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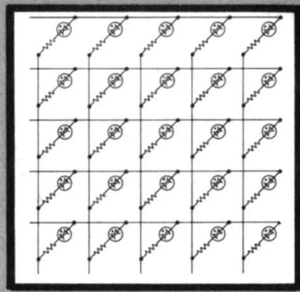
APPLICATION NEWS
A General Instrument company



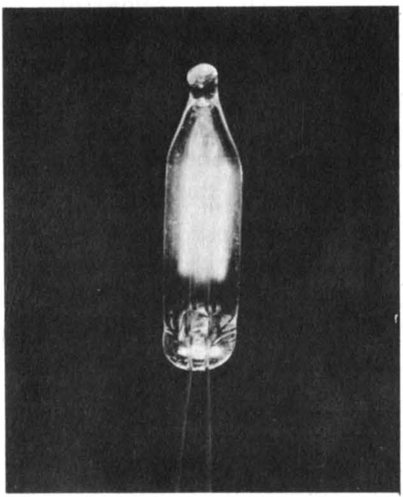
Vol. 6, No. 4

(This is the second in a series of articles on the characteristics and applications of neon glow lamps. The first part which covered construction and operation appeared in Signalite Application News, *Vol. 6, No. 3 -Ed.)*

DESIGN, OPERATION AND APPLICATION OF NEON GLOW LAMPS

By Frank McKendry
Signalite, Incorporated

Part II· Ignition Characteristics and Methods



There are a variety of ways which can be employed to turn on and turn off neon lamps. The most appropriate method is the one which best meets the requirements and characteristics of the specific circuit in which the lamp is to be used.

Turn-On Method

In Figures 1 and 2 various ways are illustrated to turn the neon lamp on. However, regardless of the method employed, the breakdown voltage of the device must alwavs be exceeded.

Figure 1A illustrates the method of turning a lamp on by DC In this case a suitable resistor is placed in series with a power supply and the power supply voltage is raised to a point where the voltage exceeds the breakdown voltage of the lamp. The voltage across the lamp will suddenly drop to its maintaining voltage and will operate at a current determined by the supply and the resistive load line. It will stay at this point until the voltage is reduced to a value below its maintaining voltage.

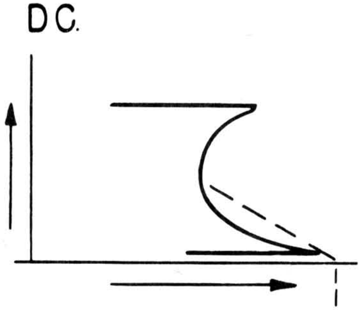


Figure 1A

Figure 1B illustrates the action of the lamp relative to different ramp voltages. A slow ramp, about 10V per second, results in the lamp firing at the same level as that determined by the application of DC. However, a fast ramp, about 10V per millisecond or less, results in an apparently higher breakdown voltage. The voltage in excess of the DC breakdown value is called overshoot. This is caused by the finite ionization time of the lamp and is the result of the inability of sufficient ions to be generated during the early portions of the ramp.

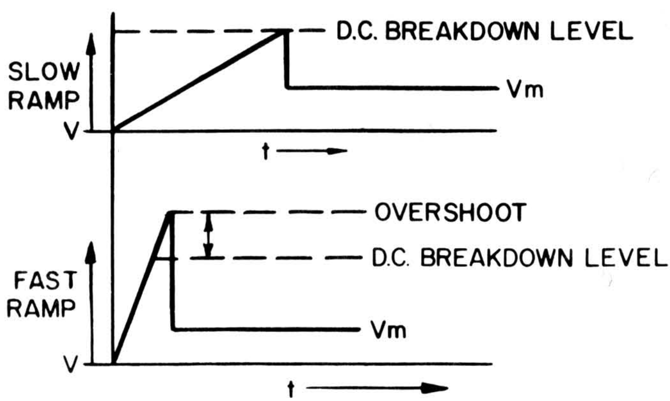


Figure 1B

Figure 1C illustrates the action of a lamp when exposed to an AC voltage. This is typically the action of the devices used in 1/2 wave and full wave proportional controls if one assumes that the capacitor is charging at the same rate as the line frequency The voltage will rise to the breakdown voltage of the lamp at which point the lamp will fire delivering a pulse to the gate of the SCR or triac. The lamp will stay at its maintaining voltage until such time that the line voltage drops below the maintaining voltage and the lamp will extinguish. The firing point in the positive and negative direction can vary a few volts because the tubes are not necessarily symmetrical in both directions.

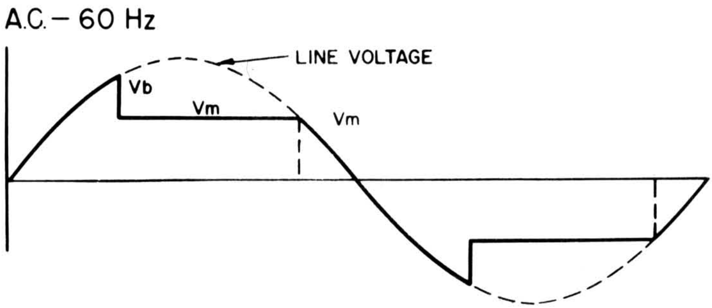


Figure 1C

Pulse voltage turn on is shown in Figure 1D. A lamp is biased at some point below its breakdown voltage but above its maintaining voltage. A pulse of sufficient amplitude which has a width in excess of the ionization time is superimposed on the bias voltage. The lamp will turn on during the existence of the pulse, and after the pulse has been removed it will stay on, sustained by the bias voltage at a point on the curve as determined by the bias voltage and the resistive load line. If the bias voltage is not greater than the maintaining voltage, the lamp will go off when the pulse is removed.

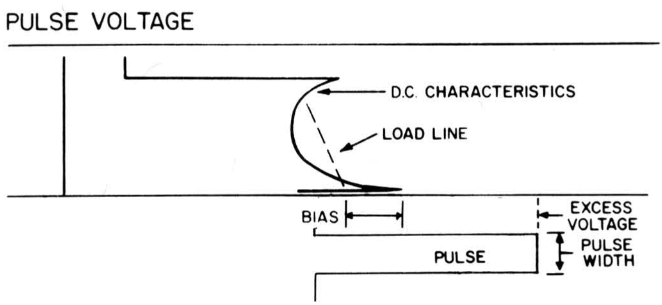


Figure 1D

Figure 2A illustrates the action of a laser or flash tube on the characteristics of a glow lamp. It is to be particularly noted that the breakdown voltage (dark) can be modified when sufficient illumination is presented to the lamp. This illumination is not arbitrary in frequency as it must be the exciting wave length for the particular gas molecules involved. Also, the cathode has a photoelectric work function that must be exceeded for the cathode to emit electrons. Therefore, a laser, with its monochromatic output, would have to have the exact exciting frequency of the gas molecules or sufficient energy to exceed the work function of the cathode. A flash tube, on the other hand, puts out a broad spectrum of frequency some of which is bound to be the exciting frequency of the gas, or have sufficient energy to overcome the photoelectric work function. Since, however, the power involved in the exciting frequency (generally U V) is very low, the flash tube must almost be in physical contact with the neon lamp in order to turn it on.

The glass used to make lamps is lead glass, G-1 or G-12. These glasses have poor spectral transmission below 3000 angstroms. The frequencies below 3000 angstroms are the very frequencies to which gas excitation or photoelectric work function are most sensitive. Consequently, high intensity is needed to get a small amount of U V. through the glass.

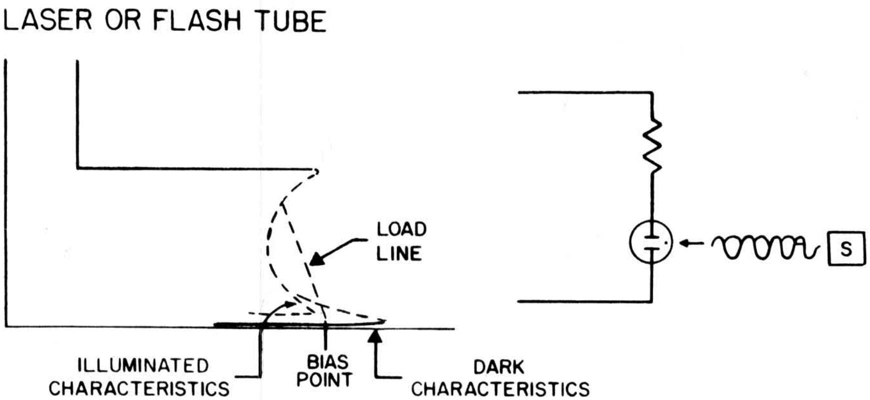


Figure 2A

The exciting of the gas molecules by high voltage is illustrated in Figure 2B. If a voltage source of sufficient magnitude is placed around or on the glass envelope of a lamp, sufficient ions are generated to lower the breakdown voltage. This is very similar to the action of the laser and a flash tube.

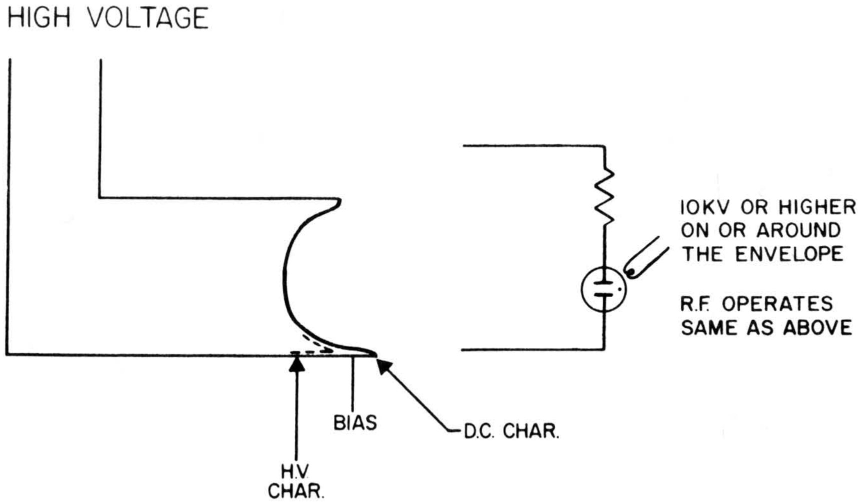


Figure 2B

Application of R.F near or on the glass envelope will excite the tube in the above manner and will reduce the breakdown voltage (dark) as indicated above.

A general note on DC operation should be made here relative to turn on characteristics. If a device is run for some hours with current flowing in one direction, a lamp becomes "polarized" If such a lamp were tested for its breakdown voltage in the reverse direction before and after the application of DC, it would be noted that its breakdown voltage has gone up. If the lamp now has current passed for some hours in the reverse direction, the breakdown voltage will return to its original reading. This fact is important when designing circuitry where a lamp is occasionally reversed in polarity.

Trigger Tube Turn-On

Trigger tubes are generally used for high-speed applications. The speed is derived from the fact that the tube is ionized by a keep-alive current flowing between the trigger and cathode. Keep-alive currents are generally in the microampere range and, therefore, high values of resistance are used in the circuit. This provides the added advantage of a high impedance.

In the keep-alive technique, the tube is used in the following manner. A low current is caused to flow between the trigger and the cathode to pre-ionize the tube. A voltage in excess of the breakdown voltage is applied across the anode and cathode as a pulse or step function. The tube will respond to this voltage in a period of time as low as 10 microseconds. It should be specifically noted that the trigger current causes only a small variation in the breakdown voltage from anode to cathode, about 5 or 10V

The device can also be used, as the name implies, as a trigger device. In this configuration, a voltage is applied across the anode and cathode which is slightly less than the breakdown voltage. Trigger current is then supplied via the trigger to cathode circuit and the breakdown voltage from anode to cathode is lowered to a value below the bias voltage; thus the tube will turn on. It should be noted that this mode of operation does not have the speed of response of the keep-alive technique because the ions must be generated by the trigger to cathode pulse.

In Figure 3B it can be seen that the trigger to cathode breakdown voltage is less than the anode to cathode breakdown voltage. This is a direct result of the Paschen's curve. Namely, the pressure of the device is constant, and therefore, the breakdown voltage from the trigger to the cathode and from the anode to the cathode depends on the spacing of these electrodes. Since the trigger is closer to the cathode its breakdown voltage will be lower than that of the anode.

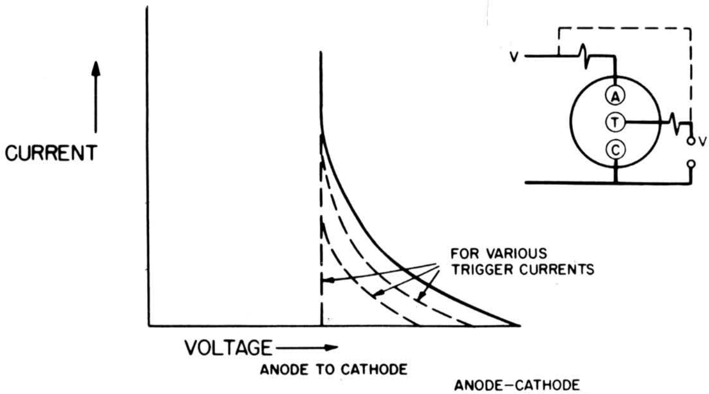


Figure 3A

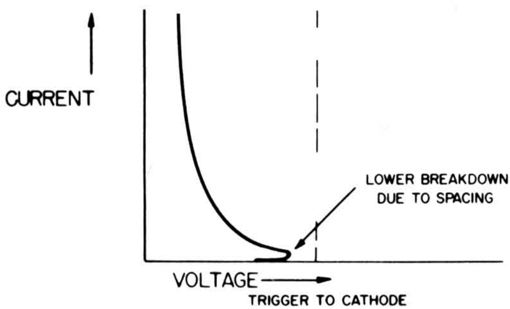


Figure 3B

Given the same set of minimal voltage conditions, a diode will turn on in several milliseconds while a trigger tube, with keep-alive current, will turn on in tens of microseconds. The turn-on time for diodes is given in Figure 4A. The ionization time, or turn-on time, is directly related to how much voltage in excess of the DC breakdown voltage is applied to the device. In addition, the curve is dependent on the intensity of the ambient light while the measurements were being made.

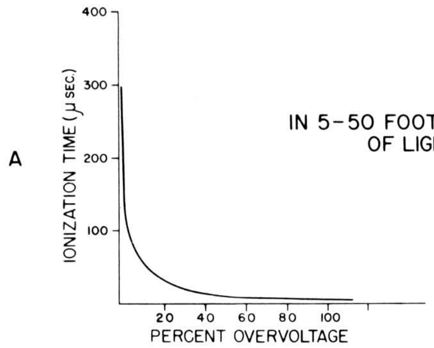


Figure 4A

This curve represents the fastest possible ionization time for a given percent of overvoltage.

For less than 20% overvoltage, the curve is going asymptotic to the time scale. Therefore, for a small change in overvoltage a large change in ionization time will occur When the percentage of overvoltage exceeds 40% any further decrease in ionization time is small.

This curve was obtained using square wave drive (Figure 4B) with variable pulse width. For any wave shape other than square wave, the turn-on time will be longer than indicated in the curve (4A).

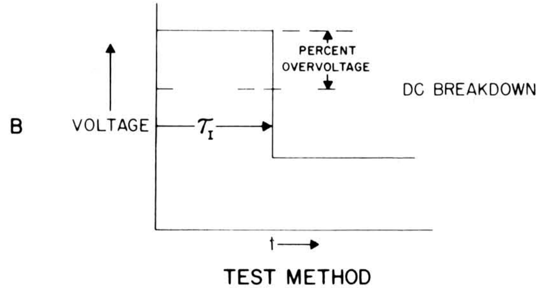


Figure 4B

Turn-Off Time

It is generally desired to know the turn-off time of the light output and the voltage recovery, or deionization time. Figure 5A indicates the turn-off time of the light. DC current was supplied to a lamp for some period of time. At time T = O the circuit was interrupted instantaneously The light level rose from the DC level to about five times the DC light level and then proceeded in a long tail descent to darkness in a period of 200 microseconds. This light peak was caused by a number of excited electrons that could not return to ground state while current was flowing. When the current was interrupted they spontaneously returned to the ground state generating the increase in light output for a period of a few microseconds.

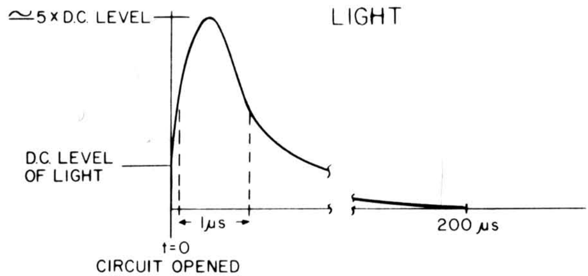


Figure 5A

Figure 5B demonstrates the relationship of the voltage recovery This particular curve was made from data taken on a lamp with

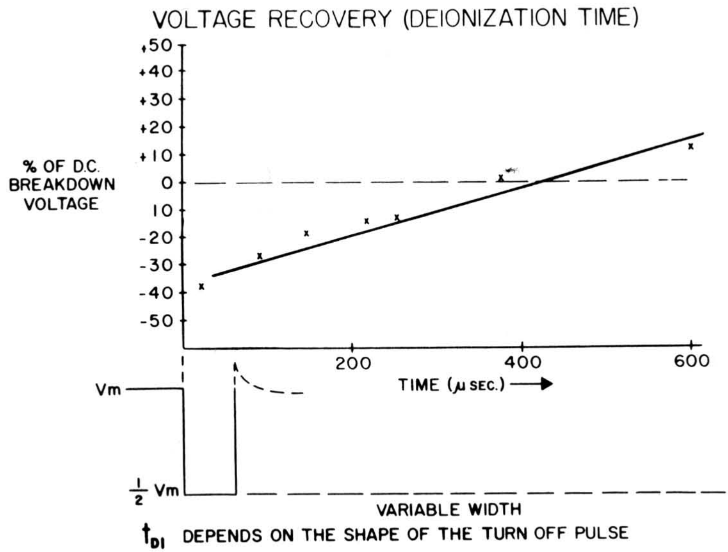


Figure 5B

2 ma flowing. It is to be emphasized that for other currents the slope of the curve will be significantly different. With high currents flowing, the recovery time will be longer, while with lower currents flowing, the recovery time will be faster

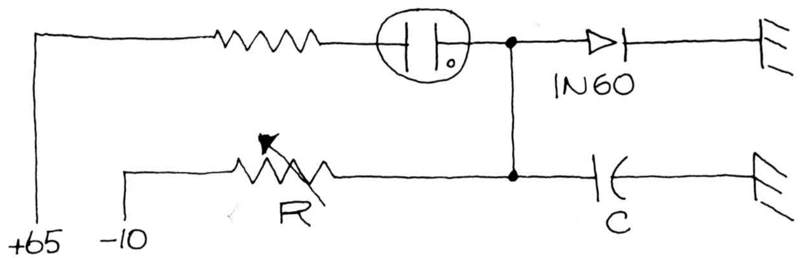
The curve was obtained by operating the above lamp at its maintaining voltage and driving it off to 1/2 its maintaining voltage with a square wave. The 1/2 maintaining voltage was chosen because it is the voltage at which the lamp recovers the fastest. The width of the drive pulse was varied and the voltage to which the tube recovered was determined at the positive excursion. For pulses less than 20 microseconds long, the tube did not recover past its maintaining voltage. As the pulse width was increased the percent of voltage recovered was approximately linearly related to the pulse width. A pulse width of about 400 microseconds was necessary before the tube recovered to its DC breakdown voltage.

For shapes other than a square wave and for voltage levels of other than 1/2 maintaining voltage the results would be slightly different than those indicated in the curve.

LONG TIMER CIRCUIT

Gentlemen

(Here is) a timing circuit using lower voltage capacitor—smaller RC for longer timing.



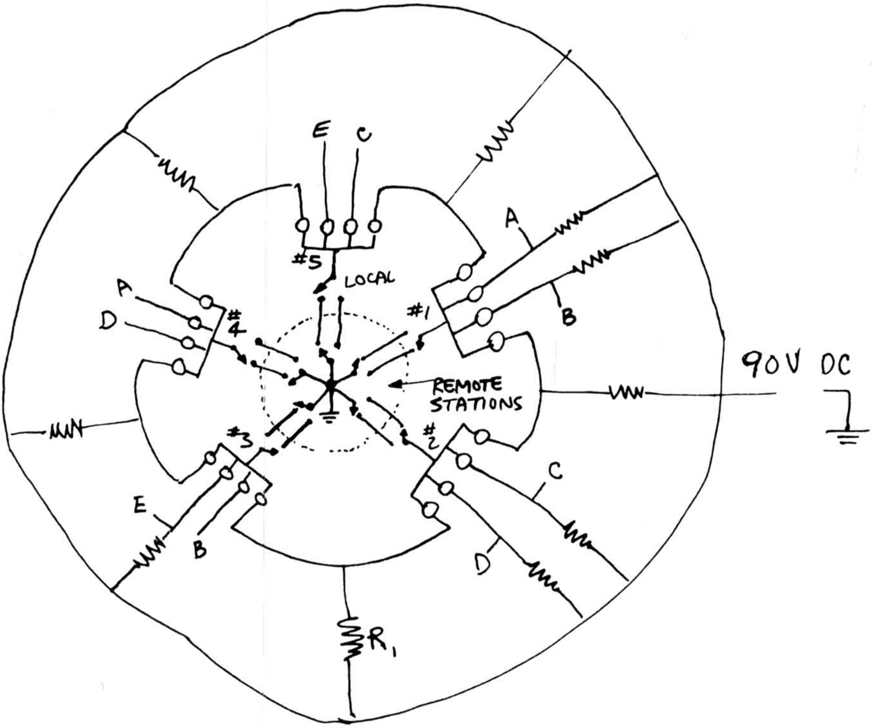
R. W Bush
Sylvania

ANSWER TO CAN YOU SOLVE THIS: Vol. 6, No. 2

LOW COST PRIORITY CALL

Gentlemen

A solution to the "Low Cost Priority Call," Vol. 6, No. 2, Signalite Application News, is as follows.



All lamps are located at one local point. Remote switches are located at stations that may call for service.

Operation

First remote switch closed lights all 4 lamps, second remote switch lights 3 lamps, etc. Correction of first station problem permits the #1 remote or local switch to be moved. This turns off all #1 lights, and permits 4 lights to burn for station 2, 3 lights for the next station, etc. Closing #1 switch again gives the station last priority

Single pole switches can be used for control from remote point only if desired.

Robert M. Reimer
Greenhills, Ohio

LOST IN THE WOODS

The Editor·

I originally devised this little "Wink" ight as a camp, trail or dock marker for use in our northern hunting and fishing country.

It has since been used for a number of other applications.

It operates happily at 60 below zero and a pair of Alkaline "AA" penlite cells operate for a period of one year if placed in service in late October During the severe winter months, the cells are fresh and active and their declining stage occurs in the less demanding summer nights.

Should the cells freeze up, the "Winker" stops in the off state and starts again when cell voltages rise to a working level (.35 volts per cell).

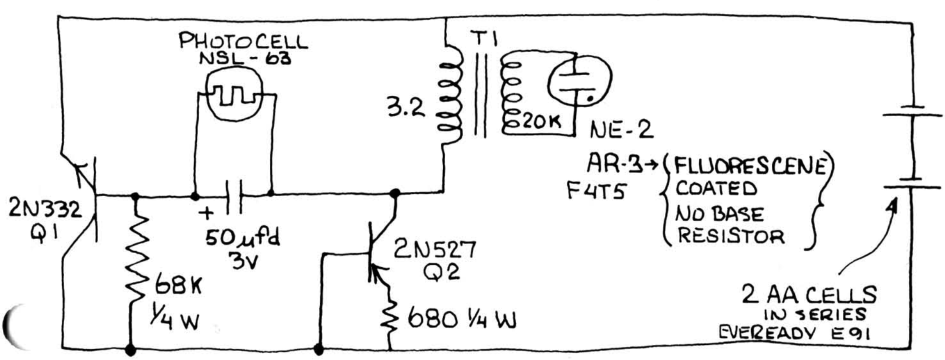
The photo cell starts the "Wink" at dusk and stops it at dawn

The off state current is (with discrete Q) less than 140 uA. The "Wink" pulse draws 100 MA for 1.2 MS. (Alkaline cells are a must for durability and low impedance).

A much brighter "Wink is obtained if the NE-2 is replaced with an AR-3 lamp (resistor removed from base of lamp) which is coated with fluorescene.

If you want a real flasher, use a 4 watt fluorescent lamp (F4T5). This flashes so brightly in a dark cabin many people find it disturbs their sleep.

One final note: If a bank of solar cells were used to "top up" the alkaline cells during daylight hours, this could be a perpetual "Wink" light.



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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*

* * * * *

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