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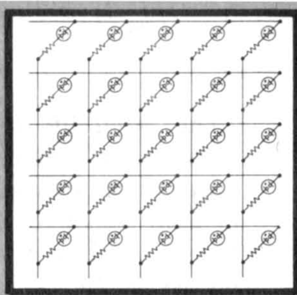


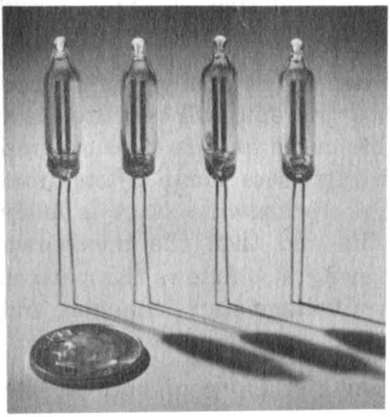
Vol. 7, No. 2

*(This is the last of a four-part series on the characteristics and applications of neon glow lamps prepared by Signalite Inc. to assist you in your use of these devices. If you would like a reprint of the entire discussion, simply drop us a line.)*

# DESIGN, OPERATION AND APPLICATION OF NEON GLOW LAMPS

By: Frank McKendry
Signalite Inc.

## PART IV: LIFE, SPECIFICATIONS AND HANDLING



In order to obtain maximum performance from a neon lamp, as with any other component, it is important to specify what is required correctly. Such specifications are a combination of the requirements of the circuitry in which the lamp will be used, the environment and performance of the equipment, and the available characteristics of the lamps themselves. In addition to these specifications, there are certain mechanical characteristics which can affect the performance and/or lifetime of a neon lamp.

*Life*

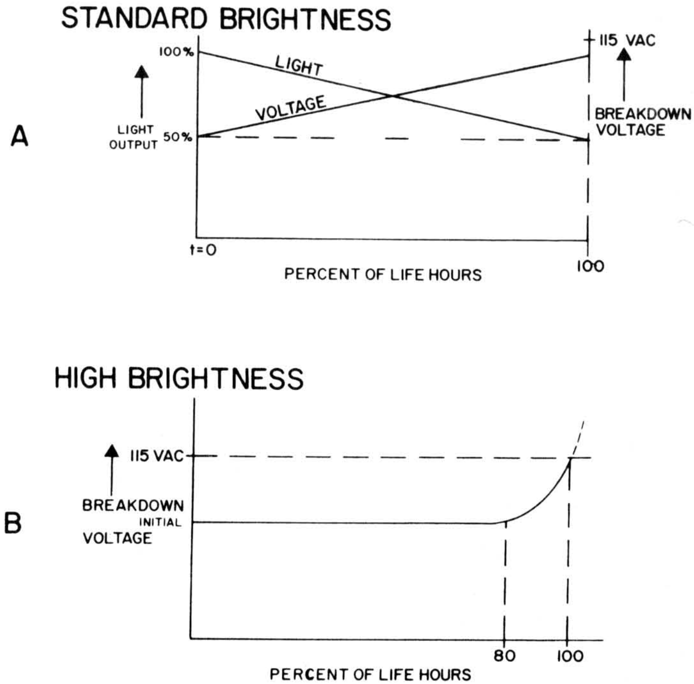
The rated life for neon lamps is the length of operating time, expressed in hours, that produces certain specified changes in their characteristics when operated at design current. In most applications, the lamp is not on all of the time. In these applications only the time during which the lamp has current flowing through it determines the useful life. If this period is of a short duration, as in pulsing operations, the useful life will have to reflect the fact that the lamp's rated life is not being consumed while it is inoperative. Actual life would be equal to the lamp's rated life divided by the operating duty cycle. In many applications the actual useful life, i.e., calculated operation time of the lamp, will exceed by many times the estimated lifetime of the equipment or circuit in which the lamp is installed.

Lifetime depends in part on the construction techniques used, and in part on the operating conditions of the lamp. Shown in Figure 1 are life test results for two different construction techniques. 1) standard brightness lamps, and 2) high brightness lamps. Figure 1A shows the average lifetime in percentage for the standard brightness lamp operating under specified design conditions. The end of life for this type of lamp is specified as that period of time which has passed (on the average) until the light output is reduced to 50% of its initial light output. Standard brightness lamps are designed so that this period is 25,000 years or more. Note that the breakdown voltage of the lamp goes up with increased usage, but that at 25,000 hours it is still below 115 vac.

The life of a high-brightness lamp is defined as that period of time which has passed (on the average) until the unit will not fire on a standard line voltage of 115 vac. The life curve for this type of lamp is illustrated in Figure 1B. The high-brightness lamp differs from the standard brightness lamp in that its breakdown voltage is fairly constant to about 80% of its rated life and then the breakdown voltage rises very rapidly The light intensity also follows this pattern in that it is constant until the breakdown voltage starts changing and then decreases.

The light output of both lamps changes for one or both of the following reasons:

1. Sputtering takes place continually in the lamps and the sputtered material deposits on the glass wall of the envelope. As the period of usage increases more and more material is deposited on the wall building up an increasingly opaque coating. This restricts the amount of light that can be emitted from the tube.
2. As the breakdown voltage of the lamp increases, its maintaining voltage also increases. The current being passed through the




LIFE CALCULATIONS

$$\text{LIFE (HRS)} \propto \frac{1}{I^n}$$

STANDARD BRIGHTNESS ~ $n \simeq 3$

HIGH BRIGHTNESS $n \simeq 4.5$

$$\frac{L_1}{\frac{1}{I_1^n}} \quad \frac{L_2}{\frac{1}{I_2^n}}$$

$$L_2 = L_1 \frac{I_1^n}{I_2^n}$$

EXAMPLE – HIGH BRIGHTNESS

DESIGN CURRENT = 2ma

OPERATE CURRENT = 4ma

$$\text{LIFE}_2 = 25{,}000 \times \frac{2^{4.5}}{4^{4.5}}$$

$$= \frac{25{,}000}{22.7}$$

= 1,100 HOURS

*Figure 1*

lamp is determined by the voltage drop across the series resistor, and as the maintaining voltage increases, the drop across R decreases with a resulting decrease in current. Since the light output is directly proportional to the current flowing through the lamp, the light output is linearly reduced also.

Also indicated in Figure 1 are calculations that must be made if a lamp is used at other than its design current. It is to be particularly noted that life of a neon lamp is proportional to $1/I^n$ where for standard brightness lamps "n" is approximately 3 and for high-brightness lamps "n" is approximately 4.5. The example indicates that for a high-brightness lamp operated at twice its design current its life is shortened to approximately 4.4% of its rated life at the design current.

For lamps used as components in electronic curcuitry light output is not usually a matter of prime importance except where they are being used with photocells. In circuit component applications the critical characteristics are usually the breakdown and maintaining voltage ratings. Because these change gradually, the end of life occurs when the lamp no longer meets specifications, rather than a catastrophic failure. Life testing of neon lamps must be conducted at design current and cannot be accelerated. Running a lamp at currents above its design current causes spot heating of the cathode emissive material. This, in turn, will increase the sputtering of the emissive material, changing the lamp's aging characteristics at a rate that is not reproducible or easily ralated to its life at normal usage. Consequently, any attempt to accelerate aging at higher currents will not be applicable to actual service.

In addition to construction, life expectancy depends on the operating conditions of the lamp with life increasing as operating currents are decreased. If the lamp is installed in a circuit where it will be subjected to pulsing, the peak current, pulse wave shape and pulse duration all will have their effect on lamp lifetimes. Operation on direct curren rather than alternating current will shorten lifetime figures perhaps up to 50% in some installations, because of the fact that only one electrode is being used instead of both. As a rule of thumb, average circuit component neon lamps will have rated lifetimes in the area of 7,500 hours of continuous operation.

*Electrical Specifications*

The electrical specifications shown in Table I are self-explanatory However, it should be pointed out that circuit components have more specifications than indicators. Because of this fact, they are generally higher priced. The only specification that requires some additional definition is light output. It is indicated that standard brightness lamps have an output of .06 lumens per milliampere while high-brightness lamps have an output of .15 lumens per milliampere. It would appear on the basis of this data that a high-brightness lamp is only a factor of three higher in light output than a standard brightness lamp. However, because additiona current can be passed through the high-brightness lamp without reducing life characteristics, these lamps can put out about 8 times as much light as the standard brightness lamp.

A general rule of thumb is to keep the number of specifications to a minimum so as to keep the cost to a minimum.

## TABLE I
## ELECTRICAL SPECIFICATIONS TO BE SPECIFIED

| | INDICATORS | CIRCUIT COMPONENTS |
|---|---|---|
| BREAKDOWN VOLTAGE (AC or DC) | ___ V MAX | ___V. ±___ |
| MAINTAINING VOLTAGE | NOT SPEC. | ___ V. ±___ |
| DESIGN CURRENT | RES. SPEC. | ___ MA. |
| LIFE (AT DESIGN CURRENT) | ___ AVG. | ___ AVG. |
| DEFINITION (STAND. B.) | 50% of Light | ___ (Volts) |
| (HIGH B.) | Will not fire on line voltage | |
| LEAKAGE RESISTANCE | NOT SPEC. | ___ MEG OHM |
| EXTINGUISHING VOLTAGE | NOT SPEC. | ___ VOLTS |
| TURN ON TIME (DARK) | 90% 1 SEC.<br>99% 3 SEC. | ___ MILLI-SEC. |
| LIGHT OUTPUT (PER MILLIAMP-REF.) | S.B. .06 LUM/MA.<br>H.B. 15 LUM/MA. | NOT SPEC. |
| CORONA COVERAGE | H.B. 1/3 MIN.<br>S.B. 3/4 MIN. | NOT SPEC.<br>NOT SPEC. |

*Mechanical Specifications*

In general, only a few mechanical specifications are required and are included in our standard catalog. Table II gives the more common mechanical specifications plus some additional specifications that are normally not published. The information indicated can be considered to be standard purchasing specifications, or manufacturing dimensions and tolerances. Any specifications outside of these particular dimensions would require an unusually high order volume, and in general the lamp would be more expensive than standard types. Standard shock and vibration specifications are indicated; however, devices can be made to withstand much higher values. To indicate this capability, Signalite is presently producing a device that withstands a 20,000 G shock.

*Potting*

In many circuit applications it may be desirable to pot the lamp as indicated in Figure 2. Because the envelope is constructed of glass, it is desirable to pot the lamp in a soft material. Materials such as silastic are acceptable. After curing of the soft material, the lamp can then be potted in such materials as epoxy, glass-filled epoxy, quartz filled epoxy and the like. Strain relief should be provided prior to potting in the soft material so that any external mechanical forces cannot be transmitted to the seal area of the lamp.

## TABLE II
## MECHANICAL SPECIFICATIONS TO BE SPECIFIED

| | |
|---|---|
| ENVELOPE | |
| LENGTH (in.), max | ½, ¾, 27/32, 1  1 1/16* |
| DIAMETER (in.) | .222  .244 |
| LEADS | |
| DIAMETER (in.) | .016 ± .001 |
| LENGTH (in.) | PER CUSTOMER DRAWING (1" and 2" are standard) |
| CENTER TO CENTER DIST (in.) | .061 NOM. (AT ELECTRODES) |
| RESISTOR | PER CUSTOMER DRAWING |
| SOLDER DIP | PER CUSTOMER DRAWING |
| BULB | |
| CLEAR, FROSTED, ETC. | PER CUSTOMER DRAWING |
| SHOCK | |
| TEN SHOCKS OF 30 G's OF A DURATION OF 11±1 MILLISECOND | |
| VIBRATION | |
| SINUSOIDAL DRIVE, 5-55Hz., HALF AMPLITUDE .03 INCHES | |

*Only standard 3-element trigger tubes and voltage regulators are normally available in 1 1/16" length.

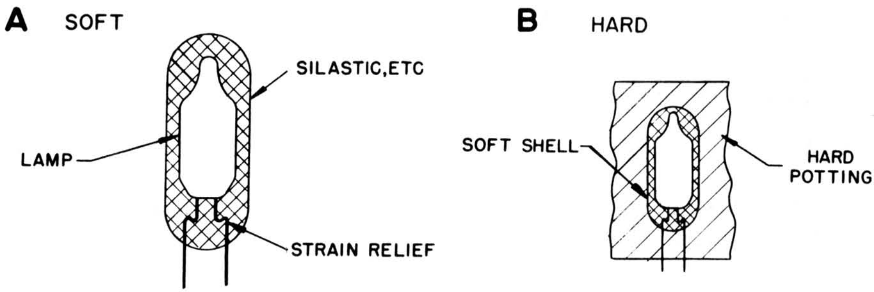



*Figure 2*

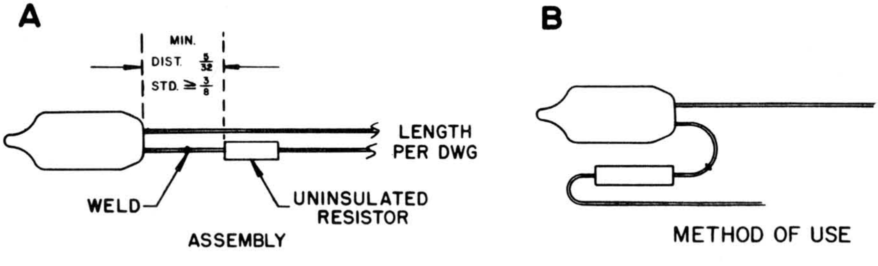



*Figure 3*

### *Resistor Assemblies*

Lamps can be purchased with one or more resistors attached to one or both leads as shown in Figure 3. The resistor is attached by butt welding a lead of the lamp to a lead of the resistor In equipment that is to be used at high ambient temperature we recommend ½ w or ¼ w insulated resistors. These resistors have derating curves that start at 70 degrees centigrade and are linearly derated to zero at 150 degrees centigrade.

*Lead Bending*

If it is necessary to fit a lamp or lamp and resistor in an assembly, it is very important to bend the leads properly. Improper bending of the leads can result in a fracture of the glass where the lead enters the press area of the lamp. Figure 4B indicates the proper method of bending the leads. The bending fixture firmly grasps the lead for a distance of at least 1/8" from the glass. The lead then is bent around a curved surface of the fixture. This results in the lead coming straight out of the glass for some minimum distance and reduces the probability of the glass being fractured.

In this series of discussions we have tried to anticipate and answer most of the commonly asked questions about the characteristics and applications of neon lamps. Because the applications vary over so wide a spectrum, we may not have answered all of the questions

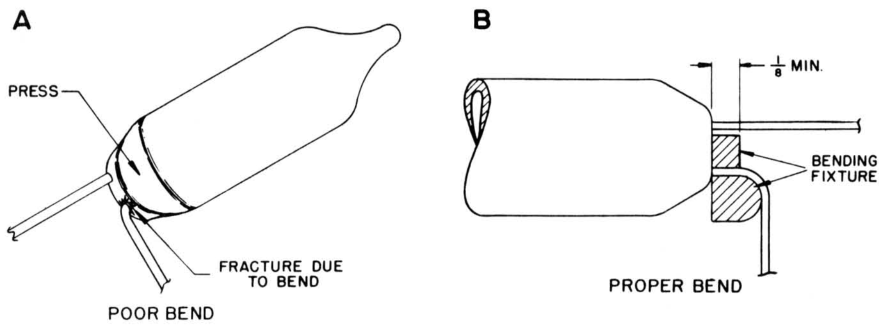



*Figure 4*

pertinent to a specific application. If such be the case and you would like detailed information concerning an individual use and/or characteristic, please contact Signalite's Application Engineering Department. There is no obligation for this service.

## SIGNALITE PART OF NEW GENERAL INSTRUMENT ELECTRO—OPTICAL GROUP

General Instrument Corporation has established an Electro-Optical Products Group (EOPG) for the design and manufacture of miniature lamps and gas discharge devices used in the computer, aerospace, communications, electronics and other industries. Alvin W. Gershon, formerly president of Signalite, was named group vice president and will have responsibility of this new unit of the diversified electronics company. T.J. Thomas was named president of Signalite to succeed Mr Gershon.

The Electro-Optical Products Group consists of four General Instrument subsidiaries. They are:

- Signalite Incorporated which produces neon glow lamps for use as indicators and circuit components, spark gaps, flash tubes, and microwave components.
- Chicago Miniature Lamp Works, Chicago, Ill., which designs, manufactures and markets subminiature incandescent lamps and energy emitting devices.
- Hivac, Ltd., South Ruislip, England, the largest producer in the United Kingdom of neon indicator lamps and assemblies, number tubes, barreters, delayed action fuses, and dekatrons.
- Vitality Bulbs, Ltd., of Bury St. Edmond's, England, the major producer in the United Kingdom of subminiature incandescent bulbs. Hivac and Vitality have substantial sales in the Common Market.

In addition to serving the computer, aerospace, electronics and communications industries, the four subsidiaries also supply the marine, automotive, appliance, control, optical, instrumentation and business machine industries. General Instrument's acquisition of Chicago Miniature Lamp Works was completed July 25, 1969, Mr. Gershon announced. Ernest E. Freeman, Jr., will continue as president of this unit. The EOPG is the eighth product group into which General Instrument's operations are divided. Its headquarters will be in Neptune, N.J.

### T. J. THOMAS

Mr Thomas joined Signalite Inc. as president after 17 years at Kearfott, a Division of Singer-General Precision Inc., Clifton, N.J. During his professional career at Kearfott he progressed from Project Engineer to General Manager of the Electromechanical Division and Vice President in 1961 He was then promoted to Group Vice President and subsequently, Senior Vice President in Charge of the Avionics Branch.

Prior to joining Kearfott Mr. Thomas had worked as an engineer on aircraft turbojet controls for Curtiss-Wright Corporation following two years as a naval communications officer aboard a troop transport operating in the Pacific Theater He graduated from Pennsylvania State University with a BSME in 1944 and obtained his MSME degree from Stevens Institute of Technology in 1951 He has contributed several articles to trade magazines, and holds several patents. He is a contributing author of a book on Avionics. Mr. Thomas is a member of the American Institute of Aeronautics and Astronautics, the Armed Forces Communications and Electronics Association, and the American Ordnance Association.

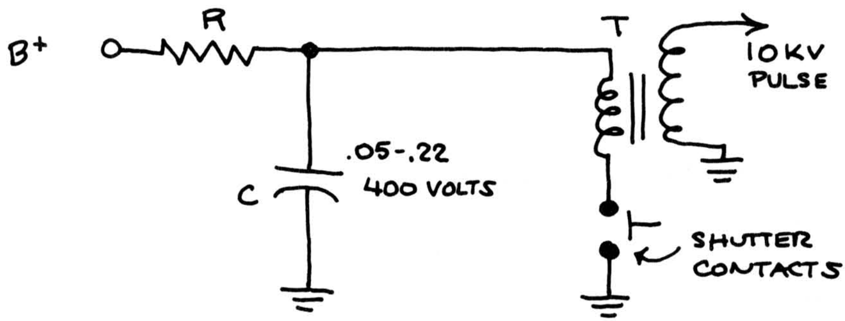
***It is Signalite's policy to publish letters based on their intrinsic interest only. We do not necessarily agree with all comments and suggested uses and will upon occasion wait for your reaction before taking editorial space for ours.***

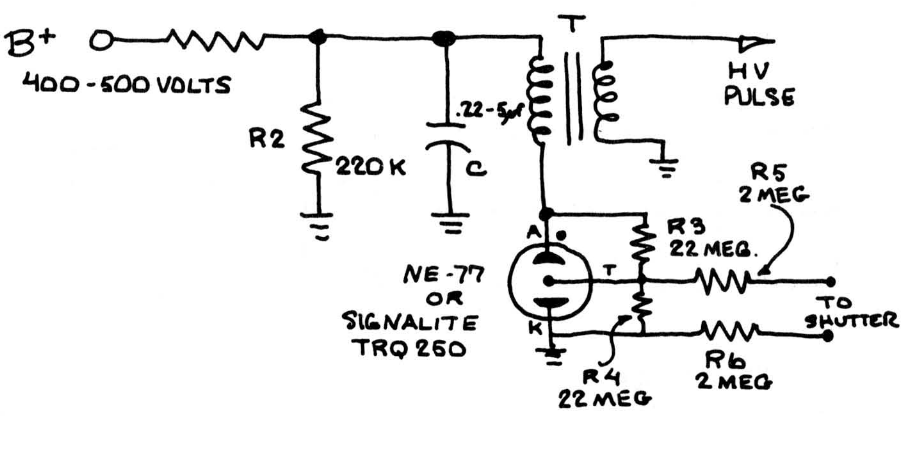
## TRIGGERING ELECTRONIC FLASH UNITS

Gentlemen

The following application of a 3-element trigger lamp may be of interest to camera owners who use electronic flash, and who are interested in prolonging the life of their shutter contacts. In most electronic flash units, a small capacitor is charged to about 200-400 volts and then discharged through the camera shutter contacts into primary of a trigger transformer, in order to generate the high voltage needed to fire the Xenon flash tube.

The instantaneous current flowing through the contacts may reach several amperes, eventually causing them to become pitted and erratic.



By using a 3-element trigger tube (NE-77 or Signalite TRQ 250) as shown below, the shutter current can be reduced to 50 microamperes or less, which is so low that the flash tube can be fired by bridging the shutter contacts with your tongue!

R1 and R2 are chosen to charge C to a voltage just less than the breakdown voltage of the trigger tube. R3 and R4 bias the trigger electrode at a stable voltage to prevent random firings. R5 and R6 are isolation resistors which completely protect the user from the high voltage used in the flash unit.

The trigger lamp should be placed as close as possible to the "ready" light in the flash unit, since its firing voltage is much higher than normal when in complete darkness. The value of C may have to be increased over the original value used to assure that sufficient energy is delivered to the trigger transformer, T

After a short break-in period it may be necessary to vary R1 slightly as the trigger voltage of the tube stabilizes. I have used this circuit for over 4 years, and it has consistently given me reliable operation.

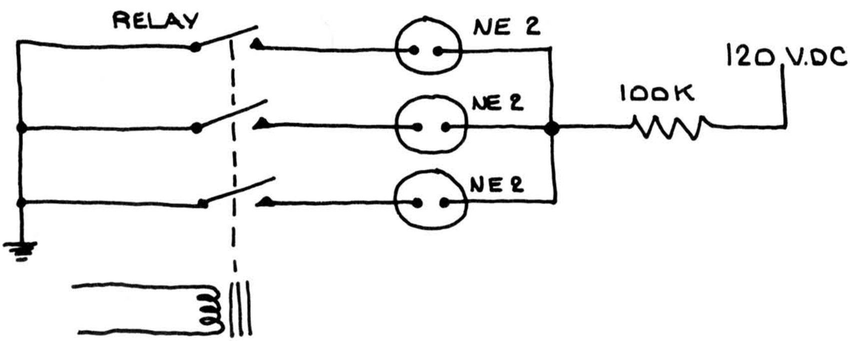
Sincerely
Robert Parsons
Hazeltine Corporation

## RELAY OPERATION SEQUENCE

Dear Sir·

The (following) circuits have been used by me in the application designated in the drawing, and have proven to be accurate and consistent in operation.

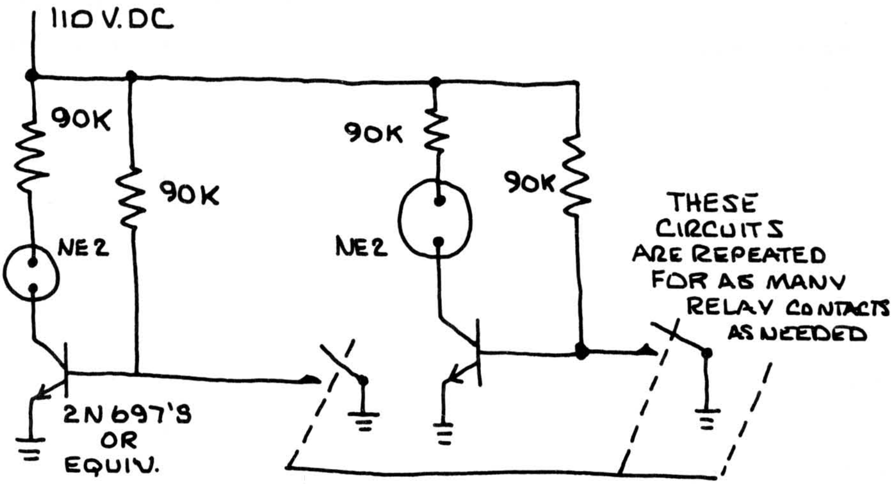
To determine the closing sequence of a relay's contacts, the following circuit was used



Upon energizing the relay, the first contact to close will ignite the glow lamp that is wired in that contact's circuit. No other lamp will ignite after the first one is lit.

After noting this contact as the first to close, the lamp is removed and the relay is again energized to determine the next contact to sequentially close. This routine is continued until one lamp is left, this one being in the circuit of the last contact.

Determining the sequential opening of a relay's contacts by means of glow lamps involves a bit more circuitry·




Here, all transistors are biased "OFF" until the relay contacts are broken (either by energizing or de-energizing the relay).

The first transistor to be turned "ON" causes its glow lamp to ignite. No other lamp can glow after this one is lit. This contact is the first "break" or open.

The lamp is removed and the test continued to determine the 2nd, 3rd, 4th, and so on

Very truly yours,
James E. Laino
Grumman Aircraft Engineering Corp.

*Ed. Note.*

*Time differences as low as 10 microseconds can be determined if the NE-2 lamps are replaced with trigger tubes (3-element devices). This is accomplished by causing a "keep-alive" current to flow between the trigger and the cathode. This pre-ionizes the tube and when voltage is applied between the anode and cathode, the response is very rapid.*

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## *Drop Us A Line.*

If you have an interesting application of neon glow lamps in your circuitry. . or a problem concerning the use of neon lamps, drop us a note telling about it. Interesting letters will be published in a future issue of the **Application News**—and we will send you an Owl Eye Nite Lite for your home.

Applications which in the opinion of Signalite have significant interest will also be brought to the attention of the editors of leading technical publications for consideration as articles and featurettes. If you would like help in preparing your material for publication, just send us the facts and data. We will put it in the correct form for publication. Your by-line and company credit will be given with your permission.

For immediate technical application or circuit design assistance, you may contact Signalite directly at

*TWX: 201-775-2255*   *TEL: 201-775-2490*

* * * * *

**For information about Signalite Neon Glow Lamps for circuit component and/or indicator applications, for specifications on lamps, for general information about Signalite and its products, call us at any of the following telephone numbers:**

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