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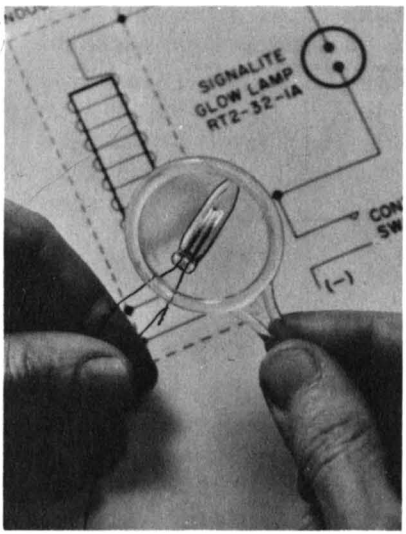
(This is the third of a four-part series of articles prepared for Signalite Application News *to help you use neon glow lamps by providing a better understanding of their principles of operation and applications. Part I, Construction, Operation and Operational Characteristics, appeared in Vol. 6, No. 3. Part II, Turn On and Turn Off, appeared in Vol. 6, No. 4. Back copies may be obtained by writing to Signalite.)*

DESIGN, OPERATION AND APPLICATION OF NEON GLOW LAMPS

By: Frank McKendry
Signalite, Incorporated



The small size, low current requirements, light output, stable voltage operation, and other characteristics of neon lamps make these devices applicable to a wide variety of tasks in electronic and electrical circuitry. Many of these applications have been discussed in previous issues of *Signalite Application News* and in the book, *Applications of Neon Glow Lamps,* by the late Edward Bauman.

While many variations on individual circuits can be constructed depending on the specific require-

Yours free . . . for telling us how you use or would like to use neon glow lamps

You can get a free Signalite Owl Eye Nite Lite simply by sending us an application for neon glow lamps, a problem or solution on their use. Each reader will receive the Nite Lite whether or not his letter is used in the Application News. In addition we welcome longer articles for feature treatment which we will also place in a leading technical magazine in your name.

ments or tasks to be performed, there are several basic circuits which can illustrate various applications. In Table I is a list of many of the applications which Signalite has provided neon lamps for—in most cases standard production lamps, in some cases specially designed lamps with unusual characteristics to meet a specific need.

Basically, the neon lamp will perform one, or a combination, of three operations. indicate, switch, and regulate. This, of course, is an oversimplification. Under switching, for example, would be included simple switching, energy transfer, memory switching, frequency dividers, oscillators, timers, proportional control, and so forth. The circuits that will be discussed here are basic circuits and are intended to show the application of the principles rather than to provide a comprehensive review of all circuit possibilities.

Figure 1 shows a straight-forward indicator circuit which tells one that power is supplied to the unit or that the unit is on. Lenses are generally used with the lamp to provide contrast and to diffuse the light. Indicators can be used on either AC or DC. The light-emitting characteristic of neon lamps is characteristic of all lamps with the exception of voltage regulators, and thus many times the lamp can be used to provide both an indicator function as well as another precision-type function in the circuit.

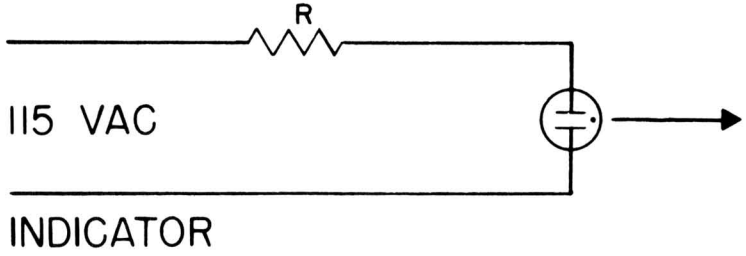


Figure 1

A simple timer circuit is shown in Figure 2. This circuit can provide time delays up to several minutes. The AC is half wave rectified by the diode and this half wave is applied to C and the lamp through R. The resistor can be a variable resistor such as a thermistor, electrodes in a solution, and the like. It limits the rate of charge the capacitor can obtain for each half cycle and, consequently, the voltage builds up slowly on the capacitor At some time after the power is applied the voltage across the capacitor will reach the firing voltage of the lamp and the lamp will turn on. The lamp will discharge the capacitor to slightly lower than the maintaining voltage of the lamp and the lamp will go off.

The capacitor now starts charging again and the cycle repeats as long as power is applied. It should be noted that it will take much

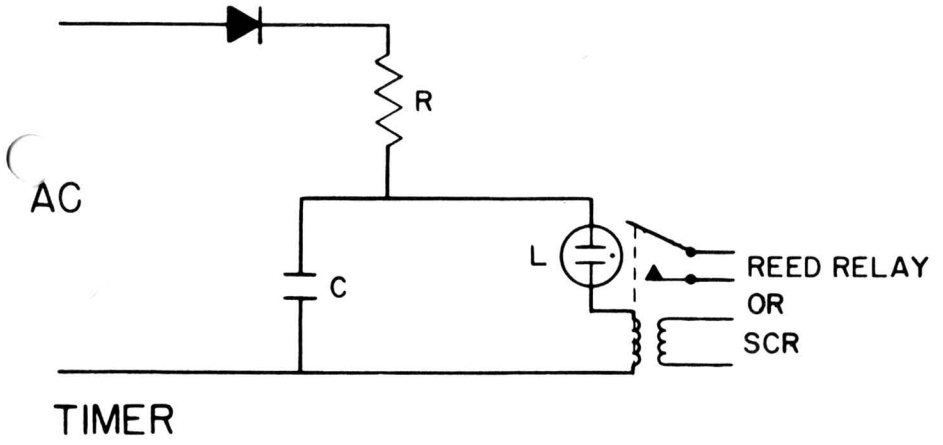


Figure 2

longer for the first pulse to occur than for subsequent pulses. This is because the capacitor is starting to charge from 0 volts initially and charges from slightly lower than the lamp's maintaining voltage thereafter For very long delays leakage resistance must be as high as 20,000 megohms. Lamps with leakage resistance as high as 1 million megohms are manufactured by Signalite.

The circuit in Figure 3 operates on a similar principle to that in Figure 2 except that DC is supplied and no rectifier is necessary For the same magnitude of input voltage, the circuit will not give as long a time delay as that of Figure 2 because only a half wave is applied in Figure 2.

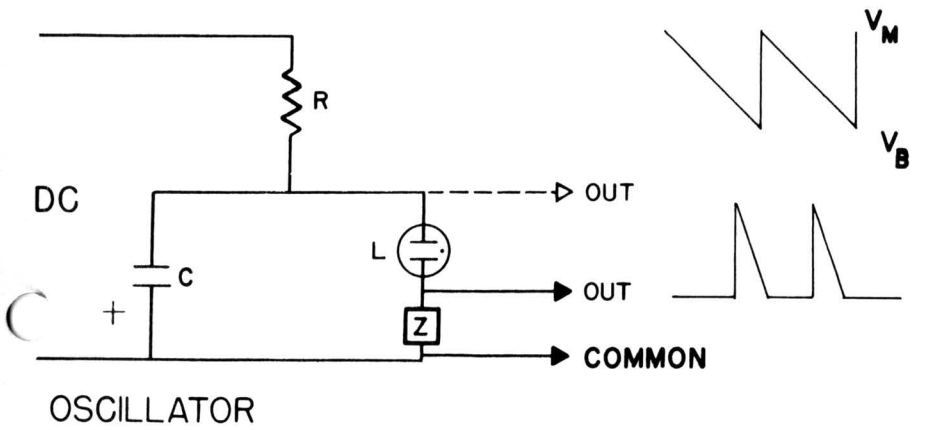
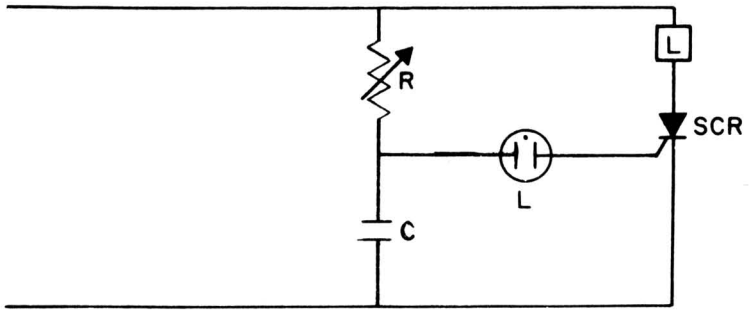


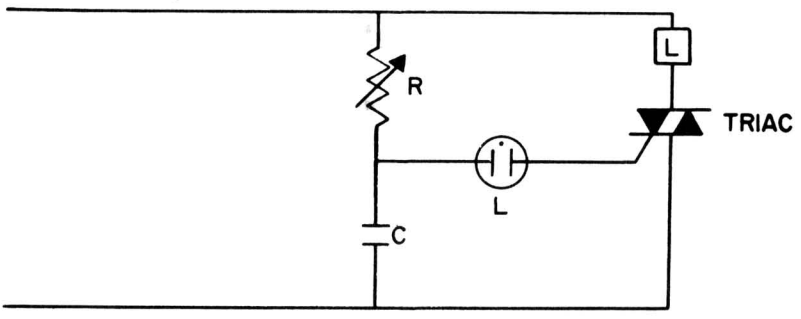
Figure 3

The circuits in Figures 4 and 5 are similar in operation and differ only in the amount of phase angle available to the load. An SCR is only functional when its anode is positive relative to its cathode. Thus, it can only function on ½ of the AC wave or for a 180 phase angle. A triac, on the other hand, will function on both halves of the line providing a gate pulse is supplied during both periods. Both halves of the line correspond to a 360 phase angle.



PROPORTIONAL CONTROL—½ WAVE

Figure 4



PROPORTIONAL CONTROL—FULL WAVE

Figure 5

The resistor-capacitor combination determines when the voltage across the lamp will reach the breakdown voltage during each half cycle. When the lamp fires it discharges the capacitor through the gate circuit and the SCR or triac will turn on. (This assumes that the anode of the SCR is positive.) On the negative half cycle the pulsing circuit supplies a negative pulse to the SCR. This is in the reverse bias direction of the gate to cathode junction and the SCR could not turn on even if the anode were the correct polarity

Triac circuits differ in that triacs can be turned on with either

positive or negative pulses regardless of the polarity across the device. Thus, on the first half cycle the positive pulse will turn the triac on, and on the next half cycle the negative pulse will turn it on. Both the SCR and the triac go off when the AC voltage goes through zero.

Varying the resistance value will cause the lamp to reach its firing voltage earlier or later in each half cycle. Therefore, the output will vary in "proportion" to the amount of the AC wave that the circuit allows to be applied. The resistor can be a potentiometer as in the case of a motor speed control, a thermistor as in the case of a heat control, or similar variables.

We recommend low gate current SCR's for most applications. Use of these SCR's results in a longer lamp life since the lamp does not have to deliver such high peak gate current.

The circuit in Figure 6 shows a series-shunt photochopper. The variable resistors shown are in fact photocells whose resistance is low when light is shining on them, and high in the dark. Lamps A and B can be controlled by external circuitry or could be installed in a flip-flop arrangement. Only one lamp should be on at a time. Lamp B is on when no output signal is desired. Photocell B essentially shorts (several K ohms) the input. Light A is off and the impedance of photocell A is many megohms. Thus, the input signal is effectively shunted.

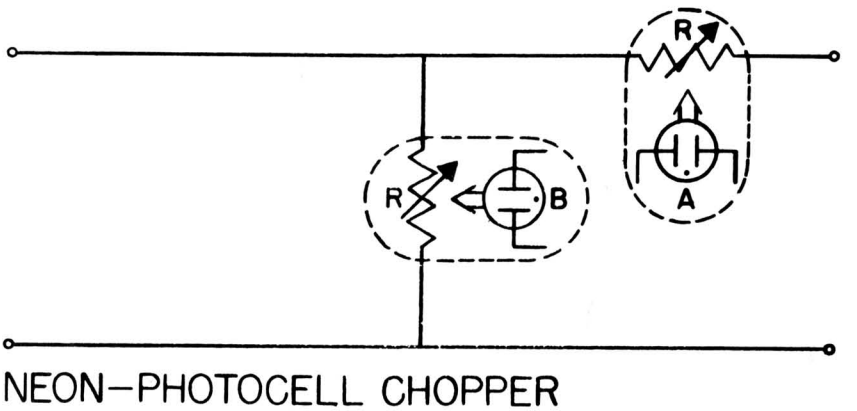


Figure 6

When B is off and A is on the signal is allowed to pass. This occurs because B is many megohms while A is several K ohms. Many other configurations are possible in the neon-photocell type circuitry.

Because of the bistable characteristics of the neon lamp, many different types of memory switch circuits can be constructed. (See Signalite Application News, Vol. 4, No. 3.)

TABLE 1

CIRCUIT COMPONENT USES	SIGNALITE APPLICATION NEWS NO.	NEON TYPE NOS.
1. Television		
Voltage Regulator		
Vidicons	5-1	Z82R7, Z133R6
Photomultipliers	3-2	Z84R2
Memory Circuits	2-2, 4-3	T2-27-1WR760, LT2-27-1A TRQ250, TRJ250
Remote Control		
Volume		A287
Color		
Hue (Tint)		
Pulse Shaper		
Horizontal		
Vertical		
Feedback - H.V.		
2. Appliances		
Timers		
Fixed	1-2, 1-3, 3-3, 5-3, 5-5	A078, A039A, A243, T2-27-1WR760, T2-27-1WR250, T2-27-1R100, RT2-32-1A
Controlled by variable		
SCR Proportional Controls	2-4, 2-5, 5-2	A230
Blenders		
Hand Tools		
3. Suppressors		
AC Line	2-1, 4-1, 5-3	A051
Lightning-Telephone Line-Low Energy		A280
Bilateral Clippers-Semiconductors, F. W. Bridge		
Suppressors (Other)	1-1, 1-2, 1-3, 2-1, 6-2	A240A-G
4. Instruments		
Choppers - DC to AC - Low Level		
Transformer	6-2	A083 (½ white)
Photocell	2-2, 6-2	A083 (½ white)
Binary Decoding - with Photocell-To Nixie, —etc.	3-3	A059
Switches with Photocell	2-1, 2-2, 2-4, 3-3, 4-1, 4-2 4-3, 5-1, 5-3, 6-1, 6-2	A057B, A059, RLT2-27-1A, TRQ250, LT2-24-1, A078, T2-27-1R100, LT2-27-1
Frequency Divider		
Clocks	4-1	
Ring Counters	3-3, 6-1	A059, A257
Organs	2-2, 2-3, 2-4	A078
Others	2-4, 2-5, 3-4, 4-4	A078, A057B, T2-24-2
Voltage Regulators - Power Supplies	2-2, 2-4, 3-2, 5-1, 6-2	All regulators
Audio Pass		
Interrogation	3-1	A280
Remote Sensing		
Moving Signs - Stock Market, etc.		A230
Displays - Alpha-Numeric		A230
5. Energy Transfer		
Electronic Match for Stoves, Etc.	4-4	A258
Flash Tube Triggering	3-3, 5-2	A051, A057B, A079, A258
Mechanical Activating		
6. Telephone Equipment - Automatic Number Identification	1-3, 4-1, 5-5	RT2-24-2, T2-27-1R100, T2-27-1W760

A simple circuit shown in Figure 7 uses a gas device for switching small signals and is used for remote control or in conjunction with a short or long term erasible memory where it might be desired to store a program or other data for three or four days, or longer, and then erase them. Low leakage is an important factor in this type of application. The capacitor leakage resistance is in the area of $10^{+18}\Omega$, at low voltages, the neon lamp leakage is $10^{+12}\Omega$ and the FET transistor leakage should be about $10^{+13}\Omega$. With these values, it has been shown that there is a loss of 5% in 1000 hours.

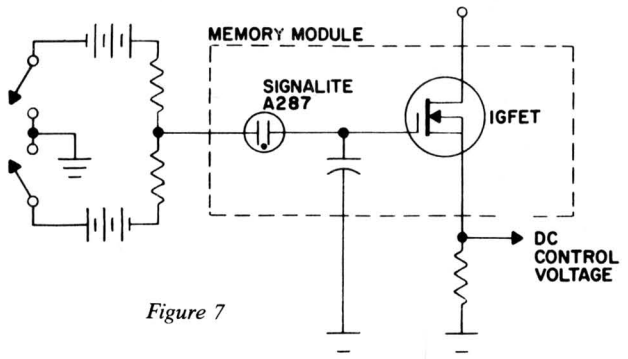


Figure 7

In this circuit when either of the function switches shown are closed, the neon lamp will conduct and allow a charge on the capacitor to be varied up or down in response to the direction of control desired. The FET transistor which is following the capacitor voltage has a function to provide the variable DC control voltage output.

Gas discharge devices can be specifically made to handle energy transfer The devices used for energy transfer operate between the breakdown voltage and the arc mode voltage. The voltage across the tube when it is in the arc mode is approximately 19v and the device has low dynamic impedance. Depending on the breakdown voltage, various energy transfer efficiencies can be obtained. The maximum energy transfer efficiency appears to be 70% with present technologies. Figure #8 shows a circuit using the energy transfer characteristics of a gas device for developing several KV to trigger a flash tube.

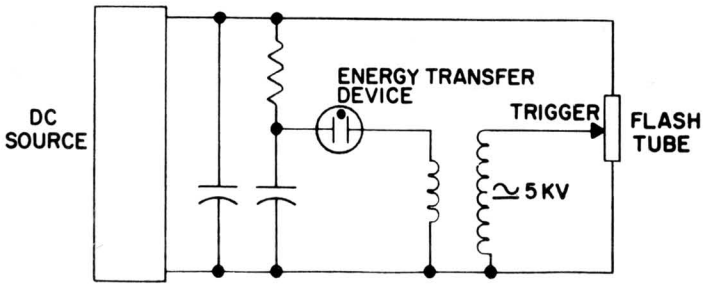


Figure 8

One of the most useful of the basic characteristics of a specially designed gas discharge device is that it maintains a constant operating voltage over a wide operating current range. Because of this these devices are widely used as voltage regulators, voltage references, surge protectors and other regulatory devices. In Figure 9 is shown a simple circuit for protecting other circuit components against the counter electro-motive force created when the current through an inductive load is opened. Under the sudden surge of counter emf, the lamp breaks down and ignites. The stored energy in the coil discharges very rapidly through the lamp. Voltage on the circuit is held to the maintaining voltage of the lamp until such time as the counter emf falls below this maintaining voltage, at which point the lamp extinguishes. The same principle applies whether the surge is counter emf, as in this case, or an externally induced surge on the power line caused by any of a variety of factors, including lightning.

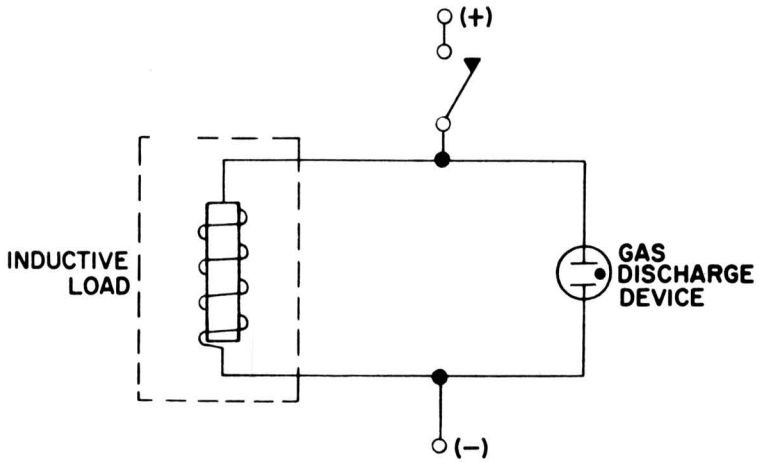


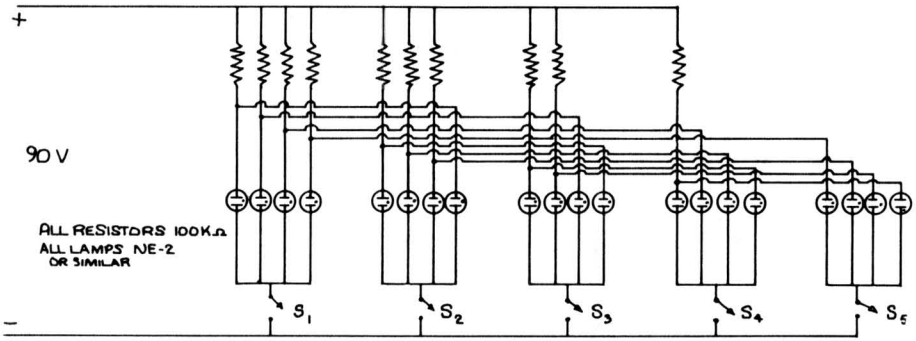
Figure 9

(Space does not permit a complete description of all types of circuits and applications that neon lamps have been used in, or are possible. Signalite always welcomes comments, suggestions and questions concerning such uses. Anyone wishing additional information should contact the Sales Department at Signalite.)

ANSWER TO CAN YOU SOLVE THIS: VOL. 6, NO. 2

Dear Sir·

A simple solution to A. F Hackman's need for a "low cost priority call" (Signalite Application News) is shown in the enclosed schematic. This is an extension of a circuit used as a game ("reflexometer"). The first switch closed will light four neon lamps, the second will light three lamps, etc. The last switch to be closed will not light any of the lamps for his station. When one station is serviced, then the switch is opened and the next to be serviced will show four lamps lit. This circuit can be extended to many more stations if desired.



The circuit works because the lamps are arranged in parallel Thus when one lamp is lit the voltage drops and will not allow the lamp in parallel with it to fire. The circuit is arranged so that when the first four lamps fire then one lamp in each other station is excluded from firing. This then happens in sequence.

Very truly yours,

E. R. Stewart
Allison Div General Motors

YOUR GLOW LAMP APPLICATION FORUM

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.

GOODBYE COLD FURNACE

Signalite Inc.

Here is my suggestion for use of neon lamps in control of oil heating systems.

I was repeatedly annoyed by failure of the burner controls discovered only when we started to shiver

The opening of safety relay contacts as a result of overtemperature or failure to ignite is now indicated by connecting across NC contacts a neon light. Thus, attention for a check-up and reset of relay is indicated visually I wish manufacturers of furnace controls would adopt this feature.

We found this innovation simple and very convenient.

Milo P Hnilicka
Chief Scientist
National Research Corp.

SORRY ABOUT THAT

(Ed. Note.

In our last issue, we published John Hamelink's circuit for a little "Wink" light used by him as a camp, trail or dock marker—see page 311, Vol. 6, No. 4. Several of our readers have written us to tell us that the circuit doesn't work, among them John Hamelink who sent us the following letter.)

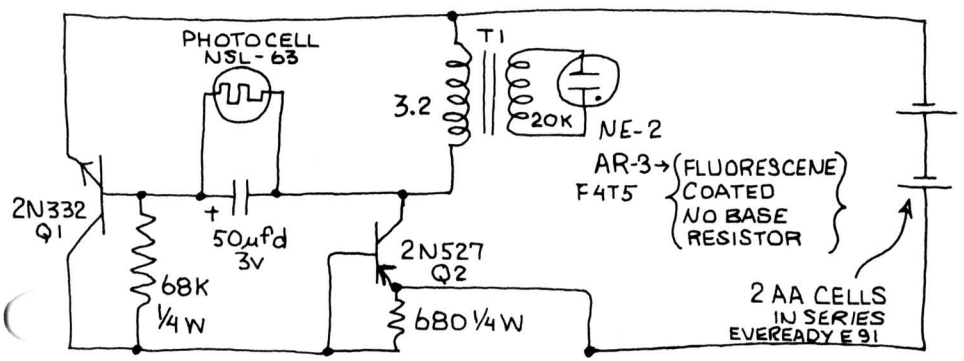
Dear Sir·

I wish to draw to your attention the "Wink" light published on page 311, Vol. 6, No. 4; incorrectly shows the battery returned to Base of Q2. This — battery should connect to the emitter of Q2.

Over the past many years, I have on many occasions demonstrated my ability to make errors and therefore I am not pointing fingers.

I have received some queries about this hookup from your readers and would suggest it a desirable courtesy to note a correction in a future issue.

A correct schematic is attached.



Yours very truly,
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* * * * *

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