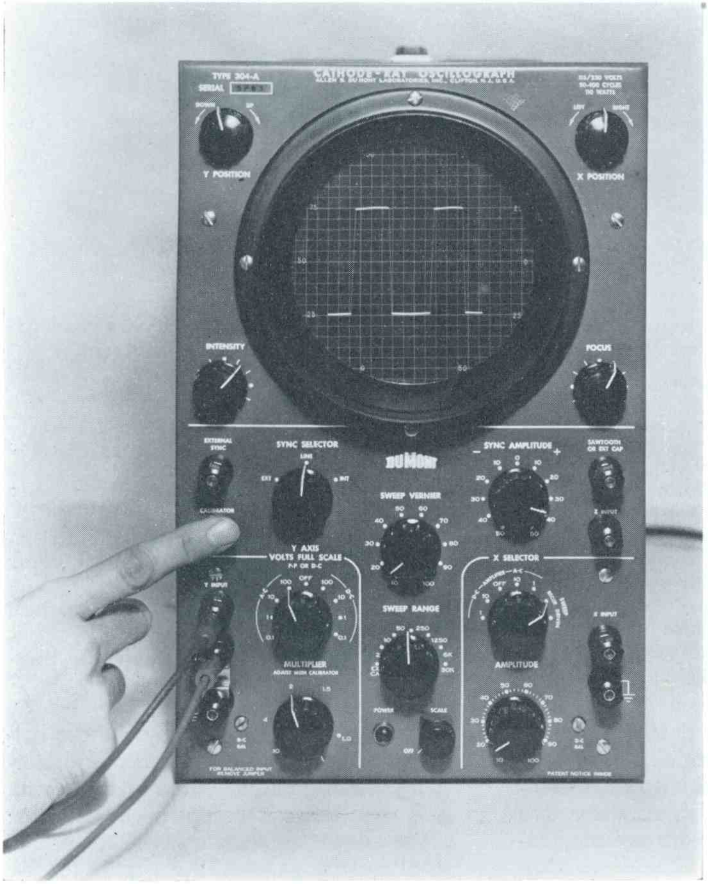


Figure 5a. The ease of voltage calibration with the Type 304-A is shown in these illustrations. First, the square wave standardizing signal is applied to the screen by depressing the CALIBRATOR push-button and adjusted by means of the MULTIPLIER control to produce a half-scale deflection. In this example the VOLTS FULL SCALE switch indicates 100 and the MULTIPLIER indicates 2, for a factor of 100 x 2 or 200 volts full scale.

Figure 5b. After the preliminary adjustments, the waveform under study, a sawtooth signal in this example, is displayed by again depressing the CALIBRATOR push button. Reading directly from the scale, and without disturbing either the VOLTS FULL SCALE or MULTIPLIER controls, the peak-to-peak value of the sawtooth waveform is seen to be 65 volts.

It can also be observed that any portion of the test waveform may be measured directly from the scale, and furthermore, that at no time during the calibration is it necessary to disturb the connections to the oscillograph

with increasing line voltage. This is designed to compensate for the reduction in the sensitivity of the cathode-ray tube caused by higher accelerating potentials resulting from the increased line voltage. Hence, variation in overall sensitivity owing to line-voltage fluctuations is minimized.

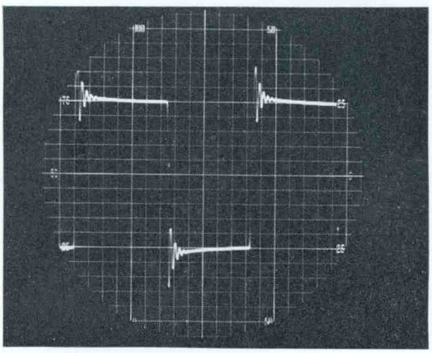


Figure 6. A square-wave has been applied to a servo circuit with output displayed on a Type 304-A. Note how amount of overshoot may be read directly from the scale

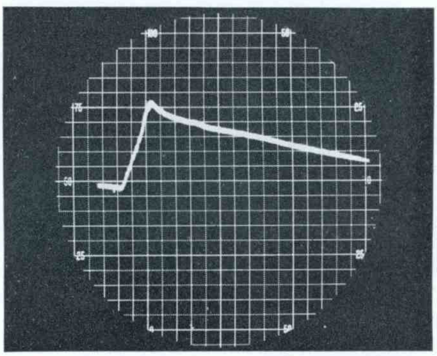


Figure 7. Resistance variation in a heated piece of Thyrite that is allowed to cool, displayed on a 15 second sweep attained by means of an external capacitor

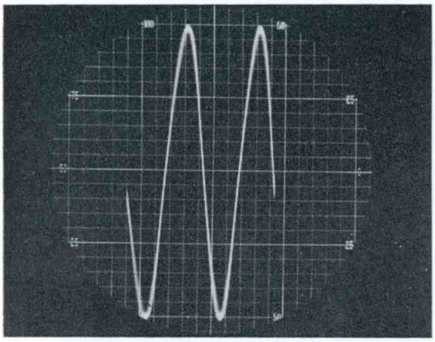


Figure 8. Sinewave displayed on a cathode-ray oscillograph with no astigmatism control. Note defocussing of the horizontal positions of the trace

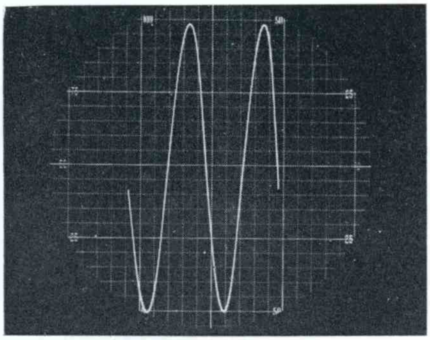


Figure 9. Same sinewave as Figure 8, displayed on a Type 304-A with astigmatism control adjusted properly. Uniform focus greatly facilitates precise measurement

Examples

The following oscillograms, illustrating the versatility of the Type 304-A, show measurements directly from the scale of the Type 304-A: Figure 6, the amount of overshoot in a servomechanism, and Figure 7, resistance versus temperature changes in a piece of Thyrite.

An astigmatism control, designed to assure a very small, uniform spot with excellent resolution under all conditions of normal use, is included in the Type 304-A. The value of this control is clearly illustrated in Figures 8 and 9.

Sweeps of the Type 304-A can be expanded up to six times full-screen diameter on any sweep speed. This feature is illustrated in Figures 10 and 11 where, in a certain application, the contact bounce of a relay must be measured.

Other applications of the Type 304-A are shown in Figures 12 and 13. Figure 12 is an oscillogram of the heating characteristics of an incandescent lamp, while Figure 13 illustrates the characteristic of a crystal diode.

Each of the foregoing examples reflects the care in design and manufacture which has gone into the Type 304-A. With its matchless background in the field of os-

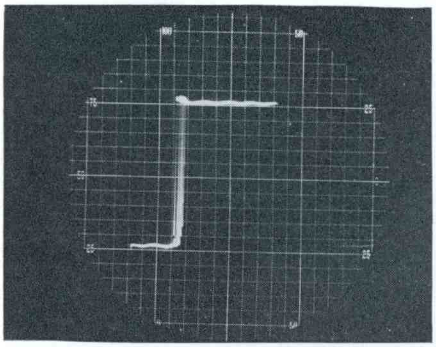


Figure 10. Sweep expansion in the Type 304-A enables study of high-frequency portions of lower frequency signals. Here the contact bounce of a relay is displayed without expansion, with the result that the bounce is obscure

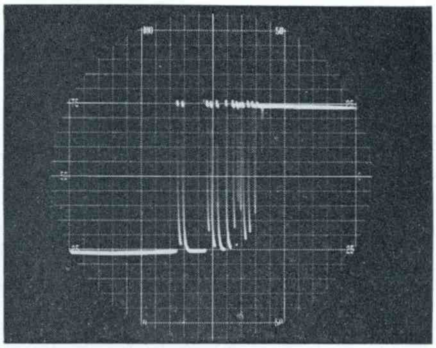


Figure 11. With the sweep of the Type 304-A expanded, details of the contact bounce of the relay which were not visible in Figure 10 are clearly resolved

cillography Du Mont has combined its facilities for the design of cathode-ray tubes and cathode-ray instruments to produce the first true electronic voltmeter.

Precision-built throughout, yet possessing the ruggedness of the Type 304-H, the Type 304-A is equally suitable for mechanical as well as exacting electronic applications. The versatility of the Type 304-A, plus the cost-saving possibilities in the number of auxiliary instruments it eliminates, makes it the ideal instrument for the production line as well as the laboratory.

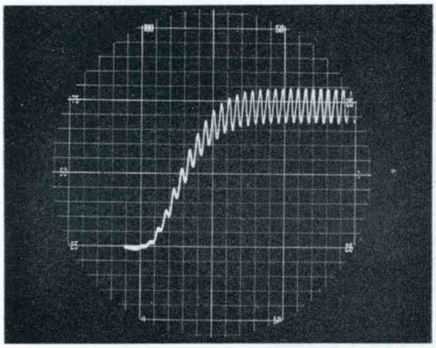


Figure 12. Heating of an incandescent lamp displayed on driven sweep. Oscillations in the gradual rise to incandescence represent the light output of the bulb as the filament heats. D-C response of the Type 304-A assures faithful presentation of such low-frequency phenomena

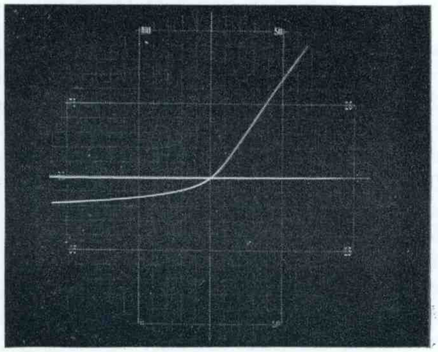


Figure 13. Characteristic of a crystal diode with a zero base line established as a reference. Because of identical frequency response on both X and Y axes, a series of similar graphs at varying frequencies may be obtained with the Type 304-A with no danger of distortion on either axis

Specifications

Cathode-ray Tube: Type 5ADP- flat-face Cathode-ray Tube operated at an overall accelerating potential of 3000 volts.

Vertical Deflection — Deflection factor—through amplifier at full gain, 0.1 volt d-c full scale, equivalent to 0.025 volt d-c per inch. Direct to deflection plates, 128 to 156 volts d-c full scale. **Undistorted deflection:** More than 4 inches. Equivalent to 16 inches of vertical expansion. **Sinusoidal Frequency Response:** (For any setting of controls) with direct coupling, is down not more than 10% at 10 and 100,000 cps; a-c or d-c coupling, down not more than 50% at 300,000 cps. **Input Impedance:** to amplifier, 2 megohms paralleled by 50 $\mu\mu$f; direct (unbalanced), 1.5 megohms paralleled by 20 $\mu\mu$f; direct (balanced) 3 megohms paralleled by 20 $\mu\mu$f.

Maximum Allowable Input Potential: a-c coupling 1,000 volts d-c plus peak a-c; d-c coupling; on all ranges of the VOLTS FULL SCALE switch except 0.1 where it is 100 volts d-c plus peak a-c.

Horizontal Deflection — Deflection factor — through amplifier at full gain, 1.2 volts d-c full scale. Direct to deflection plates, 160 to 200 volts d-c full scale.

Sinusoidal Frequency Response: (for any setting of controls) with direct coupling, is down not more than 10% from 0 to 100,000 cps; with capacitive coupling, is down not more than 10% at 10 and 100,000 cps; a-c or d-c coupling, down not more than 50% at 300,000 cps. **Input Impedance:** to amplifier, 2.2 megohms paralleled by 50 $\mu\mu$f; direct (unbalanced), 1.5 megohms paralleled by 20 $\mu\mu$f; direct (balanced), 3 megohms paralleled by 20 $\mu\mu$f.

Linear Sweeps — Frequency Range — Recurrent and driven sweeps variable in frequency from 2 to 30,000 cps. Provision incorporated for extra low-frequency sweeps by attaching external capacitance to convenient terminals, with 0.5 second sweep secured for each microfarad of external capacitance. **Sweep Amplitude:** Four inch minimum of undistorted sweep is available; sweep amplitude at minimum X-amplitude control setting is less than ½ inch; both driven and recurrent sweeps expandable up to 6 times full-screen diameter with positioning over the entire range and negligible distortion present in the visible portion; direction of sweep, from left to right, return trace automatically blanked; sweep synchronization from signal of either polarity, with sync limiting on driven and recurrent sweep. Maximum sweep speed, with sweep expansion, is one inch per microsecond. **Voltage Measurement:** Within frequency range of the instrument, will measure signals in amplitude range from 0 to 1000 volts; VOLTS FULL SCALE range, 0 to 0.1, 1, 10, 100 volts with accuracy of ±2%; MULTIPLIER range, from X1 to X10 continuously; calibration voltage accuracy, 5%.

Intensity Modulation: A Z-axis front panel connection available at input impedance of 0.2 megohm paralleled by 80 $\mu\mu$f; positive signals increase intensity of beam.

Maximum Photographic Writing Rates: With Type 296 using f/2.8 lens, 0.8 inches/μsec; with Types 321 and 295, using f/1.5 lens, 2.8 inches/μsec.

Tube Complement: 2-6AL5; 6-12AU7; 2-6J6; 1-5Y3GT; 2-6AQ5; 1-OB2; 1-6Q5G; 2-1X2A; 2-5963.

Power Source: 115 or 230 volts ±10% at 50-400 cycles; 110 w.

Physical Characteristics: Instrument is housed in metal cabinet provided with leather carrying handle. **Overall Dimensions:** height, 13½" (33.6 cm); width, 8¾" (22 cm); depth, 19½" (49.5 cm). **Weight** 50 lbs. (22.6 kg). Instrument is supplied with illuminated, calibrated scale and proper filter. Illumination is adjustable from zero to more than adequate level for recording.

Cat. No.	Description
1622-A	115 volts, 50-400 cps. Type 5ADP1 Cathode-ray Tube
1625-A	115 volts, 50-400 cps. Type 5ADP7 Cathode-ray Tube
1626-A	115 volts, 50-400 cps. Type 5ADP11 Cathode-ray Tube
1627-A	230 volts, 50-400 cps. Type 5ADP1 Cathode-ray Tube
1630-A	230 volts, 50-400 cps. Type 5ADP7 Cathode-ray Tube
1631-A	230 volts, 50-400 cps. Type 5ADP11 Cathode-ray Tube

We've Moved

In order to meet increasing production requirements, the Instrument Division has moved to new quarters at 760 Bloomfield Ave., Clifton, N. J. The new plant offers 75,750 square feet for manufacturing and office space and is equipped with the most modern facilities for production and development of cathode-ray instruments.

The building is adjacent to Du Mont's tube manufacturing facilities and to the company's main offices.

All correspondence with the Instrument Division should now be addressed to 760 Bloomfield Ave., Clifton, N. J.