Chapter XII

SOME INTERESTING INDICATOR APPLICATIONS

When the neon glow lamp was first developed commercially over 40 years ago, it found immediate application as a pilot light in appliances and as a location indicator. While light output is relatively low compared to the incandescent lamps it replaced, it was sufficient for the purposes to which it was put, and it offered many other advantages.

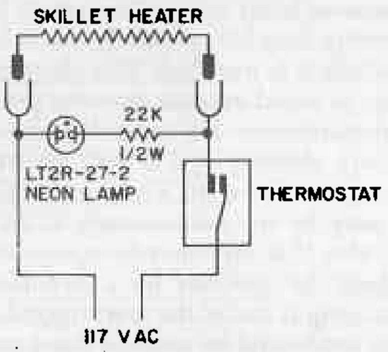
Since the neon lamp has no filament to burn out, the lamp has an extremely long life, generally much longer than the appliance in which it is installed. This characteristic permits the neon lamp to be wired into the circuitry permanently.

Power requirements for neon lamps are extremely low. Standard lamps running on 115 volts ac with the 100K resistor dissipate only 1/10 watt. They draw only .6 milliamperes. Thus, they may be run continuously at an insignificant cost. This means, also, that they may be operated directly from line voltage without the necessity for a step-down transformer.

The neon lamp is one of the most rugged components made. It is virtually unaffected by average shock and vibration. Thermal shock, such a major factor in the life of an incandescent lamp, does not exist with the neon lamp. Consequently, repeated on-off cycling has virtually no effect on its lifetime. The neon lamp runs at a relatively low temperature, averaging perhaps 120°F in ambient temperatures of 70°F, so that under normal conditions it feels only warm to the touch and is not detrimental to temperature sensitive devices in close proximity to it.

Light output is generally confined to the bright orange range, a color that historically has been associated with warning devices and, thus, commands attention. The light level of a standard brightness lamp is sufficient in applications which are related to darkness, such as night lights and electric blankets. Where a higher degree of light is desired, the high brightness neon lamps provide an indication which can readily be seen under normal ambient lighting conditions. These lamps are generally 10 times as bright as the standard neon lamp, and today are used in most appliances.

The basic use of the neon indicator lamp is to indicate that power is on or available for the device with which it is associated. Generally, this is a 115 volt or 230 volt pilot light, used on either alternating or direct current. Most common pilot light household uses include freezers, electric ovens, radio-photographs, electric blankets, escutcheon lighting for dials, circuit testers, blenders and mixers and many others.

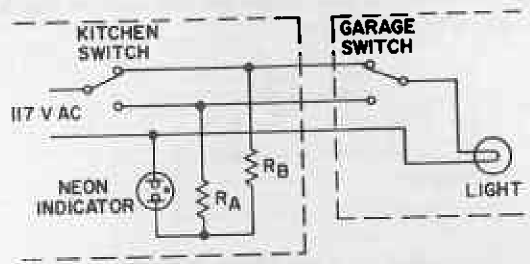


12-1 Indicator for electric heating appliances

Because of their low current characteristics, neon lamps are frequently wired across the thermostat in electric heating devices. In this type of circuit the neon lamp is off until the preset temperature is reached at which point it lights. They are thus used to indicate the temperature condition without causing the heating element to draw current. The neon lamp may also be wired across the heating element as shown in Figure 12-1 to indicate that the heating element is on. They are found on electric frying pans, deep fat friers, coffee pots, electric range ovens, waffle irons, and many common household appliances.

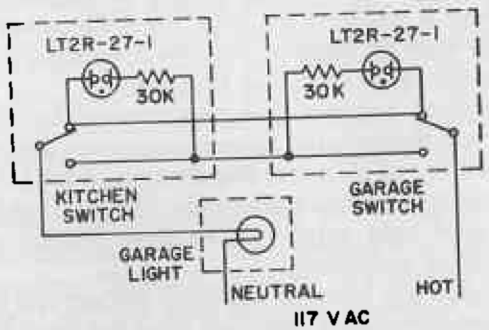
Neon lamps are also used to indicate the condition of an electrical circuit, either directly or remotely. For example, a

three-way switch which operates a remote circuit may be wired as shown in Figure 12-2. This approach indicates when the remote circuit is energized. The two resistors, R_A and R_B, are equal to each other and equal to the normal series resistance for the neon lamp. With both switches on the same line, both the neon lamp and the remote circuit are on. With the switches on opposing lines, the two resistors form a voltage divider and thereby reduce the voltage across the lamp to less than its ignition potential. Consequently, the lamp and the remote circuit are both off.



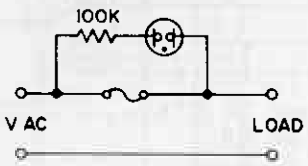
12-2 Local on-off status indicator for remote circuit controlled by 3-way switches

It might be noted that should the lamp on the remote circuit burn out or be removed the neon lamp will not extinguish. This can be used as positive indication that the lamp in the re-



12-3 On-off status indicator for remote circuit controlled by 3-way switches mote circuit is inoperative. A method for indicating the opposite condition, that is, indicating when the remote circuit is de-energized, is shown in Figure 12-3. This circuit provides an indicator lamp at each switch position. However, only one resistor is required for each neon lamp instead of the two in Figure 12-2.

In fuse boxes and circuit breaker panels the neon lamp can be used to indicate a failed fuse or a "popped" circuit breaker. (Figure 12-4) In this arrangement the lamp comes on when the circuit is broken. The current that flows through the lamp is sufficiently low that it can cause no damage on the load side of the fuse or circuit breaker.

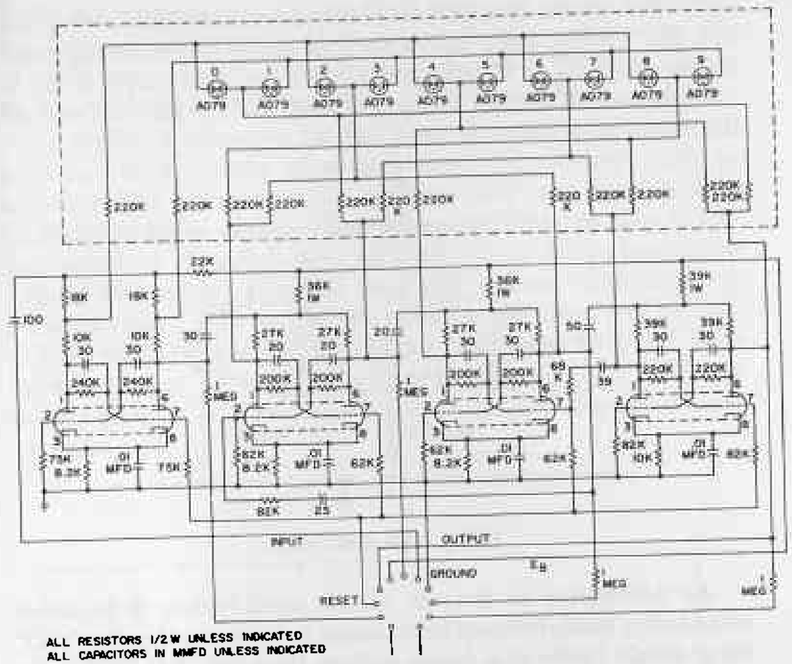


12-4 Fuse failure indicator

In numerical displays neon lamps are used frequently to illuminate the digits screened on the front panel of the unit as shown in Figure 12-5. The sharp differentiation of the neon lamp between when it is on and when it is off is a major advantage here. An incandescent lamp in the same application would have a tendency to "slur" over the numerical display simply because its filament requires a noticeable time to illuminate and a noticeable time to go out.

High speed reaction time requirements for the lamps are evident from the fact that these counters are designed for high speed counting of electrical impulses up to 1.2 Mc and separations of as little as 0.8 microseconds. The high brightness lamps provide good light output for accurate reading under all external lighting conditions.

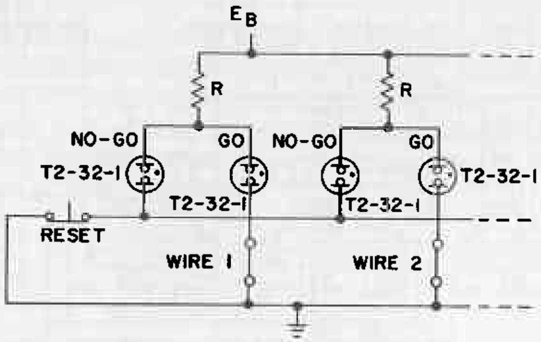
The difference between the firing voltage and the maintaining voltage of the neon lamp can form the basis for a compact and inexpensive harness tester which will continuously monitor



12-5 Numerical display for binary counters

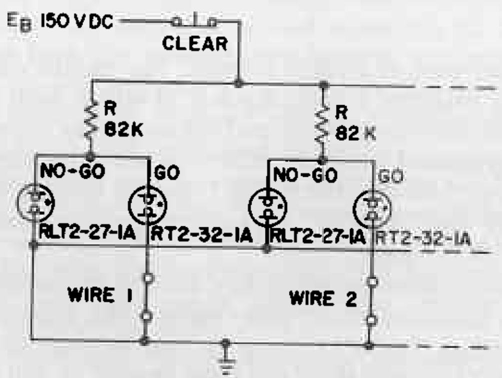
each individual wire in a cable harness. The circuit shown in Figure 12-6 is basically a neon flip-flop in which each wire is associated with two neon lamps and resistors. One terminal of each wire is grounded while the other completes the circuit for the "GO" lamp. Initially, the RESET button is used to open the circuit for the "NO-GO" lamps, extinguishing them and lighting the "GO" lamps.

A momentary open circuit in any wire in the harness will extinguish its associated "GO" lamp causing the voltage across the corresponding "NO-GO" lamp to rise beyond its breakdown voltage. Once this lamp has been ignited, it will stay on until the RESET button is pushed, enabling the operator to determine which, if any, wires have open-circuited during the test. The T2-32-1 lamp can be used in any of the following combinations: if E_B is 90 vdc and all R's are 33K-1/2W, if E_B is 135 vdc and all R's are 82K-1/2W, and if E_B is 250 vdc and all R's are 220K-1/2W.



12-6 Harness tester

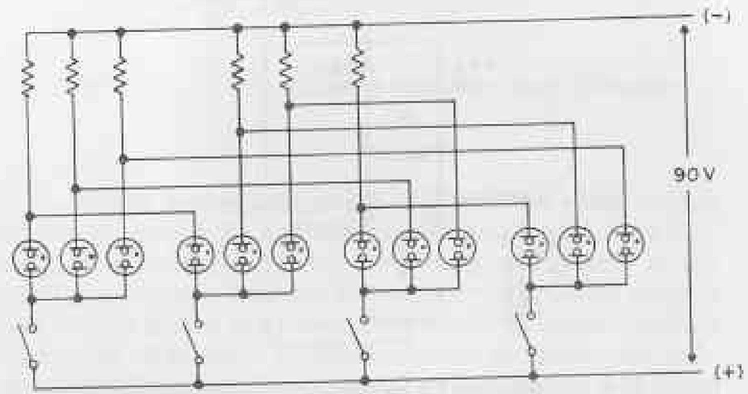
An alternative to the use of the reset button is to select neon lamps with different breakdown voltages so that the "GO" lamp would ignite at a lower voltage than the "NO-GO" lamp as shown in Figure 12-7. When the circuit is energized, all



12-7 "Go-No Go" cable tester

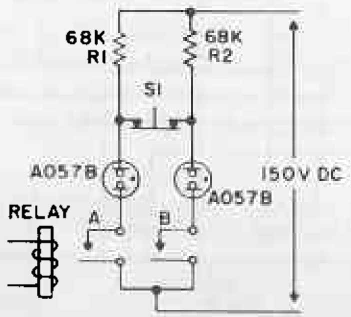
"GO" lamps ignite and stay on if all wires are good. If there is an open or momentarily open circuit in the series wire, the voltage rises to 150 vdc which causes the "NO-GO" lamp to fire, staying on and blocking the "GO" lamp from reigniting.

A similar application for the neon lamp is to indicate the sequence of operation of various electrical devices, such as switches. The circuit shown in Figure 12-8 was developed to indicate the order in which four micro-switches are closed. The first switch to close will light all three of the lamps associated with it. The second switch to close will find one of its lamps in a circuit shared with an already lit lamp, and thus, will be able to light only two of the three lamps associated with it. The third switch to close will likewise be able to light only one lamp, and there will be no lamps to be lit by the fourth switch when it closes.



12-8 Sequence of operation indicator

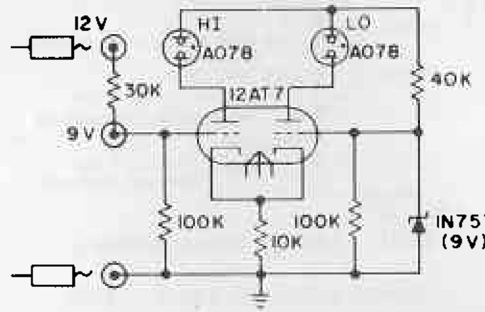
Another sequence tester is shown in Figure 12-9 where it was necessary to know which contact closed first. It was vital in this application that contacts A make slightly ahead of contacts B. The test is performed in the following manner. When switch S_1 is closed and the relay energized, both neon indicator lights should come on indicating a continuity through both sets of contacts. Then, switch S_1 is opened and the relay is again energized. This time neon lamp A should indicate if the relay is properly adjusted. Only one lamp will come on since the maintaining voltage of either lamp is below the breakdown voltage of the other. If both A and B neon lamps fail to come on, this merely indicates that A and B contacts have closed simultaneously. If neon lamp B only comes on, it means that contact B is closing ahead of contact A. It is also possible to use this circuit in vibration testing. Because of the low current requirements of the neon lamps, flickering of the lights under subdued light during the test would give positive visual indication of poor contact in the relay being tested.



12-9 **Indicator for sequence of contact closing**

The range of uses for neon lamps in various industrial operations is limited only by the ingenuity of the engineer. In Figure 12-10 a GO-NO-GO test apparatus for balancing two voltage divider points in production by unskilled workers is shown. Sensitivity is such that a variance of 200 mv in either

direction shows up as a distinct variation in illumination level of the two lamps. Increase in illumination level of the input side indicates a voltage higher than desired, and conversely for the fixed side. Although nine volts is used as the reference level in this circuit, any voltage from zero up to the limits of the dissipation level of the tube can be used. If the apparatus is to be used to test high impedance circuits, grid resistors would have to be increased.

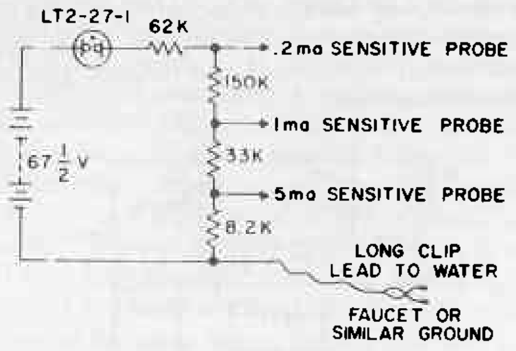


12-10 **Vacuum tube voltmeter with neon lamp indication**

The circuit shown in Figure 12-11 is a device which detects whether any part of an appliance or machine would allow current to flow through a person touching it and ground at the same time. Electric toasters, for example, frequently allow a small current to flow if a person touches the metal case and the kitchen sink. Current is detected because the insulation leakages involved are usually very small approximating a constant current source. Safety ratings which have been established by Consumers' Union can be used:

If the current is less than 0.1 ma rms, it is acceptable.
If the current is less than 1 ma rms, there will be a slight shock.
If the current is less than 5 ma rms, it may be considered a borderline case.

And if the current is greater than 5 ma rms, it is definitely unacceptable. This level could be dangerous and above the "let go" current.

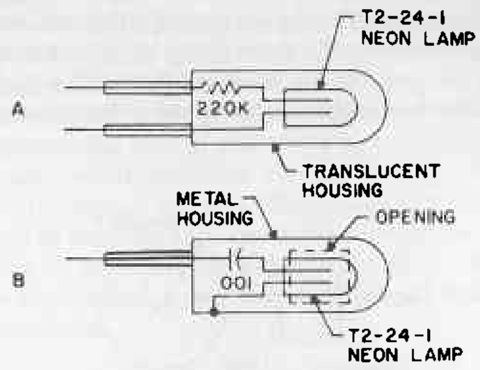


12-11 Leakage current indicator

The unit has a long ground lead and three pointed probes coming from one end. The lamp is installed in a visible location. In use the ground wire is clipped to a convenient ground point and devices such as machine tools, toasters, washers, mixers, electric drills, wiring, conduit, etc. are touched with the various probes to determine the leakage current.

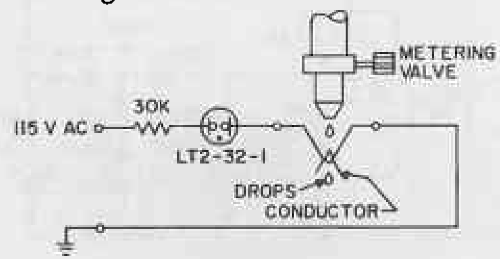
On the subject of probes, Figure 12-12 shows schematics of two neon lamp probes which can be used to test the household circuitry. In Figure 12-12A the lamp is enclosed in a transparent or translucent housing and connected to the insulated leads through a 220K resistor. Both probes are touched to wires in the circuit to be tested. It may be used on either 115 or 230 volts ac, and the intensity of light output will show what the voltage is. Figure 12-12B is a single probe detector which can be used to determine when 115 or 230 volts is available. The lamp in this case is enclosed in a metal housing with a window or opening through which the light output can be seen. One lead is attached to the housing, and the other is connected to the insulated probe through a 0.001μ fd, 400 volt capacitor. The

lamp will light when the probe is touched to the hot side and will not light when touching the ground or neutral side. The metal housing must be in contact with the human body.



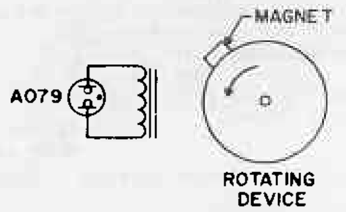
12-12 Power line testing probes

Neon lamps are frequently used to provide remote indication of the condition, status, or progress of a process. In Figure 12-13 the flow of an electrically conductive liquid, such as aqueous ammonia is monitored. As drops of the solution are released, they fall and form a conductive path between the two corrosion resistant wires which are in a series circuit with the neon lamp. A suitable voltage source such as 115 volts ac is used to flash the light.



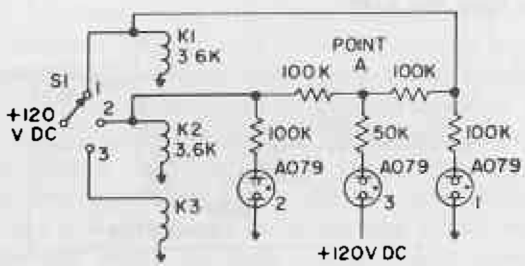
12-13 Flow indicator

In Figure 12-14 the neon lamp is used to provide positive remote indication that a rotating device is running. The lamp is connected across the coil of an inductor with a moderately high turns ratio, such as the coil from a 10,000 ohm relay. Each time the magnetic material goes through the coil it will induce a counter emf causing the neon lamp to glow momentarily. It would also be possible to place a photocell adjacent to the lamp and have the reaction of the photocell activate a rotational counter.



12-15 Status of relay indicator

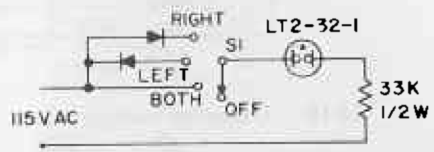
The circuit shown in Figure 12-15 was developed to indicate the status of three relays, K_1, K_2 and K_3, through a visual means. Since the relays were operated on 120 volts dc, it would have been a simple matter except for the fact that only the terminals on K_1 and K_2 were accessible. The other components were completely not reachable without considerable modification.



12-14 Indicator for rotating device

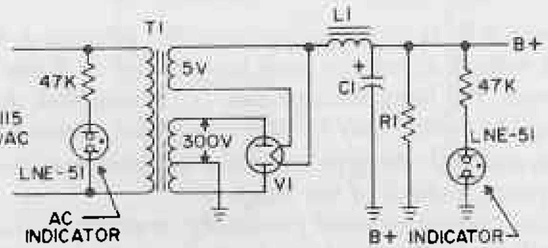
When S_1 selects relay K_1, lamp number 1 lights. Point A goes to 60 volts holding off lamp number 3. When S_1 selects relay K_2, lamp number 2 lights while Point A still holds off lamp number 3. When S_1 selects K_3, however, Point A is no longer at 60 volts dc and lamp number 3 finds a return through K_1 and K_2 (3.6K ohms each). Lamp number 3, it should be noted, is connected to 120 volts.

It is characteristic of neon glow lamps that when operated on direct current the area of glow will be centered around one electrode, and when operated on alternating current, both electrodes will appear to glow. This characteristic is used in Figure 12-16 to indicate four conditions using one glow lamp. By switching S_1 as indicated, either right electrode, left electrode, or both electrodes may be activated, as well as neither in the off condition.



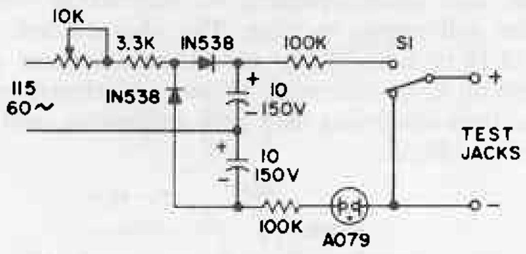
12-16 4-condition indicator

In the representative power supply schematic shown in Figure 12-17, a glowing neon lamp indicates the presence of a charge stored in capacitor C_1 due to failure of the bleeder resistor R_1. In trouble shooting equipment associated with this



12-17 Power supply showing ac and dc condition supply, the neon lamp not glowing would immediately point out the absence of E_B indicating trouble in T_1, V_1, L_1, or associated circuitry.

A method of using a neon glow lamp to help locate a leaky capacitor is shown in Figure 12-18. This is essentially a voltage doubler. The actual voltage is controlled by R_1. Closing switch S_1 applies voltage to the test item. The resultant blinking of the neon lamp is an indication of the leakage of the capacitor.



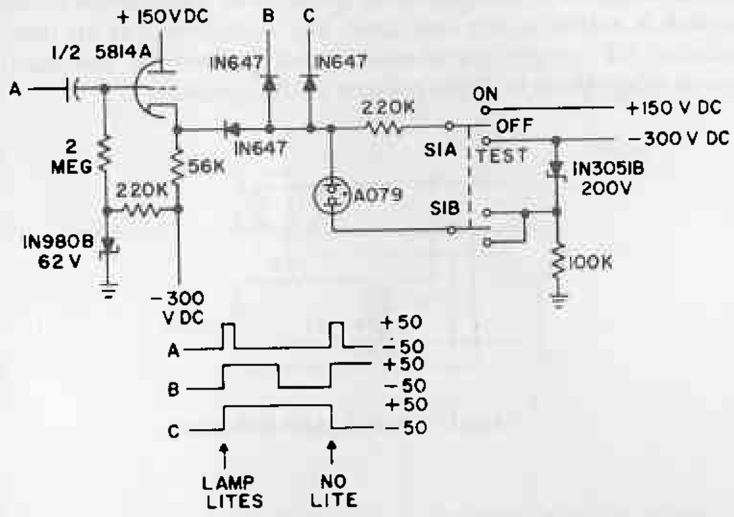
12-18 Capacitor leakage tester

There are many different jobs that can be performed in the indication area. For example, the circuit in Figure 12-19 was designed to give a visual indication whenever three pulses appear simultaneously. The signals at B and C are gates of 100 volt amplitude from –50 to +50. When a pulse appears at A, its dc level is changed so that it appears about –50 to +50 vdc also.

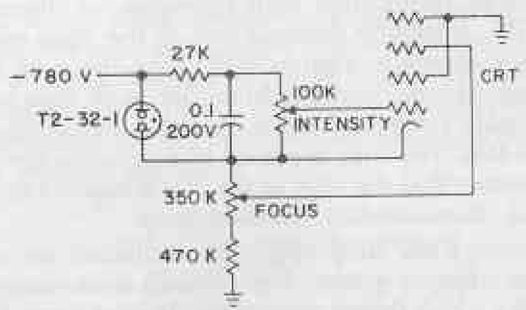
If switch S_1 is in the on position, the pulse at A will cause enough voltage across the neon lamp to fire it. When the pulse disappears, the lamp extinguishes. To insure that the lamp is working, the switch may be pressed against a spring loaded on position and 200 vdc appears across the lamp and the 220K resistor, giving a check of the lamp.

As has been mentioned previously, many times a neon glow lamp will be used to perform more than one function, usually combining its use as a circuit component with the fact that it is a light producing component. In the circuit in Figure 12-20

the glow lamp serves as an equipment pilot light indicating that power is available and as a bias regulator for grid 1 of the cathode ray tube.

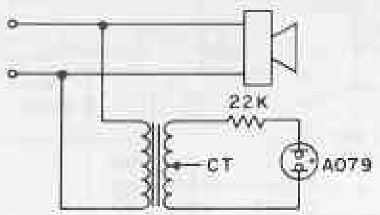


12-19 Indicator for simultaneous pulses



12-20 Pilot light and bias regulator

There are times when a multiplicity of circuits are used and it is desirable, or necessary, to know which one is energized. Such a condition is typical of annunciator applications. Another, shown in Figure 12-21, is similar in that it is used to indicate which of a multiplicity of speakers in a communications system is active at any one time. The transformer is an inexpensive A.F. output transformer wired backwards. The lamp glows when there is audio present at the speaker.

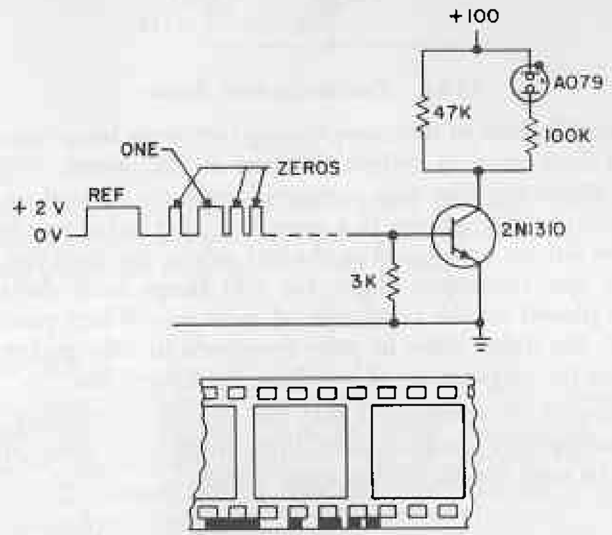


12-21 Annunciator indicator

While the light output from neon lamps, as has been discussed earlier, does not recommend them for many applications where high luminosity is required, there are certain applications where the light output will perform certain tasks. Some of these are in conjunction with photocells as discussed in Chapter VIII. A slightly different use of the light output of neon lamps is shown in Figure 12-22. Here the neon lamp is used to mark 35 mm instrumentation film with time information. The binary time code and a transistor driven glow lamp perform the task. The lamp is placed in a rig inside the camera in such a manner that the edge of the film is exposed through a pin size hole illuminated by the neon lamp.

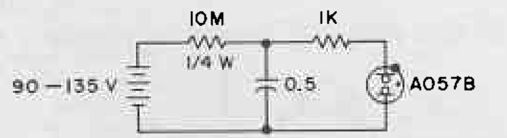
Many times neon lamp relaxation oscillators are used as blinkers and attention-getters. Figure 12-23 is an example of a simple flasher which flashes approximately once every five seconds. The time interval in this type of blinker can be varied but the time the lamp is on is moderately short.

Another type of blinker which is generally more effective because the lamp is on longer and because the light oscillates from side to side is shown in Figure 12-24. In this circuit lamp L_1 will light when power is applied. The condenser will then

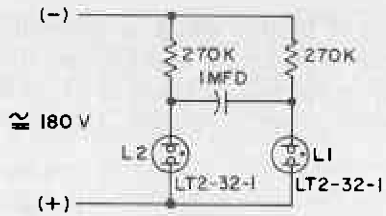


12-22 Film marker

begin to charge to the breakdown voltage potential of the other lamp, L_2. When L_2 fires, a pulse is transferred to L_1, driving it off. L_2 will then stay on while the condenser charges in the other direction toward the breakdown potential of L_1. When L_1 breaks down, L_2 will be driven off. The cycle is repeated as long as power is applied.



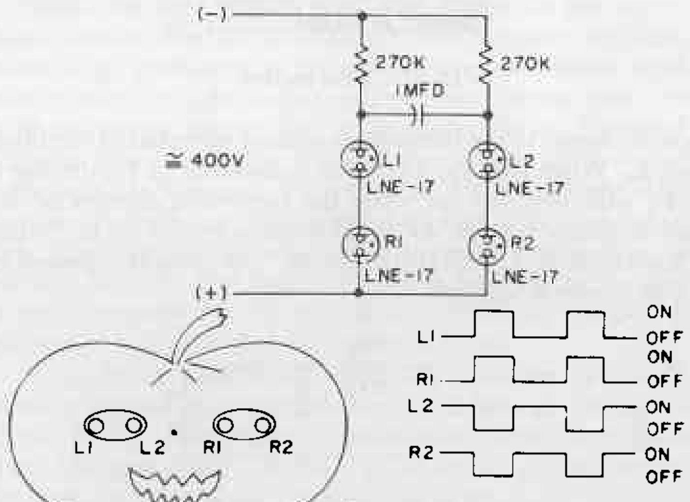
12-23 Simple neon flasher



12-24 Oscillating neon flasher

A modification of this circuit using two neon lamps on each leg has been used to delight children at Halloween. (Figure 12-25) Physically, the two common lamps are located on the same side of different eyes in a pumpkin. That is, the two lamps from the left leg are placed on the left side of the right eye and the left eye. Correspondingly, the two lamps from the right leg are placed on the right side of each eye. When power is applied, the lights blink in pairs from side to side, giving the pumpkin the appearance of watching for hobgoblins.

It should be understood that for maximum visibility and most satisfactory performance, high brightness neon lamps should be used for all blinker applications.



12-25 Dual oscillating neon flasher

CREDITS

In addition to the references cited in each chapter, the author gratefully acknowledges the contributions from the following people in making this book possible.

CHAPTER II

H. Cook, Lockheed Electronics Co.; William Eisenreich, Medical Electronics, Inc.; D. K. Fraedrich, Alexandria, Va.; D. R. Jaster, Automatic Electric Co.; Bill W. Napier, Fort Smith, Ark.; I. D. Sarrell, MHD Research Inc.; Ronald J. Zenone, Electronic Specialty Co.

CHAPTER III

Joseph J. Ruk, Pacific Tel. & Tel. Co.; Keith L. Williams, Wabash Magnetics, Inc.; R. F. Woody, Jr., Christiansburg, Va.

CHAPTER V

Kenneth D. Dymoke, Phillips Petroleum Co.; William F. Kamsler, Scientific Data Systems; Gerhard A. Leidholz, Cordis Corp.; Richard L. Shaum, Sandia Corp.

CHAPTER VI

J. A. Burt, University of Toronto; Ernest F. Koshinz, Glen-Tek Scientific Co.

CHAPTER IX

C. J. Crouse, C. B. Fall Co.; D. Weigand, Brookhaven National Laboratory.

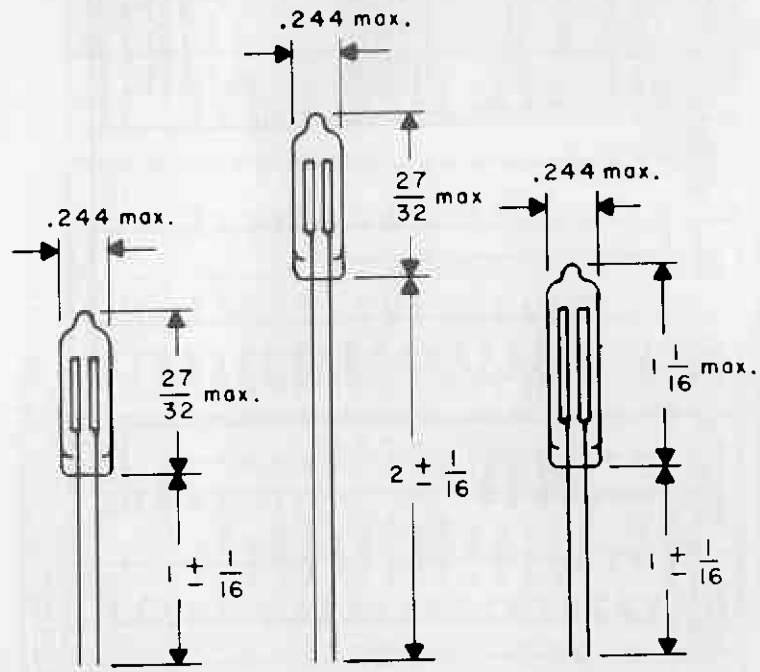
CHAPTER XII

M. L. Aitel, Haddon Heights, N.J.; V. F. Banko, Thiokol Chemical Corp.; R. J. Boileau, Motorola, Inc.; I. L. Fischer, Bendix Corp.; Computer Measurements Co.; Fred G. Degler, Leeds & Northrup Co.; Abraham Goodman, The Singer Co.; David L. Hirsch, Hughes Aircraft Co.; Theodore F. Koch, General American Transportation Corp.; A. H. Koenig, Magnetic Controls Co.; Erwin C. Lawson, Union Carbide Corp.; Ray E. Lawson, Edgerton, Germeshausen & Grier, Inc.; Peter Lefferts, Carter-Princeton; Frank J. Lutz, Jr., RCA Service Co.; Al Millman, Radio Corporation of America; Edward S. Shepard, Sr., Electronic Instrumentation; Virgil R. Walker, Aluminum Co. of America; Carl Wesser, Jr., Wesser Marine & Mobile Radio; R. M. Whaling, La Mesa, Calif.; B. E. Wrigley, Techron Laboratories.

APPENDIX

PHYSICAL AND ELECTRICAL CHARACTERISTICS OF NEON GLOW LAMPS DISCUSSED IN THIS BOOK

DIMENSIONS:



(Drawing "A") (Drawing "B") (Drawing "C")

ELECTRICAL:

Electrical characteristics are listed on the following pages. Unless otherwise specified, electrical measurements for all lamps are taken at +20°C, 40% relative humidity, and in normal lighting (5 foot-candles minimum).

SOME TYPICAL CIRCUIT COMPONENT NEON LAMPS [1]

Type No.	Breakdown Voltage vdc	Maintaining Voltage vdc	Design Current (average) ma	Extinguishing Voltage vdc	Average Life Hours	Oper. Temp.	Dims. (Ref: Dwgs. Page 157)	Remarks
AO 74	85(max)[2]	50-60	0.3	48	10,000	OPERATING TEMPERATURE RANGE FOR ALL LAMPS IS −55° To +90° C	A	Designed for photocell operation
AO 83	105(max)[2]	60-70	2.0	58	5,000		A	Designed for photocell operation
T2-27-1R100	66-74[2]	52-59	0.5	50	10,000		A	For trigger applications Designed for operation in total darkness
T2-27-1WR250	100-120[2]	60-70	2.5	55(min)	5,000		A	
T2-27-1WR350	115-140[2]	60-70	2.5	55(min)	5,000		A	
T2-27-1WR500	140-160[2]	60-70	3.0	55(min)	5,000		A	
T2-27-1WR760	170-200[2]	60-70	3.0	55(min)	5,000		A	
AO 59-2	65-75	52-53	0.3		7,500		A	Close maintaining voltage series - use in simple voltage regulator or voltage reference applications or where maintaining voltage must be held to within ±.5 volts
AO 59-3	65-75	53-54	0.3		7,500		A	
AO 59-4	65-75	54-55	0.3		7,500		A	
AO 59-5	65-75	55-56	0.3		7,500		A	
AO 59-6	65-75	56-57	0.3		7,500		A	
AO 59-7	65-75	57-58	0.3		7,500		A	
AO 59-8	65-75	58-59	0.3		7,500		A	
AO 59-9	65-75	59-60	0.3		7,500		A	
AO 57B	85(max)[2]	60(max)	2 [3]		10,000		C	SCR Trigger
RT 2-32-1A	70-90[2]	50-65	6.0	50	5,000		C	High Current Glow Lamp
AO 79	70(max)	58	0.3	47	7,500		A	Tansistor Applications
AO 78	70±4[2]	55±5	0.3	48(min)	10,000		A	For timing circuits leakage resistance is 10,000 megohms min.
AO 51	205-250	Not Specified	—[4]	Not Applicable	—[4]		A	Arc suppression of 115 NAC circuits
RLT 2-27-1	115-210	55-80	2.0	55	5,000		A	For memory circuits

Notes:
1. Close Tolerance Lamps Designed and Manufactured Specifically for use in Electronic Circuitry.
2. In Total Darkness
3. Peak Current 80 ma.
4. Depends on Energy Switched and Application.

VOLTAGE REGULATOR AND REFERENCE TUBES

Type No.	Breakdown Voltage vdc		Reference Voltage	Meas. At	Regulation[1] Current Limits	Temp. Coeff.	Operative Current ma			Life Expectancy	Typical Variations at 250 hrs	Dimensions (Ref:Dwgs. Page 157)
	Max.	Typical	vdc	ma	ma	mv/°C	Max[2]	Min as Shunt reg	Min Parallel with capacitor	Hours	%	
Z82R7	110	102	82±1	2.0	0.25-7.0	-2	10.0	0.25	0.45	30,000	<0.2	Dimensions for all voltage regulator and voltage reference tubes shown on Drawing C
Z82R10	115	105	82±1	2.0	0.3-10.0	-2	14.0	0.3	0.7	30,000	<0.3	
Z82R15	118	107	82±1	2.0	0.5-15	-2	17.0	0.5	0.9	30,000	<0.5	
Z83R4	110	100	83±1	1.5	0.25-4.2	-2	6,0	0.25	0.4	30,000	<0.2	
Z84R2	110	100	84±1	1.0	0.15-2.0	-2	3.0	0.15	0.35	30,000	<0.2	
Z91R2	118	110	91±1	1.0	0.1-2.0	-3.5	3.0	0.1	0.3	30,000	<0.3	
Z91R4	120	111	91±1	1.5	0.2-4.0	-3.5	6.0	0.2	0.35	30,000	<0.3	
Z91R7	130	120	91±1	1.5	0.25-7.0	-3.5	10.0	0.25	0.4	30,000	<0.3	
Z91R10	135	122	91±1	1.5	0.25-10	-3.5	12.0	0.25	0.5	25,000	<0.3	
Z100R12	150	140	100±1	3.0	0.6-12.0	-9	14.0	0.6	1.8	30,000	<0.6	
Z103R2	130	115	103±1	0.8	0.2-2.0	-4.5	3.0	0.2	0.25	20,000	<0.4	
Z103R4	130	120	103±1	1.0	0.2-4.0	-4.5	5.0	0.2	0.25	20,000	<0.6	
Z105R7	160	150	105±1	2.5	0.6-7.0	-9	10.0	0.6	1.3	30,000	<0.6	
Z110R4	165	155	110±1	1.5	0.5-4.0	-9	6.0	0.5	0.95	30,000	<0.4	
Z115R4	150	140	115±1	0.8	0.15-4.0	15	6.0	0.15	0.3	20,000	<0.3	
Z115R7	155	145	115±1	1.5	0.5-7.0	15	9.0	0.5	2.0	20,000	<0.3	
Z116R2	145	138	116±1	0.6	0.12-2.0	15	3.0	0.12	0.3	20,000	<0.3	
Z139R1.9	185	175	139±3	0.5	0.3-1.9	-10	3.0	0.3	0.6	20,000	<0.35	
Z143R1.9	220	195	143±3	0.5	0.3-1.9	-10	3.0	0.3	0.6	20,000	<0.2	

Notes:
1. Limits for less than one volt variation.
2. Maximum continuous current without permanent damage to tube.

THREE-ELEMENT TRIGGER TUBES

Type Number	Anode to Cathode[1]					Trigger to Cathode[2]					Trigger to Anode[3]		Life	Dimensions
	Maximum Stand-off Voltage vdc	Breakdown voltage vdc	Maintaining Voltage k vdc	Measured at ma	Operating Current ma	Breakdown Voltage vdc	Turn-on Current (max)	Maintaining Voltage vdc	Measured at ma	Max. Current ma	Stand-off Voltage vdc	Breakdown Voltage vdc	Hours	(Ref. Dwgs Page 157)
TRJ 250	149	150-185	96±2	2	0.1 TO 4	163±5	1µa	83±2	2	4	114	115-165	25,000	DWG C
TRQ 250[4]	189	190-230	100±2	2	1 TO 6	116±6	1µa	91±2	2	6	129	130-180	25,000	DWG C
120TG-27-2	95	96-120	65-77	0.5	0.5	65-82	<1µa	60-72	0.5	0.5	Not Specified	Not Specified	5,000	DWG B
180TG-27-1	164	165-200	70-80	2	2	80-102	1µa	51-67	2	2	"	"	4,000	DWG A
LTG-27-2	159	160-180	70-90	2	2	90-114	1µa	60-84	2	2	"	"	5,000	DWG B

Notes:

1. Anode Positive, Cathode Negative, Trigger Floating.
2. Anode Floating, Cathode Negative, Trigger Positive.
3. Anode Positive, Cathode Floating, Trigger Negative.
4. Electrically Interchangeable with NE-77.