Signalite

APPLICATION NEWS

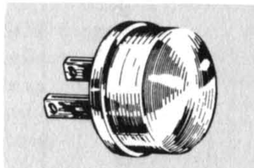
from the desk of

Ed Bauman, Chief Engineer

VOL. 2, NO. 4

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.

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Neon Lamp Triggering of SCR's in Proportional Power Control Applications

by: R. G. McKenna

Manager of Power Device Characterization

Texas Instruments, Inc.

Industrial, commercial and consumer applications of the silicon controlled rectifier have increased rapidly during the past several years. Many of these applications are in proportional power control circuits operating at power-line frequency, such as heater controls, motor speed controls, and light dimmers. In spite of the varied nature of these applications, and the different size SCR's dictated by the load requirements, they all have a common need for some sort of phase-shift triggering circuit. The neon lamp in a synchronized relaxation oscillator provides a natural and practical answer.

The SCR is very well suited to pulse triggering, if certain precautions are observed. Since the SCR is a bistable device, it needs only to be triggered with a short duration pulse to enable it to switch from the blocking state to the conducting state. However, it requires a certain minimum amount of energy (or charge), and, when used with inductive loads, a certain minimum triggering pulse width (dependent upon its latch-in current, and the rise time of the load current). Figure 1 shows a typical curve for I_{GT} vs PW for the Texas Instruments TI 40A2 industrial type SCR. This curve assumes a resistive load. The curve shows that a pulse width greater than 10 μsec should normally be used. But when inductive loads are controlled, the triggering pulse width must be longer than the anode current rise time to the latch-in current level.

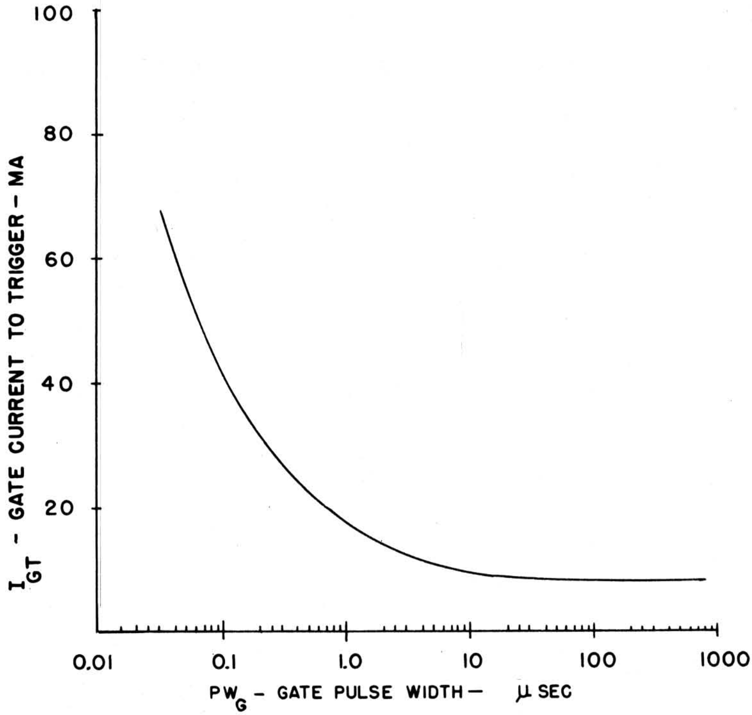


FIGURE 1. TYPICAL GATE CURRENT TO TRIGGER THE TI-40A2 VS. GATE PULSE WIDTH

The A057B neon glow lamp manufactured by Signalite Inc., Neptune, N. J. is designed to operate with a 75-mA recurrent peak surge current at a 10% duty cycle, and is capable of providing sufficient triggering energy for all but the largest SCR's. Figure 2 shows the current wave shape into an SCR gate when a 0.1-μfd capacitor is discharged through the A057B. The 20-μsec pulse width is sufficient to trigger TI 40A0 series SCR's controlling resistive, capacitive, and most inductive loads. Such loads include universal motors used in most small hand tools and appliances. If more highly inductive loads must be controlled, a larger value capacitor may be used if care is taken to add limiting resistance in series with the neon lamp to limit its peak current to 75mA.

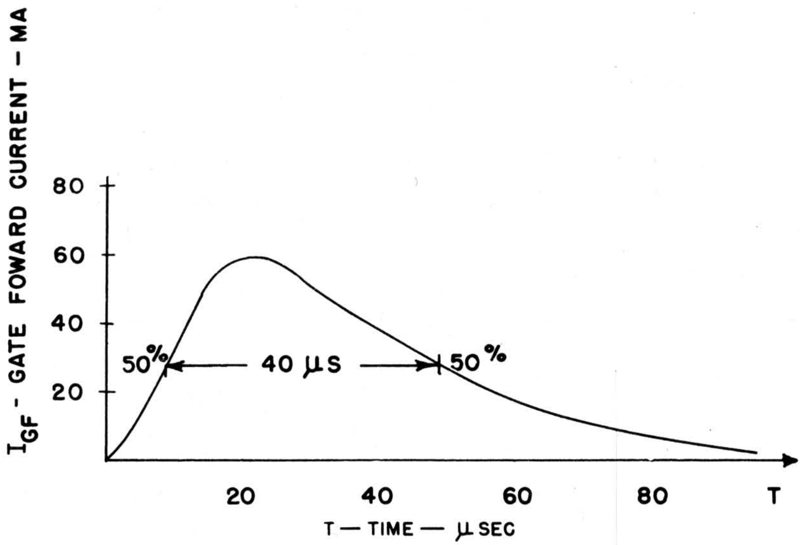


FIGURE 2. TYPICAL GATE TRIGGER CIRCUIT WAVE SHAPE

Figure 3 shows the RMS power supplied to a load by an SCR triggered by a phase shift circuit of the kind shown in Fig. 4. This basic proportional power control circuit is capable of providing a minimum conduction angle of approximately 40°, and a maximum conduction angle of about 150°. This is a range of from 24% to 95% available power in a half-wave circuit supplied to the load.

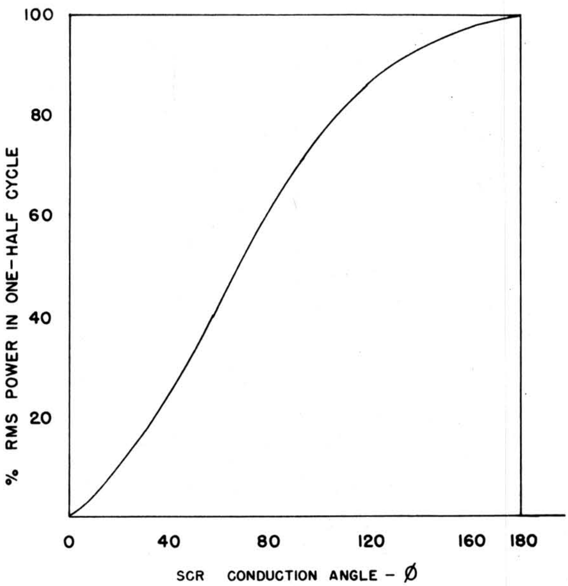
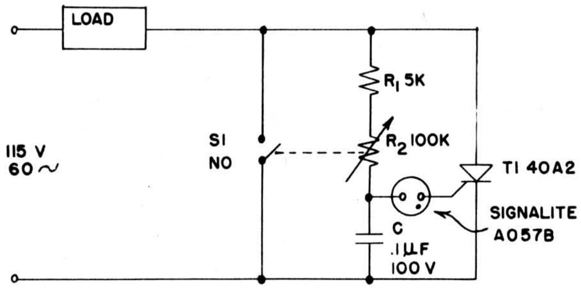


FIGURE 3. % AVAILABLE RMS POWER IN ONE-HALF CYCLE VS. SCR CONDUCTION ANGLE

In operation, resistors R_1 and R_2 in combination with capacitor C form the time delay circuit. During a positive half-cycle of sine wave voltage, C charges at a rate determined by R_1 plus R_2. When the voltage across C reaches the break-over voltage of the Signalite A057B (75 volts typical) the neon lamp will break back to a maintaining voltage of approximately 53 volts, allowing the capacitor to discharge into the gate of the SCR. Since the SCR is only capable of conduction in one direction, it can only be made to supply one-half cycle of sine wave current to the load. Switch S_1 is ganged to the potentiometer, so that it closes at the end of the clock-wise rotation of the pot, applying full power to the load.



NOTES: 1. SI IS A NO CONTACT WHICH CLOSES AT CW END OF POT TO APPLY FULL POWER TO THE LOAD.
2. THE TI 40A2 WILL HANDLE UP TO 600 WATT LOADS, IF MORE POWER IS REQUIRED, THE TI X92 WILL HANDLE LOADS UP TO 1.5 KW.

FIGURE 4. HALF WAVE PROPORTIONAL POWER CONTROL

The symmetrical control circuit shown in Fig. 5 uses two RC circuits with a common R to control the firing point of the two A057B's triggering the two SCR's. Diode D_1 shunts C_2 to supply the charging current to R_1 R_2 C_1 on the positive half-cycle, while D_2 performs a similar function on the negative half-cycle. When this circuit is used for an incandescant light dimmer, it may cause a small amount of flicker at initial stages of conduction at low light levels. This is due to variation in values of C_1 and C_2, as well as in the break-over voltages of the A057B's. A solution to this is to reduce the value that allows minimum conduction angle before flickering. The lamp may then be dimmed to this level, and S_1 opens at full CCW turn of the potentiometer to turn the lamp off. The LC_3 filter reduces the radio frequency interference (RFI) caused by the fast turn-on of the SCR's, and the resulting high-frequency components generated by the high di/dt. The 150 μh shown is a minimum effective inductance, and for critical applications, 500 μh or more may be required. The 0.067 μfd is a good nominal value of filter capacitance, and a maximum of about 0.1 μfd should be used to prevent unnecessarily high surge currents through the SCR at turn-on. A simple filter such as this is sufficient for proportional power control circuits used for home light dimmers and appliance controls. Proportional power controls used to control such inductive loads as universal motors do not need the filter, as the motor provides the inductance. (Usually, the RFI from the brushes is substantially higher than that from the SCR, so the RFI from the di/dt is insignificant anyhow!)

When a motor is controlled, it is wise to make R_1 an adjustable resistor, so that the maximum resistance in the timing circuit may be set to provide a minimum conduction angle for the SCR's. This allows the minimum speed of the motor to be set above the speed where it begins to "cog," or run with bursts of power.

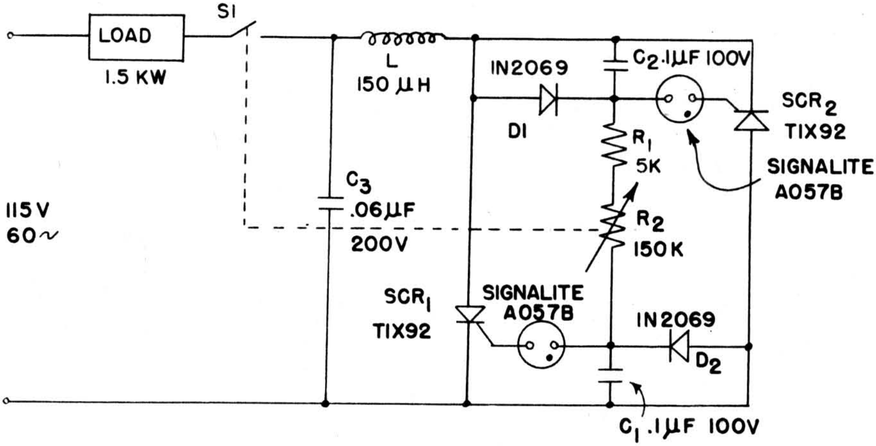


FIGURE 5. DIRECT COUPLED SYMMETRICAL POWER CONTROL

Figure 6 shows another version of a symmetrical power control using a single timing circuit providing 120 pps pulses to the SCR gates through the pulse transformer T_1. Since the same timing circuit fires both SCR's in this circuit, it eliminates the unsymmetrical firing problem, and the resulting flicker of tungsten loads, discussed above for Fig. 5. Because of the alternate positive and negative voltages to which capacitor C charges, and the change in magnitude of these voltages before and after the A057B neon bulb fires, there is a hysteresis effect in the control characteristics of this type circuit. As R_2 is decreased from its maximum value, C is allowed to charge to a higher voltage on each half-cycle. When it charges to the firing voltage of the A057B, the SCR is turned on, shorting the control circuit voltage, so that on the next half-cycle, the capacitor starts charging from a low voltage, and will charge to the neon lamp firing voltage at an earlier firing angle. The potentiometer resistance may now be increased to phase back the SCR firing angle, giving a hysteresis effect.

The transformer T_1 is not critical. The Sprague 31Z286 is a 1:1:1 with $L_p \approx$ 10 μh designed for SCR triggering. An equivalent transformer, such as a simple 1:1:1 with 40 turns per winding on a ferrite or soft iron core, may also be used.

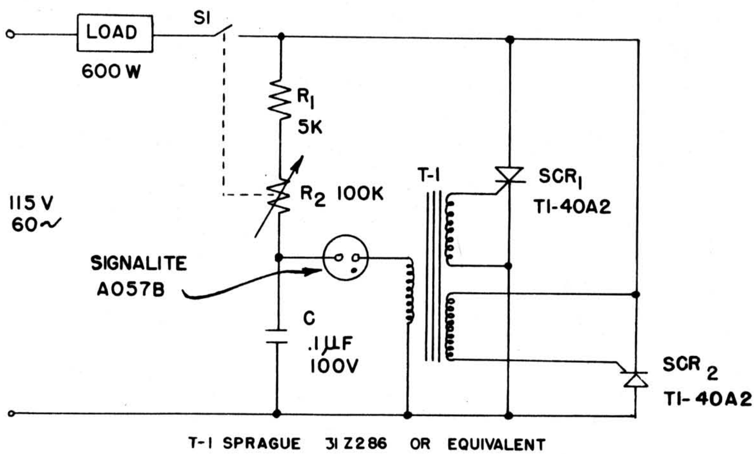
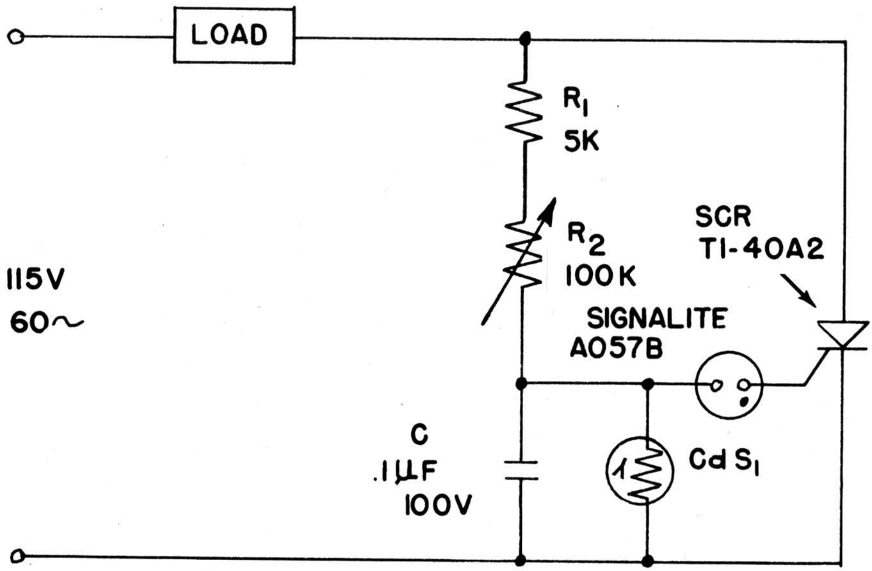


FIGURE 6. TRANSFORMER COUPLED SYMMETRICAL POWER CONTROL

A photocell-controlled light dimmer may be made by adding a cadmium sulfide photocell across the timing capacitor of the circuit in Fig. 4, as shown in Fig. 7. The photocell has approximately 1 megohm dark resistance, which has very little effect on the phase shift circuit, but the light resistance of less than 1 kilohm is sufficient to prevent the capacitor from charging to the neon lamp firing voltage. This results in an out-of-phase light-controlled light dimmer. The light level may be set manually with R_2, when the CdS cell is dark, and the light will be dimmed below that level as the CdS cell is exposed to light, until the light is "dimmed off" completely. Variations in the component values may be made to set the light sensitivity level of the circuit. To reduce the sensitivity, a photocell with a higher light resistance range may be used, a resistor may be added in series with it, or the capacitor value may be increased, (with appropriate changes in R_1 and R_2). The opposite changes will tend to increase the circuit sensitivity.

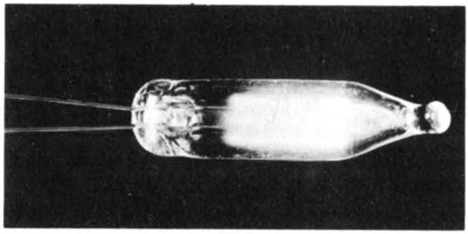


Cd S1 – JEM POWERMASTER CDS 113 CADMIUM SULFIDE CELL OR EQUIVALENT

FIGURE 7. PHOTO-CELL CONTROLLED PROPORTIONAL POWER CONTROL

Circuit possibilities are endless. Transistors may be introduced into the timing circuit to permit electronic control and feedback control circuits. However, in circuits of this type, the stability of the firing angle becomes more critical. Since this is directly dependent upon the stability of the neon lamp, it becomes a critical component. Lamps to meet such requirements with maintaining voltages held to within ±1 volt and breakdown voltages held to within ±3 volts, are produced by Signalite. The A057B is designed for high-current-pulse applications, and has better stability and longer life than standard, low-current lamps.

NEON VOLTAGE REFERENCE TUBE INTRODUCED



A new subminiature cold cathode voltage reference tube for use in stable regulated power supplies, dc amplifiers, oscilliscope calibrators and similar applications has been developed by Signalite, Inc., Neptune, N. J. Designated Z82R10, the new tube has been designed for maximum electrical stability for voltage reference and voltage regulator applications.

The new voltage reference tube is the newest in a family of neon glow lamps produced by Signalite specifically for use as electronic circuit components. Its performance parameters are rigidly controlled to meet the tight specifications required in electronic circuitry. Use of this new line for voltage reference offers the advantages of close voltage control, low temperature coefficients and low price in a subminiature envelope.

Reference voltage is 82 vdc ± 1 volt. Ignition voltage for the Z82R10 reference tube is 115 vdc maximum. Variation in the regulating voltage from 0.5 ma to 10 ma is less than 1 volt. Typical temperature coefficient is minus 1 mv per degree Centigrade. Operating temperature range is $-55°C$ to $+90°C$. Storage temperature range is $-55°C$ to $+100°C$.

The Z82R10 cold cathode reference tube is produced in the standard T-2 size neon glow lamp tube. Overall length is $1\frac{1}{16}$ in. maximum, diameter is 0.244 in. maximum, lead wire length is 1.0 in.

For further information contact Signalite Inc., 1933 Heck Ave., Neptune, N.J.

CAN YOU SOLVE THIS ? ?????

Gentlemen:

I have a problem that perhaps you or your readers may be able to solve. I need a simple neon glow lamp oscillator with an approximately rectangular output voltage. The frequency range would be 50 cps or lower. The circuit must be self competing, i.e. if the supply voltage were removed or other circuit connection were broken to stop oscillation during an operating cycle, the circuit must be such that the output completes the cycle before it shuts off completely.

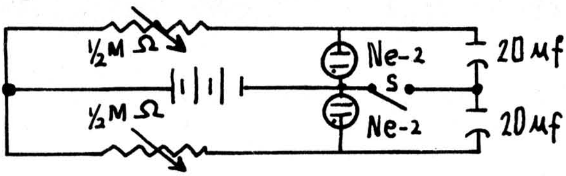
Can anyone help?

Cordially,

Louis E. Frenzel, Jr.
Member of the Technical Staff
McCollum Laboratories, Inc.

Answer to Can You Solve This: Vol 2, No. 3 ....

In the circuit below Mr. Kirson wanted to know why when switch "S" closed, the glow lamps did not glow.



Dear Sir:

With regard to Mr. Dennis Kirson's problem in Vol. 2, No. 3 of Signalite Application News, I would like to present my analysis of the difficulty:

With switch S closed each NE-2 operates in its own relaxation oscillator circuit, independent of the other. Assuming a minimum ionization current of about 250 μamps, resistor R must be larger than about 100 K to maintain oscillation. (Smaller values will allow the bulb voltage to reach its sustaining potential at this ionization current.) Thus, with the resistor capable of being varied from ½ megohm to 100 K, the current through it can vary from 180 μamp to 900 μamps when the capacitor has zero charge.

It is quite possible that the capacitor has sufficient leakage to form a voltage divider capable of holding the bulb voltage below the firing potential, at these current levels.

Since both capacitors are in the same can and were thus made under identical manufacturing conditions, it is reasonable that their leakages be similar, thus, both circuits would be inoperative.

However, with switch S open, one NE-2 will go "on" before the other due to the capacitors being essentially out of the circuit momentarily, and no two bulbs likely to have the same ignition potential.

At this time, the "on" bulb develops its sustaining voltage of about 60 volts. It is held on by the sum of the currents through its resistor, and the capacitor charging current through the second resistor, being greater than the minimum ionization current. Thus, the capacitors in series are now connected between the second bulb and a 60 volts potential. This leaves only 20 volts required to fire the second bulb. The capacitor leakage can easily be low enough to allow this 20 volt charge potential and still not allow the 80 or so volts required in the first circuit with S closed.

I would suggest that normal borax type electrolytics not be used. Tantalum units would be an improvement, and mylar tubular capacitors (or other non-electrolytic types) arranged in parallel for proper value, would be quite reliable.

Sincerely,

Roy S. Reichert
Bell Telephone Laboratories

Ed. Note:

We have received other replies, all of which said essentially the same thing — which is correct.

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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.

VOLTAGE DIVIDER TESTER

Dear Sir:

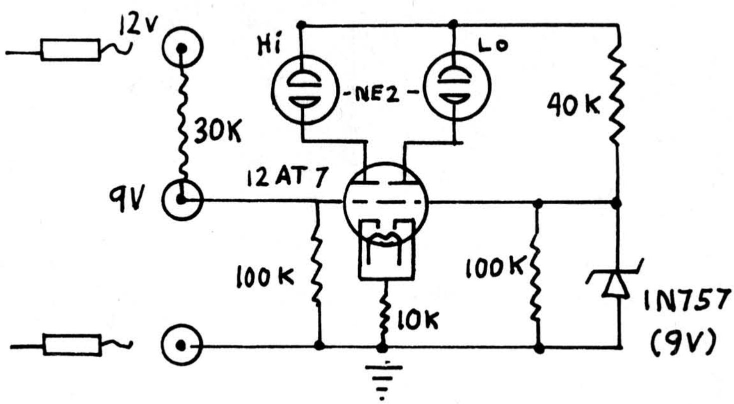
I have appended a sketch of an application which might be of interest to your readers.

The unit is a "go-no-go" test apparatus used for balancing two voltage divider points in production by unskilled workers. Sensitivity is such that variance of 200 mv in either direction shows up as a distinct variation in illumination level of the two lamps. Increase in illumination level of the input side indicates a voltage higher than desired and conversely for the fixed side.

Though 9 volts is used as a reference level, any voltage from zero and up (to the limits of the dissipation level of the tube) and by voltage divider, again up, will apply. If used to test high impedance circuits, grid resistors would have to be increased, of course.

Sincerely yours,

B. E. Wrigley
Manager
Techron Laboratories



Ed. Note:

Suggest use of AO-78 lamps because of the extreme close tolerance in breakdown voltage: 70 vdc ±4 breakdown, 55 ±5 vdc maintaining.

VARIATION ON A THEME

Gentlemen:

Here is the circuit of a neon frequency divider circuit I designed. The lamps used were NE-2. Components had to be selected to match the lamp characteristics.

The first stage, a relaxation oscillator, has its natural frequency determined by R2 and C1. The familiar sawtooth waveform is shown at A. The synchronizing sine wave is a low impedance generator in series with I1. The sine wave synchronizes the first stage by advancing or retarding the discharge of I1 because it adds or subtracts itself to the ionizing potential.

Succeeding stages have natural frequencies lower than their synchronized frequencies because the negative pulse at B supplies an increased voltage to I2, firing it prematurely.

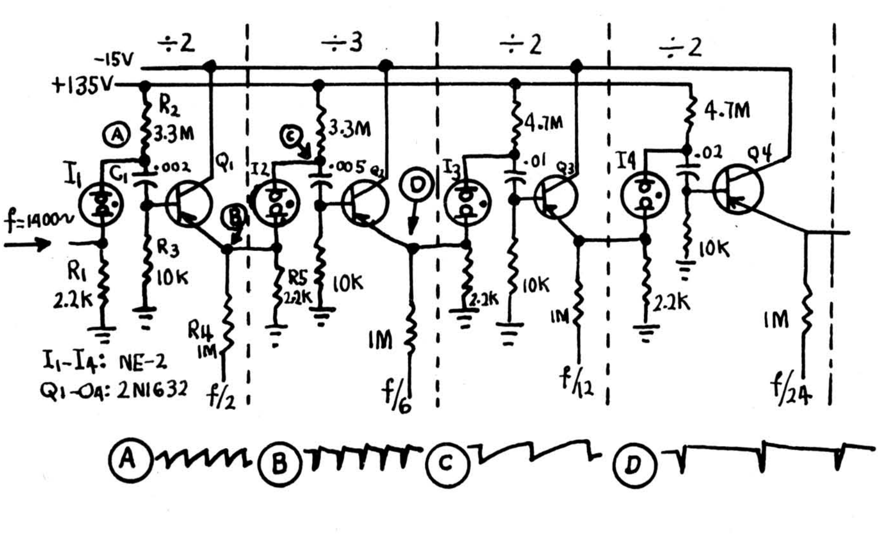
The circuit was intended for use as an electronic organ tone generator which would have all stages to divide by 2. The second stage was adjusted to divide by 3 to prove it could be done.

If lamps having a large difference between ionization firing voltage and maintaining voltage were used, the negative spike could be sufficiently large to produce synchronization of the next stage without an amplifier.

The 2N1632 was selected for its high breakdown potential. Tube-type cathode followers actually would perform better.

Very Truly yours,

R. F. Woody, Jr.



Ed. Note:

Lamps all AO 78.

We note an interesting variation on the conventional frequency dividers used in electronic organs in that Mr. Woody has used transistors for coupling the signals from one stage to the next, and also supplying an isolated output signal.

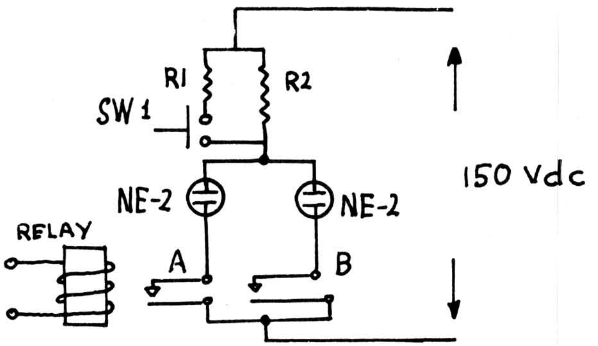
TESTING A TEMPERATURE REGULATOR

Dear Mr. Bauman:

I have enclosed a sketch with a brief outline of the application of neon tubes for determining the closure of relay contacts where it was necessary to know which contact closed first in an air borne temperature regulator.

Sincerely yours,

Edward S. Shepard, Sr.
Electronic Instrumentation



The above test circuit was used in production, in testing a cabin temperature regulator where it was vital that contacts A make, slightly ahead of contacts B, operation of the test is as follows: SW-1 is closed and with the relay energized both NE-2 indicator lights should come on indicating continuity through both sets of contacts, next, SW-1 is opened and the relay is again energized, this time neon light A should indicate if the relay is properly adjusted, inasmuch as resistor R2 is adjusted so that only enough voltage is available to ignite one neon light: if both A and B neon lights fail to come on this merely indicates that A and B contacts have closed simultaneously, or if B neon light only indicates this means that contact B is closing ahead of contact A.

This test circuit was also useful on the shake table during environmental testing of dry-circuit type relays because of the low current requirements of approx., 0.5 ma of the NE-2, flickering of the lights in a darkened room during test gave a positive visual indication of poor contact in the relay being tested.

Ed. Note:

Suggest A057B in place of Ne-2's since the A057B has a very short ionization time and is designed to operate in darkness. Hence in subdued light the lamp does not change its characteristics.

MINIATURE REGULATED POWER SUPPLY

Dear Mr. Bauman:

Enclosed is one of our applications for neon glow lamps.

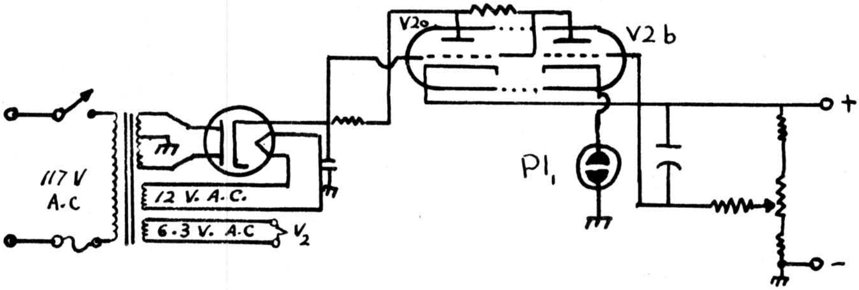
The circuit shown is a miniature regulated power supply, designed as a mid-way point between gaseous VR tubes and laboratory regulated power supplies.

P1 is a neon glow lamp incased in a pilot light housing, and serves to hold the cathode of V2b at a fixed positive voltage with respect to ground. P1 also serves to indicate whether or not V2b is drawing current.

Under conditions of high-voltage and high-current output, the power supply tends to drift out of regulation. P1 is an indicator for this condition, as it ceases to glow when the power supply drifts very far out of regulation.

Very truly yours,

Don Weissgerber, Jr.
General Enterprises Corp.



Ed. Note:

Suggest use Z82R10 (see new product release, page 71 *)*

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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 the leading technical publications for consideration as articles and featurettes. Your by-line and company credit will be given with your permission.

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