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INSTRUCTION MANUAL

TYPE 1531-P2

FLASH DELAY

GENERAL RADIO COMPANY

B

INSTRUCTION MANUAL

TYPE 1531-P2
FLASH DELAY

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GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

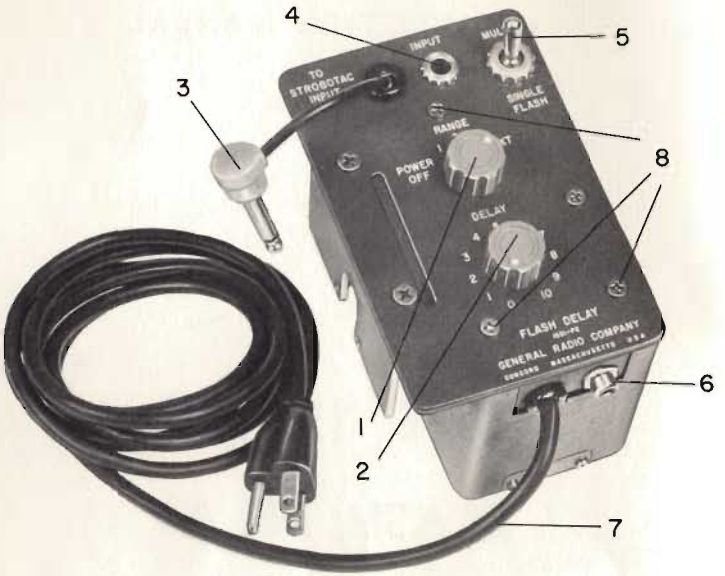


Figure 1-1. Type 1531-P2 Flash Delay.

SPECIFICATIONS

Time-Delay Range: Approximately 100 microseconds to 0.8 second in three overlapping ranges, continuously adjustable on each range.

Output Pulse: Better than 13 volts available for triggering the Types 1531-A and 1538-A Strobotac® electronic strobo scopes and the Type 1539-A Strobolume.

Sensitivity: A As little as 0.3-volt input will produce sufficient output to trigger the stroboscope.

Inputs: Phone jack for triggering; jack for camera synchronization.

Accessories Supplied: Trigger cable, phone-plug adaptor, carrying case and spare fuses.

Accessories Available: Type 1536-A Photoelectric Pickoff.

Power Requirements: 105 to 125 (or 210 to 250) volts, 50 to 400 c/s; 5 watts with Type 1536-A connected.

Mounting: Aluminum case with bracket which clips directly onto the Strobotac electronic stroboscope.

Dimensions: 5 1/8 by 3 1/8 by 3 3/4 inches (135 by 86 by 96 mm).

Net Weight: 2 pounds (1 kg). **Shipping Weight:** 5 pounds 2.3 kg).

Section 1

INTRODUCTION

1.1 PURPOSE.

The Type 1531-P2 Flash Delay (Figure 1-1) is a small, portable, time-delay unit for use with the Type 1531 and 1538 Strobotac® electronic stroboscopes, and the Type 1539 Stroboslave. It makes possible the insertion of a controlled delay period between an externally generated trigger pulse and the resulting light flash from the stroboscope. In conjunction with the Type 1536-A Photoelectric Pickoff or other device that will produce an electrical synchronizing signal (refer to paragraph 2.5), the flash delay makes it possible to synchronize the flash with any point in the cycle of operation of the object under observation. This combination of photoelectric pickoff, flash delay, and Strobotac electronic stroboscope provides design, development, or service personnel with an extremely valuable tool with which to view almost any type of moving device.

The flash delay also provides a convenient method of obtaining single-flash photographs of any particular point in the cycle of operation of a moving object (refer to paragraph 2.7).

1.2 DESCRIPTION.

1.2.1 GENERAL. The Flash Delay will function from a series of pulses with any repetition rate that will trigger the stroboscope. The operator can observe any desired point in the cycle of the moving object by adjusting the time-delay setting of the Type 1531-P2. With a minimum setting, the stroboscope will flash at essentially the same time as the synchronizing signal from the photoelectric pickoff. The object under observation will therefore be viewed when its reflecting surface is opposite the pickoff head. As the time-delay setting is increased, the flash from the stroboscope will occur some time after the pickoff signal produced by the reflecting

surface. For example, if the amount of delay set into the Type 1531-P2 is equal to the time it takes a rotating object under observation to complete half a revolution, the object will be viewed when the reflecting spot is 180° from the head of the photoelectric pickoff. If the time-delay setting is equal to the time for one complete revolution, the object will be observed when the reflecting surface is again opposite the pickoff head. Thus it is possible to view the object at any desired point in its cycle of operation. Small variations in the speed of the rotating object will not produce any significant change in the point of synchronization. Also, large variations in speed will not affect the synchronization appreciably if the flash delay is set for a small delay time.

Without the use of the flash delay, exact synchronization between the rotating object and the flash from the stroboscope is extremely difficult and often impossible to obtain by adjustment of the internal oscillator in the stroboscope. Small variations in the oscillator frequency or in the speed of the rotating device result in a slow rotation of the viewing point. To stop this rotation, it is necessary to offset the frequency of the stroboscope flashes slightly from the speed of the rotating object, and, when the desired point in the cycle is reached, the stroboscope frequency must be adjusted quickly to match the speed of the object under observation. Small variations in the rotational speed require a continual adjustment of the frequency of the stroboscope. This adjustment is eliminated by the use of the flash delay.

1.2.2 CONTROLS AND CONNECTORS. The controls and connectors on the Type 1531-P2 Flash Delay are listed in Table 1-1 (see Figure 1-1).

1.2.3 POSITIONING FOR USE. The Type 1531-P2 Flash Delay clips easily to the right side of the Type 1531 or Type 1538 stroboscope cabinet to form one composite instrument, for more convenient operation. A mounting bracket is supplied with the Type 1539 Stroboslave for this purpose. Refer to paragraph 2.1.

Table 1-1
CONTROLS AND CONNECTORS

Figure 1-1 Ref No.	Name	Type	Function
1	RANGE	Five-position rotary selector switch	Turns instrument on and OFF; selects one of three delay ranges, or in the EXT position enables the stroboscope to be triggered by the closing of an external mechanical switch.
2	DELAY	Continuous rotary control	Provides continuous adjustment of the time delay, over the range selected by the RANGE switch.
3	TO STROBOTAC INPUT	Short length of cable, terminated in two-terminal plug	Output of Flash Delay; normally connects to INPUT jack on stroboscope Types 1531 or 1538, and Type 1539 Stroboslave.
4	INPUT	Three-terminal jack	To connect Type 1536-A Photoelectric Pickoff to the flash delay.
5	MULT—SINGLE FLASH	Two-position toggle switch	In MULT position, gives delayed output pulse after every input pulse. In SINGLE FLASH position, gives a single delayed output pulse after each contact closure at the external control jack.
6	—	Two-terminal jack	To connect external control switch to flash delay.
7	—	Permanently attached three-wire power cord and plug	To connect flash delay to power line (either 115- or 230-volt, 50- to 60-cycle or 400-cycle line).

1.2.4 ACCESSORIES SUPPLIED. Table 1-2 lists the accessories supplied with the Type 1531-P2 Flash Delay.

Table 1-2
ACCESSORIES SUPPLIED WITH FLASH DELAY

Catalog Number	Description	Quantity
1531-0421	Trigger Cable (with push-button switch)	1
1531-0461	Plug (phone-plug adaptor)	1
1556-0400	Carrying case	1
5330-0300	Fuse, 0.062 A, 115 V*	1
5330-0200	Fuse, 0.031 A, 230 V*	1

*One fuse supplied; 115 V unless otherwise specified.

Section 2

OPERATING PROCEDURE

2.1 ATTACHMENT TO STROBOTAC OR STROBSLAVE.

Attach the Type 1531-P2 Flash Delay to the right side of the Type 1531 or Type 1538 stroboscope. To do this, simply locate the slot in the mounting bracket (on the left side of the flash delay) over the handle pivot on the stroboscope and push straight down until the flash delay snaps into place. Insert the plug on the short cable (engraved TO STROBOTAC INPUT) in the INPUT jack on the panel of the stroboscope. The short length of cable prevents the operator from inadvertently inserting the plug in the OUTPUT jack on the stroboscope, which might damage the flash delay.

To remove the flash delay, first pull out the stroboscope-input plug. Press the bottom of the case of the flash delay to the left, toward the stroboscope. This releases the mounting bracket from under the trim strip on the stroboscope. Then pull the flash delay straight up, to disengage it.

To attach the Flash Delay to a Type 1539 Stroboslave, refer to the mounting procedure (paragraph 2.1) in the Instruction Manual furnished with the Type 1539.

2.2 POWER REQUIREMENTS.

The Type 1531-P2 Flash Delay can be operated from either a 115- or 230-volt, 50- to 60-cycle line. The voltage for which the instrument is wired is noted on the plate on the front of the case, below the power cord. Converting the unit from 115- to 230-volt operation, or vice versa, requires only a minor wiring modification (refer to schematic diagram, Figure 4-2, and paragraph 4.3).

2.3 TURNING ON THE INSTRUMENT.

Check that the line voltage corresponds to that designated by the plate on the front of the case; then plug in the three-wire power cord. To turn on the instrument, set the RANGE switch to one of the three numbered positions or to EXT. There is no pilot light to indicate when power is applied, but with the Type 1536 Photoelectric Pickoff connected to the INPUT jack, the lamp in the pickoff will light and serve as a pilot light when the flash delay is turned on.

2.4 SETTING THE DELAY.

Each of the three numbered RANGE switch positions covers approximately a 100-to-1 time range, as follows:

Range 1. 100 μsec to 10 msec
Range 2. 1 msec to 100 msec
Range 3. 10 msec to 1 sec

The DELAY control provides a continuous adjustment of the delay between the output pulse from the flash delay and the synchronizing signal, over the range selected by the RANGE switch.

The particular delay range required for a given application will depend upon the basic speed of the device that is to be observed. The slower the speed, the longer the delay required to permit observation of any point in the complete cycle of operation of the device. In general, it is best to start on range 1 and turn the DELAY knob through its entire span. This determines the portion of the cycle that can be viewed on range 1. If this portion is insufficient, change to range 2 and again rotate the DELAY knob through its entire span. It is now possible to view a larger portion of the cycle, but if this is still insufficient, range 3 can be used. In general, use range 1 when the speed of rotation is 6000 rpm or higher, range 2 when the speed is between 600 and 6000 rpm, and range 3 when it is less than 600 rpm or when a time delay as long as one second is required for a special application.

If considerable variation in the speed of the rotating object is encountered, the reflective spot for use with the photoelectric pickoff should be placed so that the trigger pulse occurs before the desired viewing point is reached. With this arrangement, large variations in speed will not shift the observed point significantly. The amount of jitter produced by a given variation in speed can easily be determined. With the viewing point at or near the 360-degree phase point, the phase jitter produced by a variation of 10% in speed will produce an angular variation of 10% of 360°, or 36°. But at the 180-degree viewing point, the same variation of 10% will produce a jitter of only 18°. Therefore, if the reflective tape is located close to the viewing point (short time delay) the effect of speed variations will be minimized.

The delay time between the input trigger pulse and the output pulse contains a small amount of jitter from pulse to pulse that is inherent in the circuit. The jitter is approximately 0.25% of the delay

at the maximum setting of each range and essentially drops to zero at the minimum settings. A 10% power line variation produces approximately a 3% change in the delay time.

2.5 OPERATION WITH THE TYPE 1536 PHOTOELECTRIC PICKOFF.

The flash delay was designed to be used with the Type 1536 Photoelectric Pickoff as its trigger source. The pickoff provides a simple, convenient method of obtaining pulses in synchronization with the rotating object to be observed. (Refer to the Instruction Manual for the Type 1536.) Power for operation of the lamp and the photocell is supplied by the flash delay. It is necessary only to insert the plug of the pickoff into the INPUT jack on the panel of the delay unit. Attach the piece of metalized reflective tape (supplied) to the object. If the moving surface is shiny, the black tape (also supplied) should be used to mask all but a small section of the reflecting surface. Place the pickoff one-half to one inch from the rotating object.

To operate the pickoff-delay-stroboscope combination, first clip the flash delay to the side of the stroboscope and insert the output plug into the INPUT jack of the stroboscope. Connect the power cords of both the stroboscope and the flash delay to a power line receptacle of the proper rating, and turn on both instruments. Allow 10 or 15 seconds for the stroboscope to warm up, and set its range switch to the proper EXT position (refer to the Instruction Manual for the stroboscope). Now set the RPM dial fully clockwise and gradually turn it counterclockwise until the stroboscope flashes. Then turn it back (clockwise) approximately 10 to 20 degrees. The stroboscope will now operate from the output pulses of the flash delay. Mount the photoelectric pickoff conveniently on or near the object to be observed and adjust its position so that the stroboscope flashes.

Set the RANGE switch and the DELAY control on the flash delay to produce a view of the moving object at the desired point in its cycle.

2.6 OPERATION WITH OTHER INPUTS.

Other inputs of at least 0.3 volt, such as that from a magnetic pickoff, can be used to trigger the flash delay. The 3-wire-to-2-wire adaptor (supplied) must be used with any 2-wire input to avoid short-circuiting the power supply of the flash delay. The input signal must be positive going (refer to paragraphs 3.2 and 3.3).

2.7 SINGLE-FLASH PHOTOGRAPHY.

A permanent record can be obtained at any point in the cycle of the moving object by single-flash photography. With the MULT—SINGLE FLASH switch on the delay unit at MULT, adjust the delay so that the object image is stopped at the desired point in its cycle. Connect the X contacts of the camera to the external control jack (6, in Figure 1-1). Adjust the camera position and focusing, and set the lens opening according to the guide number indicated in the Type 1531, 1538 and 1539 Operating Instructions. Set the speed of the shutter so that the latter is open for at least one complete cycle of operation of the object. For example, if a shaft to be photographed is running at a speed of 100 revolutions per second, then a shutter speed of 1/100 second or longer can be used. For a rotation of 50 revolutions per second, a shutter speed of 1/50 second or longer must be used.

When the camera is properly set, change the toggle switch on the flash delay to SINGLE FLASH. The stroboscope light will stop flashing. Then it is necessary only to cock the shutter and trip it, and the picture is taken.

Section 3

PRINCIPLES OF OPERATION

3.1 GENERAL.

The Type 1531-P2 Flash Delay consists of an input preamplifier, a pulse-shaping Schmitt trigger circuit, an adjustable time-delay circuit, and an output stage, as shown in the block diagram, Figure 3-1. An auxiliary flip-flop circuit, on single-flash operation, is inserted between the time-delay circuits and the output stage. These individual sections are described in the following paragraphs.

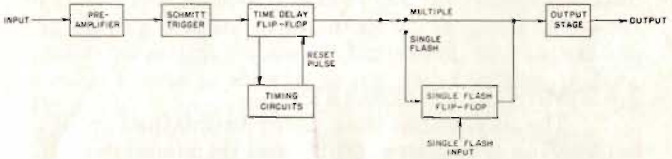


Figure 3-1. Block diagram of Type 1531-P2 Flash Delay.

3.2 PREAMPLIFIER.

The preamplifier is a two-stage transistor feedback amplifier, with a gain of approximately 20. The ac feedback from the emitter of transistor Q101 (see Figure 4-2) to the junction of the bias voltage divider (R102 and R104) increases the input impedance of the amplifier to approximately one megohm. The input to the preamplifier is capacitance coupled to the INPUT jack on the panel. The gain of the preamplifier is such that an input signal of 0.3 volt will provide an adequate signal for the Schmitt circuit. The preamplifier output feeds directly into the input of the Schmitt trigger circuit.

3.3 SCHMITT TRIGGER CIRCUIT.

This circuit generates a standard output pulse from the preamplifier output, to drive the time-delay circuits. If the input to the preamplifier is much less than 0.3 volt, the signal at the Schmitt

circuit input will not be sufficient to overcome the hysteresis and no output pulse will be generated. The output of the Schmitt trigger circuit is capacitance coupled to the time-delay circuits. Diode CR-102 is used to eliminate the negative pulse of the differentiated output.

NOTE

A positive pulse is required at the input to the Schmitt circuit to produce an output pulse. Therefore, the flash delay will operate with positive-going input pulses, but not with negative-going pulses.

3.4 TIME-DELAY CIRCUITS.

The adjustable time delay is obtained from a unijunction transistor, Q107, and its associated RC network, consisting of capacitors C504, C505, C506, and resistor R201. The voltage across the RC combination is controlled by a flip-flop circuit consisting of transistors Q105 and Q106. When a positive pulse from the Schmitt trigger circuit is received at the input to Q105, the latter is turned off and Q106 is turned on. The collector voltage of Q106 therefore rises to approximately the value of B+. Since this voltage is applied across the RC combination, the voltage across the capacitor increases gradually, at a rate determined by the RC time constant. The capacitor is connected to the emitter of transistor Q107, and when its voltage reaches a value equal to approximately one-half the B+ value, the accompanying breakdown between the emitter and base 1 provides a low-impedance path for the discharge of the capacitor through R125. The resulting pulse produced by the discharge current is fed to the base of Q106 and turns off this transistor, thus returning the flip-flop circuit to its original state. The voltage across the RC combination (the collector voltage of Q106) remains approximately zero until another trigger pulse is applied to the

flip-flop circuit. The negative transition at the collector of Q106, which occurs at the end of the delay period, is coupled to the output stage.

If the delay set into the time-delay circuit is longer than the time between the input synchronization pulses, additional pulses to the time-delay flip-flop circuit will not affect the timing cycle. For example, if the time delay is set to a value greater than one period of the input synchronization pulses but less than the time for two periods, the flash delay will reject every other synchronization pulse and the stroboscope will flash at one-half the rate of rotation of the object under observation.

Diode CR103, in series with the RC network, prevents any further discharge of the capacitor after the timing cycle, regardless of the time between synchronization pulses. Therefore, the capacitor always starts to charge at the same voltage value. This makes possible a smooth adjustment of the phasing of the rotating object through the 360-degree point.

3.5 OUTPUT CIRCUIT.

The output circuit consists of a single transistor, Q110, which is normally in the conducting state. The negative pulse from transistor Q106, at the end of the time-delay cycle, momentarily turns off transistor Q110, thereby raising its collector voltage. This produces a positive output pulse of approximately 15 volts amplitude, which is coupled to the input of the stroboscope.

3.6 SINGLE-FLASH FLIP-FLOP CIRCUIT.

In the single-flash mode, a flip-flop circuit is inserted between the output of the time-delay circuits and the output stage. This flip-flop circuit acts as a gate that is normally nonconducting and prevents the synchronizing pulses from appearing at the output of the flash delay. The first pulse that occurs after the switch is set at the SINGLE FLASH position turns off Q108 and turns on Q109. Subse-

quent pulses will not change the state of the flip-flop circuit. When a switch connected to external control jack J202 is closed, resistor R127 is shorted, which produces a negative pulse through C114 to the input of Q109. This pulse turns off Q109 and turns on Q108, which makes the gate conducting. The next synchronizing pulse at Q108 returns the flip-flop circuit to its previous state and produces a negative transition at the collector of Q109. This negative pulse is applied to the output stage and produces a positive output pulse. Once again, subsequent synchronizing pulses will not change the state of the flip-flop circuit. Therefore, the first synchronizing pulse that arrives after a contact closure at J202 passes to the output stage, while all preceding and following synchronizing pulses are blocked.

Diode CR106 is used to prevent clipping of the synchronizing pulse due to contact bounce. The first negative pulse after contact closure turns off Q109 and turns on Q108. The collector voltage of Q109 then rises to approximately the value of B+. Thus CR106 is back-biased through R136, which prevents subsequent pulses due to contact bounce from clipping the waveforms when the desired synchronizing pulse arrives.

In the EXT position of the RANGE switch, the negative pulse produced by a switch closure at J202 is fed directly to the output stage and produces a positive output pulse to trigger the stroboscope. Therefore this pulse is produced by a switch closure, rather than by a switch opening.

3.7 POWER SUPPLY.

The power supply consists of a power transformer, T501, a bridge rectifier circuit, and the associated RC filtering. The output of the RC filter (approximately 25 volts) is fed to the input jack and supplies power for the lamp and the photocell circuit of the Type 1536 Photoelectric Pickoff. Transistor Q501 supplies additional filtering for the B+ voltage in the flash delay. Be sure that B+ is not accidently shorted when the instrument is serviced, as this will burn out transistor Q501.

Section 4

SERVICE AND MAINTENANCE

4.1 WARRANTY.

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, Sales Engineering Office, or authorized repair agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

4.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest Sales Engineering Office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

4.3 DISASSEMBLING THE INSTRUMENT.

To take the instrument out of the case, simply remove the three screws in the bottom of the case and lift out the instrument.

To further disassemble the flash delay, remove the three hex spacers on the lower etched board (see Figure 4-1) and swing the board out from the instrument. The panel can be separated from the other etched board (containing the power supply and the timing capacitors) if three panel screws are removed, Figure 1-1, #8. The instrument will operate with the panel and two etched boards separated in this manner.

4.4 CONNECTION TO POWER SUPPLY.

The flash delay is normally supplied for 115-volt operation, but the power transformer can be reconnected for 230-volt service (see schematic diagram, Figure 4-2). Appropriate measures should be taken so that the legend indicates the new input voltage. On instruments changed from 230 to 115

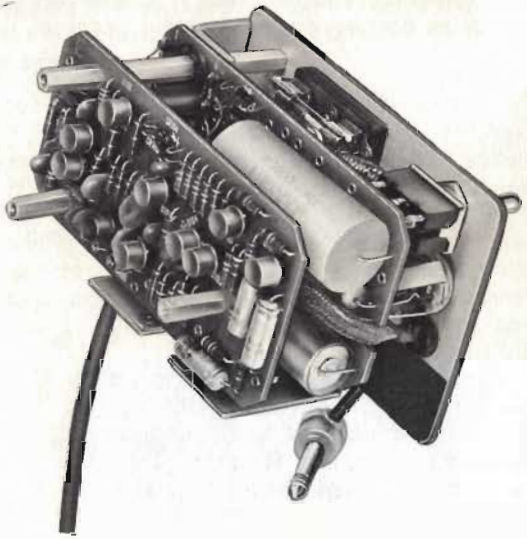


Figure 4-1. Interior view of the Type 1531-P2 Flash Delay.

volts, this simply means removal of the 230-v name plate; a 115-v legend is marked beneath. For instruments changed to 230 volts, a nameplate (Part Number 5590-1664) may be ordered from General Radio.

When changing connections, be sure to replace the fuse with one of current rating for the new input voltage (refer to the Parts List). To replace the fuse, first remove the instrument from the case (paragraph 4.3). The fuse holder is located on the side of the panel opposite the mounting bracket.

4.5 DC VOLTAGE MEASUREMENTS.

The following table lists the correct dc voltages at the transistor terminals, as measured with a vacuum-tube voltmeter or an oscilloscope. Set the RANGE switch to one of the three numbered ranges (not to EXT) and make the measurements with no signal applied to the INPUT terminals.

CAUTION

When making measurements, be careful not to short B+, as this will undoubtedly burn out transistor Q 501. Attach the leads from the voltmeter or oscilloscope with the instrument turned off.

DC VOLTAGE MEASUREMENTS

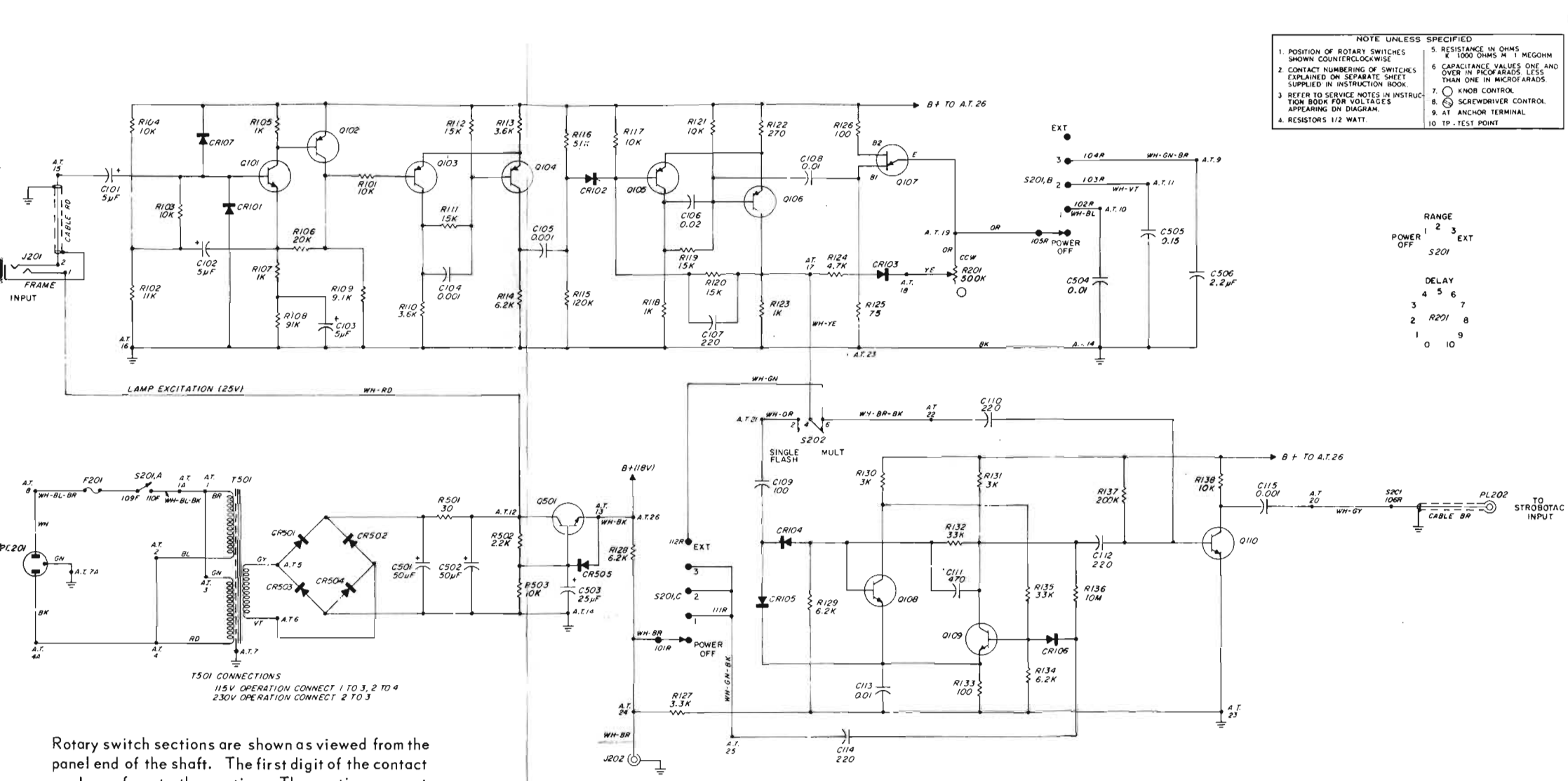
Transistor	Collector (Volts)	Emmitter (Volts)	Base (Volts)
Q101	+18	+ 9	
Q102	+ 7.5	+18	
Q103	+ 8	+ 9	
Q104	0	+ 9	
Q105	+13.5	+14	
Q106	+ 0.8	+14	
Q107	+ 0.1	+ 3	+ 18
Q108	+17*	+ 0.6	
Q109	+ 0.6*	+ 0.6	
Q110	0	0	
Q501	+23	+18	

* Voltages on collectors of Q108 and Q109 will be interchanged when flip-flop circuit is in other state.

PARTS LIST

Ref No.	Description	Part No.
Capacitors		
C101	Electrolytic, 5 µF 50 V	4450-3900
C102	Electrolytic, 5 µF 50 V	4450-3900
C103	Electrolytic, 5 µF 50 V	4450-3900
C104	Ceramic, 0.001 µF ±20% 500 V	4404-2109
C105	Ceramic, 0.001 µF ±20% 500 V	4404-2109
C106	Ceramic, 0.02 µF 50 V	4402-3200
C107	Ceramic, 220 pF ±20% 500 V	4404-1229
C108	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100
C109	Ceramic, 100 pF ±20% 500 V	4404-1109
C110	Ceramic, 220 pF ±20% 500 V	4404-1229
C111	Ceramic, 470 pF ±20% 500 V	4404-1479
C112	Ceramic, 220 pF ±20% 500 V	4404-1229
C113	Ceramic, 0.01 µF +80 -20% 50 V	4401-3100
C114	Ceramic, 220 pF ±20% 500 V	4404-1229
C115	Ceramic, 0.001 µF ±20% 500 V	4404-2109
C501	Electrolytic, 50 µF 50 V	4450-2200
C502	Electrolytic, 50 µF 50 V	4450-2200
C503	Electrolytic, 25 µF 50 V	4450-3000
C504	Plastic, 0.01 µF ±10% 100 V	4860-7750
C505	Plastic, 0.15 µF ±10% 100 V	4860-7895
C506	Plastic, 2.2 µF ±10% 100 V	4860-8300
Diodes		
CR101 through CR107	Diode, Type 1N645	6082-1016
CR501 through CR505	Diode, Type 1N645	6082-1016
Fuses		
F201	Fuse for 115 V: FUF-1, 0.062 Amp	5330-0300
F201	Fuse for 230 V: FUF-1, 0.031 Amp	5330-0200
Jacks		
J201	Jack	4260-1200
J202	Jack	4260-1280
Plugs		
PL201	Cable, Power	4200-1800
PL202	Cable Assembly	8160-1000
Resistors		
R101	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R102	Composition, 11 kΩ ±5% 1/2 W	6100-3115
R103	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R104	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R105	Composition, 1 kΩ ±5% 1/2 W	6100-2105
R106	Composition, 20 kΩ ±5% 1/2 W	6100-3205
R107	Composition, 1 kΩ ±5% 1/2 W	6100-2105

Resistors (cont)		
R108	Composition, 91 kΩ ±5% 1/2 W	6100-3915
R109	Composition, 9.1 kΩ ±5% 1/2 W	6100-2915
R110	Composition, 3.6 kΩ ±5% 1/2 W	6100-2365
R111	Composition, 15 kΩ ±5% 1/2 W	6100-3155
R112	Composition, 15 kΩ ±5% 1/2 W	6100-3155
R113	Composition, 3.6 kΩ ±5% 1/2 W	6100-2365
R114	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625
R115	Composition, 120 kΩ ±5% 1/2 W	6100-4125
R116	Composition, 51 kΩ ±5% 1/2 W	6100-3515
R117	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R118	Composition, 1 kΩ ±5% 1/2 W	6100-2105
R119	Composition, 15 kΩ ±5% 1/2 W	6100-3155
R120	Composition, 15 kΩ ±5% 1/2 W	6100-3155
R121	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R122	Composition, 270 Ω ±5% 1/2 W	6100-1275
R123	Composition, 1 kΩ ±5% 1/2 W	6100-2105
R124	Composition, 4.7 kΩ ±5% 1/2 W	6100-2475
R125	Composition, 75 Ω ±5% 1/2 W	6100-0755
R126	Composition, 100 Ω ±5% 1/2 W	6100-1105
R127	Composition, 3.3 kΩ ±5% 1/2 W	6100-2335
R128	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625
R129	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625
R130	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R131	Composition, 3 kΩ ±5% 1/2 W	6100-2305
R132	Composition, 33 kΩ ±5% 1/2 W	6100-3335
R133	Composition, 100 Ω ±5% 1/2 W	6100-1105
R134	Composition, 6.2 kΩ ±5% 1/2 W	6100-2625
R135	Composition, 33 kΩ ±5% 1/2 W	6100-3335
R136	Composition, 10 MΩ ±5% 1/2 W	6100-6105
R137	Composition, 200 kΩ ±5% 1/2 W	6100-4205
R138	Composition, 10 kΩ ±5% 1/2 W	6100-3105
R201	Potentiometer, 500 kΩ ±10%	6010-2200
R501	Composition, 30 Ω ±5% 1/2 W	6100-0305
R502	Composition 2.2 kΩ ±5% 1/2 W	6100-2225
R503	Composition, 10 kΩ ±5% 1/2 W	6100-3105
Switches		
S201	Switch, Rotary	7890-3160
S202	Switch, Toggle	7910-0800
Transistors		
Q101	Transistor, Type 2N1304	8210-1304
Q102	Transistor, Type 2N1305	8210-1305
Q103 through Q106	Transistor, Type 2N1372	8210-1372
Q107	Transistor, Type 2N671B	8210-1026
Q108 through Q110	Transistor, Type 2N1304	8210-1304
Q501	Transistor, Type 2N697	8210-1040
Transformers		
T501	Transformer	0746-4380



Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

Figure 4-2 Schematic Diagram of Type 1531-P2 Flash Delay.

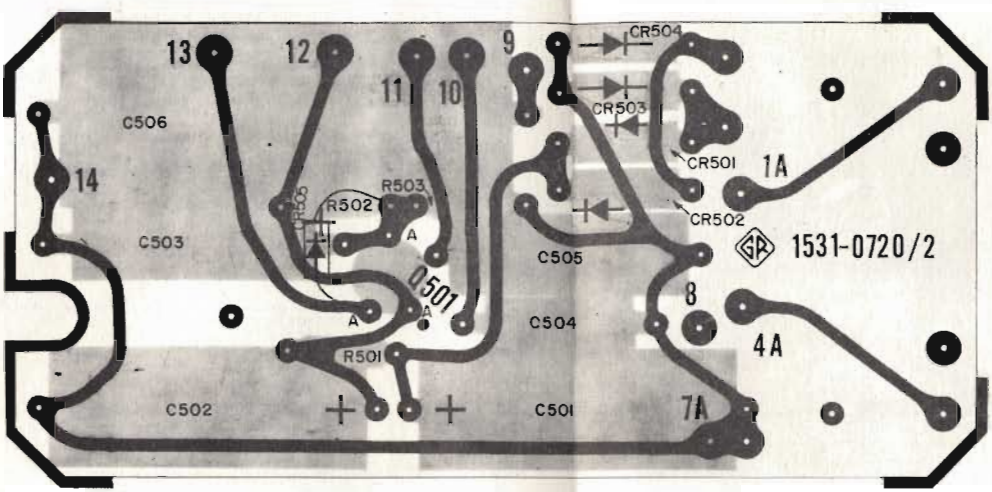


Figure 4-3. Power supply etched board (nearest to panel).

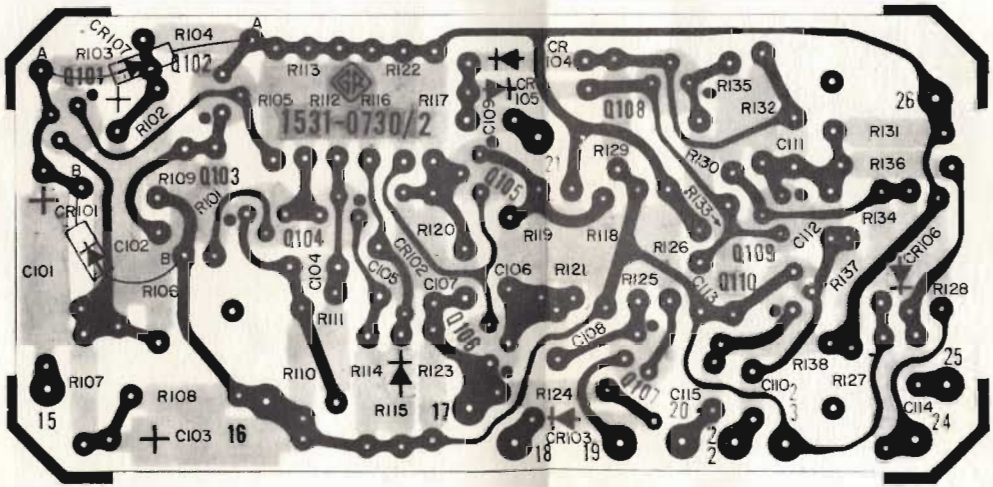


Figure 4-4. Amplifier and delay-circuit etched board (furthest from panel).