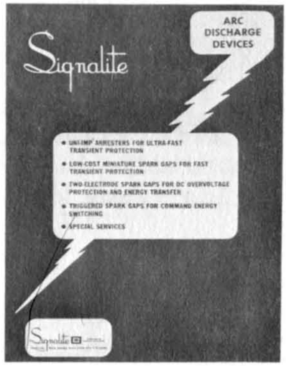
Signalite
APPLICATION NEWS
A DIVISION OF GENERAL INSTRUMENT



Vol. 9, No. 4

Signalite 1933 Heck Avenue, Neptune, N. J. 07753

SIGNALITE ANNOUNCES SUBSTANTIAL PRICE REDUCTION IN SURGE ARRESTORS

Price reductions as high as 50% have been announced by Signalite for quantity purchases of Uni-Imp® surge arresters effective November 1, 1971

In addition to lower prices Signalite has also added a new quantity category - 100 to 199 pieces. The price changes affect the UBD and UGT model series as follows:

Model	1-9	10-99	100-199	200-499
UBD	**$25.00**	**$19.00**	was $16.00 **NOW $10.00**	was $16.00 **NOW $ 7.00**
UGT	**$30.00**	**$25.00**	was $21.00 **NOW $14.00**	was $21.00 **NOW $ 9.00**

These changes cover six Uni-Imp models with ratings from 550 volts to 20 KV. For specifications of the Uni-Imp arresters write for Signalite's new catalog described on page 431.

The price reductions have resulted from the excellent rate of acceptance of these products by manufacturers of electronic equipment which, in turn, has enabled Signalite to realize substantial savings in production costs.

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

You can get a free Signalite Owl Eye Nite Lite simply by sending us an application for neon glow lamps or spark gaps, 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.

GUIDE TO HIGH ENERGY DEVICES FOR SWITCHING AND CIRCUIT PROTECTION

By· Michael I. Distefano
Signalite Division
General Instrument Corp.

High energy devices, sometimes called "spark gaps" or "surge arrestors" are highly useful circuit components with relatively obscure documentation. In order to remedy this situation and to provide all those who can utilize these devices with sufficient information to make intelligent judgements about them, the following information on characteristics and applications has been compiled.

There is quite a variety of devices which fall within the category of "spark gaps." The spark plug in your car is a spark gap using air as the dielectric. The carbon block type of surge arrestor, familiar in electric utility and telephone applications, also uses air as a dielectric. In this discussion we shall confine ourselves to the gas-filled type of device which contains two or more electrodes sealed in a chamber filled with various gas mixtures, the gas-filled gap shown in Figure 1. Because

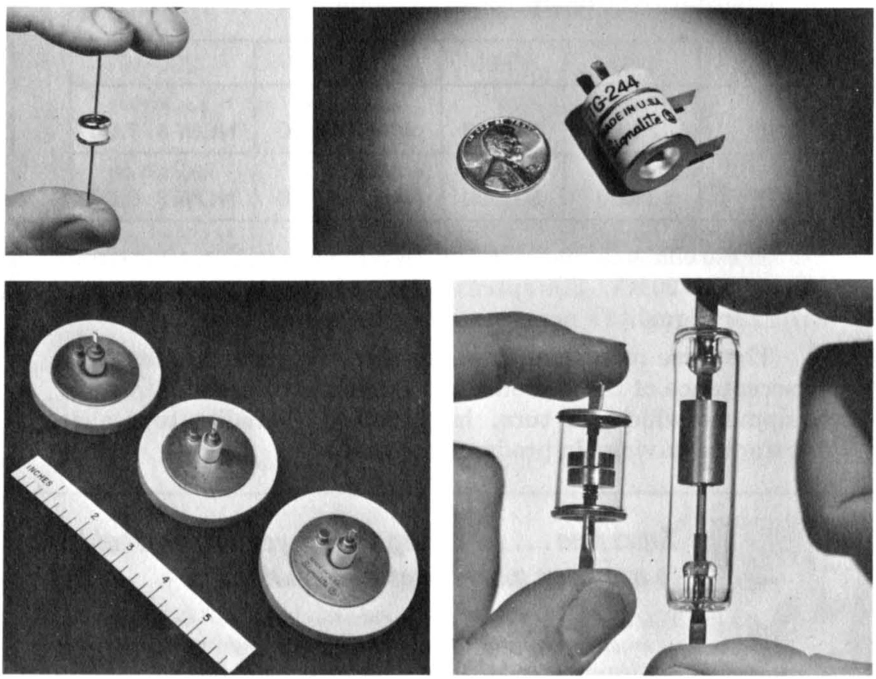


Figure 1

Typical spark gap configurations.

of its unique characteristics this type of device has two basic applications in electronic and electrical circuitry: as a protective device to prevent damage to circuits and components against sudden voltage overloads, and as a high energy voltage sensitive switch. This latter application leads to many specific uses for transfer of energy which will be discussed later

SPARK GAP OPERATION

Before detailing specific uses for these devices a brief word on how they operate is in order. Spark gaps are cold-cathode discharge devices which operate as high energy, short duration, low loss switches. Normal operation is in the arc mode with tube drops (operating voltage during current conduction) in the order of tens of volts for currents in hundreds to thousands of amperes. They present a near infinite impedance to a circuit while unfired and a near short when fired. The tube drop is a dynamic inverse function of current.

Operation of the spark gap occurs when the voltage applied is sufficient to ionize the gas in the envelope permitting a discharge from one electrode to the other. The degree of ionization is a direct function of the current through the gap during operation. Since the amount of current available is proportional to the source impedance, the "turn-off" of the gap is dependent upon the source impedance. Deionization requires a finite amount of time and is dependent upon the current level of the previous pulse, i.e., the higher the current, the longer the turn-off time. In a situation where voltage is reapplied quickly, such reapplication may find the gap not fully deionized and the gap would break down at a lower voltage level. If the source impedance is low enough to maintain conduction through the gap, provision must be made for circuit interruption before excessive energy is dissipated in the gap, ultimately destroying the unit. Spark gaps are typically designed for short term operation and should not normally be used on long duty cycle applications.

A term that is often heard in descriptions of spark gaps is "impulse ratio." This is the ratio between the voltage at which a gap fires in the presence of a steep wavefront (rapid pulse) and the voltage at which the gap fires on a slowly rising DC voltage. A ratio of unity (1:1) means that the device will trip at its rated breakdown voltage regardless of the rate of rise of the wavefront of the transient. (Note: Breakdown voltage, firing voltage and trip voltage are synominous terms referring to the point at which the gap begins to conduct and are used interchangeably throughout this discussion.) Impulse ratios greater than 1:1 define the amount of overshoot the gap will permit before tripping when the wavefront is very steep. See Figure 2.

Impulse ratio is of critical importance to the designer who is using a gap to protect sensitive components. The impulse ratio of some gaps

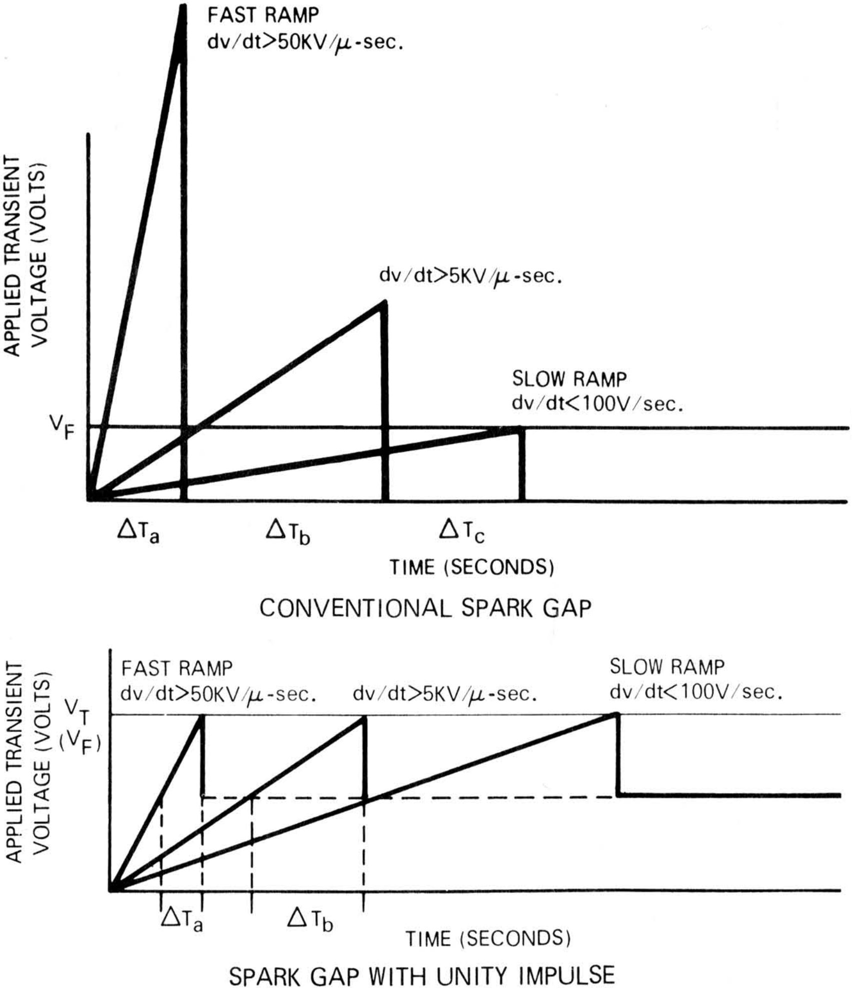


Figure 2:

In a conventional gas-filled spark gap (top), the trip voltage increases as the ramp rate of the transient pulse increases. Extremely fast pulses may damage or destroy components or circuitry because of the high firing level of the conventional gap. With a gap that has a 1:1 impulse ratio (bottom) no variation in the trip voltage is experienced regardless of the rate of rise of the transient pulse.

can be as high as 10:1. Such a poor impulse ratio could easily permit destruction of the circuit or component it is supposed to protect since harmful spikes with steep wavefronts can by-pass the gap before it can operate. If the gap is chosen on the basis of its high impulse ratio, transients with slow wavefronts will cause the gap to trip prematurely at lower voltages causing unnecessary shut-down of the circuit. Obviously, the closer the impulse ratio is to unity (as shown in Figure 2), the more reliable will be the protection.

CIRCUIT AND COMPONENT PROTECTION

Transients are found in most circuitry and are generated by a variety of causes. External transients may be induced by power surges, switching, lightning strikes, and other causes. Internal transients arise from switching of inductive loads, component failures, arcing, and other phenomena. Unfortunately, because of the indeterminate nature it is difficult to predict the magnitude, wavefront characteristics or frequency of occurrence. Although it is difficult, if not impossible, to prevent all voltage surges, some form of protection is generally a good practice and is in certain cases mandatory

A simple example of using a gap to protect an expensive component, in this case a capacitor, is shown in Figure 3. An overvoltage on the line is sensed by the spark gap which fires and shunts the surge before it reaches destructive levels.

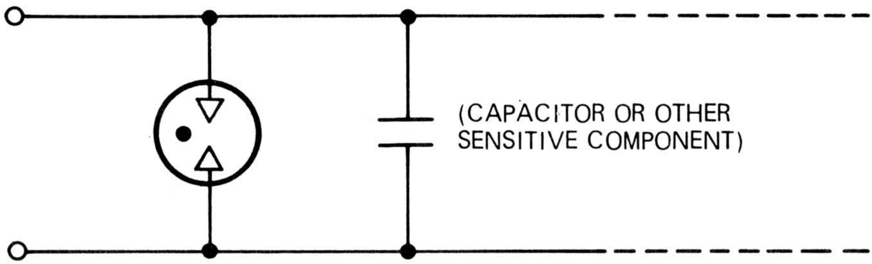


Figure 3:

Basic circuit for using a spark gap to protect a component against overvoltage.

A power line application using a spark gap to protect the distribution transformer and the load components is shown in Figure 4. A spurious transient pulse voltage may be caused by any of several

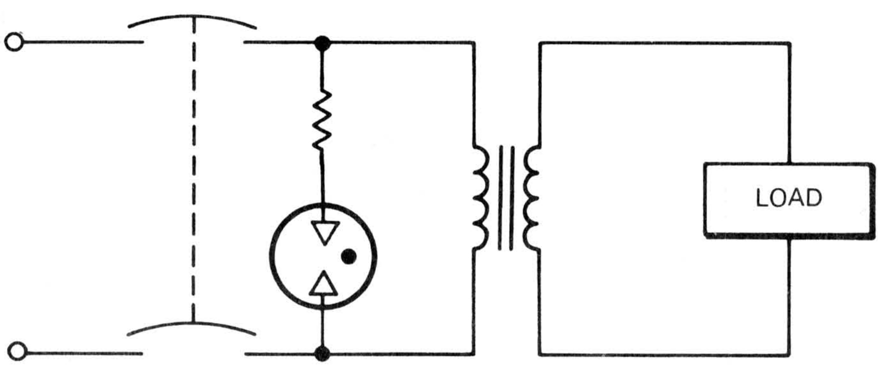


Figure 4:

Typical application of spark gap to protect circuit and components against spurious incoming pulse voltages.

reasons, such as lightning discharges, a short circuit in an inductive load, induced voltages from external transmitters or line transients from the primary circuit.

Another approach to protecting the circuit or components from transients on an AC line is pictured in Figure 5. If the transient has sufficient energy to ionize the protective gap to a point where the gap's sustaining voltage is less than the applied line voltage, the follow-on

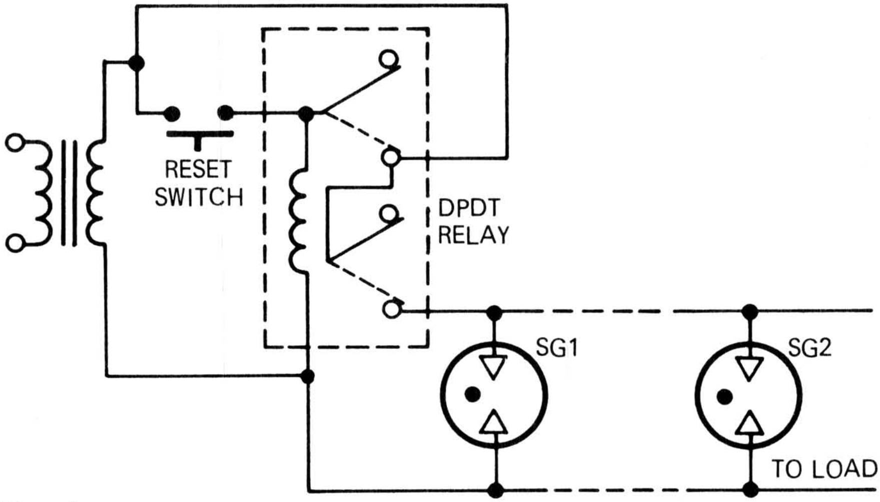


Figure 5:
Transient suppression on line voltage using a two-element spark gap. A second gap (SG2) may be added as shown for additional protection.

current, whose magnitude depends on the source impedance, will continue to flow. Passage of this "short circuit" current will drop the voltage actoss the relay coil below its drop-out value and the relay will interrupt the supply to the load and the spark gap. Manual or automatic reset and zero crossing switches can be added.

Figure 6 illustrates spark gap protection of a modulator circuit. The gap is mounted across a radar pulse transformer secondary that has a normal repetitive pulse voltage applied across it. A magnetron misfire causes a buildup of voltage across the pulse transformer secondary which could become many times the normal level. This spurious voltage causes the gap to discharge and conduct the transformer current through it. As soon as the transient condition has passed (that is, the magnetron starts firing again), the normal magnetron current flow is restored.

ENERGY TRANSFER SWITCHES

The gas filled spark gap is, by virtue of its nature of operation, a short duration, high energy switch. It is capable of handling high peak

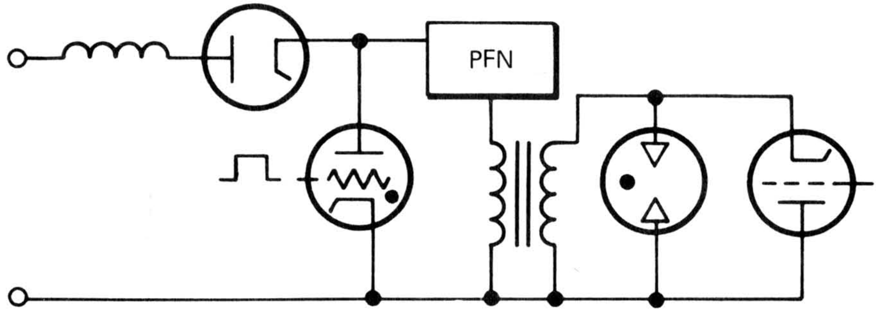


Figure 6:
Spark gap protection of RF modulator circuit.

power loads in the megawatt range for short durations. As such it has a variety of applications in transferring pulses in such applications as exploding bridge wires, triggering flash tubes, capacitive discharge ignition systems, etc.

A typical circuit for using a spark gap to trigger a flash tube is illustrated in Figure 7 Voltage from the DC source is stored in the capacitor and, when the trip voltage of the spark gap is reached, is released through the transformer to trigger the flash tube. When the

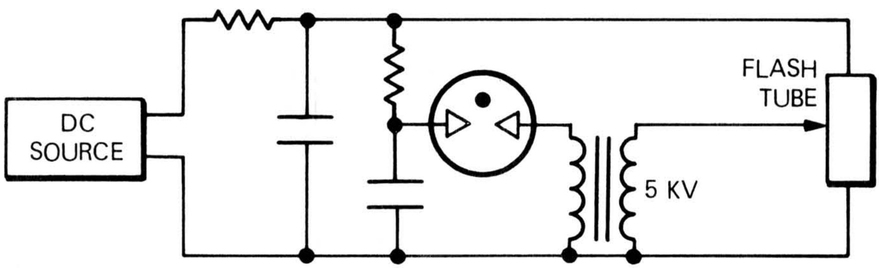


Figure 7:
Typical circuit for triggering a flash tube using a two-element spark gap.

charge on the capacitor is decreased below the sustaining level of the gap, it extinguishes and the capacitor again begins to charge, providing a relaxation oscillator operation for the next discharge to fire the flash tube.

The circuit shown in Figure 8 is actually a test circuit for generating a high energy transient to evaluate another spark gap (SG2), although it could also be used to provide a pulse in a 440 volt line for other purposes as well. Spark gap SG1 is used to apply a 1000 ampere short duration transient pulse to ionize the gap under test (SG2) to a point where the maintaining voltage across SG1 is less than the voltage across capacitor C1. This allows the energy from C1 to be dissipated

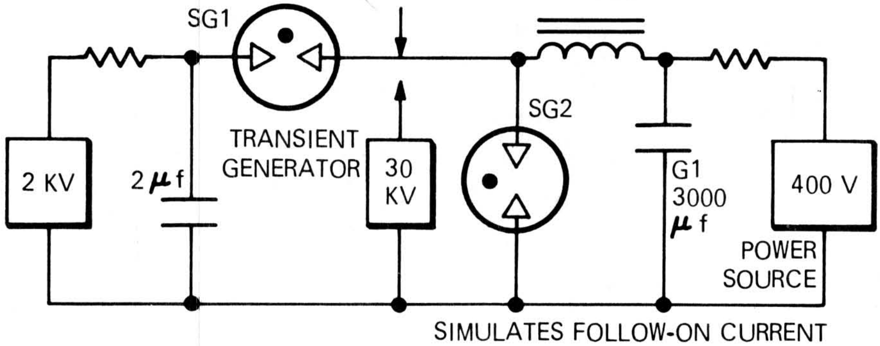


Figure 8:

In this circuit spark gap SG1 functions as an energy transfer switch and gap SG2 functions as a transient suppressor. If desired, gap SG1 could be replaced by a triggered gap and the transient generator would then be replaced by a trigger transformer.

across SG2 producing a current pulse of approximately 100 amperes peak and 8 milliseconds base width. The purpose of this test is to simulate a half-cycle follow on current from a 60 Hz source with 100 ampere peak value.

TRIGGERED SPARK GAPS

The three-element triggered spark gap is a circuit component which permits high levels of stored energy to be switched in fractions of a micro-second. These high levels of stored energy can be switched on command by low energy control pulses. Triggered gaps require no standby power, are relatively small in size and are extremely rugged for severe environmental requirements.

As with the two-element spark gap, the triggered gap presents a near infinite impedance to the circuit before ionization. Trigger energy can be provided by a trigger transformer, capacitor discharge, or some similar means. When the trigger voltage reaches the breakdown potential, a low energy discharge takes place between the trigger and

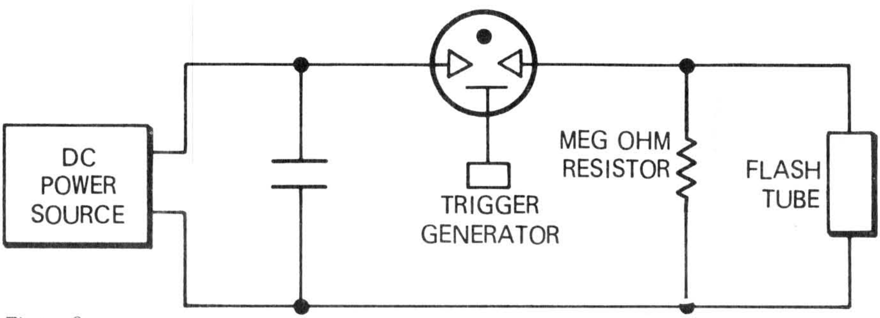


Figure 9:

Triggered spark gap used to fire flash tube.

adjacent electrode. This causes the high energy main discharge to take place.

A variation on the circuit for triggering flash tubes discussed above is shown in Figure 9. Firing of the spark gap is controlled by the trigger generator which then permits discharging of the capacitor to activate the flash tube.

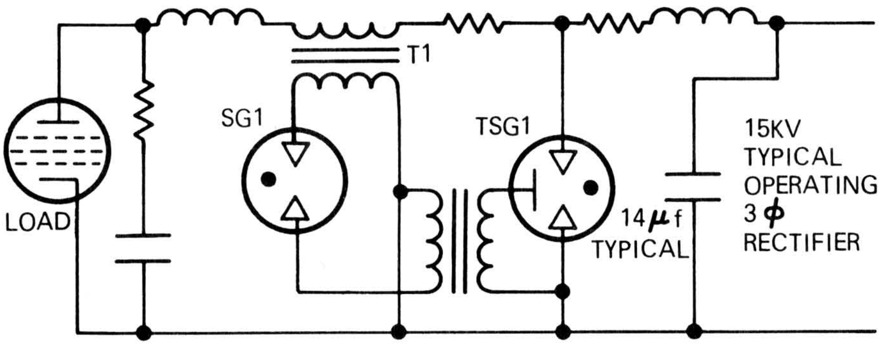


Figure 10:
"Crowbar" circuit for fast protection against overcurrent surges.

Depicted in Figure 10 is a crowbar circuit for extremely fast protection of the circuit from overcurrent. An arc fault occuring in the load causes excessive current to be drawn from the supply capacitor. The stored energy in this capacitor would destroy the grids in the load if allowed to dissipate there. Transformer T1 senses this overcurrent and provides a trigger pulse to the fast acting triggered gap which then "crowbars" the remaining energy in the capacitor and prevents

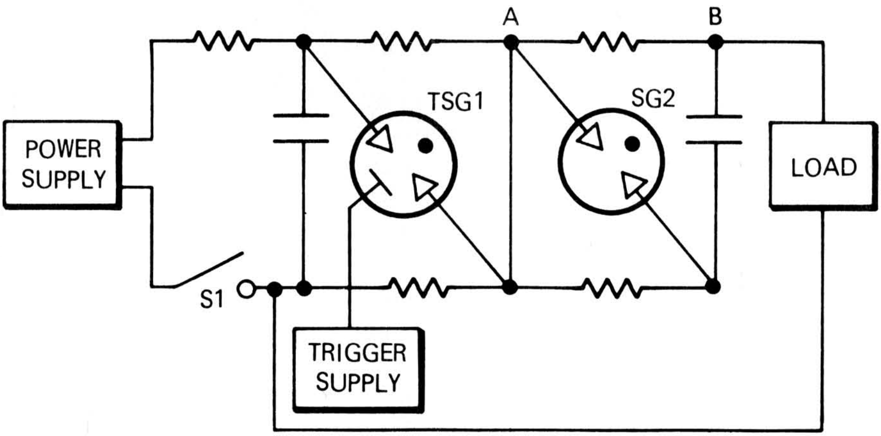


Figure 11
Typical Marx Generator using three-element (TSG1) and two-element (TSG2) spark gaps.

destruction of the load. At the same time fuses or circuit breakers in the supply primary circuits are activated, thus removing all power The two-element gap shown in this circuit acts as a regulator to prevent spurious firing of the triggered gap.

The circuit for a Marx Generator is illustrated in Figure 11. In operation all capacitors are charged in parallel. After switch S1 is opened a low level pulse is applied to the trigger electrode in the triggered gap SG1 from the trigger supply. When this gap fires the voltage at point A is doubled providing an overvoltage pulse to the two-element gap SG2 which then fires. Voltage at point B then is tripled.

CONCLUSION

In recent years considerable progress has been made in the design and production of spark gaps to the point where they can be used far more widely than previously. Overall dimensions have been reduced. Uni-Imp gaps are now available with unity impulse ratios which operate in "zero" reaction time. Trip voltage ratings for the Uni-Imp start at 550 volts and go as high as 30 KV Another series of gaps, the Comm-Gaps , ideal for protection of telecommunications lines and solid state circuitry, start at 75 volts and go up to 1000 volts. Not all gaps have the same characteristics, however, and it is recommended that Signalite be contacted if there is any question on the application.

YOUR GLOW LAMP APPLICATION FORUM

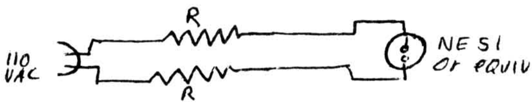
It is Signalite's policy to publish letters based on their intrinsic interest only. We do not necessarily agree with all comments and suggested uses and will upon occasion wait for your reaction before taking editorial space for ours.

DETECTING TRANSMITTER RF LEAKS

Gentlemen

How about an RF Sniffer? This would be a device about the size of a fountain pen with a linecord and an AC plug coming out the back of it. In the front end would be the sniffer

The sniffer circuit would be as follows.



R would be high enough to just fire the bulb.

With the bulb just barely lit, when it is put in an RF field, it will glow blue or purple. This is used for locating RF leaks around door edges and seams of transmitter cabinets and along cables.

This circuit is nothing new, but putting it in a handy container would eliminate a lot of problems caused by bare leads, etc , caused by hastily constructed "sniffers".

Thank you,

George R. Keller
WCBS-TV (Transmitter)
New York, N Y.

Ed Note If the RF field is strong enough, there may be no need for the AC supply

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Drop Us A Line . .

If you have an interesting application of neon glow lamps or spark gaps in your circuitry . or a problem concerning the use of these components, 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 interest.

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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