DUMONT

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Allen B. DuMont Laboratories, Inc.

TECHNICAL PRODUCTS DIVISION

760 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

DUMONT

DYNAMIC ENGINE ANALYZER

TYPE 901

2/17/66

Please return to Larry at

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TECHNICAL PRODUCTS DIVISION
Clifton, N. J.
U. S. A.

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Figure 1-1. Du Mont Type 901 Engine Analyzer

SECTION 1
TECHNICAL SUMMARY

1-1. INTRODUCTION

The Du Mont Type 901 Engine Analyzer is an accurate electronic instrument for analyzing the performance characteristics of engines either in the garage or on the road. It is particularly adapted to locating troubles in the ignition system; however, by using suitable auxiliary pickups (transducers) it becomes equally useful in studying such engine performance factors as valve operation, pressure, vibration, ignition timing, ignition advance, and pre-ignition.

The Type 901 incorporates a 5-inch cathode-ray tube which displays information pictorially in the form of vertical deflections as the beam forms a horizontal line across its face. Each cylinder is represented by a separate horizontal line appearing on the tube face from top to bottom and in the firing order of the engine. Any deviation from normal engine operation is clearly indicated on the waveform the exact instant the event occurs. The Type 901 may be used on any engine having from 4 to 18 cylinders and operating over speed ranges of 400 to 4000 RPM. Engine speeds can be directly read from a tachometer on the front panel.

1-2. FEATURES

(*1*) Visual dynamic patterns on the tube face show the exact condition of engine operation.

(*2*) No troublesome mechanical hookups required. Convenient clip-on connections.

(*3*) Engine operation not affected. All testing done without disconnecting any engine wires.

(*4*) Eliminates trial and error method in automotive servicing.

(*5*) Signals taken from secondary circuit show condition at the spark plug.

(*6*) Total length of baselines is equal to 720° of crank rotation.

(*7*) Each baseline represents one cylinder cycle displayed across full screen width.

(*8*) Number of lines automatically produced is equal to the number of cylinders in engine.

(*9*) Accurate, absolute, cylinder-to-cylinder readings of such phenomena as dwell and spark duration.

(*10*) Tachometer for direct reading of engine RPM.

(*11*) Can be operated from a car battery (6 or 12 volts) using the Du Mont Type 2625 Vibrator Power Pack or on a bench using 115 volts, 50-400 cycles.

(*12*) Dependability proven by years of use in laboratories and varied field services.

(*13*) Conveniently applied to automotive, aircraft, tank or other internal combustion engines using 4, 6, 7, 8, 9, 12, 14, or 18 cylinders.

(*14*) Dual signal selection enables signals from external pickups to be used.

(*15*) Can be used for almost any engine function that can be converted to an equivalent electrical signal by using a suitable external pickup (transducer).

(*16*) No pre-amplification necessary due to the bandwidth and high-gain of the signal amplifiers.

(*17*) Enables fast phenomena of engine functions to be recorded and observed which are otherwise too fast for mechanical or direct observations.

1-3. CIRCUITRY EMPLOYED

For a general understanding of the electrical circuits incorporated in the Engine Analyzer, refer to the over-all functional block diagram, Figure 3-1. A detailed explanation of the circuit operation will be found in Section 3.

1-4. TECHNICAL SUMMARY

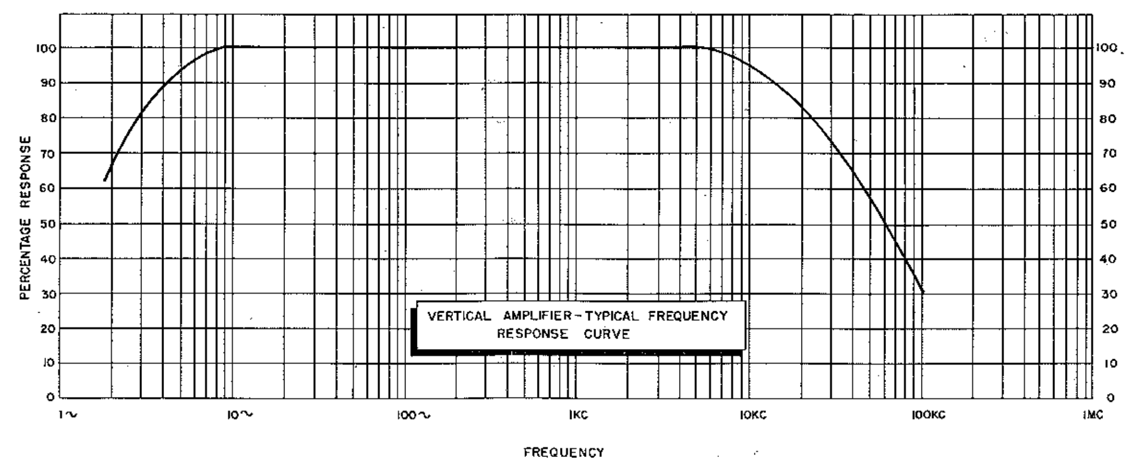
The electrical and physical characteristics of the Type 901 are listed in Table 1-1, Technical Summary Sheet, which follows:

TABLE 1-1
TECHNICAL SUMMARY

GENERAL INFORMATION	
Name and Designation of unit	Du Mont Type 901 Engine Analyzer
CATHODE-RAY TUBE	
Type	5ADPI (flat-face, tight tolerance)
Nominal Accelerating Potential	3000 volts
Cathode-ray Tube Scale	Silk screened, removable scale calibrated in distributor degrees of dwell for 4, 6, and 8-cylinder engines including graduations 5° beyond zero
VERTICAL DEFLECTION CIRCUIT	
Signal Selection	Either of two inputs selectable by front panel IGNITION-PICKUP switch
Ignition	Signal fed internally from COIL INPUT to amplifier
Pickup	Signal fed from external pickup (transducer), through a telephone jack (pickup) to amplifier
Sensitivity	0.016 rms volts/inch minimum
Input Impedance	200K ohms to 1 megohm (depending upon SENSITIVITY setting) shunted by approximately 125 μμf
Sinusoidal Frequency Response (Referred to sensitivity at 1 kc)	Not more than 3 db down from 5 cycles to 30 kc
Vertical Sweep Synchronization	Vertical sweep synchronized from No. 1 cylinder using RED pickup lead
Vertical Lock	VERTICAL LOCK control permits stable operation over range of engine speeds
Vertical Sweep Generator	Linear driven sweep time base provided by a gas triode
Vertical Sweep Frequency	Equal to one-half the engine RPM
Line Spacing	Front-panel control permits desired separation of the displayed lines or superimposes them.
Vertical Centering	Permits position of any line to within 1¼ inches of CRT center with maximum spacing between lines
HORIZONTAL DEFLECTION CIRCUIT	
Horizontal Sweep Synchronization	Horizontal sweep synchronized internally from COIL INPUT using BLACK pickup lead
Horizontal Lock	Horizontal lock control permits stable operation over range of engine speeds
Horizontal Sweep Generator	Linear driven sweep time base provided by a gas triode. Return trace automatically blanked
Horizontal Sweep Frequency	Equal to one-half the engine RPM times the number of cylinders
Horizontal Line Length	Continuously variable over range from 3 inches to 8 inches for each line
SPECIAL FEATURES	
Cylinder Selection	Selects number of cylinders for proper tachometer reading; 4, 6, 7, 8, 9, 12, 14, and 18
Tachometer	Single range 0 to 4000 RPM. Accuracy ±5%
Tilt Correction	Vertical signal deflected at right angles to baselines
Size Correction	Horizontal size constant to within +5% to —10% of value at 1000 RPM
Speed Range	From 400 to 4000 RPM

TABLE 1-1
TECHNICAL SUMMARY (Continued)

POWER SUPPLY				
Primary Source	115 volts ±10%			
Primary Frequency	50-400 cycles			
Primary Power	75 watts (approximately)			
PHYSICAL CHARACTERISTICS				
Height	15¼ inches			
Width	9¼ inches			
Length	20½ inches			
Weight	50 pounds (approximately)			
TUBE COMPLEMENT	5ADP1 - 1	6J7 - 2	12AY7 - 1	1X2A - 2
	6AQ5 - 1	884 - 2	12AX7 - 2	6X4 - 1
	6AU6 - 3	12AU7 - 5	OB2 - 1	
ACCESSORIES SUPPLIED				
No. 1 Cylinder Signal Lead (Red)	Eleven-foot capacity pickup lead			
Ignition Coil Signal Lead (Black)	Eleven-foot capacity pickup lead			
Calibrated Scale (Removable)	Calibrated in distributor degrees of dwell for 4, 6 and 8 cylinder engines including 5° beyond zero			



SECTION 2
OPERATION

2-1. GENERAL

The Du Mont Type 901 Engine Analyzer is shipped with all tubes in place and ready to operate. Since this instrument is portable no special installation procedure is required.

2-2. FRONT-PANEL FACILITIES (See Figure 2-1)

The front-panel markings are essentially self explanatory, and after carefully studying Table 2-1, the operator will find it possible to master the controls with a minimum of practice.

TABLE 2-1
FRONT-PANEL FACILITIES

NAME	FUNCTION
SENSITIVITY	Control: determines the height of signal deflection (wiggles)
LINE START	Control: positions pattern to the left or right
LINE SPACING	Control with switch: adjusts vertical spacing between lines. When set fully CCW, pattern collapses to a single line allowing overlapping of signals for comparison
LINE LENGTH	Control: determines width of pattern
IGNITION-PICKUP	DPDT Switch: When set to IGNITION, internally couples coil-ignition signal from COIL INPUT and applies signal to vertical amplifier. When set to PICKUP, internally couples external signal (transducer) thru telephone jack to amplifier
BRIGHTNESS	Control: varies the trace brightness
NUMBER OF CYLINDERS	Switch: selects number of cylinders in the engine under test for proper tachometer reading
FOCUS	Control: adjusts sharpness of the lines
PICKUP	Telephone Jack: provides input connection for auxiliary pickups (transducers)
VERTICAL LOCK	Control: adjusts to show same number of base lines in the pattern as there are cylinders in car under test
VERTICAL CENTERING	Control: positions pattern up and down on screen
HORIZONTAL LOCK	Control: holds pattern stable horizontally
NO. 1 CYL INPUT	Red Binding Posts: provides terminals for coupling the signal from ignition lead of No. 1 cylinder
COIL INPUT	Black Binding Posts: provides terminals for coupling the signal from coil to distributor lead
ENGINE RPM	Tachometer: indicates engine speeds to an accuracy of $\pm 5\%$
POWER	Toggle Switch: turns equipment on
PILOT LIGHT	Indicator: lights when POWER is turned ON

2-3. PRECAUTION AGAINST SCREEN BURNING

Keep the BRIGHTNESS low when the equipment is not being used, and never allow a spot to remain stationary on the screen. This condition will exist only when trouble is present and the spot stops moving.

2-4. ENERGIZING EQUIPMENT

To place the Type 901 in operation, plug power cord into a 115-volt, 50-400 cycle outlet and throw POWER switch to ON position. To eliminate shock hazard, ground unit with pigtail provided on line cord.

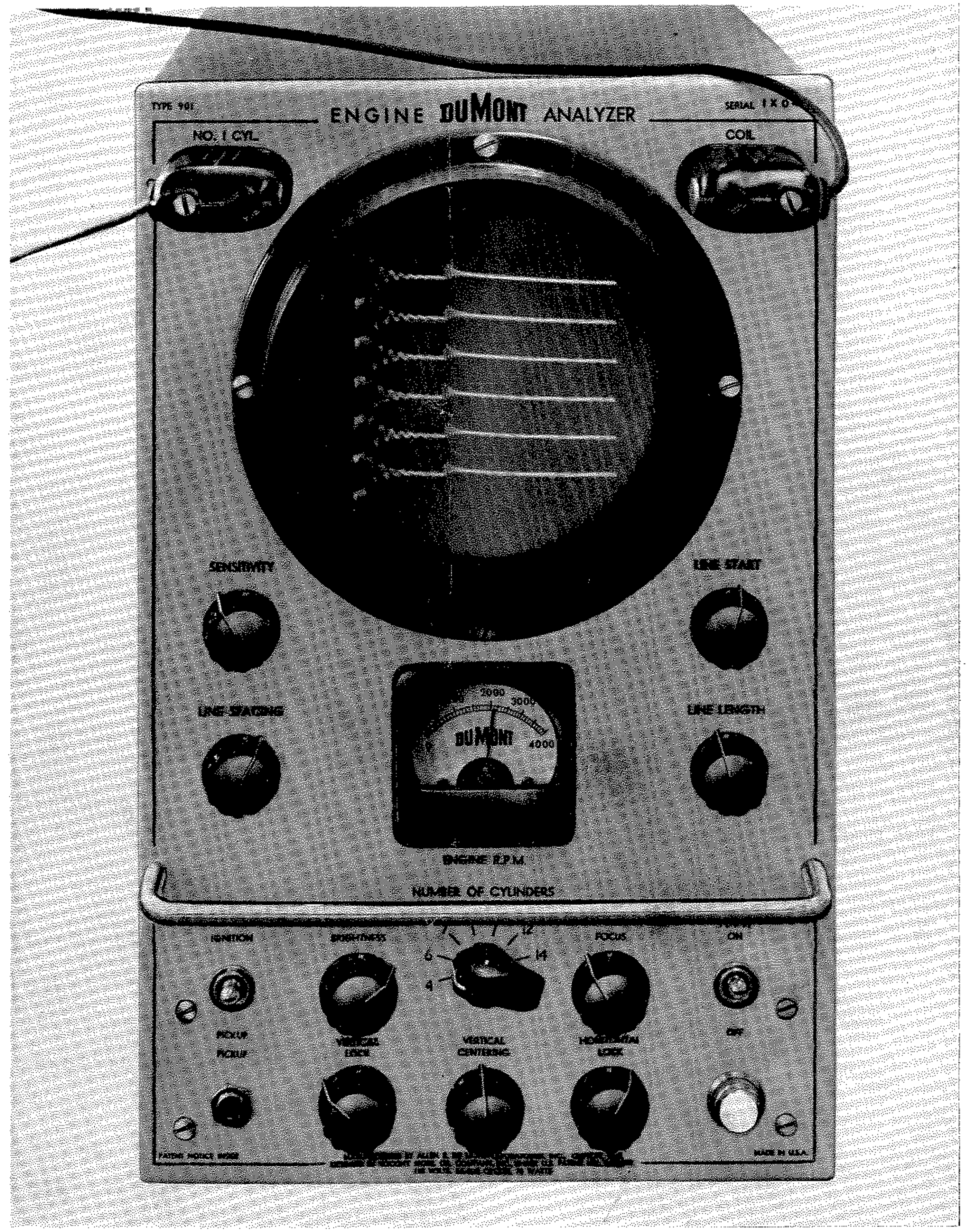


Figure 2-1. Knob Setting for Stationary Setting

2-5. STATIONARY TESTING OF IGNITION SYSTEM

Step 1. Place instrument on table preferably close to distributor side of engine.

Step 2. Plug into 115 volts a-c, 50-400 cycles only.

Step 3. Plug black pickup lead into COIL INPUT (black binding posts) on front panel, fastening clip end over coil to distributor lead.

Step 4. Plug red pickup lead into NO. 1 CYL INPUT (red binding posts) on front panel, fastening clip end over ignition lead of No. 1 spark plug.

CAUTION

Locate clips so that they do not touch spark plug, plug terminal, or any metal parts, particularly those at high voltage. Keep wires away from fan belt and other moving engine parts. Be sure panel connection is made so signal is not grounded.

Step 5. Set front-panel controls as shown in Figure 2-1 and turn instrument on. Readjust VERTICAL LOCK, if necessary, to obtain the proper number of lines on screen.

These settings will suffice for most installations, and once set for a specific car only minor changes, if any, need be made when used on other cars.

Step 6. Locate calibrated scale in proper position on screen as to the number of cylinders under test.

After following the above steps, the pattern appearing on the screen should resemble either Figure 2-2 or 2-3 shown below, provided the ignition system is operating satisfactorily.

NOTE: After a stable pattern appears, the appropriate front-panel controls may be readjusted slightly to suit personal preference. To obtain a satisfactory pattern with a minimum amount of flicker, engine speeds of 1000 to 1200 RPM are recommended. If no pattern appears after approximately five minutes, refer to the Trouble Shooting Chart in Section 4.

2-6. WAVEFORM ANALYSIS

The following procedure is recommended for analyzing the waveform appearing on the screen of the Type 901 Engine Analyzer.

Step 1. Set up instrument per instructions of Paragraph 2-5.

Step 2. Adjust LINE START to align left end of baseline with left vertical index of scale.

Step 3. Adjust LINE LENGTH to align right end of baseline with zero at right end of scale.

Step 4. Determine spark duration, cam angle, and dwell angle (see Figure 2-4).

(a) Spark duration is usually 3½° to 5° at 1000 RPM.

NOTE: A *spark line longer* than normal indicates spark plug gap is too narrow.

A *spark line shorter* than normal indicates spark plug gap is too wide.

Step 5. Examine *spark duration* for hash, upward slope to the right, or for any other irregularities. (See Section I in Waveform Guide Book for further examples.)

Step 6. Examine duration of *low-frequency oscillations* (widely-spaced wiggles—Figure 2-4).

(a) Several cycles should be present.

(b) If only two or less cycles are present, refer to Section I of Waveform Guide Book for further analysis of *spark duration* and *low-frequency oscillations*.

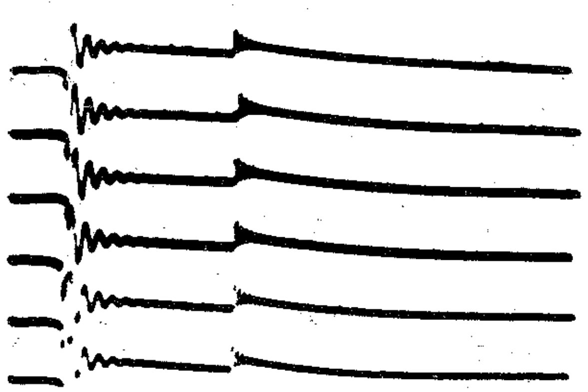


Figure 2-2. Standard Pattern (6 cyl.)

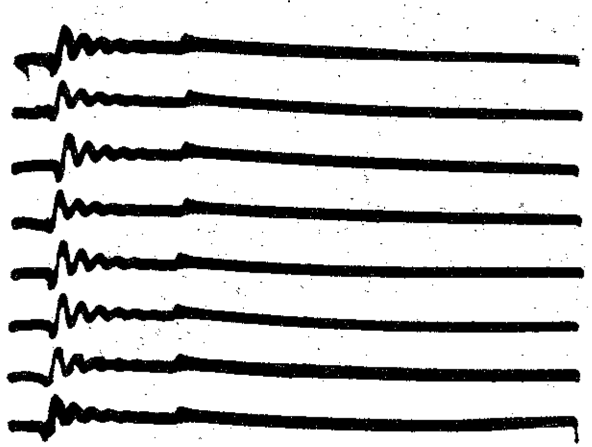


Figure 2-3. Standard Pattern (8 cyl.)

Note: The presentation of the traces will be in the firing order of the engine.

Step 7. Check the *points close* signals to see that they align one under the other (with no offset) as shown in Figure 2-2 or 2-3.

(a) check that the *high-frequency oscillations* (closely-spaced wiggles—Figure 2-4) appear as shown in Figure 2-2 or 2-3.

(b) Notice that the height of the first cycle is the largest and the height of the cycles which follow are smaller and smaller. If the first cycle is not the highest, see Figure 2-8. (Waveform Guide Book) for probable cause and remedy.

(c) Baselines may be superimposed to check amount of variation of *points close* signal by rotating LINE SPACING fully counterclockwise.

(d) Refer to Section II of Waveform Guide Book for further analysis of *points close* troubles.

Step 8. Check the *points open* signal to see that they align one under the other (with no offset) as shown in Figure 2-2 or 2-3.

(a) A clean line end indicates satisfactory breaker point operation.

(b) A fuzzy line end indicates poor breaker point operation.

(c) Refer to Section III of Waveform Guide Book for further analysis of *points open* troubles.

2-7. OPERATING HINTS

The previous procedure [paragraph 2-6] is sufficient for analysis, however, the following techniques are suggested for additional engine analysis:

a. The waveform may be expanded or "blown up" to better study troubled portions, by rotating LINE LENGTH clockwise. Any desired portion of the expanded waveform may be positioned left or right on screen by rotating the LINE START control.

b. A useful technique to isolate ignition lead-wire trouble is to deliberately short the spark plug, and to note the increase in length of the spark line. Normally shorting the spark plug should double the length of the spark line. A lesser increase in length on one or more (but not all spark lines) indicates that the spark plug lead or connection on that cylinder is defective. If all cylinders fail to double in spark line length, check the rotor gap and coil-to-distributor lead. Move red pickup lead from No. 1 cylinder to some other cylinder momentarily while checking No. 1.

NOTE: If the red pickup lead is connected to any other cylinder lead except the first, the sequence of the firing order on the screen will be started from that cylinder.

c. *Low-frequency* oscillation (see Figure 2-4) are a function of time. If speed is doubled, base line will be drawn out in one-half the time. Hence, the low-frequency oscillations appear twice as long.

Points close and *points open* are a function of crank angle; hence, they should stay constant regardless of speed.

Spark Line remains nearly constant in length because the system energy is lower and the cylinder compression is higher at higher speeds.

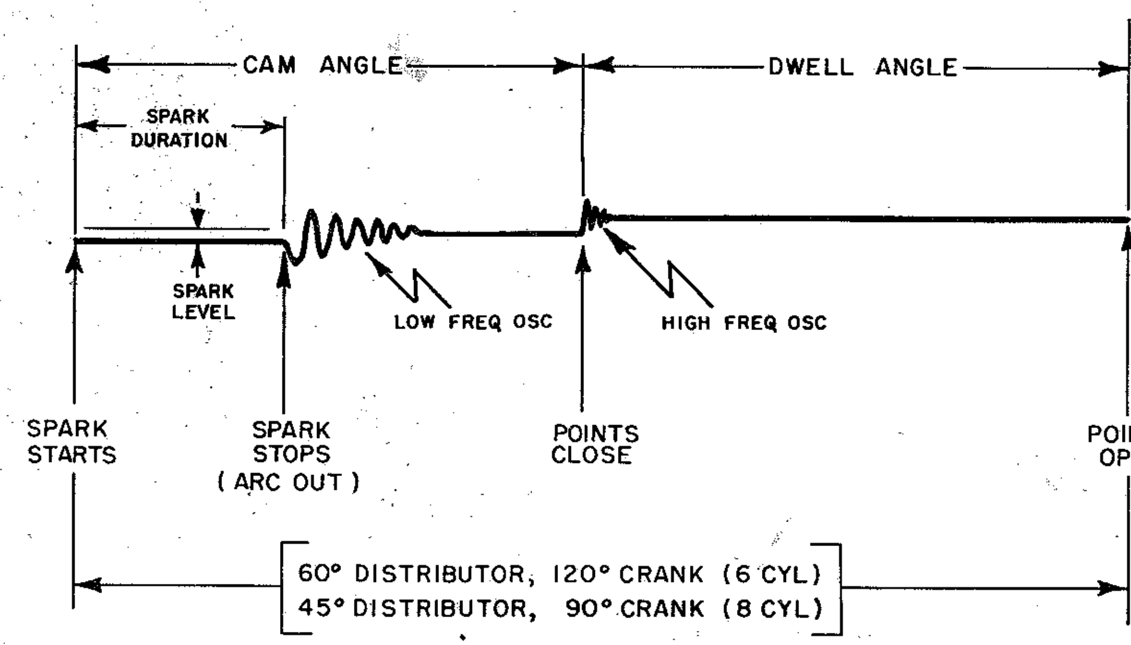


Figure 2-4. Waveform Analysis

SECTION 3
THEORY OF OPERATION

3-1. GENERAL

The Du Mont Type 901 Engine Analyzer is essentially a cathode-ray oscillograph with auxiliary circuits designed for the particular application of engine testing. Since the cathode-ray tube requires moderately high potentials for its operation, amplifiers and control circuits are required to obtain a maximum of flexibility and usefulness. Sawtooth voltages produced by two sweep generators are combined, developing a pattern on the cathode-ray tube corresponding to the number of cylinders in the engine under test. Such a pattern is frequently called a raster. Synchronizing circuits are used to enable this pattern to be locked or synchronized with the rotation of the engine, and enable the instrument to follow changes in engine speed. In addition, a signal amplifier channel is provided to display the desired information upon the lines forming the raster. Refer to block diagram Figure 3-1 and schematic when following circuitry discussed in the following paragraphs.

3-2. VERTICAL AMPLIFIER

a. Vertical Signal Amplifier

The vertical amplifier consists of a signal amplifier and two vertical deflection amplifiers. The input stage (V101) uses a dual-triode type tube of low microphonic characteristics. This tube as well as those used in the deflection amplifier (V102 and V103) is mechanically shock-mounted on rubber mounts to further reduce microphonic effects when used in a moving vehicle. The input stage is connected as a differential amplifier with both grids used for signal input, although one grid is often grounded at the pickup device. A SENSITIVITY control is located ahead of the input stage having an input impedance from 200K ohms at minimum sensitivity to approximately 1 megohm at maximum setting. Maximum sensitivity is such that 12 rms millivolts input will produce approximately one inch of deflection.

b. Vertical Deflection Amplifier

The vertical deflection amplifier which immediately follows the input stage, uses two pentodes (V102 and V103) in a balanced circuit. Two input grids are thus provided in the stage, one receiving the signal from the input stage, while the other receives the vertical sweep signal. The stage is self-inverting due to the high value cathode resistor employed, and both signal and raster components are effectively inverted to provide balanced deflection for both. The LINE SPACING control determines the amplitude of the vertical raster component. The VERTICAL CENTERING control is located in the screen circuit of the deflection amplifier stage permitting instantaneous positioning and is independent of all other circuits.

3-3. SYNCHRONIZING CIRCUITS

a. General

The synchronizing circuits (vertical and horizontal sync) are designed to operate over a wide range of signal inputs such as might be encountered in practice from one engine to another. Their function is to accept ignition signals derived from the capacitive pickup clips and to deliver clean, uniform synchronizing signals to the sawtooth generators (V203 and V302) required for sweep. (The circuits are similar except for some component values which differ in particular instances to suit the frequency ranges involved.) A correction circuit (V304A-B) holds the pattern at nearly constant size over the full range of speed variations.

b. Vertical and Horizontal Sync Amplifiers

The vertical and horizontal sync amplifiers each consists of one-half of a high gain dual-triode (V201-A and V201-B) as their first stage and dual-triode type tube (V202 and V301) in the succeeding stage used as a pulse shaper and amplifier. A VERTICAL and HORIZONTAL LOCK control is located at the input of the respective stages and is capacitively coupled to the grid, which is returned to the positive supply to discriminate in favor of the negative components of the spark signal it receives. Since the grid is held essentially at zero bias, positive signals will not be accepted, but negative signals will be amplified, resulting in large positive signals in the plate circuit. Integration is accomplished by the capacitor in the plate circuit of the first section. The second stage amplifies, inverts the polarity, and clips the pulse further to deliver a clean triggering signal to the grids of the two thyratrons (V203 and V302) which are used in the two saw-generating circuits.

3-4. RASTER GENERATING CIRCUIT

a. General

To generate a raster-type pattern, two similar saw-generating circuits are used. Since the raster is composed of two saw-tooth voltages a downward slope to the right of all baselines would be evident with the absence of the tilt correcting signal. The direction and degree of the slope is determined by the direction of the deflection and by the number of lines in the pattern respectively. Since the pattern starts at the top and works to the bottom, and the horizontal deflection is from left-to-right, the lines will slope downward to the right. To correct for this slope, and to have the vertical deflections at right angles to the baselines a portion of the horizontal saw, of negative polarity, is applied to the vertical circuit.

Each of the saw-generating circuits employs a thyratron (V203, V302) switching tube and a pentode constant-current tube (V204, V303). In operation, the capacitor in the plate circuit of the thyratron charges through the resistance of the constant-current tube until a synchronizing or trigger pulse is received at the thyratron grid. This results in discharge of the capacitor through the thyratron, following which the action is repeated. In contrast to the more conventional arrangement, the plate of the thyratron remains fixed at its plate potential, and since the constant-current tube is in the cathode circuit, charging of the capacitator decreases the potential on the cathode, thus increasing the voltage across the capacitor. To minimize loading on the capacitor, each circuit is connected to a cathode-follower, the output of which is connected to succeeding circuits.

b. Vertical Saw Generator

The vertical saw generator (V203) derives its synchronizing pulse from NO. 1 CYL INPUT; hence, the vertical saw frequency is equal to one-half of the engine rpm. The output of this generator is applied to the grid of V205-A. The other section of this tube (V205-B) receives the tilt correction signal from the horizontal circuit.

The TILT ADJ (R226—service adjustment) controls the amplitude of the horizontal saw signal coupled to V205-B thus, allowing correction of the line level. The tilt correction and vertical saw signals are mixed in the cathode circuits, and their combined output is coupled to the vertical deflection amplifier (V103) via the LINE SPACING control (R113). Resistors R218 thru R224 automatically compensate

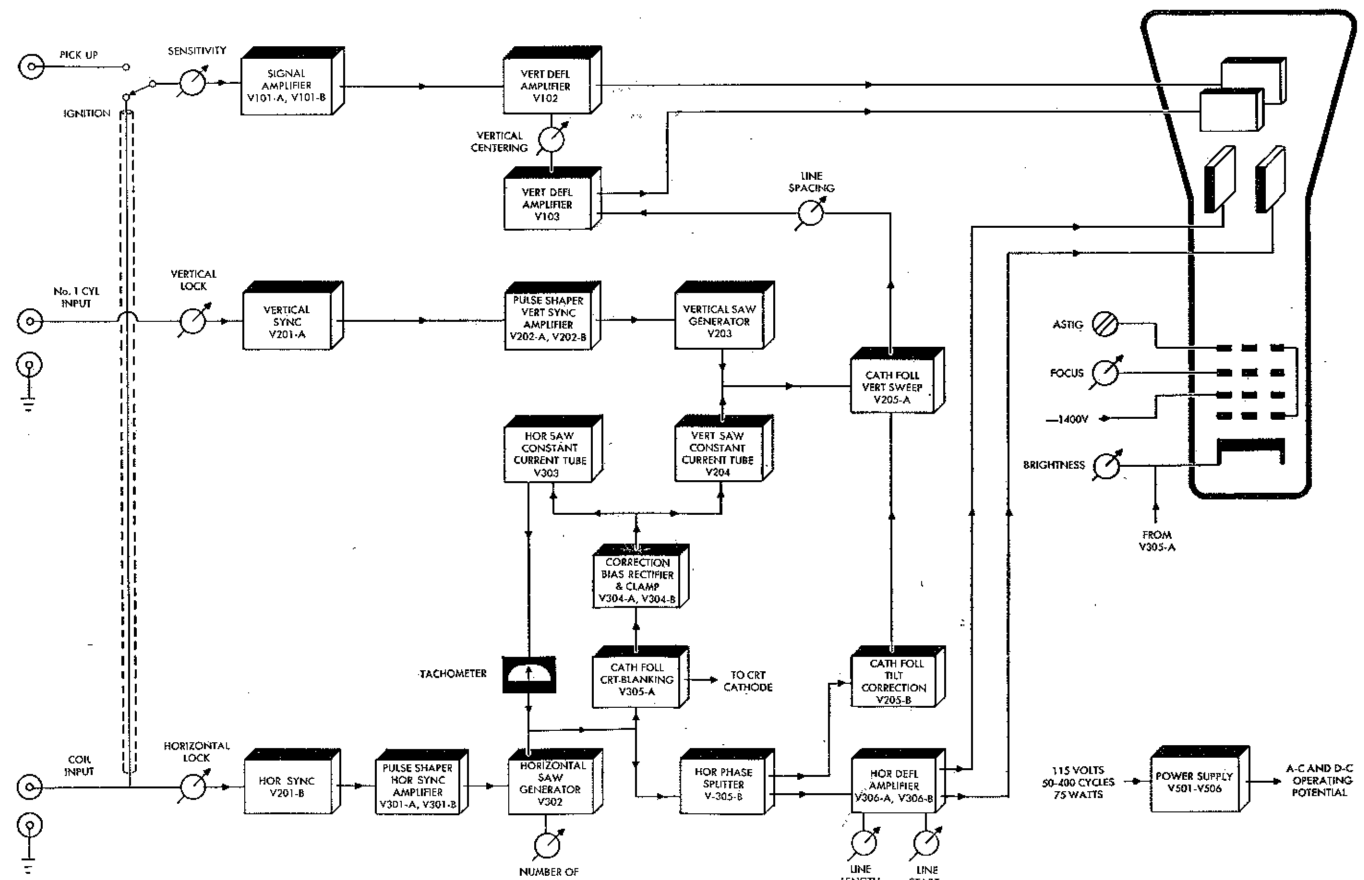


Figure 3-1. Functional Block Diagram, Type 901 Engine Analyzer

for the amplitude of the tilt signal in the cathode circuit of V205 as the NUMBER OF CYLINDERS switch (S201) is set to different positions.

The D-C BAL service adjustment (R217) varies the d-c level at one end of the LINE SPACING control to equal that at the other end. This arrangement provides for symmetrical vertical expansion of the pattern as the LINE SPACING control is advanced.

The distance between each horizontal line is controlled by adjusting the composite signal (vertical saw and tilt correction) voltages applied to V103 by the LINE SPACING control. When the LINE SPACING control is set fully CCW, switch S102 is opened and disconnects the vertical saw from V103. This feature enables all baselines to be superimposed for direct comparison.

c. Horizontal Saw Generator

The horizontal saw generator (V302) derives its synchronizing pulse from the COIL INPUT. Since this lead contains the impulses from all plugs, the horizontal saw frequency is equal to the product of one-half the engine rpm times the number of cylinders. The output of the horizontal saw generator is applied to the grid of a cathode follower (V305-A) and to the grid of the horizontal phase splitter (V305-B). From the cathode of V305-B, the negative saw is coupled to the horizontal deflection amplifier (V306) via the LINE START CLAMP service adjustment (R320) and the LINE LENGTH control (R323). Through conventional amplifier operation, V306-B amplifies and inverts the saw for application to one of the horizontal deflection plates. Since the grid of V306-A is held at a-c ground by C321, the sawtooth signal at the common cathode effectively results in a signal at the grid of V306-A that is essentially equal, but opposite in phase, to that at the grid of V306-B. The resulting sawtooth signal at the plate of V306-A is coupled to the other horizontal deflection plate.

Horizontal positioning is accomplished by varying the d-c potential on the grid of V306-A by adjustment of the LINE START control (R328).

The d-c level at the CCW end of the LINE LENGTH control is established at the junction of a voltage divider (R321 and R322). The LINE START CLAMP service adjustment (R320) establishes the d-c level at the CW end of the LINE LENGTH control. Proper adjustment of the LINE START CLAMP is obtained my simultaneously adjusting it with the LINE LENGTH control, to obtain a minimum amount of horizontal depositioning at the left end of the baselines when the LINE LENGTH control is varied.

The cathode follower stage, V305-A, serves two functions: (1) it isolates the size correction bias rectifier (V304-A) and clamp (V304-B) from the saw generating circuit; and (2) it couples the fast-rising trailing edge of the saw signal to the cathode of the cathode-ray tube to blank the horizontal return trace. There is no blanking of the vertical return trace.

A negative saw from the plate of the horizontal phase splitter (V305-B) is capacitively coupled (C315) to the vertical sweep cathode follower (V205-B) to correct the sloping base lines. Proper adjustment of this slope correction signal is made by varying the TILT service ADJustment (R226).

3-5. SIZE CORRECTION

A negative saw is coupled from V305-A to V304, operating the size correction circuit. This circuit consists of a peak rectifier (V304-A) and a clamping diode (V304-B) which are designed to produce a corrective bias that varies in accordance with the engine speed or frequency of the horizontal saw. The clamping diode section (V304-B) establishes the d-c level of the saw at 35 volts. The cathode of V304-A is biased at a positive potential of 35 volts and will conduct whenever the negative saw exceeds this voltage. Upon conduction of V304-A, a negative d-c voltage is developed across R314. This negative bias is used to control the grids of the constant current tubes (V204 and V303). As the saw voltage tends to increase (as engine speed increases), the bias increases raising the resistance of the constant current tubes, reducing the peak value of the saw.

3-6. TACHOMETER

The ENGINE RPM (tachometer) consists of an ammeter (M301) in series with the horizontal saw constant current tube (V303). This meter, calibrated to indicate engine rpm, reads the average current which is proportional to the speed of the engine. To keep the average current within the same limits, capacitors C309 thru C314 are switched in as the NUMBER OF CYLINDERS switch is set to different positions.

While not necessary for saw generation, these capacitors are selected to an accuracy of 2% in order to maintain tachometer accuracy. The values used have been chosen to require a minimum number of physical units and a minimum number of unique values. By grouping the capacitors in various combinations all ranges are covered except the 7 and 14 cylinder positions. Since the value of the capacitor group in these positions is not exactly that required, a small correction is made by switching a compensating resistor (R310) in the meter circuit. The METER service ADJ (R312) adjusts the meter circuit resistance to a predetermined value, since meter resistance is not held to close tolerance.

3-7. POWER SUPPLY

a. General

A self-contained power supply furnishes all the necessary voltages and currents required for operation of the Type 901. The power source is 115 volts, 50 to 400 cycles, with a power consumption of approximately 75 watts.

Supplied as an accessory is the Type 2625 Power Pack to be used when operation from 6 or 12 volts is required.

b. High-Voltage Section

Two half-wave rectifiers (V501 and V502) furnish positive (1600V) and negative (—1400V) potentials for operation of the cathode-ray tube. A divider circuit at the output of the negative filter furnishes intermediate voltages required by the cathode-ray tube.

c. Low-Voltage Section

A full-wave rectifier (V503) is used for the low voltage positive supply. Two selenium rectifiers are used in a full-wave circuit to furnish a low negative potential for biasing purposes. The output of the positive filter (350V) is used directly to furnish plate-supply potentials for the deflection amplifiers (V102, V103, and V306).

d. Regulator Circuit

The regulator section supplies potentials derived from the voltage regulator (V504), voltage regulator amplifier (V505), and the voltage reference tube (V506). The potential of the voltage reference tube (108V) is applied to the plates of the gas triodes (V203 and V302).

SECTION 4
MAINTENANCE

WARNING

Potentials as high as 3000 volts exist in this instrument. Such voltages are dangerous to life, and every precaution should be taken to avoid contact with them. The instrument is not a hazard when enclosed in its cabinet. It should not be operated outside of its cabinet except for purposes of adjustment and repair, at which times precautions should be taken as follows . . .

(1) Never work alone.
(2) Make sure the chassis is properly grounded.
(3) Disconnect power before removing any tubes.

4-1. TROUBLE SHOOTING IN THE GARAGE

Servicing in the garage should be limited to tube replacement only. If trouble exists determine whether or not it can be remedied without removing the instrument from its cabinet. The following procedure is recommended:

Step 1. Check to see if front-panel controls are set as shown in Figure 2-1 and that IGNITION-PICK-UP switch is in IGNITION position.

Step 2. Check if red and black signal leads are plugged into proper terminals on instrument. To avoid grounding the signal, make sure that the letter "G" on the connector (top) is on the terminal marked G on the front panel.

Step 3. Check if line cord is plugged into live outlet.

Step 4. Check fuse at rear of instrument.

NOTE: If trouble still exists after making these checks, proceed to Step 5.

Step 5. Turn instrument OFF.

Step 6. Remove instrument from cabinet (see Paragraph 4-2).

Step 7. Turn instrument ON.

Step 8. Check to see if all tubes are lit. Removal of tube shields may be necessary in order to see tubes.

NOTE: V101, V201, V202, V205, V301, V304, V305, and V306 will show two separate individual lights because of their double heaters. V506 contains a gas and will glow instead of burning like tubes with heaters. (See Figure 4-5.)

WARNING

Potentials as high as 3000 volts exist in this instrument. Precaution should be taken as follows:

(1) Never work alone.
(2) Make sure chassis is properly grounded.
(3) Disconnect power before removing any tubes.

Step 9. Replace tube(s) that do not light.

Step 10. If trouble persists after making tube changes, replace original tube(s) in its socket.

Step 11. Package instrument and forward it to the nearest authorized service shop, or the jobber where the instrument was purchased.

4-2. TROUBLE SHOOTING IN THE SERVICE SHOP

a. General

The first step in correcting any trouble or failure that may occur is to isolate that section of the circuit causing the trouble. As an aid in isolating and servicing the trouble refer to the block diagram Figure 3-1 and the Trouble Shooting Chart Table 4-2.

The next step after isolating the trouble to a particular section is to determine the specific tube circuit involved. A replacement tube should be tried before attempting any other test. *Indiscriminate tube changing must be avoided. If after tube replacement the trouble persists, replace the original tube in its socket.*

NOTE: Replacement of certain tubes will require resetting on one or more service adjustment. Consult Table 4-4 for special instructions. If trouble persists, voltage and resistance measurements should be made. (See Table 4-3.)

b. Access to Chassis

To remove the instrument from its cabinet, remove the two screws located on rear bottom of cabinet and slide instrument forward, making sure that line cord is free to slide through the hole provided.

c. Service Adjustment

Do not touch any service adjustments unless test clearly indicates a need to do so. Such adjustments should not be attempted without a complete understanding of the proper procedure. Consult Table 4-1 and Figure 4-5.

d. Trouble Shooting Using Internal Signal

Step 1. Make test hookup as shown in Figure 4-1.

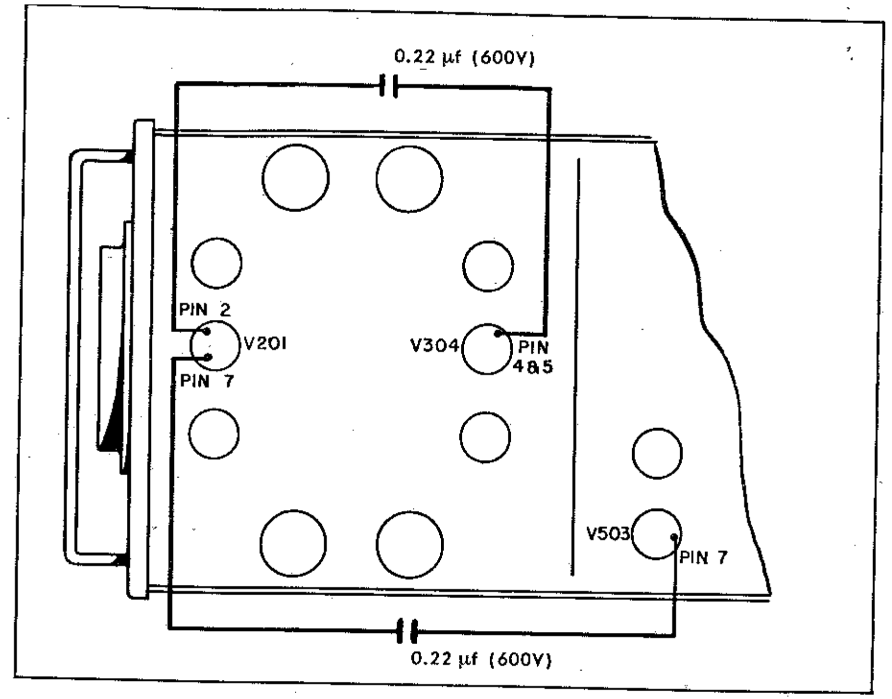
Step 2. Set HORIZONTAL LOCK and SENSITIVITY control fully clockwise.

Step 3. Set NUMBER OF CYLINDERS switch to 4.

Step 4. Trouble shoot the equipment with an oscillograph using the Table of Waveforms (Table 4-5) as a guide.

Step 5. After trouble has been corrected, a final check of performance of the equipment should be made as follows:

Figure 4-1. Main Chassis Bottom View Showing Internal Signal Hookup



a. Set IGNITION-PICKUP switch to IGNITION; check to see that pattern on screen agrees with Figures 4-2 and 4-3.

b. If patterns check remove hookup and replace instrument in its cabinet.

c. Attach unit to car and check operation. (See Paragraph 2-5.)

4-3. REPLACEMENT OF CATHODE-RAY TUBE

CAUTION

The cathode-ray tube should be handled with great care to prevent breakage, which might result in serious personal injury from flying glass. Do not employ force at any time. As an added precaution, it is advisable to wear safety goggles and gloves.

The following procedure is suggested for removal of the cathode-ray tube:

Step 1. Turn off power; remove cabinet.

Step 2. Remove filter and bezel which is held by four screws on the front panel.

Step 3. Remove inner ring and scale holding clamp by removing four screws on inner ring.

Step 4. Remove cathode-ray tube socket.

Step 5. Remove intensifier cap.

Step 6. Loosen cathode-ray tube clamp.

Step 7. Remove tube through front panel.

Step 8. Install new tube.

Step 9. Apply power and check the sweep; if not horizontal rotate tube as required.

4-4. DU MONT WARRANTY AND SERVICE NOTICE

All instruments produced by the Technical Products Division of Allen B. Du Mont Laboratories, Inc. are sold under the Du Mont Warranty. For the provisions of this warranty, and the Service policies of the Technical Products Division, see the Warranty and Service Notice on inside of back cover.

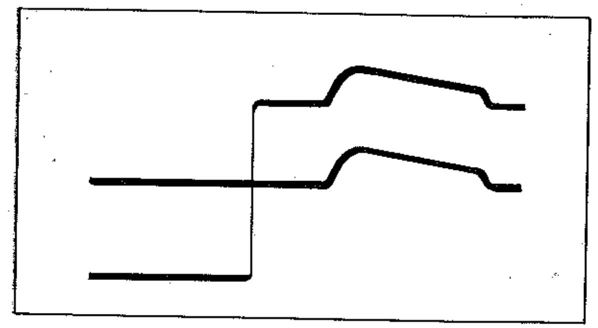


Figure 4-2. Signal Pattern with Sensitivity Set Fully CW

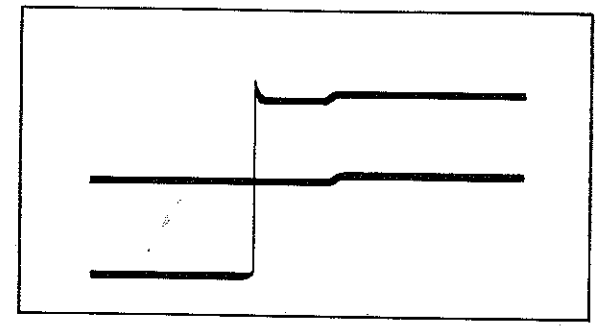


Figure 4-3. Signal Pattern with Sensitivity Set Fully CCW

TABLE 4-1. SERVICE ADJUSTMENT CHART

NAME & LOCATION	ADJUSTMENT PROCEDURE
ASTIG (R401)	Once properly adjusted, R401 should require no further attention under normal conditions. Using internal signal (hook-up as shown in Figure 4-1), adjust BRIGHTNESS for normal trace. Adjust ASTIG simultaneously with FOCUS to obtain optimum focus
TILT ADJ (R226)	Using internal signal (hook-up as shown in Figure 4-1) vary TILT ADJ (R226) until the lines are level
D-C BAL (R217)	If the center trace moves vertically as the LINE SPACING control is rotated, the D-C BAL should be adjusted in the following manner: Step 1. Make connection for using internal signal as shown in Figure 4-1 Step 2. Set NUMBER OF CYLINDERS switch to 4 and SENSITIVITY control fully counterclockwise obtaining a pattern as shown in Figure 4-4

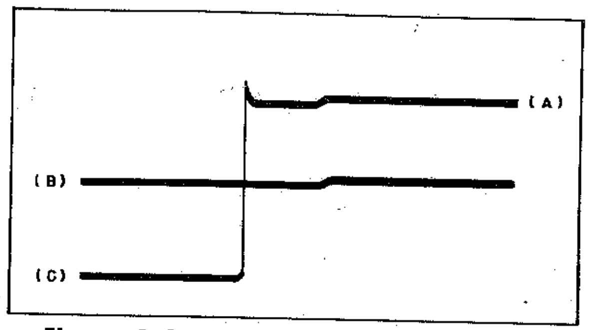


Figure 4-4. Internal Hookup Test Signal

NAME & LOCATION	ADJUSTMENT PROCEDURE
	Step 3. Adjust vertical positioning so that line B is in center of screen Step 4. Simultaneously adjust LINE SPACING and D-C BAL controls so that lines A and C will expand equally vertically on both sides of line B with no deposition of line B
REG VOLT ADJ (R508)	Set R508 to obtain 170 volts
LINE START CLAMP (R320)	If the start of the trace moves horizontally when the LINE LENGTH control is varied the LINE START CLAMP should be adjusted in the following manner: Step 1. Put calibrated scale in position on bezel Step 2. Make connection for using internal signal as shown in Figure 4-1 Step 3. Align start of trace with left index on scale Step 4. Simultaneously adjust LINE LENGTH and LINE START CLAMP for minimum amount of horizontal depositioning of the start of the trace when the LINE LENGTH control is varied
METER ADJ (R312)	To properly calibrate the ENGINE RPM meter (M301), proceed as follows: Step 1. Turn instrument OFF and zero meter (M301) by turning screwdriver adjustment on its front Step 2. Connect a 0.22 µf 600V capacitor between Pin 7 of V503 and Pin 7 of V201 Step 3. Turn instrument ON. With NUMBER OF CYLINDERS switch set to 4, adjust METER ADJ (R312) until meter reads 3600 rpm Step 4. Remove connection at Pin 7 of V503 and connect it to Pin 2 of V204. The meter should now read 1800 rpm Step 5. Remove lead connected to Pin 2 of V204, reconnect it to Pin 7 of V503 Step 6. Check meter calibrations using the chart below:

NUMBER OF CYLINDERS	TRUE ENGINE RPM	TACHOMETER READING (RPM)
4	3600	3450 - 3750
6	2400	2300 - 2500
7	2058	1980 - 2150
8	1800	1730 - 1870
9	1600	1540 - 1660
12	1200	1150 - 1250
14	1029	990 - 1070
18	800	770 - 830

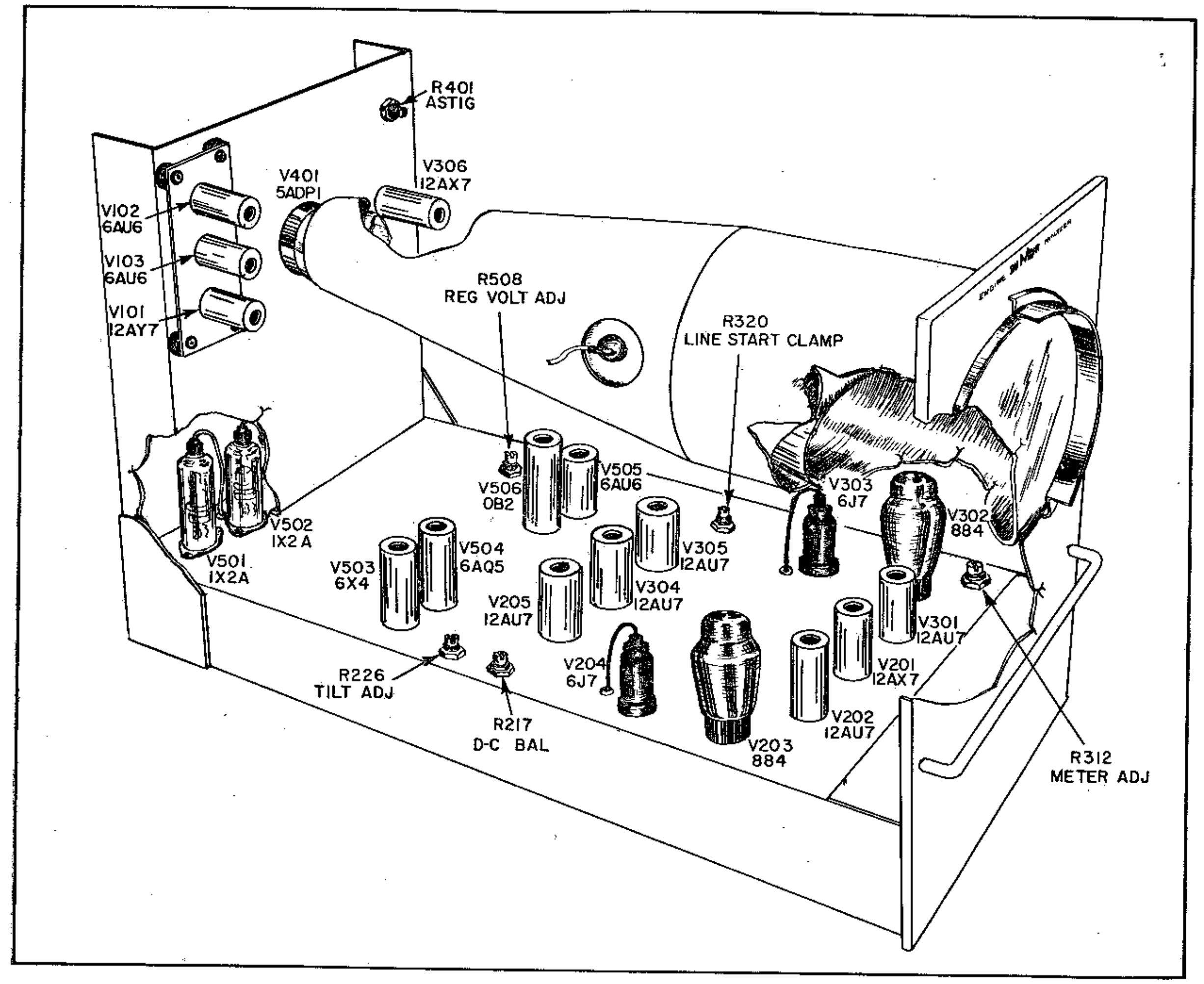


Figure 4-5. Service Adjustments and Tube Locations

TABLE 4-2
TROUBLE SHOOTING CHART

SYMPTOM	PROBABLE CAUSE	REMEDY
1. POWER SUPPLY AND CRT CIRCUITRY		
1-1. Pilot indicator fails to light	1-1a. Line cord not plugged into a live outlet 1-1b. Pilot indicator lamp open 1-1c. Blown fuse 1-1d. POWER switch defective	1-1a. Trace line failure 1-1b. Replace 1-1c. Check and replace 1-1d. Place an ohmmeter across prongs of line cord and check continuity in the ON position. Resistance should measure approximately less than 5 ohms
1-2. Line fuse blows instantly when POWER switch is turned on	1-2. Defective power supply	1-2. Make resistance checks as follows: SUPPLY — RESISTANCE TO CHASSIS 1600V — 5 M —1400V — 1.25 M 350V — 300 K 325V — 300 K —65V — 47 K 170V — 22 K 108V — 24 K 35V — 12 K
1-3. Line fuse blows 30-60 seconds after POWER switch is turned on	1-3. Defective low-voltage supply	1-3. Check V503—V506; also see 1-2a
1-4. No spot on cathode-ray tube screen	1-4a. Spot depositioned due to a defective amplifier stage 1-4b. Spot depositioned due to a broken connection between the amplifier and the deflection plates 1-4c. Defective high-voltage supply 1-4d. Intensifier cap not connected 1-4e. Defective cathode-ray tube 1-4f. CRT not properly seated in its socket 1-4g. D-C BAL (R217) improperly adjusted	1-4a. To check, see 2-1a and 3-1a 1-4b. Check to see if the vertical and horizontal deflection plate leads are correctly placed and secured 1-4c. Check V501 & V502; measure voltage and resistance per Table 4-3 1-4d. Connect intensifier cap. CAUTION — HIGH VOLTAGE 1-4e. Check to see if tube is lit. CAUTION—HIGH VOLTAGE 1-4f. Check for proper seating of CRT in socket 1-4g. To check, turn LINE SPACING fully counterclockwise. If spot appears readjust R217 per Table 4-1
1-5. Non-uniform focus	1-5. ASTIG (R401) improperly set	1-5. See Service Adjustment Chart, Table 4-1.
2. VERTICAL CIRCUITRY		
2-1. No vertical deflection with input signal applied	2-1a. Defective V101 (12AY7) or vertical amplifier component 2-1b. IGNITION-PICKUP switch incorrectly set 2-1c. Improper setting of SENSITIVITY control 2-1d. Defective components in stages V101, V102, and V103	2-1a. Replace V101 and/or check R101—R108, and C101—C104 2-1b. Set correctly. See Table 2-1 for function 2-1c. Rotate SENSITIVITY control sufficiently clockwise to obtain vertical deflection 2-1d. Check voltage and resistance per Table 4-3 to find defective components

TABLE 4-2. TROUBLE SHOOTING CHART (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
2-2. No vertical sync with signal applied	2-2a. VERTICAL LOCK improperly set 2-2b. Defective vertical sync stages 2-2c. Sync coupling capacitor(s) open	2-2a. Readjust VERTICAL LOCK 2-2b. Check V201 and/or V202. Measure voltage and resistance per Table 4-3 2-2c. Check C202, C203 and C205; replace
2-3. No vertical sweep with absence of input signal	2-3a. LINE SPACING control not rotated clockwise enough 2-3b. Defective vertical sweep stages 2-3c. Shorted sweep capacitor(s)	2-3a. Rotate clockwise 2-3b. Check and/or replace V203, V204 and/or V205; measure voltage and resistance per Table 4-3 2-3c. Check C207, C208 and C209; replace
2-4. Baselines tilt upward or downward	2-4a. TILT ADJ (R226) incorrectly set 2-4b. Defective tilt correction cathode follower 2-4c. Defective coupling capacitor	2-4a. See Service Adjustment Chart, Table 4-1 2-4b. Check V205-A; measure voltage and resistance per Table 4-3 2-4c. Check C315; replace
2-5. Hum on pattern when adjusting LINE SPACING control	2-5a. Defective V203	2-5a. Replace V203
3. HORIZONTAL CIRCUITRY		
3-1. No horizontal sweep	3-1a. Defective 302 (884), V303, V305, V306 or a component in the horizontal sweep circuit 3-1b. Defective horizontal sweep stages	3-1a. Replace either V302 thru V306. Take voltage and resistance measurements 3-1b. Check V302 thru V306. Check voltage and resistance per Table 4-3 to locate other faulty components
3-2. No horizontal sync	3-2a. HORIZONTAL LOCK improperly adjusted 3-2b. Defective horizontal sync stages	3-2a. Readjust HORIZONTAL LOCK 3-2b. Check V201-B and V301; measure voltage and resistance per Table 4-3
3-3. Start of line depositions when LINE LENGTH is rotated	3-3a. LINE START CLAMP (R320) improperly adjusted 3-3b. V305, V306 defective 3-3c. C320 leaky	3-3a. See Service Adjustment Chart, Table 4-1 3-3b. Check and replace 3-3c. Check and replace
3-4. Tachometer reading off scale with no external signal	3-4a. Defective V204, V302, V303, V304 or V305 3-4b. Shorted grid cap on V204 or V303 3-4c. C308, C316, C317 or C318 shorted 3-4d. R311, R314, R315, R316 or R317 open	3-4a. Check and replace 3-4b. Replace troubled tube 3-4c. Replace 3-4d. Replace
3-5. No indication of RPM on Tachometer with signal applied	3-5. Defective V302 and/or V303	3-5. Check and replace
3-6. Visible retrace lines	3-6a. Defective V305 3-6b. Defective C319	3-6a. Replace 3-6b. Replace
3-7. Hum in vertical and horizontal circuits	3-7. Heater/cathode leakage on V305	3-7. Replace

TABLE 4-3
VOLTAGE AND RESISTANCE MEASUREMENTS

(Tube pin to chassis, except where otherwise indicated)
Preset front-panel controls according to the following chart:

CONTROL	SETTING
SENSITIVITY	Fully CCW
LINE START	Center of range
LINE SPACING	Fully CCW
LINE LENGTH	Fully CCW
IGNITION-PICKUP	Ignition
BRIGHTNESS	For normal spot

CONTROL	SETTING
NUMBER OF CYLINDERS	Optional
FOCUS	Focused Trace
VERTICAL LOCK	Fully CCW
VERTICAL CENTERING	Center of range
HORIZONTAL LOCK	Fully CCW

VERTICAL AMPLIFIER

SYMBOL	TYPE	FUNCTION	1	2	3	4	5	6	7	8	9	COMMENTS
V101	12AY7	Signal Amplifier	150V	0V	2.3V	6.3V AC	6.3V AC	110V	0V	2.3V	0V	
			32K	2.2M	67K	0	0	132K	2.2M	67K	0	
V102	6AU6	Vertical Deflection Amplifier	12V	16V	6.3V AC	0V	240V	140V	16V			
			1.2M	50K	0	0	382K	72K	50K			
V103	6AU6	Vertical Deflection Amplifier	13V	16V	6.3V AC	0V	240V	140V	16V			
			28K	50K	0	0	382K	72K	50K			

VERTICAL SYNC AND SWEEP

SYMBOL	TYPE	FUNCTION	1	2	3	4	5	6	7	8	9	COMMENTS
V201	12AX7	(A) Vertical Sync	32V	0V	0V	6.3V AC	6.3V AC	32V	0V	0V	0V	
		(B) Horizontal Sync	770K	2.5M	0	0	0	770K	2.5M	0	0	
V202	12AU7	(A) Pulse Shaper	25V	0V	0V	6.3V AC	6.3V AC	325V	—65V *	0V	0V	* Use VTVM
		(B) Vertical Sync Amplifier	520K	1.2M	0	0	0	525K	500K	0	0	

section 4
maintenance

SYMBOL	TYPE	FUNCTION	1	2	3	4	5	6	7	8	9	COMMENTS
V203	884	Vertical Saw Generator			106V	6.3V AC	35V	108V		45V to 90V		Pin 8 voltage varies with engine RPM
				22K	34K		500K	24K	22K	∞		
V204	6J7	Vertical Saw Constant Current Tube	0V	6.3V AC	45V to 90V	106V	0.1V	0.025V	0V	0.1V	CAP —3.5V to —5.6V	Pin 3 and grid cap voltages vary with engine RPM
			0	0	∞	34K	2.6K	470	0	2.6K	∞	
V205	12AU7	(A) Vertical Sweep, Cathode Foll.	170V	45V to 90V	50V to 95V	6.3V AC	6.3V AC	170V	*0 to —1.5V	100V to 115V	0V	* Use VTVM Pins 2, 3, 7 and 8 voltages vary with engine RPM. Pin 8 resistance measurement varies with number of cylinder setting.
		(B) Tilt Correction, Cathode Foll.	22K	∞	40K	0	0	22K	500K	7K—100K	0	

HORIZONTAL SYNC AND SWEEP

SYMBOL	TYPE	FUNCTION	1	2	3	4	5	6	7	8	9	COMMENTS
V301	12AU7	(A) Pulse Shaper (B) Horizontal Sync Amplifier	320V	—65V	0V	6.3V AC	6.3V AC	25V	0V	0V	0V	Pin voltages of V301-V305 vary with engine RPM and number of cylinders.
			520K	500K	0	0	0	520K	1.2M	0	0	
V302	884	Horizontal Saw Generator			108V	6.3V AC	35V			60V to 70V		Same comment as V301
				22K	24K		500K		22K	∞	0	
V303	6J7	Horizontal Saw Constant Current Tube	0V	6.3V AC	58V to 68V	108V	0V		0V	0V	CAP —3.5V to —5.6V	Same comment as V301
			0	0	∞	24K	2.2K		0	2.2K	∞	
V304	12AU7	(A) Correction Bias Rectifier	—3.5V to —5.6V	—3.5V to —5.6V	0V to 25V	6.3V AC	6.3V AC	0V to 25V	0V to 25V	35V	0V	Pin 1 and 2 voltages of V304 depends on repetition rate of coil input.
		(B) Clamp	1.2M	1.2M	10M	0	0	10M	10M	15K	0	Same comment as V301
V305	12AU7	(A) Cathode Foll.—CRT Blanking	170V	60V to 70V	60V to 85V	6.3V AC	6.3V AC	168V	60V to 70	60V to 85V	0V	Same comment as V301
		(B) Horizontal Phase Inverter	22K	∞	47K	0	0	44K	∞	110K	0	
V306	12AX7	Horizontal Deflection Amplifier	235V	36V	22V	6.3V AC	6.3V AC	235V	20V	22V	0V	
			520K	25K	110K	0	0	520K	10K	110K	0	

TABLE 4-3. VOLTAGE AND RESISTANCE MEASUREMENTS (Continued)

INDICATOR

TUBE			PIN NUMBERS									
SYMBOL	TYPE	FUNCTION	1	14	2	3	5	7	8	9	10	11
V401	5ADP1	Cathode-ray Tube	6.3V AC / −1380V	6.3V AC	−1380V	−1400V	800V	240V	240V	175V	235V	235V
			1.3M		1.3M	1.2M	750K	382K	382K	125K	520K	520K

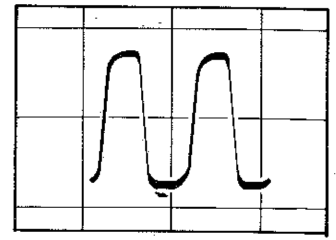
POWER SUPPLY

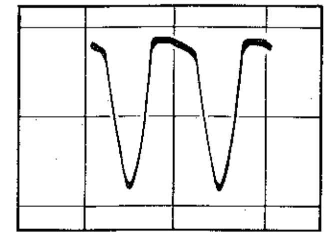
TUBE			PIN NUMBERS								
SYMBOL	TYPE	FUNCTION	CAP	2	3	4	5	6	7	8	9
V501	1X2A	Positive High-voltage Rectifier	1200V AC	1600V	1.2V AC	1600V					
			2.5K	5M		5M					
V502	1X2A	Negative High-voltage Rectifier	−1460V	1200V AC	1.2V AC	1200V AC					
			1.25M	2.0K		2.0K					
V503	6X4	Low-voltage Rectifier	134V		6.3V AC	6.3V AC		134V	80V		
			150		22K	22K		150	300K		
V504	6AQ5	Voltage Regulator	160V	170V	6.3V AC	6.3V AC	350V	350V	160V		
			500K	22K	22K	22K	300K	300K	500K		
V505	6AU6	Voltage Regulator Amplifier	104V	108V	6.3V AC	0V	160V	170V	108V		
			600K	24K	0	0	500K	22K	24K		
V506	OB2	Voltage Reference	108V	0V			108V				
			24K	0			24K				

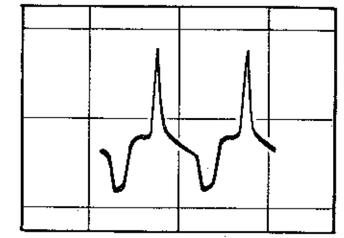
TABLE 4-4. ADJUSTMENTS TO BE MADE WHEN REPLACING TUBES

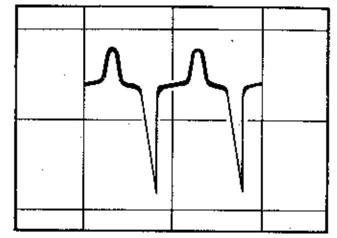
TUBE		SERVICE ADJUSTMENT
REF. SYMBOL	TYPE	
V205	12AU7	D-C BAL (R217) and TILT ADJ (R226)
V302	884	METER ADJ (R312)
V305	12AU7	LINE START CLAMP (R320), TILT ADJ (R226)
V401	5ADP1	ASTIG (R401)
V504	6AQ5	REG VOLT ADJ (R508)

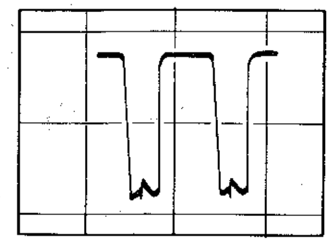
TABLE 4-5. WAVEFORM DATA
VERTICAL SYNC AND SWEEP CIRCUITRY

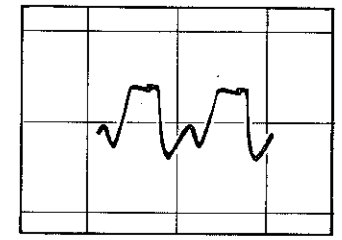

TEST POINT: V201-A PLATE PIN 1
SENSITIVITY: 200
(VOLTS/DIV)

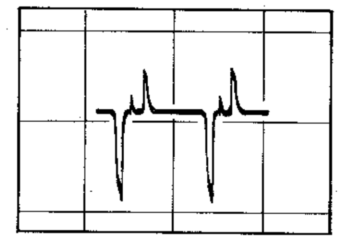

V201-A GRID, PIN 2
5

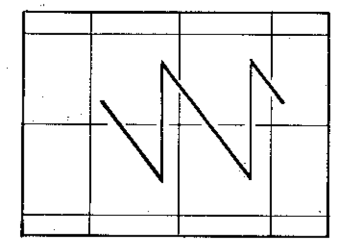

V202-B PLATE, PIN 6
100

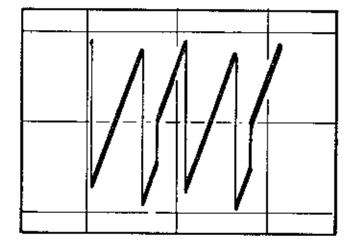

TEST POINT: V202-B GRID, PIN 7
SENSITIVITY: 100
(VOLTS/DIV)

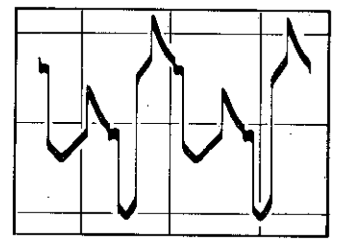

V202-A PLATE, PIN 1
200

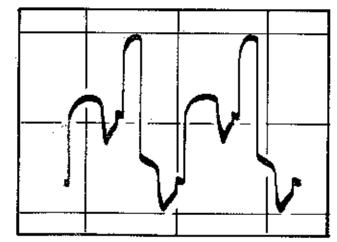

V202-A GRID, PIN 2
100

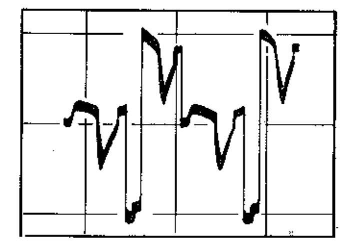

TEST POINT: V203 GRID, PIN 5
SENSITIVITY: 100
(VOLTS/DIV)

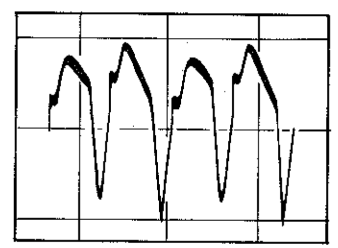

V203 CATHODE, PIN 8
10

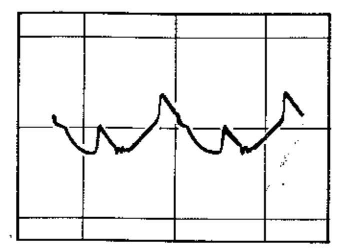

V205-B CATHODE, PIN 8
1.0


TEST POINT: V102 PLATE, PIN 5
SENSITIVITY: 10
(VOLTS/DIV)


V103 PLATE, PIN 5
10


V102 GRID, PIN 1
0.1

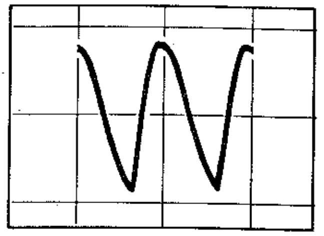

TEST POINT: V102,V103 CATHODE, PIN 7
SENSITIVITY: 1.0 (VOLT/DIV)


V101-B GRID, PIN 7
25 (MV/DIV)

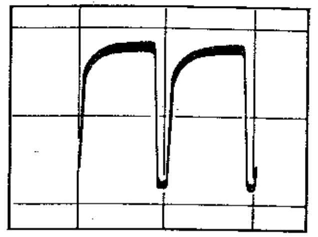
NOTE:
ALL WAVEFORMS OBTAINED USING A SWEEP FREQUENCY OF 30 CYCLES SYNCHRONIZED TO 60 CYCLE LINE

TABLE 4-5. WAVEFORM DATA (Continued)

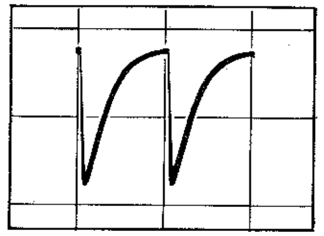
HORIZONTAL SYNC AND SWEEP CIRCUITRY



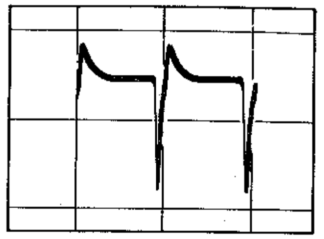
TEST POINT: V201-B GRID, PIN 7
SENSITIVITY (VOLTS/DIV): 200



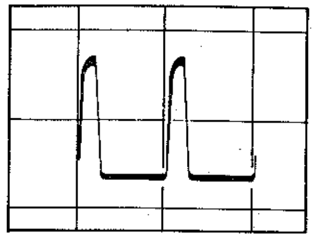
V201-B PLATE, PIN 6
200



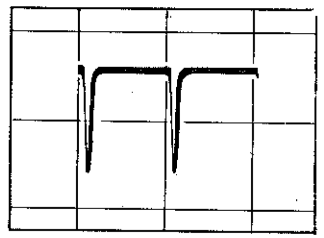
V301-A PLATE, PIN 1
200



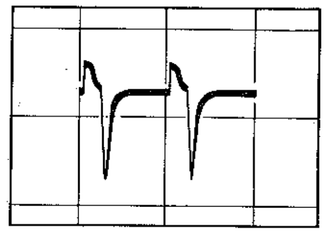
TEST POINT: V301-A GRID, PIN 2
SENSITIVITY (VOLTS/DIV): 200



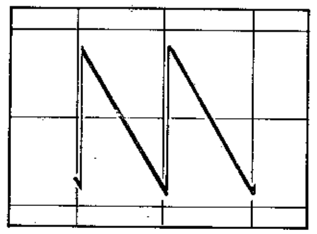
V301-B PLATE, PIN 6
200



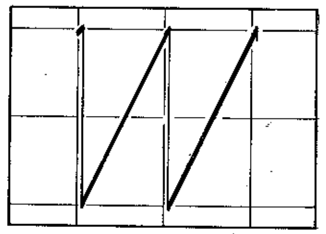
V301-B GRID, PIN 7
200



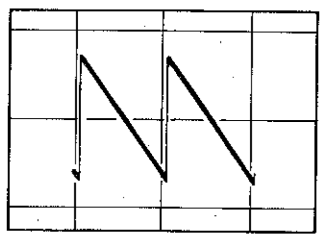
TEST POINT: V302 GRID, PIN 5
SENSITIVITY (VOLTS/DIV): 200



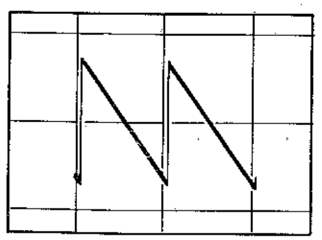
V302 CATHODE, PIN 8
25



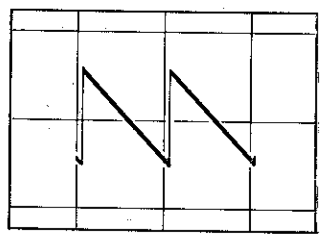
V305-B PLATE, PIN 6
2.5



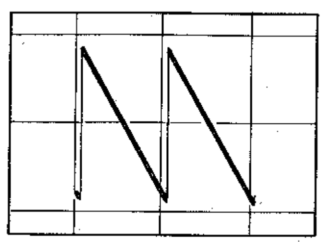
TEST POINT: V305-B CATHODE, PIN 8
SENSITIVITY (VOLTS/DIV): 25



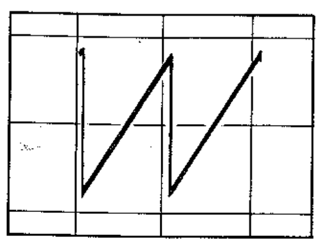
V304 CATHODE, PIN 3, 6, OR 7
25



V306-B GRID, PIN 7
2.5



TEST POINT: V306-A PLATE, PIN 1
SENSITIVITY (VOLTS/DIV): 50



V306-B PLATE, PIN 6
50

NOTE.
ALL WAVEFORMS OBTAINED USING A SWEEP FREQUENCY OF 60 CYCLES SYNCHRONIZED TO 60 CYCLE LINE

TYPE 901 ENGINE ANALYZER
COMPONENT PARTS LIST

Symbol	Part Number	Description
CAPACITORS		
C101	03011810	0.5 µf +20% −10% 600V Paper
C102	Same as C101	
C103	03141120	0.1 µf ±20% 400V Paper
C104	03002440	10 µf 450V Elect.
C105	03012890	100 µf 150V Elect.
C201	03020480	270 µµf ±10% 500V Mica
C202	03020900	51 µµf ±5% 500V Mica
C203	03020580	1000 µµf ±10% 500V Mica
C204	03127560	0.01 µf ±20% 400V Paper
C205	03128140	0.0047 µf ±20% 600V Paper
C206	Same as C203	
C207	03128220	0.1 µf ±20% 600V Paper
C208	03005960	0.5 µf +20% − 10% 600V Paper
C209A, B, C, D	03011370	420 µf 450V Elect.
C301	03018730	10 µµf ±2% 500V Ceramic
C302	Same as C204	
C303	Same as C201	
C304	Same as C203	
C305	Same as C203	
C306	Same as C203	
C307	Same as C204	
C308	Same as C203	
C309	03166381	0.047 µf ±2% 200V
C310	Same as C309	
C311	03166391	0.0314 µf ±2% 200V
C312	Same as C309	
C313	Same as C311	
C314	Same as C311	
C315	03137620	2 µf 600V Paper
C316	Same as C315	
C317	Same as C208	
C318	Same as C208	
C319	03169080	470 µµf ±20% 4KV Ceramic
C320	Same as C203	
C321	03140360	0.1 µf ±20% 200V Paper
C501	03017750	0.5 µf +20% −10% 2KV Paper
C502	Same as C501	
C503	Same as C501	
C504	03146070	40 µf 250V Elect.
C505	Same as C504	
C506	Same as C208	
C507	Same as C208	
C508	Same as C321	
RECTIFIERS		
CR202	26001940	Metallic
CR501	Same as CR202	
FUSES		
F501	11000790	3 Amp.
LAMPS		
I501	12001310	Inc. Bay 0.150 Amp.
CONNECTORS		
J101	09012260	Jack Telephone
J201	51001290	Post Binding
J202	Same as J201	
J301	51008710	Post Binding
J302	Same as J301	

Symbol	Part Number	Description
INDUCTORS		
L501	21004301	10 h fixed
METER		
M301	28002021	Tachometer
RESISTORS		
R101	02032010	100K ±10% ½W
R102	Same as R101	
R103	01018300	1M ±20% 0.5W Variable
R104	02032170	2.2M ±10% ½W
R105	Same as R104	
R106	02034960	39K ±10% 1W
R107	Same as R101	
R108	02031890	10K ±10% ½W
R109	02035000	82K ±10% 1W
R110	02031870	6.8K ±10% ½W
R111	02032140	1.2M ±10% ½W
R112	02031930	22K ±10% ½W
R113	01014600	100K ±20% 0.5W Variable (Part of S102)
R114	02034930	22K ±10% 1W
R115	01011310	100K ±20% 0.5W Variable
R116	Same as R109	
R117	Same as R109	
R201	01052750	50K ±20% 0.5W Variable
R202	Same as R104	
R203	02032090	470K ±10% ½W
R204	Same as R203	
R205	02032050	220K ±10% ½W
R206	Same as R111	
R207	Same as R205	
R208	Same as R203	
R209	Same as R108	
R210	Same as R108	
R211	02031650	100 ±10% ½W
R212	Same as R111	
R213	02031810	2.2K ±10% ½W
R214	02031730	470 ±10% ½W
R215	02034950	33K ±10% 1W
R216	02031970	47K ±10% ½W
R217	01013840	10K ±20% 0.5W Variable
R218	Same as R101	
R219	Same as R216	
R220	02031880	8.2K ±10% ½W
R221	Same as R220	
R222	Same as R220	
R223	Same as R108	
R224	02030750	13K ±5% ½W
R225	02031900	12K ±10% ½W
R226	01013910	1M ±20% 0.5W Variable
R301	Same as R201	
R302	Same as R104	
R303	Same as R203	
R304	Same as R203	
R305	Same as R205	
R306	Same as R111	
R307	Same as R205	
R308	Same as R203	
R309	Same as R108	
R310	02217900	50 ±1% 0.5W Wire Wound
R311	02217910	500 ±1% 0.5W Wire Wound
R312	01024820	500 ±10% 2W Variable Wire Wound

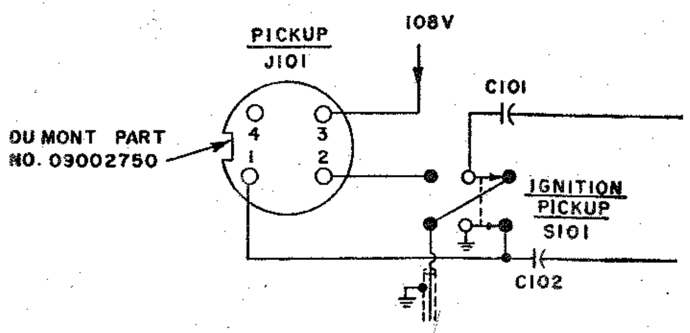
Symbol	Part Number	Description
R313	Same as R213	
R314	Same as R111	
R315	Same as R111	
R316	02032250	10M ±10% ½W
R317	Same as R216	
R318	Same as R112	
R319	Same as R216	
R320	01013870	100K ±20% 0.5W Variable
R321	Same as R109	
R322	02034900	12K ±10% 1W
R323	Same as R115	
R324	Same as R205	
R325	Same as R205	
R326	Same as R109	
R327	02032060	270K ±10% ½W
R328	01011280	25K ±20% 0.5W Variable
R329	02031940	27K ±10% ½W
R401	01011330	250K ±20% 0.5W Variable
R402	02038090	470K ±10% 2W
R403	01011340	500K ±20% 0.5W Variable
R404	02035020	120K ±10% 1W
R405	Same as R115	
R406	Same as R101	
R501	02020110	5M ±1% 2W Film
R502	02037980	56K ±10% 2W
R503	Same as R216	
R504	Same as R213	
R505	02031850	4.7K ±10% ½W
R506	Same as R505	
R507	Same as R203	
R508	01013890	500K ±20% 0.5W Variable
R509	02107960	5K ±5% 10W Wire Bound
R510	Same as R106	
R511	02031920	18K ±10% ½W

Symbol	Part Number	Description
	SWITCHES	
S101	05001160	2P2T
S102	01014600	SPST (Part of R113)
S201	05010931	Rotary 30 3PH 8P5T
S501	05001130	SPST
	TRANSFORMERS	
T501	20009861	Power
	TUBES	
V101	25009330	12AY7
V102	25000050	6AU6
V103	Same as V102	
V201	25001500	12AX7
V202	25000130	12AU7
V203	25000740	884
V204	25009380	6J7
V205	Same as V202	
V301	Same as V202	
V302	Same as V203	
V303	Same as V204	
V304	Same as V202	
V305	Same as V202	
V306	Same as V201	
V401	25007390	5ADP1
V501	25006490	1X2A
V502	Same as V501	
V503	25000170	6X4
V504	25000340	6AQ5
V505	Same as V102	
V506	25000360	0B2
	CABLE	
W501	50116900	Assembly

—NOTES—

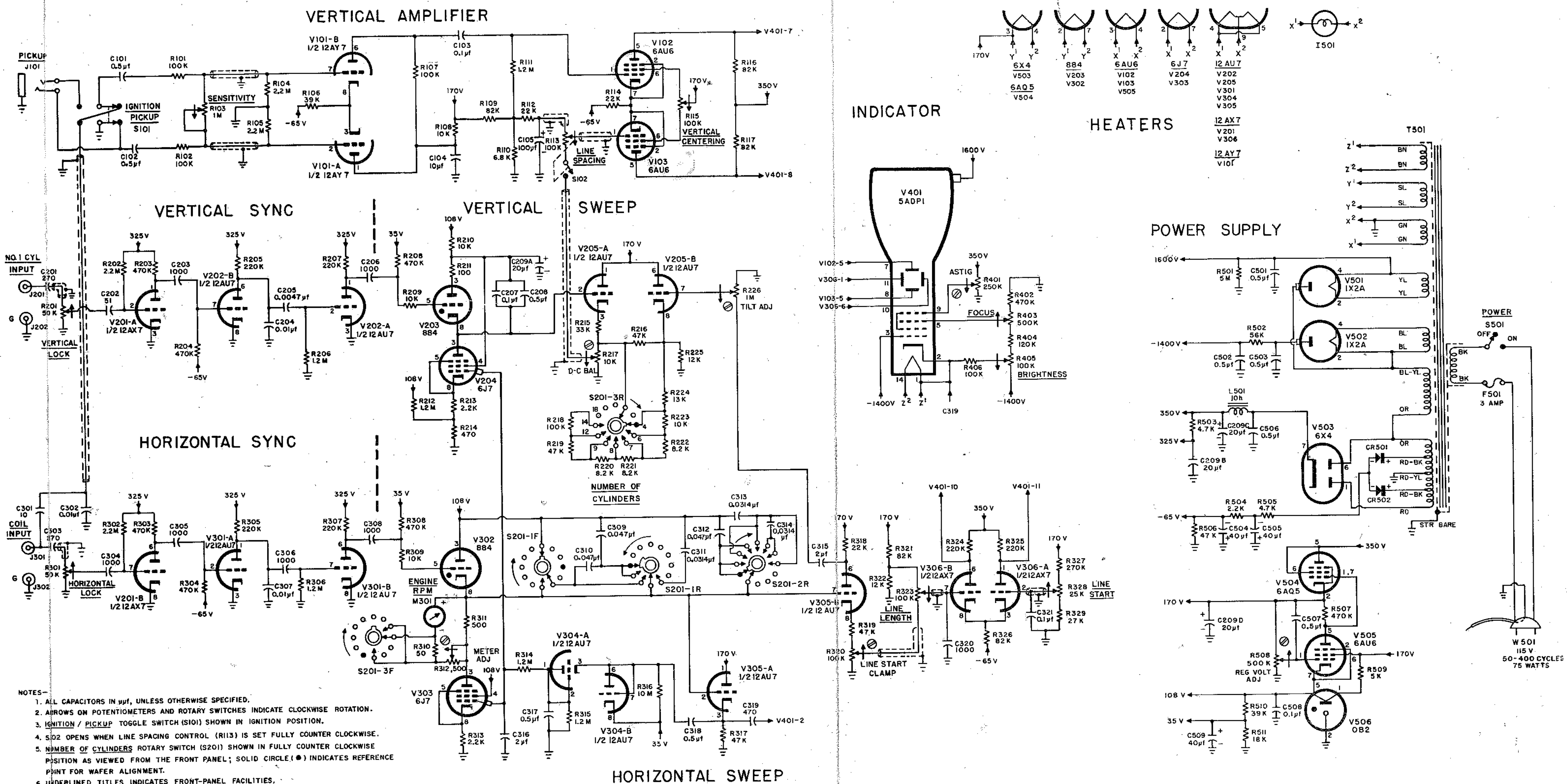
—NOTES—

REVISION SHEET
FOR
TYPE 901 INSTRUCTION BOOK SCHEMATIC



HOOKUP DIAGRAM FOR REPLACING THE EXISTING TELEPHONE TYPE PICKUP JACK (J101) ON TYPE 901 INSTRUCTION BOOK SCHEMATIC.

PART NO. 67026361



NOTES—

1. ALL CAPACITORS IN µµf, UNLESS OTHERWISE SPECIFIED.
2. ARROWS ON POTENTIOMETERS AND ROTARY SWITCHES INDICATE CLOCKWISE ROTATION.
3. IGNITION / PICKUP TOGGLE SWITCH (S101) SHOWN IN IGNITION POSITION.
4. S102 OPENS WHEN LINE SPACING CONTROL (R113) IS SET FULLY COUNTER CLOCKWISE.
5. NUMBER OF CYLINDERS ROTARY SWITCH (S201) SHOWN IN FULLY COUNTER CLOCKWISE POSITION AS VIEWED FROM THE FRONT PANEL; SOLID CIRCLE (●) INDICATES REFERENCE POINT FOR WAFER ALIGNMENT.
6. UNDERLINED TITLES INDICATES FRONT-PANEL FACILITIES.
7. ⊘ DENOTES SERVICE ADJUSTMENT.

SCHEMATIC OF CIRCUIT
DU MONT TYPE 901 ENGINE ANALYZER
Reference Drawing 98000991-4

WARRANTY AND SERVICE NOTICE
for
Industrial Type Cathode-ray Tubes and Instruments

DU MONT INSTRUMENTS

Each instrument manufactured by the Technical Products Division of Allen B. Du Mont Laboratories, Inc., is guaranteed to equal or exceed its published performance specifications. It is further guaranteed against defective materials (other than the cathode-ray tube) and workmanship for a period of one year from delivery date. Any defective instrument or an instrument that does not meet or exceed our specifications will, upon inspection by us, be repaired or replaced at our discretion should such defect appear within the guarantee period.

To register this guarantee, the enclosed guarantee card must be properly filled out and mailed to the factory immediately upon receipt of the equipment. Complete information is necessary. BOTH THE TYPE NUMBER AND THE SERIAL NUMBER OF THE INSTRUMENT MUST BE GIVEN ON THIS CARD.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

DU MONT CATHODE-RAY TUBES

Industrial type cathode-ray tubes manufactured by Allen B. Du Mont Laboratories, Inc., are guaranteed for 1000 hours of operation or for a six-month period from date of shipment, whichever expires first. Adjustments will be made on the merit of each individual claim because of the widely varying applications to which such tubes are subjected, and a tube which becomes defective during the guarantee period will be replaced ONLY AFTER INSPECTION AT THE FACTORY. Cathode-ray tubes returned under the guarantee, must be shipped with transportation paid.

BURNED-OUT HEATERS AND BROKEN GLASS ARE NOT COVERED BY THE TUBE GUARANTEE

To register a tube guarantee, the guarantee card enclosed with the tube must be filled out properly and mailed to the factory immediately upon receipt of the equipment. Complete information is necessary. TYPE NUMBER AND SERIAL NUMBER OF THE CATHODE-RAY TUBE MUST BE INCLUDED. The serial number of the tube will be found either on the glass stem of the electron-gun structure or on the bulb near the Du Mont brand. Tubes must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time and to furnish merchandise in accordance with current specifications without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications excepting under the classification of special apparatus.

SERVICE

In order to insure factory service under our guarantees, the guarantee cards enclosed with all instruments and tubes must be properly filled out and returned. In all cases where service or adjustment is requested, please write first to the factory giving complete information concerning the nature of the failure and describing the manner in which the equipment was used when failure occurred. THE TYPE NUMBER AND SERIAL NUMBER of the equipment must also be given. In this way, much time can be saved and unnecessary inconvenience often avoided. When writing in this respect, address:

Allen B. Du Mont Laboratories, Inc.
Technical Products Division
760 Bloomfield Avenue, Clifton, New Jersey

The Technical Products Division will then send to the customer, the written procedure for sending the instrument back to the factory. All equipment should be packed and shipped in accordance with this procedure; and identification tags should be attached to each tube or instrument.

REPLACEMENT PARTS

If it is necessary to order a replacement component from the factory, always give the type number and serial number of the instrument and refer to the component by its symbol designation and description on the circuit schematic. This will help to expedite service.