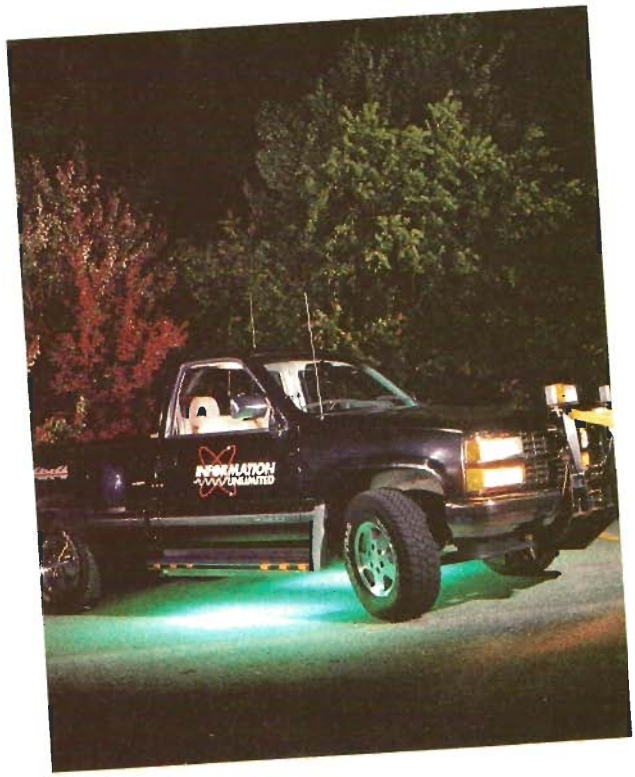
AUTOMOTIVE NEON



Build this driver circuit to illuminate your car's license plate, light up its underside for a glamorous "spaceship" look, or just create portable neon or argon light displays.

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JOIN THOSE PEOPLE WHO enjoy customizing their cars by adding a lighted frame to their license plates or illuminating the undersides of their cars in red, green, or violet to give it a "hovering spacecraft" look. This article focuses on the construction of a complete illuminated frame system for your car's license plate, but the battery-powered gas tube driver circuit described here will permit you to light up individual gas tubes mounted on the underside of your car.

The driver circuit will light up neon-filled tubes that glow with a rich ruby red or argon-filled tubes that can be prepared to glow in brilliant green, violet, or pink. If neither of those projects interest you, maybe you would be interested in making up battery-portable illuminated wands, signs, or arrows for parties, festivals or perhaps you'll build it just as unusual eye-catching home decoration?

The driver circuit

The driver circuit ionizes and sustains the illumination of neon or argon gas-filled tubes up to four feet long bent into any shape desired. The tube will remain illuminated as long as power is applied to the circuit. However, the driver circuit permits the tube's illumination level to be adjusted to maximize brightness or reduce brightness to conserve power depending on which is more important.

The driver circuit is a pulse-width modulation circuit that can illuminate a neon or argon gas tube in either a continuous or flashing mode. In that mode, the tube will blink on and off at an adjustable rate that permits it to act as an emergency beacon. The circuit is also suitable for driving battery-portable gas tubes fashioned as signs or wands for carrying around at carnivals or using as decorative conversation pieces.

A note of caution

It is illegal in *all* states to drive a car with an illuminated license plate frame that flashes while the vehicle is moving. However, the frame can serve as an attention-getting emergency beacon if the vehicle is stopped.

Also, it is illegal in at least one state to have an illuminated license plate frame on a car unless the gas tube is so masked that only the light reflecting from the plate is visible to the driver of any vehicle that is following behind the car with the lighted frame.

How the driver works

Refer to the schematic Fig. 1. An industry standard bipolar 555 timer, IC1, is configured as a duty cycle clock to control the on and off time of the circuit's high-frequency oscillator. With C2 switched into the circuit by switch S1, the output at pin 3 of IC1 will be a square wave with a duty cycle or pulse rate that is fast enough to sustain continuous illumination of the gas-filled tube.

Adjusting trimmer potentiometer R1 changes the brightness of the gas tube by altering the on-to-off ratio or the duty cycle of the squarewave that appears at the output of pin 3 of IC1. The squarewave output of IC1 appears at the base of NPN transistor Q1, which functions as a buffer amplifier. The output of Q1 then appears at the base of grounded-emitter NPN transistor Q2, which functions as the feedback element in a free-

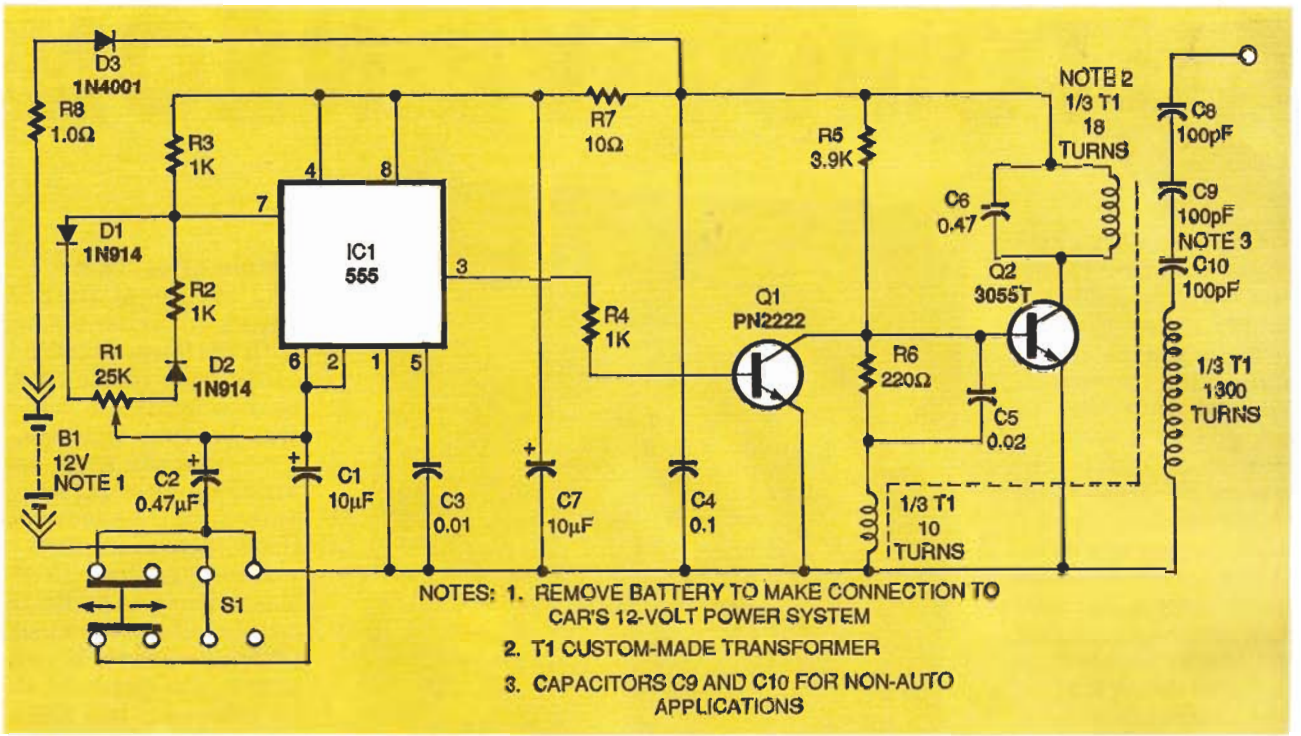

FIG. 1—DRIVER CIRCUIT SCHEMATIC. The circuit can be powered either from a battery pack or vehicle's 12-volt power system.

running oscillator circuit. Transistor Q1 acts as the switch to turn transistor Q2 on and off by clamping the transistor's base to ground.

The oscillator oscillates at a frequency of 25 to 30 kHz, and the output voltage at the top of the 1300-turn coil of T1 is approximately 2500 volts, peak-to-peak, sufficient to ionize the gas in the tube. The duty cycle pulse of IC1, as buffered by transistor Q1, controls the base of transistor Q2. The tank circuit that determines oscillator frequency, consists of capacitor C6 and the 18-turn primary coil of transformer T1.

Changes in the duration of the "on" cycle change only the brightness of the gas tube but do not affect the frequency of the oscillator. High-voltage ceramic capacitors C8, C9 and C10 correct for differences in the length of the gas tube being driven.

If switch S1 is set to the *flashing* mode, capacitor C1 is placed in parallel with capacitor C2, and the sum of their capacitive values will shorten the repetition rate of the squarewaves appearing at pin 3 of IC1. This will cause the tube to flash on and off at a rate slow enough to be seen as flashing (less than 50 pulses per second). The flashing time rate can be changed to a visually comfortable level by adjusting trimmer potentiometer R1.

Building the driver circuit

Whether you plan to operate the driver only from the battery pack or directly from an automotive 12- to 14-volt supply, it is recommended that provision be made to operate the circuit from the battery pack for testing.

If the illuminated frame is to be used on a vehicle (regardless of power source), attach a heatsink to the copper tab on the TO-220 case of transistor Q2. Omit capacitors C9 and C10 if you intend to install the system in a vehicle.

The driver circuit can be built on perforated board by point-to-point wiring method. Cut a 3¼ × 1⁵⁄₁₆-inch rectangle of prepunched circuit board (0.042-inch diameter holes in a 0.1-inch grid. With the exception of the high-voltage capacitors C8, C9 and C10 and transformer T1, all components are readily available items.

If you do not want to wind your own miniature transformer, you can purchase one from the source given in the Parts List. The neon or argon frame and plate cover assembly referenced in this article is also available from the same source. Also the high-voltage capacitors C8, C9, and C10 are available in a kit.

Refer to Parts Placement diagram Fig. 2. Before starting assembly work, cut out a rectangular relief hole in the circuit, as shown by the dotted line, to make wiring slide switch S1 easier. If you intend to install the system in a car, attach a heatsink to the tab of transistor Q2 before inserting it.

Insert all components in the approximate positions shown on Fig. 2. Insert all components in the approximate positions shown. Insert all axial-leaded resistors and diodes marked with an asterisk vertically to conserve circuit board space. A snap-on heatsink suitable for a TO-220 package is, but a satisfactory substitute can be made by cutting and folding a piece of 0.062-inch thick sheet aluminum 1 × 1½ inches. Drill a small hole in its center for mounting

it to the hole in the heat tab of transistor Q2 with a nut and bolt.

Carefully fold back one lead of all axial components shown as vertically mounted over the body of the component so that both leads can be inserted in holes spaced 0.10-inch apart. Observe the polarities of the diodes and electrolytic capacitors before inserting them and be sure that you have identified the pin functions of transistors Q1 and Q2 before inserting them in the board.

Insert and bend all leads first before doing any soldering so that extra lead lengths can be used to form the specified connections between components.

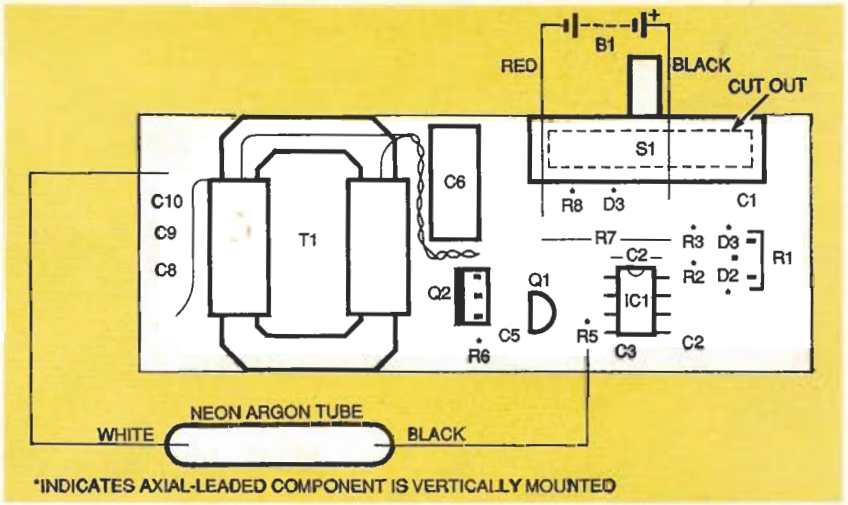

FIG. 2—DRIVER CIRCUIT PARTS PLACEMENT DIAGRAM. The circuit can be built by point-to-pont wiring on 0.1-inch grid perforated board. Transformer T1 is a non-standard component.

PARTS LIST

All resistors are ¼-watt, 10%, unless otherwise specified

R1—25,000 ohms, trimmer potentiometer, PC board mounting , carbon film
R2, R3, R4—1000 ohms
R5—3900 ohms
R6—220 ohms
R7—10 ohms
R8—1 ohm, ½-watt

Capacitors

C1, C7—10 µF, 35 volts, aluminum electrolytic, radial-leaded
C2—0.47 µF, 50 volts, aluminum electrolytic, radial-leaded
C3—0.01 µF, 50 volts, ceramic disc
C4—0.1 µF, 50 volts, ceramic disc
C5—0.02 µF, 100 volts, polyester
C6—0.47 µF, 100 volts, polypropylene, radial leaded
C8, C9, C10—100 pF, 3000 volts, ceramic multilayer, radial-leaded DIP (see text)

Semiconductors

IC1—555 timer, 8-pin DIP
Q1—2N2222, NPN bipolar transistor, TO-92
Q2—3055T NPN transistor, TO-220 package, National Semiconductor or equiv.
D1, D2—1N914 silicon diode
D3—1N4001 silicon diode

Other components

T1—transformer with 10-, 18-, and 1300-turn windings, (see text)
S1—slide switch, two-deck, three position (DP3T), PC mount, Mouser 10SL008 or equiv.
Miscellaneous: neon or argon gas tube frame assembly (see text); circuit board, (see text); circuit case (optional); 9-volt battery clip; eight-cell battery pack (optional); eight alkaline AA cells; No. 24 AWG insulated hookup wire; TO-220 heatsink, spade connectors, nut and bolt, solder
Note: Completely assembled systems, kits of parts, and individual parts for the neon/argon license plate frame with variable brightness and emergency flashing, are available from Information Unlimited: Box 716, Amherst, NH 03031, Telephone 1-603-673-4730; Fax 603 672 5406. Include $4 for shipping & handling per order. The following options are offered:

- Driver circuit transformer, T1 (28K087)—$9.50
- Printed-circuit board PC1—$4.50
- Kit of parts for system including all electronic components and PC board, but no gas tube or plastic frame (BATNEONK)—$19.50
- Ready to use aqua and purple neon tubes with plastic frames for flashing power supply (AQUA1)—$12.50; (PURP1)—$12.50
- Ready-to-install non-flashing purple license frame neon assembly (LICNPR)—$24.50
- Ready-to-install non-flashing green license-frame neon assembly (LICNGR)—$24.50
- High-brightness under-car neon assembly: Pink 4-tube kit (RG4K)—$124.50; Purple 4-tube kit (RG4L)—$124.50; Music driver for above kits (RG4M)—$39.50; Single tube kit (specify pink or purple) (RG1K)—$34.50

After soldering all components and trimming their leads, insert and solder the wires for the battery pack and vehicle's power system. Solder all the wires from transformer T1 to their specified terminal points. Connect and solder the hot and ground wires to the neon-tube frame assembly.

System assembly

Refer to assembly diagram Fig. 3, The neon or argon gas-filled tube has been bent to form a rectangle with an inside measurement of 11 × 5¼-inches so it can frame the license plates of all American and Canadian cars. The tube is embedded in RTV silicone within the lip around a transparent plastic cover that will protect the license plate.

Wires extend from both ends of the gas-filled tube for connection to the high-voltage output and ground wires of the driver circuit. Those wires can be soldered together or connected by soldering automotive spade-style connectors to their ends for more convenient connection and disconnection should it become necessary.

The battery pack needed for test purposes can also be the permanent power source, if desired. It consists of eight AA alkaline cells. If you intend to connect the system to a vehicle's electrical system, do it with approved automotive-style sol-

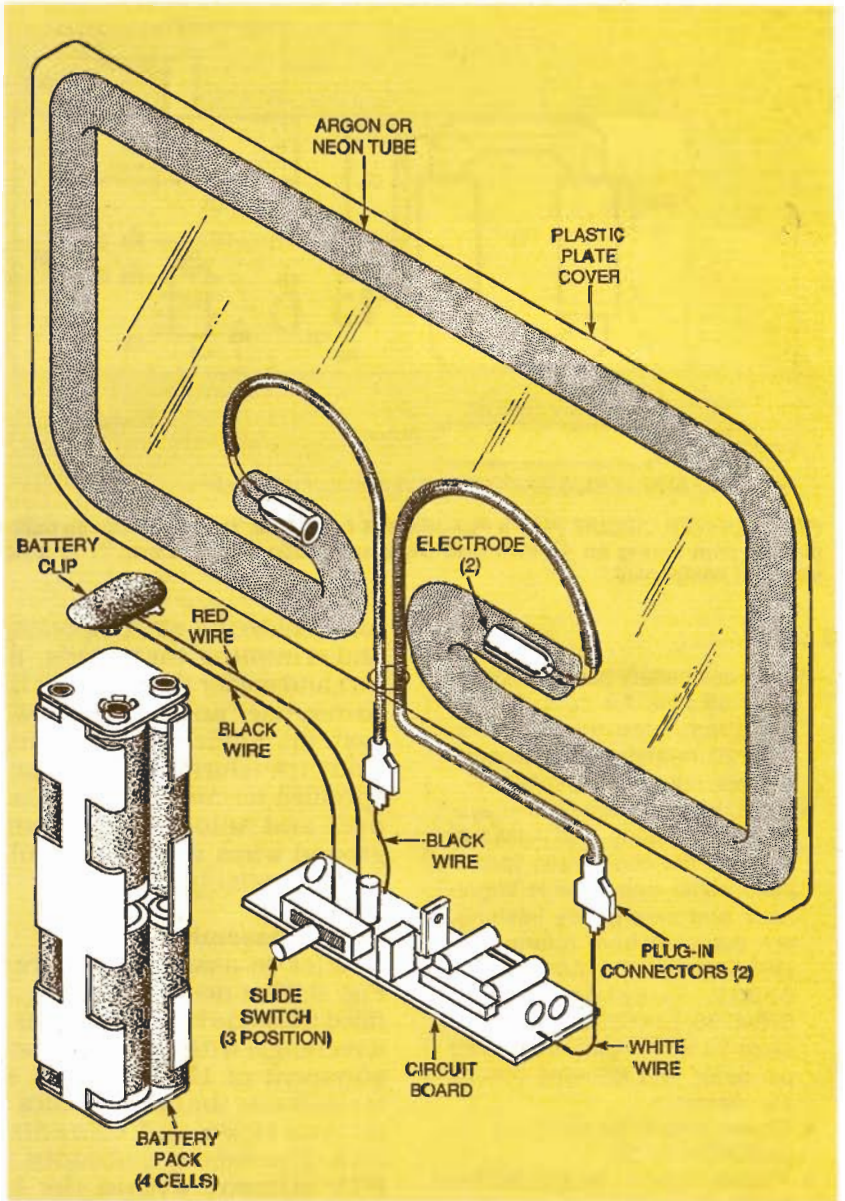

FIG. 3—NEON OR ARGON GAS TUBE LICENSE PLATE frame system showing driver circuit connections to the gas tube/ cover assembly.

derless connectors, and do as neat a job as possible.

After completing the driver circuit, it is recommended that the circuit be placed in a protective case to protect it from dust and moisture. A standard plastic project case is suitable. Drill or form holes in the case to permit the lever of slide switch S1 to be moved and permit the passage of external wires to the power source and the gas tube/ cover assembly.

Testing the system

Move the lever on the slide switch S1 to its full left OFF position. Place eight AA cells in the battery pack and snap the battery clip in position on the pack. Move the lever of S1 to the middle position and watch for ignition of the gas in the tube. Then move the switch to the right position and observe that the tube is flashing. If this does not happen, disconnect the battery power and examine the circuit for any error in parts placement or soldering and correct it.

The brightness of the glowing tube can be set by adjusting the wiper on trimmer potentiometer R1. This applies in both the continuous and flashing modes.

If the gas tube is to be run exclusively from the battery pack, you can expect about 10 hours of illumination from eight fresh alkaline AA cells before they must be replaced with a new set. Ω