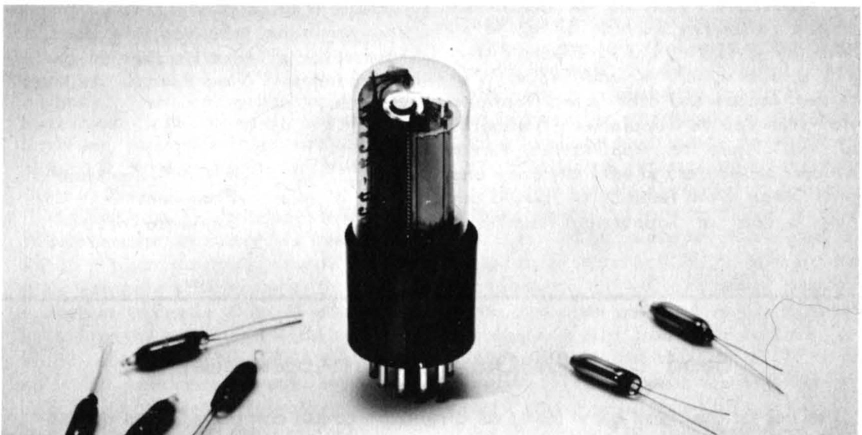
Signalite
APPLICATION NEWS

from the desk of Ed Bauman, Chief Engineer

VOL. 3, NO. 2

In this issue ...

A NEW METHOD FOR PRECISE VOLTAGE REGULATION
FOR USE WITH PHOTOMULTIPLIERS



NEONS FOR VOLTAGE REGULATION AND REFERENCE

In this issue of the Signalite Application News our lead article is devoted to the requirements for accurate voltage regulation of photomultipliers. Such accurate regulation is needed where small variations are multiplied exponentially. This accuracy can be provided with the new line of Signalite cold cathode voltage regulators recently announced.

These new tubes offer several distinct advantages over devices previously used for critical voltage regulation and/or reference. They are designed and manufactured to extremely close tolerance and exhibit a very low temperature coefficient. They are extremely stable and are available within ±1 volt of their specified reference voltage. In addition they are considerably less expensive than other types of regulation devices, such as large gas tube regulators or zener diodes.

Available for regulation on either DC or AC, these tubes are now produced in 19 models covering reference voltages from 82 to 143 volts. Specific tubes are available for regulation at the following points: 82 v, 83 v, 84 v, 91 v, 100 v, 103 v, 105 v, 110 v, 115 v, 116 v, 139 v, and 143 v. For current ranges and other specifications we refer you to Supplement Number 1 of the Signalite Application News which carries data sheets on these and other neon glow lamps. If you do not have a copy of Supplement Number 1, just drop us a line and we will be pleased to forward one to you.

GLOW LAMPS AT WORK

Also in this issue we are inaugurating a new section entitled "Glow Lamps At Work". As our long time readers know, we have devoted ourselves through the pages of the Application News to the dissemination of information on where and how neon glow lamps can be used in circuitry. While most of this information has been shown in diagram form, many readers tell us about devices and circuits which represent proven applications and are commercially available.

This new section is designed to plug a gap in our reporting by telling you about new products that have been introduced which use glow lamps in some manner. Perhaps from these, as well as from the other information which we will continue to present, you may think of ways in which your products can be improved through the use of glow lamps. If your products are already using glow lamps; send us a photo together with some information about the product and where the glow lamp is used. We would be happy to include it in a future issue. Remember, the neon tube you use does not have to be a Signalite tube to qualify for the new "Glow Lamps At Work" section.

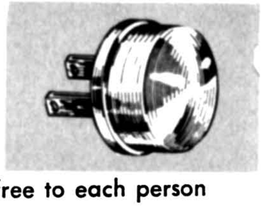
Alvin W. Gershon
President
Signalite Inc.

Send Us Your Glow Lamp Application

The use of the neon glow lamp as a reliable circuit component has dramatically increased the need for application information. We are asking that you:

1) Send application examples—both general and specific

2) Send application problems or solutions to problems that we publish



A Signalite Owl Eye Nite Lite for the home will be sent free to each person who sends us an application, a problem or a solution.

A NEW METHOD FOR PRECISE VOLTAGE REGULATION FOR USE WITH PHOTOMULTIPLIERS

by: Edward Bauman
Signalite Incorporated
Neptune, New Jersey

The past few decades have seen the development of a variety of photosensitive devices which exhibit remarkable capabilities for light detection, measurement and observation. While the earliest notation on the photoelectric effect was made by Becquerel in 1839, it wasn't for another half-century until the photoemission phenomenon was discovered by Hertz and a forerunner of the vacuum phototube was developed. It consisted of an evacuated glass bulb containing an alkali metal and an auxiliary electrode.

The modern concept of photoelectricity stems from Einstein's genius and the development of the quantum theory. His classic equation, $E = \frac{mv^2}{2} = h\nu - \phi$ tells us that the maximum energy of the emitted photo-electron, $\frac{mv^2}{2}$, is proportional to the energy of the light quanta $h\nu$ less the energy of the work function ϕ which must be given to an electron to allow it to escape the surface of the photocathode. The real progress that has been made in photosensitive cathodes, however, has paralleled the development of semiconductors and solid state technology.

An important advantage in the use of semiconductor materials over metals as the photoemitter cathode is that their quantum efficiency in the visible spectrum exceeds that of the metals by a significantly higher ratio, up to 30 per cent for semiconductors versus up to 0.1 per cent for metals. Availability of these semiconductor materials has made possible the development of special amplification techniques which are utilized in the photomultiplier tubes.

Although photoelectric emission is a relatively efficient process on a per quantum basis, the primary photocurrent for low light levels is so small that secondary electron emission is necessary to provide current amplification high enough to be useful. In the photomultiplier tube, photon energy impinging on a photocathode causes an emission of electrons. These are directed to a secondary emitting surface called a dynode. Impingement of the primary electron on the dynode causes 3 to 6 secondary electrons to be emitted per primary electron. These secondary electrons are directed to a second dynode where the process is repeated. Photomultiplier tubes may have as many as 14 dynodes. The last dynode in any case is followed by an anode which collects the electrons and provides the output signal.

In the photomultiplier the coupling and focusing of multiple secondary-emission stages (dynodes) so that the secondary electrons from one become the primary electrons of the next results in a total gain which is an exponential function of the number of stages. It is customary to describe this gain as a function of the voltage applied to the dynodes.

This indicates the necessity of providing a well regulated voltage supply for each of the dynode stages. While it is possible to operate a photomultiplier so that each stage is at the voltage required for maximum secondary emission, such a condition would require in the vicinity of 500 volts per stage. The more conventional and practical approach is to operate each dynode at the voltage which produces the maximum gain per volt. While this voltage varies from tube to tube, it is generally in the vicinity of 70 to 100 volts. Thus, again we see the need for closely regulated voltage supplies.

Depending on the method by which electrons are directed from dynode to dynode, photomultiplier structures may be classified as unfocused, electrostatically focused, and electromagnetically focused. In unfocused structures such as the grid, Venetian-blind and box types, electrons are simply accelerated from dynode to dynode by means of grids. In electrostatically focused photomultipliers a portion of each dynode serves to shape the electric field between dynodes in such a manner that secondary emission from one dynode is focused upon the optimum area of the following dynode. Mutually perpendicular electric and magnetic fields provide similar focusing of secondary electrons in electromagnetically focused photomultipliers.

The most usual type of voltage divider used for a photomultiplier tube is a series of resistors designed to divide the applied voltage equally or unequally among the various dynode stages as required by the electrostatic focusing system of the tube. (Figure 2)

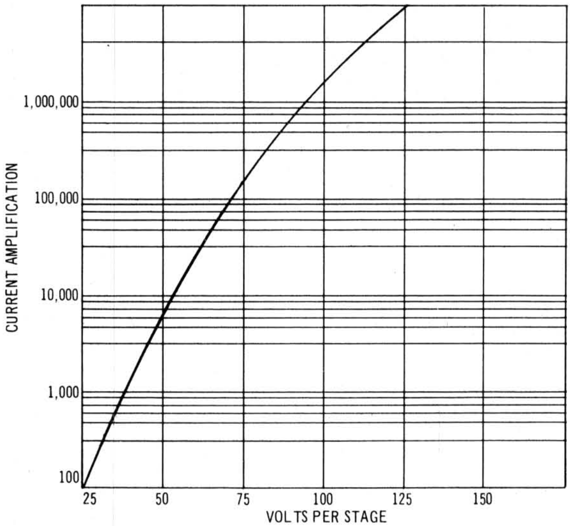


Figure 1 -- Average Amplification of Type 931-A Photomultiplier

A typical electrostatically focused photomultiplier with nine dynode stages before the collector anode may result in an overall gain of approximately one million at 100 volts per dynode stage. Variation of the amplification factor with the voltage per stage is shown in Figure 1 for a typical 931-A tube. It can be seen from this curve that photomultiplier gain is affected either by variations in the stage voltage of all the dynodes, or in the voltage of just one dynode. In practice, then, the amplification of the photomultiplier depends on the characteristics of the circuit supplying the required inter-electrode operating voltages. When this circuit is a simple resistive voltage divider, the interstage currents of the tube may alter the distribution of the dynode voltages in such manner as to cause limiting of the output current and loss of gain due to electrostatic defocusing and electron skipping of dynode stages.

In some applications the interstage currents are negligible compared with the divider current, and the relation between output current and light flux is linear. When there are significant variations in light level, these interstage currents are not negligible. This reduction in current produces the greatest loss between the last dynode and the anode. If the total applied voltage is maintained constant, the voltage lost in the output stages is redistributed among the preceding stages in a nonuniform manner. This causes unequal changes in the gain of the affected stages and may cause electrostatic defocusing, electron skipping of stages, and other effects.

Regulation of the voltage applied to the dynodes may be accomplished by either of the two following methods. One of these is to have a very tightly regulated power supply in the 1000 to 1500 volt class, and to have a high current bleeder so as to supply a low source impedance voltage to each dynode. The disadvantage of this method is that for most applications it is complex, costly and may present a severe maintenance problem.

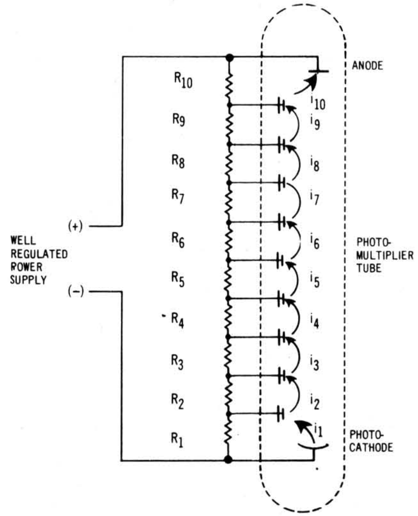


Figure 2 -- Simple Voltage Divider Network for a Multiplier Phototube

The second method is to regulate the voltage at each dynode. Several methods have been proposed and used to accomplish this. One is to use zener diodes, which exhibit good characteristics in regulation. However, they can only be used in applications where they will not be adversely affected by their poor temperature coefficients. Cost is also a factor in their selection because high voltage, close tolerance zeners tend to be prohibitively expensive.

The use of large gas tube regulators for each dynode also tends to be expensive. Frequently they do not exhibit a close enough regulation to maintain the dynode voltage within tight limits. Occasionally, they exhibit jump voltage characteristics. In some applications, their size prohibits their use.

A newer method for regulating these voltages has recently become available with the development of subminiature cold cathode voltage regulators, an outgrowth of the development program to produce neon glow lamps with the same tight tolerances as other electronic circuit components. These new tubes, manufactured by Signalite Inc., Neptune, N.J., are subminiature components whose regulation over the required current ranges is usually less than 0.1 volt (Figure 3) and whose temperature coefficient is a few milli-volts per degree Centigrade. Typical lifetime of 30,000 hours allows these tubes to be permanently wired into the circuit. Their low initial cost is well below that of other components designed for the same job. Their physical dimensions and low mass have allowed them to be used with applications of photomultipliers where there are severe space and weight limitations. (See cover photo).

A circuit for voltage regulation of

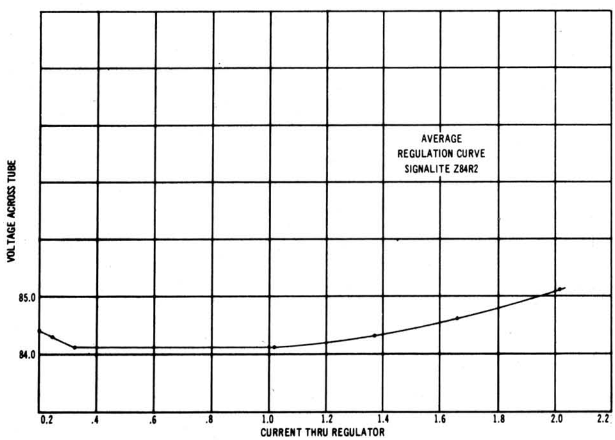


Figure 3 -- Average Regulation Curve for Signalite Z84R2

a photomultiplier tube using cold cathode voltage regulators is shown in Figure 4. This circuit was used

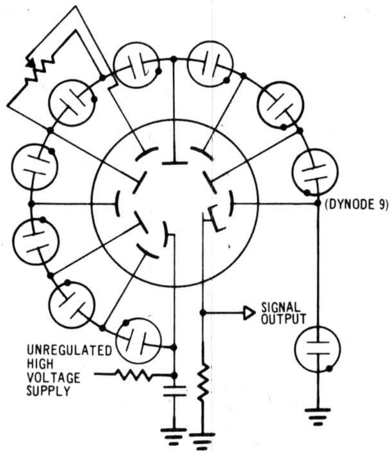


Figure 4 -- Voltage Regulation of Dynodes of a Photomultiplier Tube Using Cold Cathode Voltage Regulators (Signalite Z84R2)

with a type 931-A photomultiplier which is critically dependent on voltage. The voltage at dynode 9 of Figure 4 is plotted against the input voltage in Figure 5. Regulation is accomplished by ten Signalite voltage reference tubes, type Z84R2. These tubes have an average temperature coefficient of minus 2 mv per degree Centigrade and exhibit less than one volt change from the 84 volt reference from 0.15 to 2.0 ma. Life expectancy is 30,000 hours of continuous operation.

As was mentioned earlier photomultipliers are an important tool in detection, measurement and observation where human visual acuity is insufficient, particularly where the light level is so low as to preclude the use of other types of photosensitive devices such as photocells. Because in these applications the effects of noise or transit time can materially affect the required results, accurate regulation of voltages to the dynodes is of critical importance. These new cold cathode voltage regulators can provide reliable regulation over a long period of time in a small package and at a substantially favorable cost differential. Among photomultiplier applications which can benefit from this new development are photometry, spectrophotometric instrumentation, scintillation counters, gamma ray spectrometers, Cerenkov radiation measurement, particle size measurement, smoke detectors, celestial navigation, star tracking, flying-spot television pick-up, laser detection, timing measurement, and others. A typical photometer circuit is shown in Figure 6.

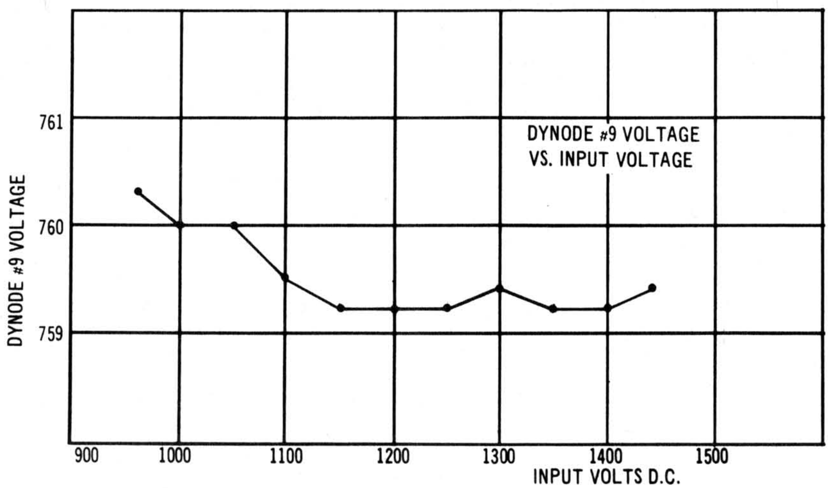


Figure 5 -- Dynode #9 Voltage vs. Input Voltage

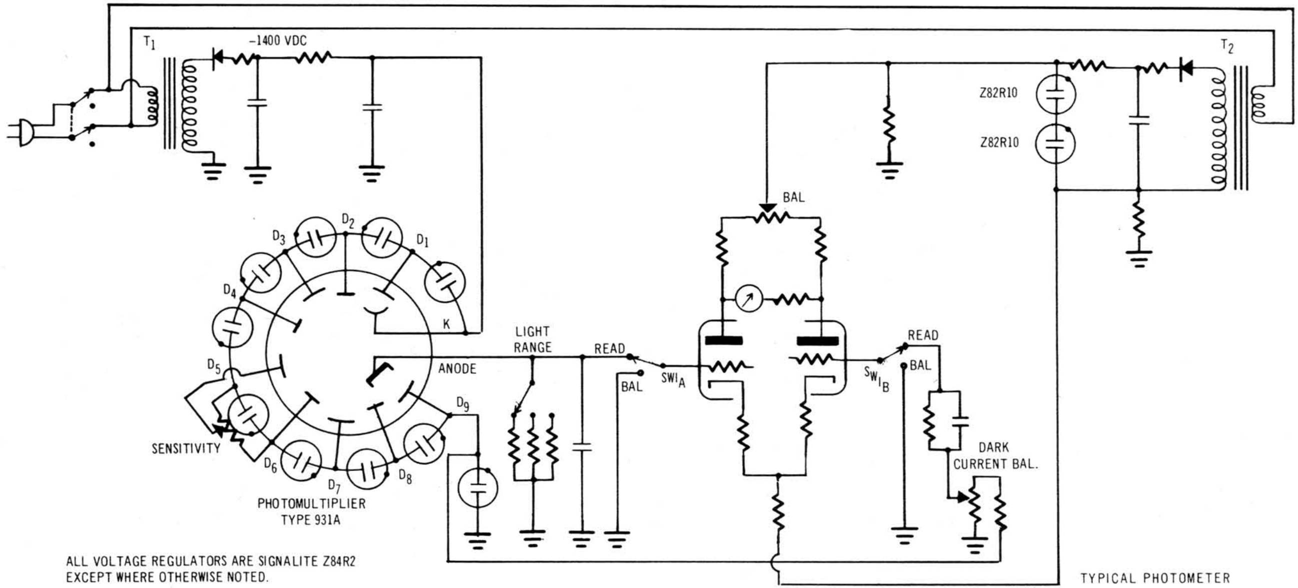


Figure 6 -- This photometer is capable of full scale readings in the microlumen range. It consists of a high voltage power supply for the photometer and a low voltage power supply for the vacuum tube voltmeter.

T1 supplies 1,000 volts AC to a half wave rectifier and a capacitor filter. This produces nominally 1,400 volts DC. This negative voltage passes through a dropping resistor and is fed through a string of 10 subminiature voltage regulators in series. Each of the dynodes is supplied voltage from a tap in the regulated voltage supply. Hence, the voltage supplied to each dynode is kept constant against variations in line voltage, dynode current or nonlinear current requirements.

The anode supplies a current through its load resistor to ground. The amount of anode current is a function of the incident light hitting the cathode. It appears as a voltage drop across the anode load resistor. In the schematic this resistor is actually a selected resistor depending on range. The voltage drop is applied to one grid of a push-pull DC amplifier. This amplifier is very stable due to the negative feedback in its cathode circuit and to its regulated power supply.

In actual operation Switch 1 is turned to the **BALANCE** position and the **BALANCE** control is adjusted for a zero reading. Next, with the photomultiplier in an enclosed housing, Switch 1 is turned to the **READ** position. The dark current **BALANCE** control is then adjusted until the meter again reads zero. The hood is removed from the photomultiplier and the light range selector switch is turned for the best reading.

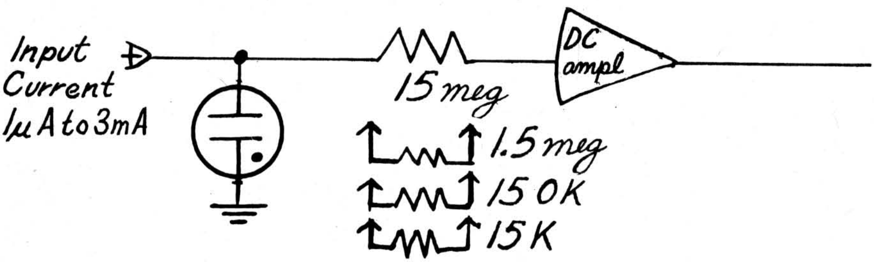
It is Signalite's policy to publish letters based on their intrinsic interest only. We do not necessarily agree with all comments and suggested uses and will upon occasion wait for your reaction before taking editorial space for ours.

All Systems Go

Dear Sir:

I wish to report use of a neon bulb in a critical circuit application where use of zener diodes would have made the circuit inoperative.

The University of Toronto Institute for Aerospace Studies built a sounding rocket nose cone successfully launched last St. Patrick's Day. On board were five cold cathode ionization gauges. The microamp signal from the gauges was amplified in a dc amplifier, as shown:



For low currents the input resistance of the amplifier was 15 meg. but for higher currents an automatic range switching circuit inserted 1.5 meg. or 150K or 15K as required in place of the 15 meg. input resistor.

The problem was that if the input current changed abruptly to a high value (say 3 mA) so that when the 15 meg. resistor was on the input, the input voltage would be 3 x 15 = 45KV! To prevent this, a voltage limiter was required. Zener diodes were considered but their high leakage at +85°C (>0.1 μA) introduced too much input signal error. The neon bulb fitted quite nicely, leakage current was low and firing voltage high. In our circuit I observed no effect due to neon leakage.

The only difficulty was input voltage clamping which was cured by using guaranteed high voltage breakdown neons. . .

J. A. Burt
Project Engineer
Univ. Toronto Institute Aerospace Studies

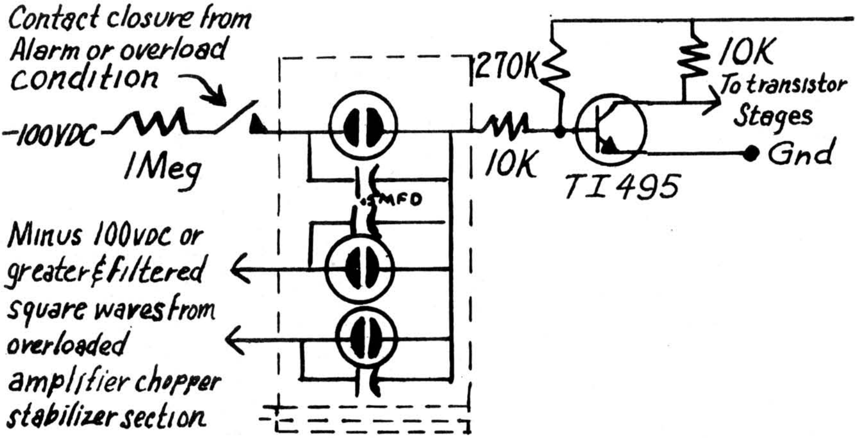
Ed Note:
Signalite's RLT2-27-1A lamp has ideal characteristics for this critical application.

Equipment Monitor

Dear Mr. Bauman:

Here is one of our applications for neon glow lamps.

The glow lamps provide visual identification as to which equipment has malfunctioned and at the same time energize a transistor driven relay to actuate an audible alarm and control circuitry.



All inputs have sufficient source impedance to limit the current flow through the glow lamps. The capacitors in parallel with the glow lamps cause them to flash as an "eye catcher".

Kenneth D. Dymoke
Phillips Petroleum Company
Atomic Energy Division

Scope Calibrator
(or general reference source)

Dear Sirs:

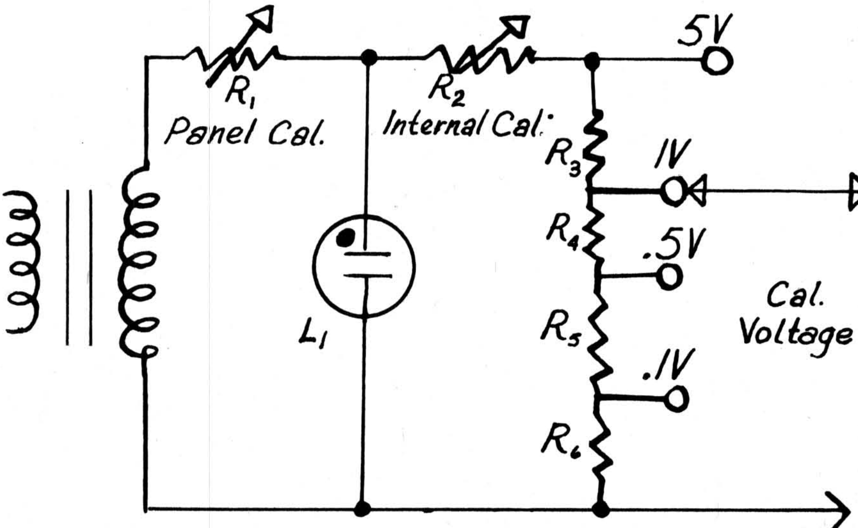
Here's an idea for use of neon bulbs. I used this circuit in an oscilloscope I constructed . . .

This calibrator uses either the ignition point of the neon bulb or extinguishing point. Once one is selected, however, it must be used from then on because the calibrating voltage is based upon this reference. I prefer the extinguishing point to eliminate possible loading problems.

R_1 and L_1 are mounted on the scope front panel. R_2 is mounted internally and is adjusted once initially to match the neon bulb being used. R_2 may be periodically recalibrated as the lamp ages.

To calibrate:

1. Connect a VTVM to the highest reference voltage tap (junction of R_2 and R_3).



2. Decrease R_1 until L_1 lights, then increase it slowly until L_1 just extinguishes. Then adjust R_2 until the VTVM reads 5 volts. Repeat this until, when R_1 is adjusted the voltage is 5 volts without re-adjusting R_2. R_2 is now calibrated.

To use:

1. Set switch to desired calibrate voltage range.
2. Adjust R_1 until L_1 extinguishes.

Obviously, any number of ranges may be used.

Ernest F. Koshinz
Glen-Tek Scientific Co.

Ed Note:
Highly reliable voltage regulators should be used in this circuit so that the calibration will not change with usage and time. Signalite has available a complete line of AC voltage regulator tubes whose specs are similar to those listed in Supplement 1, of the Signalite Application News, except that they have the same characteristics in either direction, thereby producing accurate and reliable square wave voltages. Incidentally, a dc version of Mr. Koshinz' circuit could be designed using the standard voltage regulator tubes described in Supplement 1.

Engine Performance Indicator

Dear Mr. Bauman:

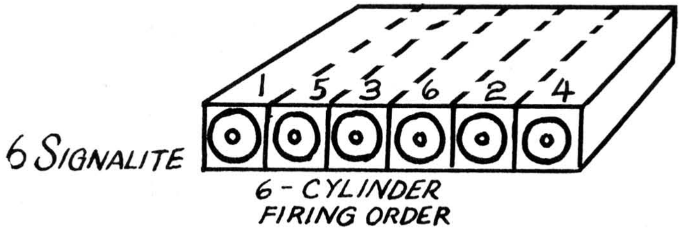
In normal operation all lamps would appear to be the same brilliance.

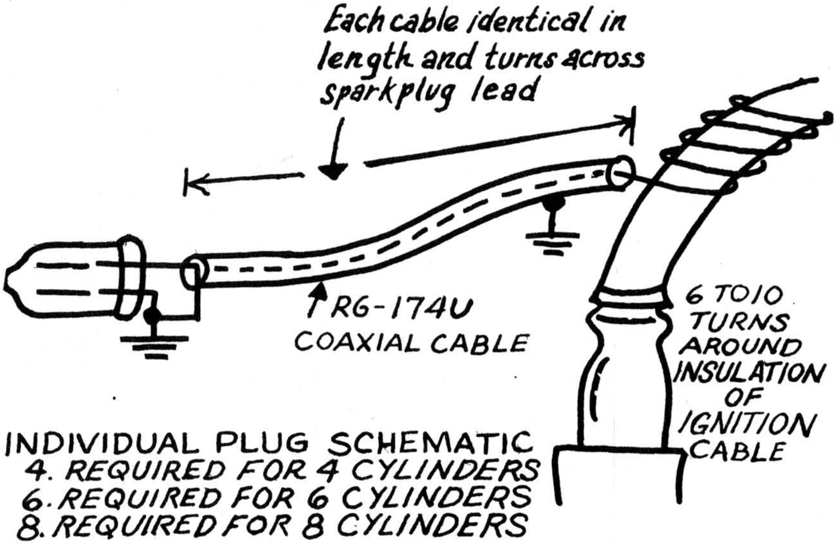
Where a single cylinder is contaminated with oil or heavy carbon, the lamp for this cylinder would appear considerably reduced in brilliance because of the lower firing voltage.

Where a cylinder appears to have a plug with very wide spacing or lean mixture, the lamp will be more brilliant.

Note: Because each lamp is capacitively coupled to the spark plug, there is no effect on the operation of the vehicle.

The capacitively coupled voltage in open circuit may vary from 500 to 5000 peak. With the lamp the voltage change reflects a current change. Thereby, changing the lamp brilliance.





The lamps should be connected in firing order, left to right, and mounted in a black honeycomb-type structure.

G.R. Scott
Senior Engineer
ITT Mackay Marine

Voltage Monitor Circuit

Dear Mr. Bauman:

An application for NE-2 Neon lamps has been found in service voltage indication of a 120/240V. lighting service, located in a hospital.

Loss of service automatically transfers load by undervoltage tripping of a main lighting breaker, followed by electrical closing of a latching tie breaker. The NE-2 lamp remains dark until service voltage returns, on which relighting occurs.

Return of service voltage permits tripping of the tie breaker, and manual closure of the lighting service breaker which had tripped.

Milton T. Brown
Detroit, Michigan

CAN YOU SOLVE THIS ? ?????

Dear Mr. Bauman:

We have recently started receiving your house publication *"Signalite Application News"* and find it very interesting.

We are most interested in any circuit that you may have available describing the use of Neon Lamps and Motor Speed Control Circuits and Stroboscope Circuits. We have an application for a stroboscope to be built into a Precision Variable Speed Motor. The range of motor speed varies from five to 5,000 RPM. We have tried a simple Strobe Disc and Neon Lamp operating at approximately 75 volts so that the "on" time is as short as possible during each half of the AC cycle. We have found, however, that at the highest motor speed the lamp is on too long a time with the result that the speed indicator is blurred and indefinite. If you have or know of any relatively simple inexpensive circuits and lamps that will permit us to pulse the light on for a short time during each cycle, we would appreciate hearing from you. Possibly some of your readers have run into the same problem.

Robert S. Marston
President
Telstar Electronics Corp.

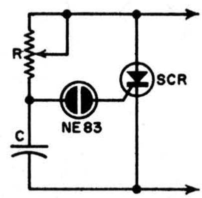
*

Ain't No 'Ornery Glow Lamps Aroun' Here

The following is an excerpt from an article, *Solid-State Dimmers & Power Controls*, in the June, 1965 issue of *Electronics World* magazine. It is published here through the courtesy of *Electronics World*. E. Bauman's answer (also below) will be published in a forthcoming issue of the same magazine.

* * * * *

". . . The main objection to the *RC* turn-on circuit are the loading of the SCR gate on capacitor *C* and the absence of a discrete turn-on pulse. Both these objections are overcome by adding a neon lamp to the circuit, as shown in Fig. 2B. *R* charges *C* until the



(B)

breakdown level of the neon is reached. At this instant, the neon ionizes and briefly conducts a turn-on pulse into the SCR gate. The precision of the turn-on is determined entirely by the neon characteristics and not by the SCR. In practice, a high-current neon, typically a low-cost NE-83, is used to provide sufficient current to guarantee SCR turn-on. The circuit is bilateral and operates equally well unilaterally.

There are several limitations to this improved circuit. The first is the intrinsic "orneriness" of neon lamps with regard to their firing levels and pulse capabilities. This is largely overcome by painting the neon black, using a fixed, short geometry, and by using only neons that have radioactive tracers added to stabilize their operating points. A second, and major, disadvantage is that a neon will not turn on at less than about 80 volts. This means that no matter how small *R* is, the circuit cannot turn on the SCR *until the a.c. line has reached at least 80 volts,* and cannot provide turn-on any later than after the a.c. line has dropped below 80 volts. This results in a reduced control range. Starting with "off", no control can be obtained until a jump to a low brilliance is achieved at 80 volts. From there, smooth control exists up to the setting at which the first 80 volts occurs. *There can never be full power applied to the load . . .*"

* * * * *

Mr. William A. Stocklin
Editor, Electronics World
307 North Michigan Avenue
Chicago, Illinois 60601

Dear Mr. Stocklin:

We have just finished reading the second article by Donald Lancaster, *"Solid State Dimmers and Power Controls"*, in your June 1965 issue. Mr. Lancaster has done an admirable job in pulling together a large amount of valuable information on his subject and is to be commended.

On one point, however, we feel compelled to take issue. On page 43 he discusses in part "the 'orneriness' of neon lamps with regard to their firing levels and pulse capabilities". A few years ago his point would have been well taken. The NE-83 lamp which he uses in many circuits certainly does have many shortcomings. As a manufacturer of this lamp we have not been satisfied with its performance in certain applications.

The problem with the NE-83 and with virtually all neon lamps designed to be used as indicators is just that. They were designed as indicators with rather loose parameters. They were not intended to meet the close tolerances demanded of circuit components in today's electronic devices.

A few years ago we at Signalite decided that something had to be done if the neon lamp were to find its proper place in electronic circuitry. The results of our efforts were announced to the industry well over a year and a half ago. A new method had been devised for the design and production of neon lamps which resulted in a product which maintained its performance and its tolerances to the same critically close level as any other component in an electronic circuit. The first lamp announced in this new series of "circuit component" glow lamps was our A059 which held its maintaining voltage at ±1 volt. Since then many new tubes have been introduced, including our line of voltage regulator and voltage reference tubes, all of which hold their tolerance of ±1 volt or less.

Concerning the use of neon glow lamps with SCR's, a very interesting discussion of this application was published by R. G. McKenna of Texas Instruments, Inc. in a recent issue of the *Signalite Application News*. In the market for light dimmers, proportional controls and motor controls, a neon tube is needed with the following characteristics: High reliability, operation in total darkness, low breakdown voltage, and the ability to handle recurring high surges of current without degradation of its electrical parameters.

Signalite's A057B tube was developed specifically to meet these requirements. Its specifications include: typical breakdown voltage in total darkness, 72 VDC; average design current, 2 ma.; peak design current, 80 ma.; maximum maintaining voltage at 2 ma., 60 VDC; average life, 10,000 hours continuous operation. (End of life is considered to be a 6 volt increase in maximum breakdown or maintaining voltage.)

This tube has had a 3-year history in the field and has been analyzed by all major manufacturers of SCR's, some of whom recommend to their customers that only this tube be used with their SCR. Its effective lifetime has outlasted many of the components associated with it.

Neon glow lamps have made tremendous strides in the past few years to the extent that the "orneriness" referred to by Mr. Lancaster no longer applies. It is important to note, however, that neo glow lamps designed and produced as indicator lamps generally do not have the reliability or close tolerances required in electronic circuitry. To try to age them into reliability, or select them against close standards does not improve the lamp and can result in an inexpensive component becoming quite expensive. It is far better to use a tube designed specifically for the purpose required.

Very truly yours,
SIGNALITE INCORPORATED

Edward Bauman
Chief Engineer

*

If your product is using neon glow lamps, send us a photograph together with some information about the product and where the glow lamp is used. It is not necessary that the lamp used be a Signalite lamp.

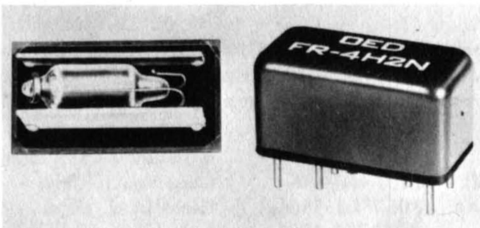
Opto-Electronic Logitron Relay

The Logitron Series, FR-N is offered in two- and four-pole, single-throw models. In this solid state switch the input is to a neon lamp and the contacts are photoconductors. Input and output circuits are completely isolated and coupled only by a light beam. Glo-Dot visual indication makes possible a fast and simple system check.

Typical ratings are 120V DC, 2 ma. input, 350mu./cell dissipation for two-pole and 125 mu. for four-pole and up to 300V DC. Provides high power gain, switching ratios greater than 10^4 with dynamic response up to 100 cps. are typical. The ''ON'' or conducting resistance is 5K or less and ''OFF'' resistance greater than 10 megohms.

Construction is compatible with printed circuit board or with plug-in assembly. Dimensions: 1" long x 1/2" wide x 3/4" high.

Opto-Electronic Devices, Inc., Subsidiary of Sigma Inst., Inc., 170 Pearl St., Braintree 85, Mass.



Fluke Voltage/Current Calibrator

The Fluke Model 382A Voltage/Current Calibrator provides accuracies of ±0.01% and ±0.02% respectively for its two-mode functions. A neon glow lamp is used in the overvoltage limit indicator circuit to supply a well regulated voltage to an adjustable divider. The output of the adjustable divider is compared to the power supply output voltage. If the output voltage increases above the voltage set by the adjustable divider, a transistor drives a current limit circuit. The output current is thus limited, keeping the output voltage from increasing above the value set by the adjustable divider across the neon glow lamp.

John Fluke Mfg. Co., Inc. P.O. Box 7428, Seattle 33, Washington.

If you have a circuit design problem involving the use of glow lamps, or have developed a circuit in which glow lamps are important for design and/or economic reasons, we would like to discuss your application in a future issue of this newsletter.

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. Your by-line and company credit will be given with your permission.

* * * * *

For immediate technical application or circuit design assistance, you may contact Ed Bauman 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:

Phoenix, Arizona	(602) 254-8889	Neptune, New Jersey	(201) 775-2490
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