DU MONT

Presents

*The **NEW** types 304 and 304-H*

Cathode-ray Oscillographs

(Successors to the World Famous Type 208-B)

The NEW Types 304 and 304-H Cathode-ray Oscillographs Are Worthy Successors to the World-Famous Type 208

WHEN THE Du Mont Type 208 Cathode-ray Oscillograph first appeared, it was hailed as being ten years ahead of its time. And subsequent performance bore out early predictions. However, as time passed, and the state of the art progressed, it was apparent to Du Mont engineers that stringent requirements of the future would demand more advanced oscillographic equipment. Thus work was begun on an instrument that would have all the features that made the Type 208 the most useful oscillograph in the world . . . PLUS MANY MORE. Only after several years of development and extensive field testing did they feel they had an instrument that could be truly called the successor to the Type 208.

The new Du Mont Types 304 and 304-H Cathode-ray Oscillographs have been TRIED AND PROVED. Designed and constructed with the same care and skill that have made Du Mont the leader in the field of cathode-ray oscillographs, they are as far ahead of their time as was the Type 208.

Picking up where the Type 208 leaves off, the Types 304 and 304-H are important contributions to the art of oscillography . . . invaluable tools for the science and technology of the future.

The NEW Types 304 and 304-H have all the features that made the Type 208 the most popular and useful oscillograph in the world — plus MANY MORE AT NO EXTRA COST!

HIGH-GAIN A-C AND D-C AMPLIFIERS FOR BOTH X- AND Y-AXES

Sensitivity:

Y-Axis — 10 millivolts rms per inch (ac and dc)
X-Axis — 50 millivolts rms per inch (ac and dc)

Frequency Response:

D-C amp. X- and Y-axes — 0-100,000 cps within 10%
0-300,000 cps within 50%

A-C amp. X- and Y-axes —
20-100,000 cps within 10%
20-300,000 cps within 50%

No pattern "bop", even with overloaded high-gain amplifier.

Excellent stability and minimum microphonics and drift are assured by careful design.

Provision also included for applying signals directly to both vertical- and horizontal-deflection plates.

EXPANSION OF DETAIL

Because deflection of over 4 times full screen diameter is available on both the X and Y axes, performance equivalent to that of a 20-inch cathode-ray tube is possible, with the high resolution of a 5-inch screen. Full positioning is available, over this entire range, on both axes. There is no on-screen distortion present even at maximum expansion.

RECURRENT *AND DRIVEN* SWEEPS

Recurrent and driven sweeps are provided, and are variable from 2 to 30,000 cps.

Sweep speeds faster than 0.75 inch per microsecond with fully expanded time base.

Provision is incorporated for sweeps of 10 seconds and slower through a facility providing for the use of external capacitors at front-panel terminals.

Sweep length is independent of sweep frequency.

STABILIZED SYNCHRONIZATION

Sync limiting is provided so that sweep length and synchronization are maintained as signal level varies widely.

INTENSITY MODULATION

Z-Axis-input terminal on the front panel is capacitively coupled to the grid of the cathode-ray tube.

15 volts peak will blank trace fully at normal intensity.

TYPE 5CP-A CATHODE-RAY TUBE OPERATED AT INCREASED ACCELERATING POTENTIAL

The Type 5CP-A Cathode-ray Tube is operated at an accelerating potential of 1780 volts in the Type 304; at 3000 volts in the Type 304-H. The higher accelerating potential of the Type 304-H facilitates the use of long-persistence screens so that fullest possible advantage may be taken of the rapid driven sweeps, the low-frequency recurrent sweeps, and the d-c amplifiers. Due to the additional intensifier potential, the photographic capabilities of the Type 304-H are *10 times* greater than those of the Type 304.

TRIED AND PROVED

The NEW Du Mont Types 304 and 304-H Cathode-ray Oscillographs have undergone a most rigid field test, both at Du Mont Laboratories and at selected laboratories and institutions throughout the country. Here in a great variety of applications, every feature was given a thorough workout. Thus, Du Mont presents the Types 304 and 304-H not as new instruments of unknown quality, but as oscillographs of TRIED AND PROVED EXCELLENCE, thoroughly capable of undertaking the difficult task of replacing the Type 208-B!

For Complete Specifications, see Page 12

CATHODE-RAY-TUBE CIRCUITS & POWER SUPPLIES

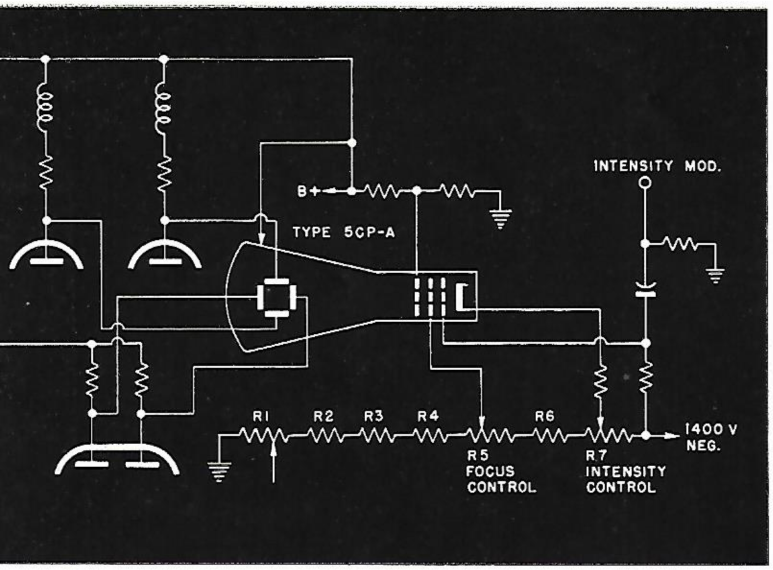

Figure 1. Cathode-ray tube circuits.

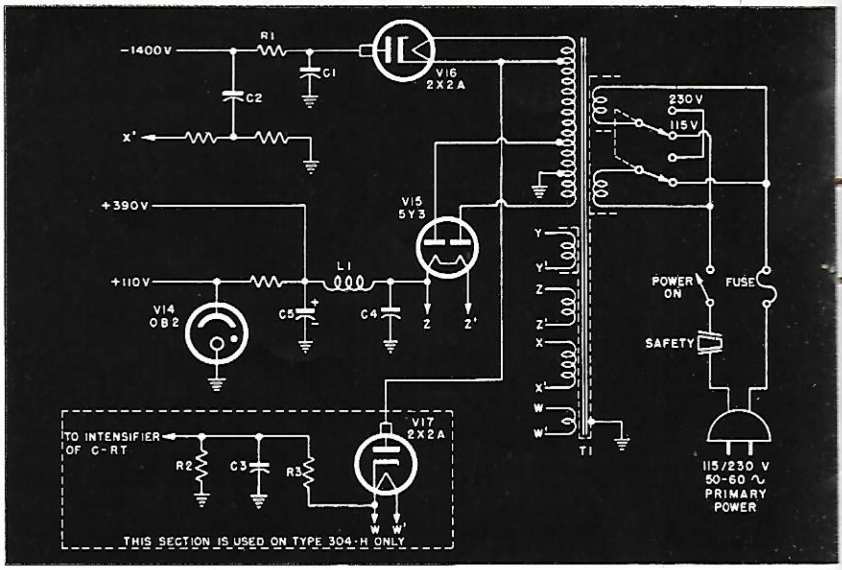

Figure 2. Power supplies of the Types 304 and 304-H.

GENERAL

The Du Mont Types 304 and 304-H differ only in the accelerating potentials at which their Type 5CP-A Cathode-ray Tube is operated. In the Type 304, an overall accelerating potential of 1780 volts is applied to the Cathode-ray Tube; in the Type 304-H an additional intensifier voltage supply increases this potential to 3000 volts. The higher accelerating potential of the Type 304-H facilitates the use of long-persistence screens, so that the fullest possible advantage may be taken of the low-frequency recurrent sweeps, the fast driven sweeps, and the d-c amplifiers of the instrument.

WRITING RATES

With 1780 volts accelerating potential as provided in the Type 304, writing rates of 0.05 inch per microsecond may be recorded, using the Du Mont Type 271-A Oscillograph-record Camera. This figure is increased to 0.09 inch per microsecond with a Du Mont Type 314-A Oscillograph-record Camera using an f/2.8 lens, and to 0.4 inch per microsecond for a Type 314-A with an f/1.5 lens.

Due to the increased accelerating potential, the photographic capabilities of the Type 304-H are almost ten times greater than those of the Type 304. The writing rates that may be recorded from the Type 304-H are: with the Type 271-A Camera, 0.4 inch per microsecond with the Type 314-A Camera, using an f/2.8 lens, 0.8 inch per microsecond; and with the Type 314-A Camera with an f/1.5 lens, 2.8 inches per microsecond.

The cathode of the Type 5CP-A Cathode-ray Tube of the Types 304 and 304-H is operated at 1400 volts, negative with respect to ground. A positive potential of 200 volts is applied to the second anode. The intensifier of the Type 304 is operated at 380 volts, positive. The intensifier of the Type 304-H is operated at 1600 volts, positive. The arrangement of output potentials of the power supplies in these instruments is such as to permit maximum utilization of all potentials developed therein, not only for their basic purpose of operating the vacuum-tube amplifiers and control circuits, but also for achieving maximum possible brightness, and thus utility from the cathode-ray tube.

CATHODE-RAY TUBE CIRCUITS

As seen from Figure 1, the voltages applied to the cathode and first anode are obtained from the voltage divider made up of R1, R2, R3, R4, R5, R6, and R7. Intensity and focus are controlled by potentiometers R7 and R5 respectively. Interdependency between intensity and focus, inherent to some degree in all electrostatically focused cathode-ray tubes, is held to a minimum in the Types 304 and 304-H through the employment of a cathode-ray tube designed with a "Zero-first-anode-current" electron gun.

HIGH-VOLTAGE POWER SUPPLY

Voltages to operate the cathode-ray tube are obtained from the high-voltage power supply. (See Figure 2). This supply consists of a half-wave rectifier, V16, the output of which is filtered by the resistance-capacitance filter, C1, R1, and C2.

In the Type 304-H, the additional intensifier voltage is supplied by another half-wave rectifier, V17. The filter system for this additional supply consists of R3, C3, and R2 the bleeder across the filter capacitor.

LOW-VOLTAGE POWER SUPPLY

The low-voltage supply consists of a full-wave rectifier V15, plus a capacitance input filter, C4, L1, and C5. The output of this system is regulated by V14. This supply furnishes plate power at approximately 390 volts, and at sufficient current ratings to supply the tubes of the instrument. A regulated output potential is also taken from this power supply to aid the stability of the operation of this instrument.

SWEEP CIRCUITS

GENERAL

Sweeps of the Du Mont Types 304 and 304-H, both recurrent and driven, are variable from 2 to 30,000 cps, with even slower sweeps possible through the use of external capacitance inserted between the X-input terminals on the front panel.

The sweep voltage is generated by the gas triode, V8, a type 6Q5G (see Figure 3). The plate voltage of this tube is obtained through resistor R1, and resistor R2, (SWEEP VERNIER control). Capacitors C1 to C5, selectively connected in parallel, determine the sweep-frequency range.

The output of the sweep generator is coupled directly to a cathode-follower stage. This is necessary since the unattenuated output of the sweep generator would saturate the cathode follower in the input circuit of the horizontal amplifier. Attenuators cannot be inserted in the plate circuit of the sweep generator because these would distort the low-frequency sweep signals.

From the cathode follower, the sweep voltage is applied to a compensated attenuator made up of capacitor C6 and resistors R3 and R4, where it is reduced to approximately 1/5th its original value. The lower end of this attenuator is returned to an adjustable negative bias. The negative bias brings the average level of the attenuated sweep to zero, so that equal expansion from both sides of the center of the screen will be observed as the sweep amplitude is increased.

The sweep signal is fed from the attenuator to the horizontal amplifiers, providing the input selector switch is on one of the sweep positions. From the horizontal amplifier, the sweep potential is applied to the horizontal deflection plates of the cathode-ray tube.

Blanking of the return trace is accomplished by applying to the cathode of the cathode-ray tube a positive pulse which is obtained by differentiating the sweep signal at the cathode of the cathode follower, V9A, and amplifying the resulting signal through V9B.

SWEEP SYNCHRONIZATION

The sweep generator of the Types 304 and 304-H may be synchronized by the signal applied to the Y-input terminal, by an external signal, or by an internally supplied voltage of power-line frequency. Synchronization may be accomplished by signals of either polarity.

The synchronizing voltage, whether external, internal, or of power-line frequency, is applied to the first half of V7. This is a phase inverter which enables the operator to select varying amounts of synchronizing voltage from either the plate or cathode of the amplifier by the use of a center-tapped potentiometer, R5. The output from this stage is fed into the second half of V7, a second stage of amplification. The positive voltage from this stage is applied to the grid of the thyratron to reduce its firing potential. Thus the applied synchronizing voltage fires the gas-filled triode each time the plate potential rises to a sufficient value, assuring that the sweep recurs at either the frequency of the synchronizing-signal rate, or at an integral submultiple.

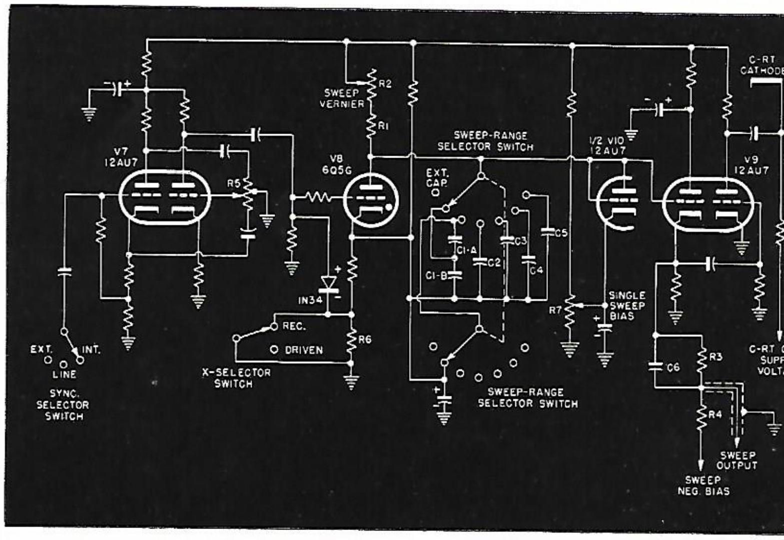

Figure 3. Sweep Circuits of the Types 304 and 304-H.

The Type IN34 germanium diode limits the amplitude of the synchronizing voltage, thus avoiding distortion due to excessive synchronization signal. This diode also prevents the grid of the thyratron from charging to too high a positive potential at higher sweep frequencies, thus avoiding premature firing of the thyratron which would reduce sweep amplitude. This annoying detail, so characteristic of the conventional gas-tube sweep circuit, will not be found in these new Du Mont instruments.

DRIVEN SWEEPS

With the X-selector switch on the driven-sweep position, the bias at the cathode of the thyratron is increased by the addition of resistor R6. As a result, the thyratron must reach a higher plate potential before it can conduct. The tube, V10, connected as a diode, does not permit the thyratron plate to reach the potential necessary for conduction. However, when a positive potential of sufficient amplitude is applied from the sync amplifier to the grid of the thyratron, the firing potential of the tube is reduced sufficiently to start it conducting. The sweep capacitor immediately discharges until the plate voltage of the thyratron drops to the extinction point. Conduction no longer occurs, and the capacitor again begins to charge and stand ready to produce another single sweep upon the arrival of another sync pulse.

EXTRA-LOW FREQUENCY SWEEPS

While the incorporated sweep range is from 2 to 30,000 cps, recurrent sweeps of lower frequencies and driven sweeps of greater length may be obtained by the use of external capacitance inserted between the X-input terminals on the front panel. With the sweep range switch at the "EXT CAP" position, driven sweep lengths of approximately 0.5 second, or recurrent sweeps of 0.5 cycles per second per microfarad of external capacitance are possible. The only limitation on the slowness of sweeps is the practical one of finding sufficiently large capacitors with sufficiently high leakage resistance.

PHYSICAL LAYOUT

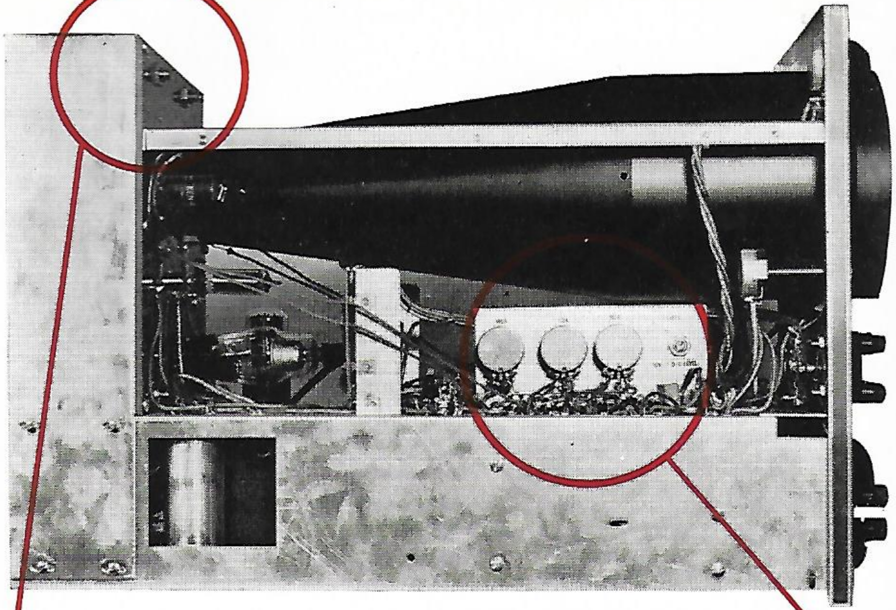

Figure 5. Right side view of the Type 304, with the cabinet removed.

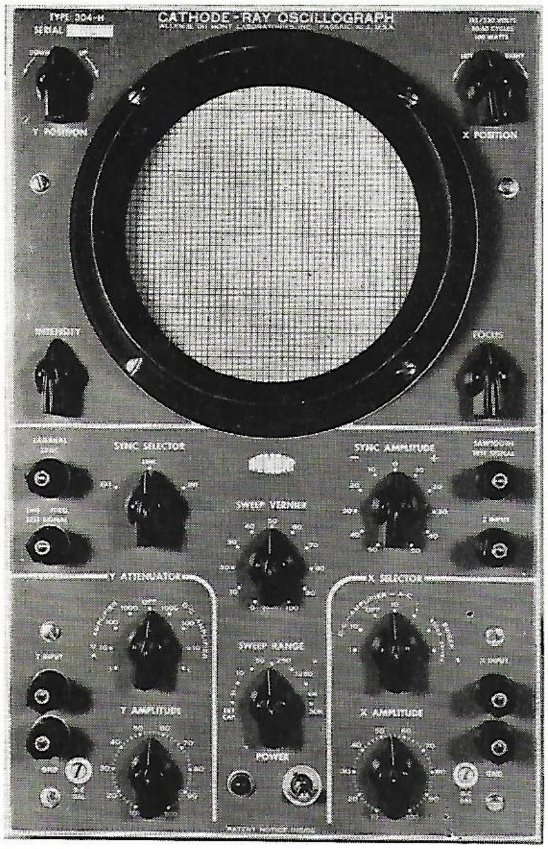

Figure 4. Front panel of the Type 304-H. Externally, the Types 304 and 304-H are identical, except for the type number designation.

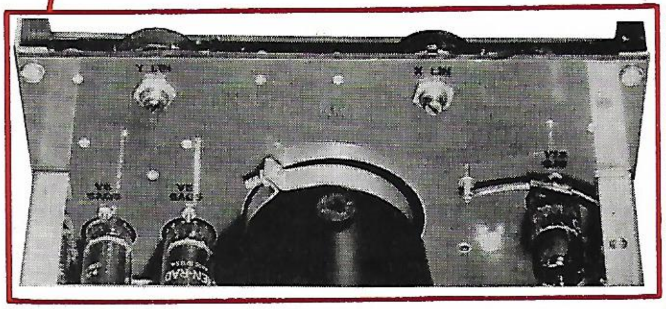

Figure 8. Detail view showing Y- and X-linearity adjustments (R8, Fig. 4, and R5, Fig. 5, respectively). These factory adjustments are provided so that sensitivity at top and bottom of the cathode-ray tube screen may be equalized with that of the middle, to assure linearity of voltage response. Like all factory adjustments in the Du Mont Types 304 and 304-H, these are readily accessible once the cabinet is removed.

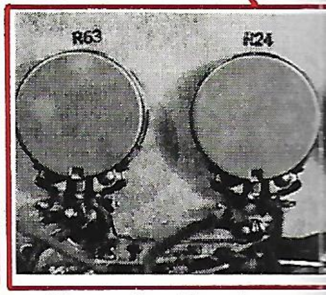

Figure 9. Detail view s
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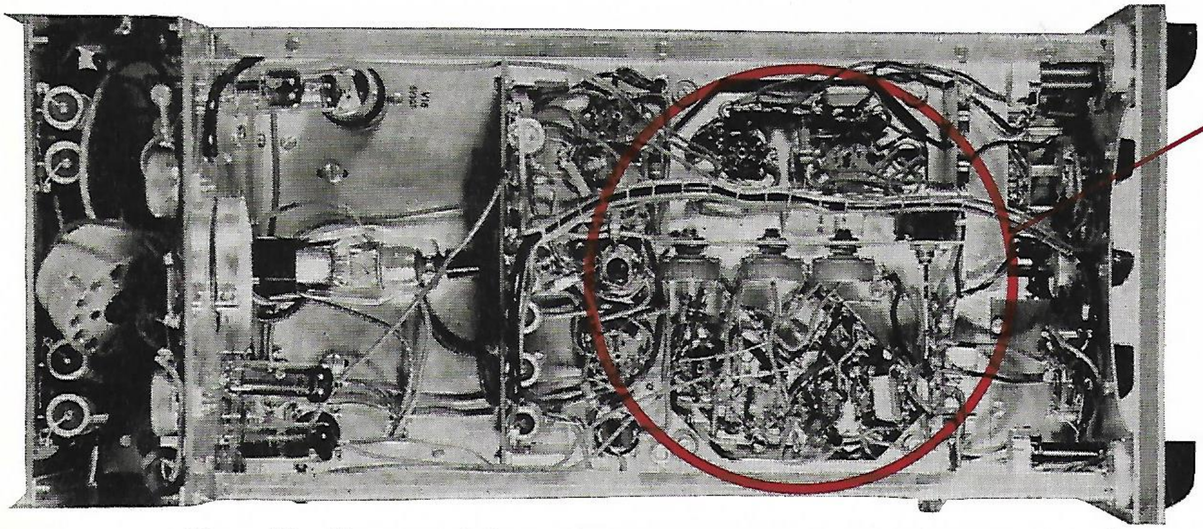

Figure 11. Top view of chassis of the Type 304, with cathode-ray tube and shield removed.

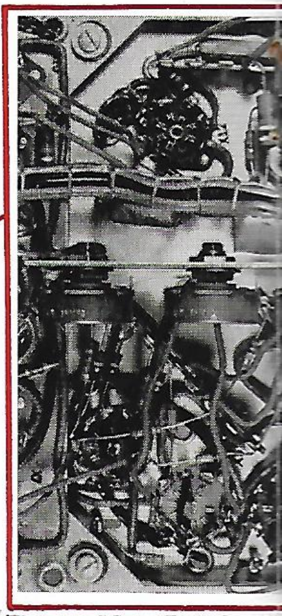

Figure 12. Detail vie
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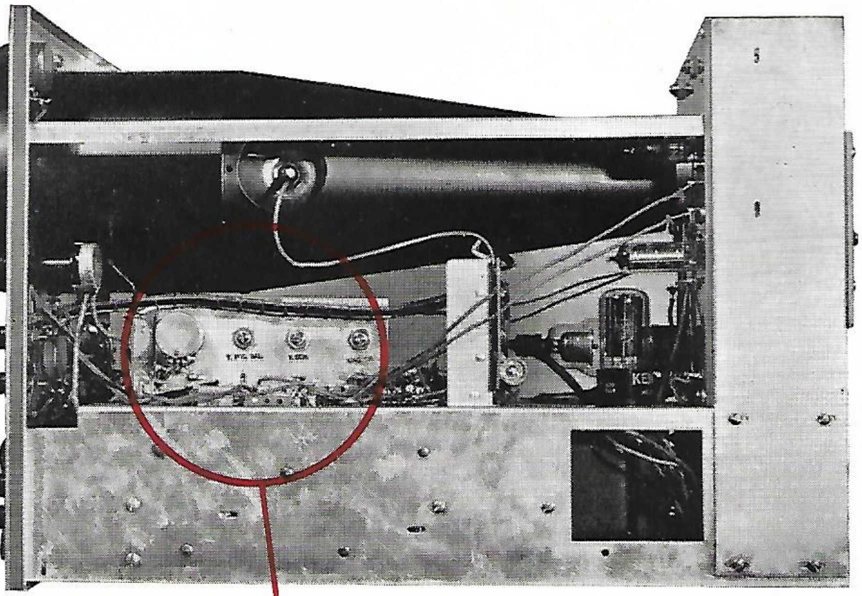

Figure 6. Left side view of the Type 304, with the cabinet removed.

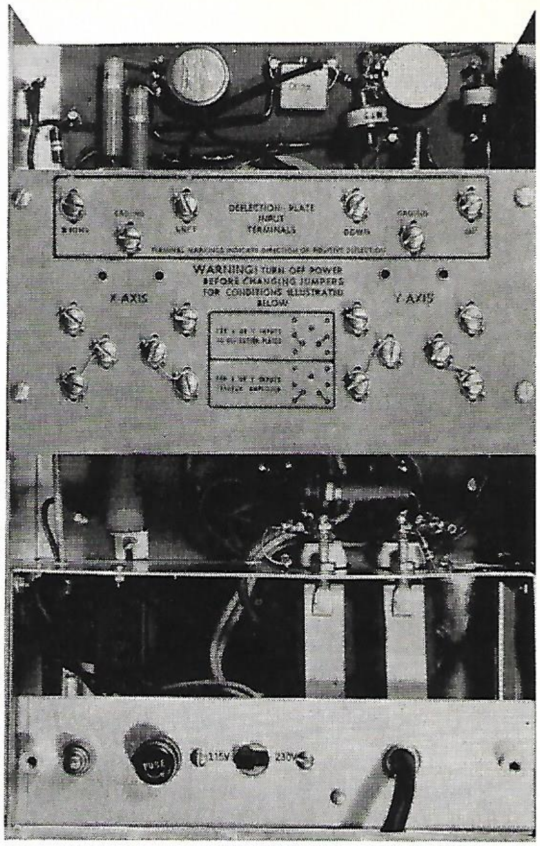

Figure 7. Rear view of Type 304, with cabinet removed. Note the variety of input connections possible through the use of the rear terminal board.

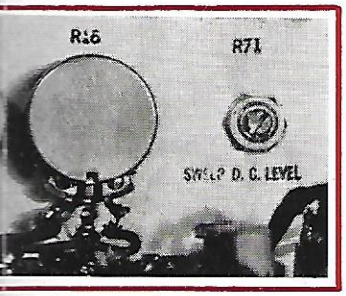

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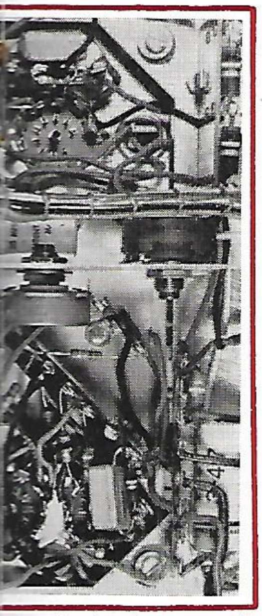
Figure 10. Detail view of factory adjustments accessible through access port in side of instrument. From left to right, these adjustments are: Y-position balance (R6, Fig. 14, which may be adjusted so that trace is at vertical center of screen when the arm of the Y-position control is at the center of its traverse; Y-sensitivity adjustment (R7, Fig. 14), which may be used to compensate for changes in sensitivity that might occur eventually, due, for example, to aging of tubes; and single sweep bias adjustment (R7, Fig. 3) which is provided so that on single sweep, the sweep will trigger only when a trigger pulse is applied to Y-input terminal.

The physical layout of the Du Mont Types 304 and 304-H was engineered with the same care and skill as were the electronic circuits. Great pains were taken to locate all components where they would have least possible interaction upon each other, while at the same time, be readily accessible for servicing. Both mechanically and electrically, the Types 304 and 304-H are ruggedly constructed to give long years of active, trouble-free service.



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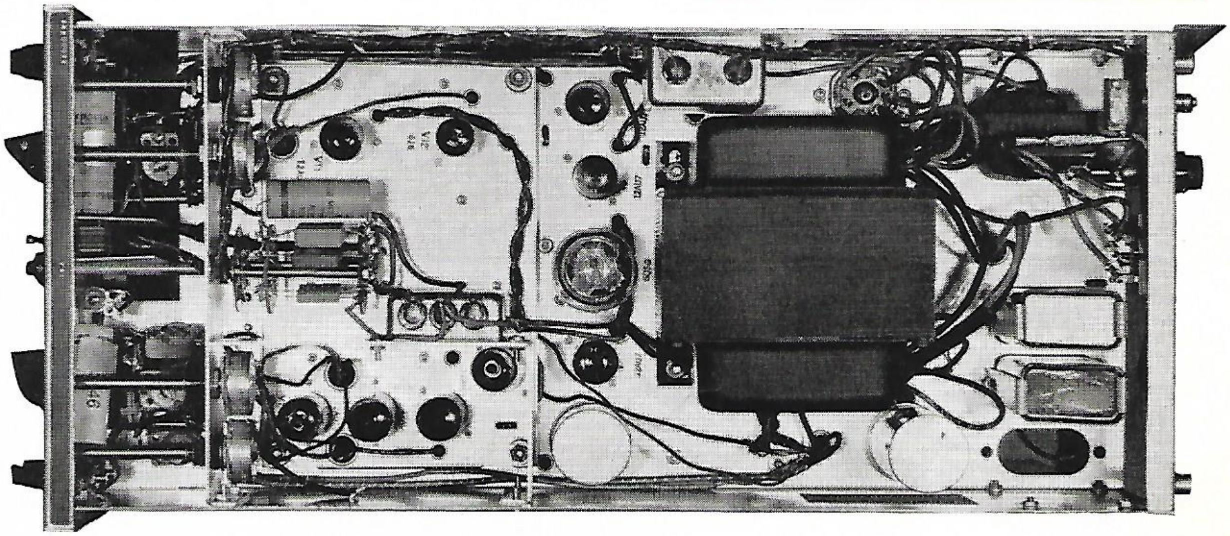


Figure 13. Under view of the Type 304. The location of such heavy components as the power transformer was carefully selected so that the instrument balances well when carried.

Y-AXIS AMPLIFIER CIRCUITS

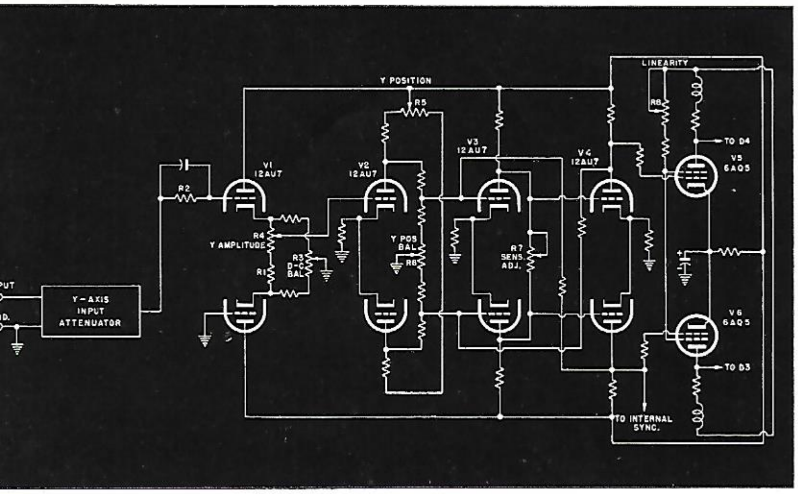


Figure 14. Y-axis amplifier circuits.

GENERAL

Signals may be applied to the Y Axis either directly to the deflection plates through the terminal board at the rear of the instrument, or through the stable, high-gain d-c and a-c amplifier. Direct coupling to the amplifier (for d-c signals) or capacitive coupling (for a-c signals) may be selected simply by operating the input attenuator switch. With this switch in the "off" position, the signal is removed from the grid of the amplifier, and this grid is grounded without affecting the input impedance of the instrument, so that connection directly to the deflection plates may be made at the rear of the oscillograph without disturbing the leads to the Y-input terminal.

SENSITIVITY AND FREQUENCY RESPONSE

With zero attenuation and maximum gain, the sensitivity of the amplifier is 10 rms millivolts per inch. Frequency response of the amplifier with direct coupling is within 10% from 0 to 100,000 cps, and within 50% from 0 to 300,000 cps. With capacitive connection, response is within 10% from 20 to 100,000 cps, and within 50% from 20 to 300,000 cps. (See Figure 28).

Attenuation ratios of 1:1, 10:1, 100:1, and 1000:1 are provided on the input attenuator, for both direct or capacitive coupling to the Y-Axis amplifier.

Y-AMPLIFIER CIRCUIT

As seen from Figure 14, the input cathode-follower (V1) precedes the continuously-variable Y-amplitude control (R4). The Y-amplitude control has a maximum attenuation ratio of slightly over 10:1. The resistor R1 is in series with the Y-amplitude control to prevent the operator from cutting down the gain completely to zero. Thus any portion of a signal that saturates the input circuit cathode follower, V1, will be deflected beyond full-screen on the cathode-ray tube, and may be seen only after the input attenuation has been increased. The input capacitor has a voltage rating of 1000 volts. The resistor R2, in series with the grid of V1, protects V1, V2, and succeeding components from damage due to excessive input voltage when the amplifier is used with its d-c connection.

The balanced arrangement of the two tubes V1 and V2 results in excellent stability. For normal operation, there should be no change in d-c position as potentiometer R4 is varied. This condition is fulfilled by providing the potentiometer R3 so that the d-c levels may be made equal at the ends of R4. This balance adjustment is located at the front panel of the instrument.

Y-AXIS POSITIONING

Vertical positioning is obtained by moving the arm of R5, which varies the d-c level at the plates of V2. When the arm of this potentiometer is at the center of its traverse, the trace should be at the vertical center of the cathode-ray screen. This condition may be fulfilled by setting R6. This positioning system is designed so that even with a vertical deflection four times full-screen diameter, positioning is available over the entire pattern.

Provision for adjustment of the sensitivity of the vertical amplifier is included in these new instruments. Sensitivity may be controlled by the potentiometer R7 which provides a variable shunt between the push-pull plates of V3. Thus, the instrument may be adjusted to compensate for any variations in sensitivity which might occur over a period of time, owing, for example, to aging of tubes. The specified sensitivity may thereby always be maintained.

The final stage of the amplifier is made up of two Type 6AQ5 pentodes. The screen grids of these pentodes are operated from the unregulated power supply, so that the sensitivity of the system rises or falls with increased or decreased line voltage. This tends to compensate for variations in sensitivity of the cathode-ray tube caused by changes in line voltage.

Adjustment of linearity of voltage response of the Y-axis amplifier is provided by the potentiometer, R8, a variable screen-grid-voltage-dropping resistor. Should the sensitivity at the top and bottom of the cathode-ray tube screen be greater than that at the middle, linearity may be restored by reducing this resistance; similarly, if the sensitivity should be greater at the center of the tube than at the top, and bottom, decreasing resistance remedies the situation. Thus, provision is made for raising the linearity of voltage response of the amplifiers of these new oscillographs to an unusually high degree for general-purpose equipment of their class.

The design of the amplifier is such that excellent stability is maintained, with microphonics and drift held to a minimum. Owing to its d-c response, the amplifier recovers immediately after being shocked by an excessive input signal.

USE OF Y AMPLIFIER ALONE

The excellent characteristics of this instrument make it extremely well suited to use, by itself, as a general-purpose amplifier around the laboratory. The output, preceded by a gain of 2000, is available at the terminal board at the rear of the instrument, and it may be employed to drive any high-impedance load.

X-AXIS AMPLIFIER CIRCUITS

GENERAL

Either the internally generated sweep signal or an external signal may be used for deflection on the X axis of the Du Mont Types 304 and 304-H. External signals may be applied either directly to the deflection plates of the cathode-ray tube at the rear terminal board or through the horizontal amplifier.

Both direct and capacitive coupling to the amplifier are available, and attenuation ratios of 1:1 and 10:1 are provided for use with either type of coupling. Also, the signal may be removed from the grid of the amplifier without detaching leads from the input terminals by setting the horizontal attenuator switch on the "off" position.

Sensitivity of the vertical amplifier is .05 rms volts per inch. Response of the horizontal amplifier is identical to that of the vertical amplifier for both direct and capacitive coupling. (See Figure 28).

X-AMPLIFIER CIRCUIT

The gain of the horizontal amplifier cannot be reduced to zero, since it is limited by resistor R1 in series with the X-gain control, R2. As in the case of the Y amplifier, R1 is provided to deflect off screen any portion of a signal that saturates the cathode follower. X-axis positioning is applied to the grid of the stage employing V12, following the cathode follower V11. The signal from V11 is applied to the other half of V12. The positioning potentiometer R3 is returned to a point near the cathode end of the cathode load on the cathode follower V11. This tends to increase the stability of the amplifier, since variations in line voltage produce about the same variations in voltage at the two grids of the first stage of amplification (V12).

A small portion of the input signal to V11 appears at the pin-8 cathode of V11. About 10% of the low-frequency components of the signal at the pin-8 cathode is lost through the resistance divider network before they can reach the pin-5 grid of V12. To avoid frequency discrimination, the capacitive divider comprising C1 and C2, is added. Additional improvement in frquency response is achieved by supplying the two halves of the cathode follower, V11, from a common plate resistor R4. This resistor produces a signal at the pin-8 cathode of V11 almost equal in amplitude, and opposite in phase to the signal which already appears at that point as a result of its connection to the other cathode of V11, thus resulting in cancellation. This assures good high-frequency response at the low end of the X-amplitude control, and it also facilitates reducing the amplitude of the sweep to less than 0.1 inch without turning off the sweep-circuit oscillator.

SWEEP EXPANSION

The high gain and high voltage-output capacitance of the horizontal amplifier enables expansion of the trace up to 6 times full-screen diameter. The horizontal positioning system is such that even with 6 times full-screen deflection, positioning is available over the entire range.

The output stage of the horizontal amplifier is a twin triode. Good linearity is maintained here by the potentiometer, R5, a factory adjustment, which arranges the relative

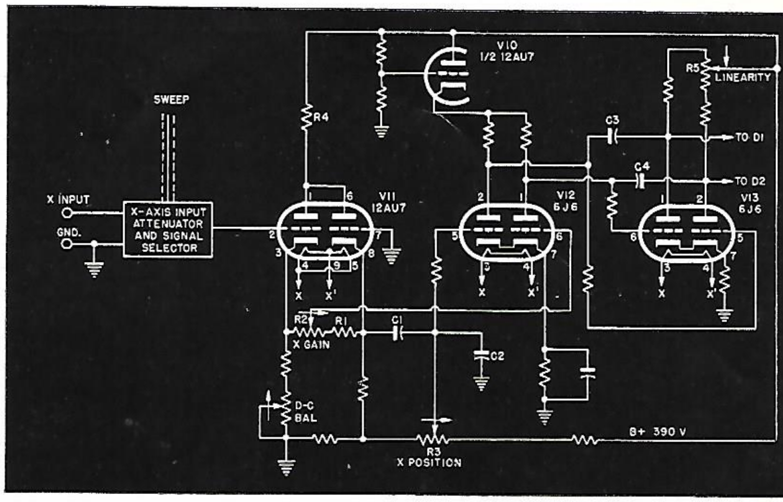


Figure 15. X-axis amplifier circuits.

resistance between the load resistors in the two phases of the output stage in such a way as to compensate for the variations in characteristics between the two sections of the output tube.

The capacitors, C3 and C4, are provided to cancel out the input capacitances of V13, and to improve the high-frequency response of the vertical amplifier.

ADDITIONAL FEATURES

Two test signals are available at terminals on the front panel of the Types 304 and 304-H: A signal of line frequency at approximately 0.5 rms volt amplitude, and a sawtooth signal of approximately 7.5 volts peak amplitude, at the frequency of the time-base generator. The sinusoidal test signal is extremely useful in checking the operation of electronic circuits. The sawtooth signal may be used to provide a sweep for another oscillograph. Also, this signal may be used to trigger a phenomenon so that it occurs in synchronization with the sweep of the oscillograph. For this purpose, the sawtooth signal may first be differentiated, in which case, the phenomenon will be triggered during the return time of the trace; or the phenomenon may be arranged to trigger when the sweep voltage rises to a predetermined level, so that the initiation of the phenomenon is delayed until a given time after beginning of the sweep.

* * *

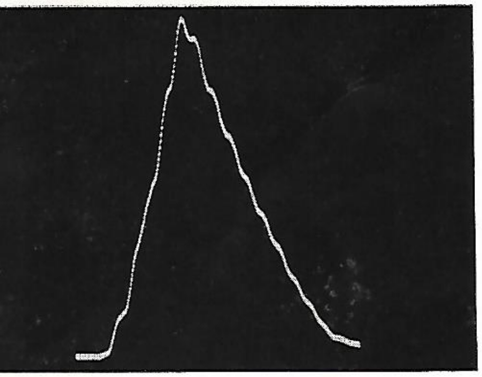
The intensity of the fluorescent trace may be modulated in these new instruments to obtain reference markers indicating time, angle, distance or other quantities.

A positive signal to brighten the trace, or negative signal to darken the trace may be applied to the Z-axis input terminal on the front panel. This terminal is capacitively connected to the grid of the cathode-ray tube. No Z-axis amplifier is provided. A negative signal of 15 volts, peak-to-peak will blank the trace from a normal intensity setting.

* * *

A Mu-metal shield offers maximum protection of the cathode-ray tube from external magnetic fields. Through employment of high-permeability material, spurious deflection of the electron beam by adjacent, strong magnetic fields is reduced to a practical minimum.

The Du Mont Types 304 and 304-H - the Most



igure 16. Indication of variation of vol-
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rough d-c amplifier channel, was dis-
played on a 10-second sweep.

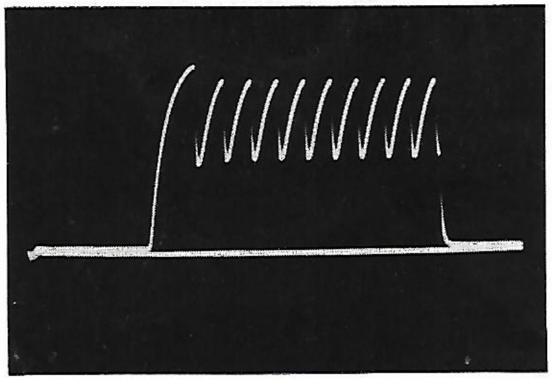


Figure 17. Voltage from oscillating neon bulb, applied through d-c amplifier channel. D-C voltages may be measured directly (base line represents zero volts).

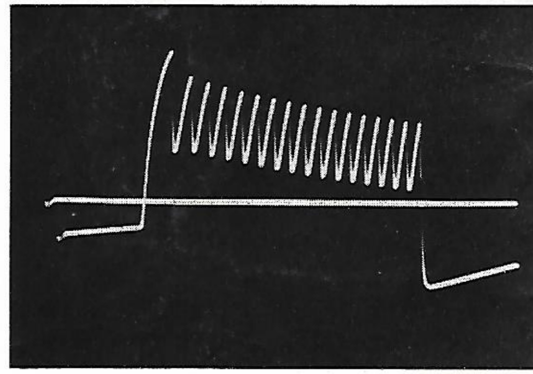


Figure 18. Waveform similar to that of Fig. 17, passed through a-c amplifier. Note tilt due to time constant of coupling circuit, and shift of reference axis.

THE goal in designing the Types 304 and 304-H Cathode-ray Oscillographs has been to create instruments which would serve over the widest possible range of applications, within the limits of practicality.

For example, to extend the use of the instrument to include low-frequency phenomena, sweep frequencies as low as two cycles per second are provided, and sweeps of considerably lower frequencies are possible by the use of additional capacitance attached between the X-input terminals at the front panel. Since, however, a conventional a-c coupled amplifier would not reproduce the low-frequency signals that are frequently displayed on sweeps of such long duration, a d-c amplifier is provided. The oscillogram of Figure 16 illustrates such an application. It is an indication of the volume of liquid in a reaction vessel, plotted as a function of time. It was recorded on a ten-second sweep, with the Y-axis input signal applied through the d-c amplifier.

The d-c amplifier is also essential in cases where the d-c level of signals of higher frequencies must be reproduced. An instance of this is seen in the oscillograms of Figures 17 and 18, both of which are representations of an oscillating neon bulb. In Figure 17 where the signal was passed through the d-c amplifier, the d-c level is maintained. The baseline represents zero volts. Note that the ignition and extinction voltage may be measured easily. In Figure 18, which shows the case where the signal was applied through the a-c amplifier, the reference axis shifted, making quantitative measurements of absolute potentials impossible.

To facilitate the use of long-persistence screens, customarily employed for the observation of low-frequency phenomena, the cathode-ray tube of the Type 304-H is operated at an overall accelerating potential of 3000 volts. This higher accelerating potential lengthens considerably the decay time of the persistence, thus increasing the utility of the long-persistence screens.

This higher potential also facilitates the observation and recording of phenomena that exhibit high writing rates, by increasing the light output from the screen. The photographic capabilities of the Type 304-H are greater by a factor of 10 than those of the Type 304. The oscillograms of Figures 19 and 20, showing a relatively high-speed transient in the form of a damped oscillation, clearly demonstrate the importance of this increased potential. In Figure 19, where an accelerating potential of 1780 volts was employed, the portions of the trace where the spot moves most rapidly, were not recorded. In Figure 20, photographed from the screen of the Type 304-H operated with an accelerating potential of 3000 volts, the entire trace was clearly recorded.

igure 22. Vibration similar to that of
ig. 21, displayed on recurrent sweep.
henomenon begins toward end of trace,
with much of the signal lost entirely.

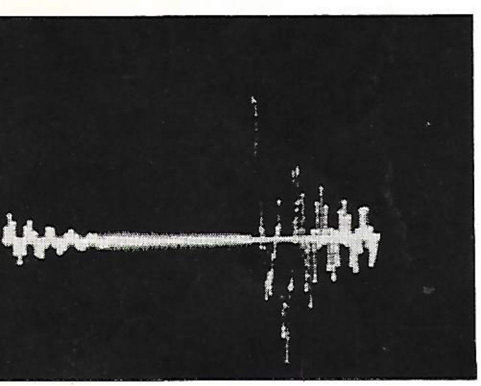


Figure 23. An oscillogram of the voltage field in the vicinity of a fluorescent lamp, displayed with no expansion of sweep. Compare with Figure 24.

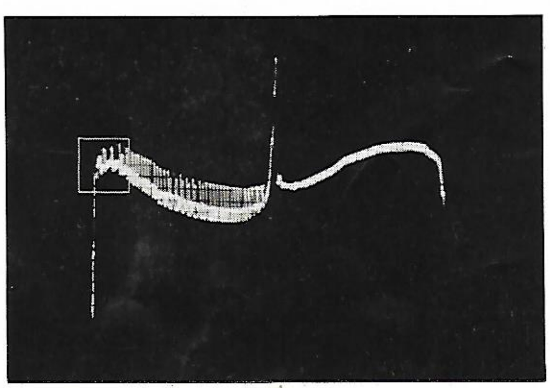
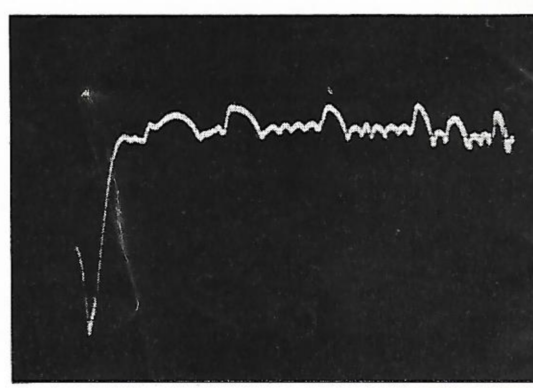


Figure 24. Portion of pattern outlined by square on Figure 23, expanded to full-screen diameter. Even at maximum expansion, no on-screen distortion is present.



Versatile Oscillographs in their Price Range

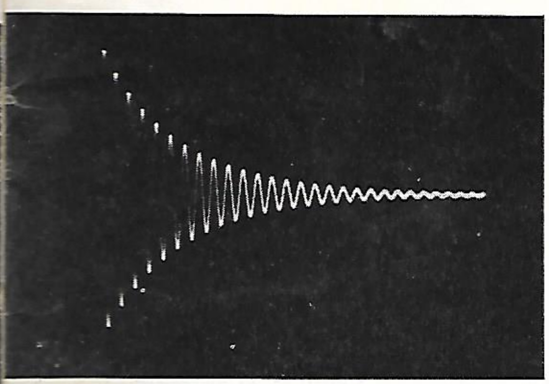


Figure 19. Relatively-high-speed transient in form of damped oscillation. With accelerating potential of 1780 volts, high-speed portion of trace was not recorded.

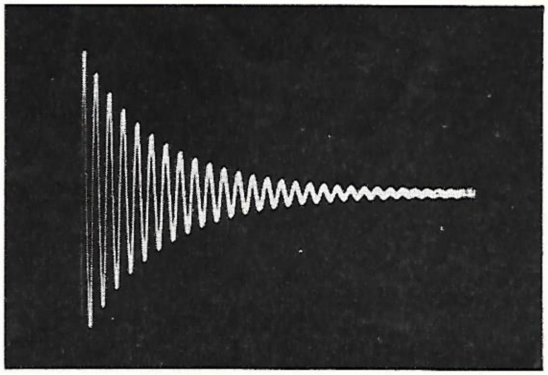


Figure 20. Waveform similar to that of Fig. 19. Increased accelerating potential of Type 304-H (3000 volts) rendered entire pattern visible.

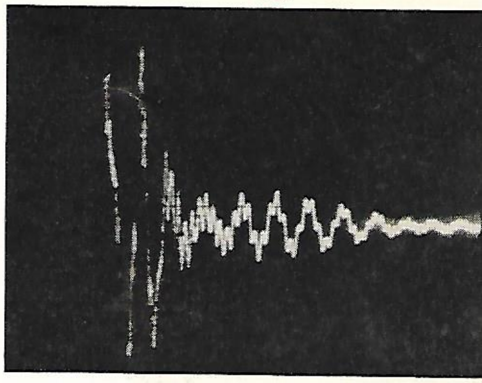


Figure 21. Random vibration in meta beam, recorded with Type 304 operating o single sweep. Note that entire phenomeno was recorded on the trace.

For the observation of phenomena occuring at random intervals, driven sweeps, triggered by the signal under investigation, are provided. An example of this is seen in the oscillogram of Figure 21 an indication of sporadic vibrations in a metal beam. Were the sweep not initiated by the first impulse from the vibration, there would be no assurance that the beginning of the sweep would coincide with the start of vibration. (See Figure 22). Thus it would be only through an occasional chance that the entire signal would appear on the trace.

Figures 23 and 24 illustrate the sweep-expansion feature of the Types 304 and 304-H. Figure 23 shows the voltage field in the vicinity of a fluorescent lamp. Figure 24 is a portion of the same pattern, identified by the square on Figure 23, expanded to full-screen diameter.

In order that reference markers, indicating time, angle, distance, or other quantity may be impressed on the pattern, provision is included for intensity modulation by applying a modulating signal at a front panel terminal. The oscillogram of Figure 25 taken from the screen of the Type 304-H, shows a 10-kc squarewave modulated by a 110-kc signal.

An application requiring many of the features of the Types 304 and 304-H is the observation and recording of nerve potentials. (See Figure 26). The differentiated sawtooth test signal triggers the stimulating pulse. And since the nerve may be stimulated only once every few seconds, a driven sweep must be employed. Sweeps of 10-second duration or longer must be used if the time required for the nerve to transmit the stimulus is to be observed. Because of the low signal levels and the long time duration of the pulse, a high-gain d-c amplifier is required. While the gain of the amplifier of the Type 304 or 304-H may not be sufficient for such applications, this amplifier's characteristics greatly simplify the problem of designing a satisfactory preamplifier for such specialized work.

Another application for which the Types 304 and 304-H are particularly well suited is found in the study of fluctuations in line voltage. Here, the extremely low-frequency sweeps permit the observation of fluctuations over a period of several seconds or more. The high gain of the vertical amplifier and the wide range position circuits permit the study of just the tips of the 60-cycle waves whose envelope forms the modulation pattern shown in Figure 27.

Every feature of the Types 304 and 304-H was conceived and designed with an eye toward versatility. Each was engineered to complement the others, so that fullest possible advantage could be taken of all.

It is this consistency of design — the result of months of development — that enables the Types 304 and 304-H to enter fields heretofore restricted to far more costly instruments. The Du Mont Types 304 and 304-H are truly the most versatile instruments in their price range.

Figure 25. A 10-kc square wave, intensity-modulated by 110-kc pulses, photographed from the screen of the Du Mont Type 304-H.

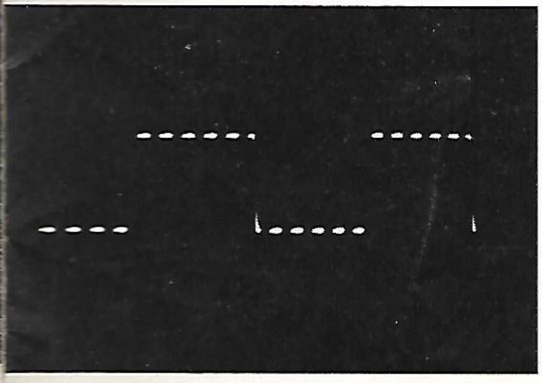


Figure 26. Observation of nerve potentials is an application requiring many features of the Types 304 and 304-H. Nerve potential above was recorded from Type 304.

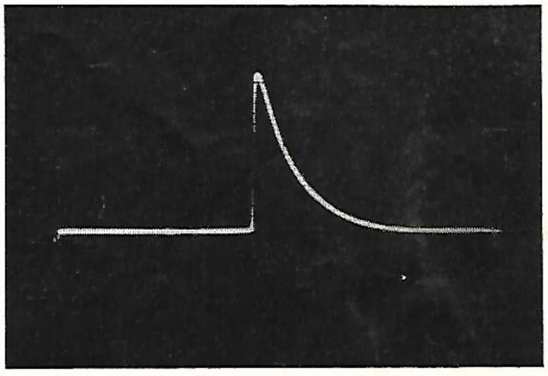
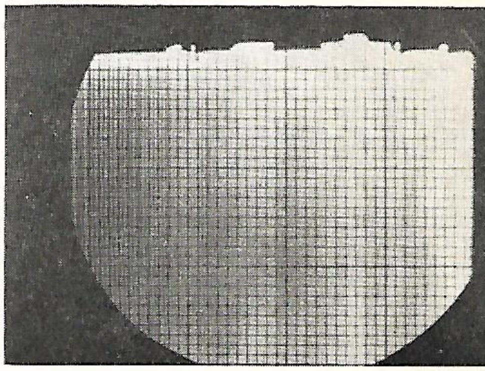


Figure 27. A recording from the screen o the Du Mont Type 304-H of fluctuation in power-line voltage, made over a perio of 3 seconds.



SPECIFICATIONS

CATHODE-RAY TUBE

Type 5CP-A

Accelerating Potentials: Type 304

E_{b2} +1600 V with respect to cathode

Intensifier +1780 V with respect to cathode

Type 304-H

E_{b2} +1600 V with respect to cathode

Intensifier +3000 V with respect to cathode

Y AXIS

Deflection Factor

Direct .... 18 rms volts/inch ±17%

Amplifier

Y Attenuator at 1:1, Y Amplitude Maximum. 10 rms millivolts/inch

Y Attenuator at 1:1, Y Amplitude Minimum. 115-190 rms millivolts/inch.

FREQUENCY RESPONSE	*d-c Amplifier*	*a-c Amplifier*
10% Response Point	100 kc	100 kc
50% Response Point	300 kc	300 kc
20 kc Squarewave	Good	Good
10 cycle Squarewave	Good	17% Saw.

Maximum Input Potential .... 1000 volts peak

Input Impedance:

Direct

Balanced .... 3 meg; 20 μμf

Unbalanced .... 1.5 meg; 20μμf

Amplifier .... 2 meg; 50 μμf

X AXIS

Deflection Factor

Direct .... 21 rms volts/inch ±17%

Amplifier

X Selector at 1:1, X Amplitude Maximum. 0.05 rms volts/inch.

FREQUENCY RESPONSE	*d-c Amplifier*	*a-c Amplifier*
10% Response Point	100 kc	100 kc
50% Response Point	300 kc	300 kc
20 kc Squarewave	Slight Overshoot	Slight Overshoot
10 cycle Squarewave	Good	17% Saw.

Maximum Input Potential .... 1000 volts peak

Input Impedance:

Direct

Balanced .... 3 meg; 20 μμf

Unbalanced .... 1.5 meg; 20μμf

Amplifier .... 2.2 meg; 50μμf

LINEAR TIME BASE — RECURRENT SWEEP AND DRIVEN SWEEP

Gas Triode .... Type 6Q5G

Sweep Frequency Range .... 2 to 30,000 cps with provision for connecting external capacitor for lower frequency sweeps (.5 sec. sweep per microfarad)

Expandable Sweep:

The sweep of this instrument is expandable to an equivalent of six times the full screen diameter of the cathode-ray tube; and the positioning circuits are broad enough to examine any portion of the sweep on the screen without distortion. The expanded sweep is capable of a sweep writing rate of one inch per microsecond, or faster.

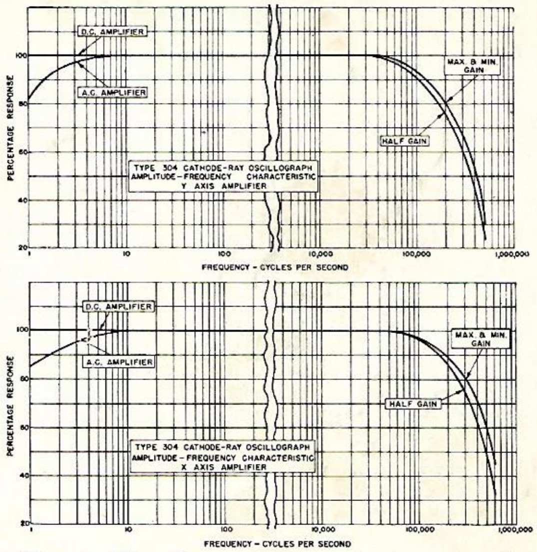


Figure 28. Frequency-response curves of the Y-amplifier (top) and X-amplifier (bottom) of the Types 304 and 304-H.

INTENSITY-MODULATION CIRCUIT

Input Impedance .... 0.2 meg, 80μμf

Sensitivity .... 15 volts peak to blank the beam at normal intensity setting

TEST SIGNALS

Line Frequency Test Signal — A test signal of approximately .5 rms volts at the power-line frequency is available at a front-panel terminal.

Sawtooth Test Signal — A sawtooth test signal at about 7.5 volts peak at 47k output impedance at the frequency of the time-base generator is available at a front-panel terminal.

POSITIONING AND UNDISTORTED DEFLECTION

The d-c positioning system is such that even with 4 times full-screen expansion on Y axis, any portion of pattern may be centered on the screen; for X-axis deflection, with 6 times full screen expansion, any portion of the trace may be centered on the screen. Even at maximum expansion, there is no on-screen distortion present.

POWER SUPPLY

Primary Power Potential: 115 or 230 rms volts ±10%

Frequency .... 50-60 cycles

Power Consumption .... 100 watts approx.

Fuse Protection .... 1.5 ampere

TUBE COMPLEMENT

8-12AU7; 2-6AQ5; 1-6Q5G; 1-0B2; 2-6J6; 1-5Y3; 1-2X2A; 1 additional 2X2A for Type 304-H.

PHYSICAL SPECIFICATIONS

Height .... 13¼″ Depth .... 19″

Width .... 8⅝″ Weight .... 50 lbs.

Cat. No.	*Type No.*	*Description*	*Price*
1336-A	304	Type 5CP1-A; 115V,50-60 CPS	$285.00
1340-A	304	Type 5CP11-A;115V,50-60 CPS	285.00
1341-A	304	Type 5CP1-A; 230V,50-60 CPS	285.00
1345-A	304	Type 5CP11-A;230V,50-60 CPS	285.00
1490-A	304-H	Type 5CP1-A; 115V,50-60 CPS	307.50
1493-A	304-H	Type 5CP7-A; 115V,50-60 CPS	307.50
1494-A	304-H	Type 5CP11-A;115V,50-60 CPS	307.50
1495-A	304-H	Type 5CP1-A; 230V,50-60 CPS	307.50
1498-A	304-H	Type 5CP7-A; 230V,50-60 CPS	307.50
1499-A	304-H	Type 5CP11-A;230V,50-60 CPS	307.50

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Instrument Division

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