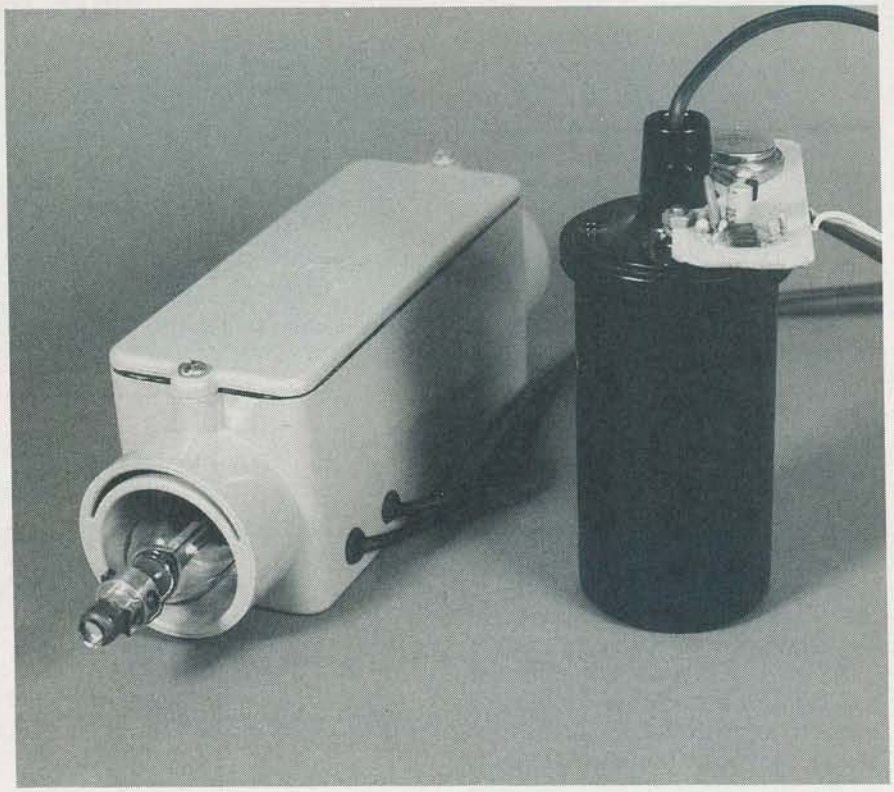
BUILD A SIMPLE LASER POWER SUPPLY



BY GREGORY GRAY

Here's a simple, inexpensive, and easy-to-build power-supply circuit for your low-power laser tube.

I had always been fascinated with lasers, but until recently, the cost of laser tubes always seemed to be just beyond my modest budget. That's no longer the case; today hobbyists can buy small helium-neon (He-Ne) gas laser tubes for $35.00. A similar tube would have cost hundreds of dollars just five years ago.

Isn't progress wonderful? But as luck would have it, just as soon as you clear one hurdle, another crops up to take its place. Now the problem no longer lies in getting the laser tube; instead the problem is getting a power supply that's capable of driving the tube. Although there are commercial units available, locating an inexpensive laser power supply can be a big problem—much bigger than I had expected.

Of course, there have been many magazine articles dealing with the subject, but most required special parts and special high-voltage transformers, which were only available from the manufacturer at somewhat higher prices than I wanted to pay. Being a graduate of the "Burned Silicon" technical institute, I decided to design my own.

The *Laser Power Supply* presented in this article is the way I got around the power-supply dilemma. While it is not what you'd call "high tech," it does serve its purpose quite well. The circuit is capable of driving most tubes with 0.5 mW to 7 mW ratings. But before we get to the project, a few cautionary words are in order.

The power supply uses an automobile ignition coil to generate a high voltage, which is required to operate the laser tube. If you've ever been zapped by a car's live spark plug wire, you know its not a pleasant feeling. Also, the beam of light produced by a laser is very intense, and can cause damage to the eye if viewed directly. Doctors use lasers to weld severed blood vessels in patients whose retinas (back part of your eye) have detached; therefore, **never look directly into any laser beam**. Viewing a laser head on is akin to looking at the sun through a telescope, which can damage the eye depending on the level and duration of exposure. So resist the urge to view the beam directly, or reflected off any mirrored surface.

How It Works. Figure 1 shows the schematic diagram of the Laser Power Supply. The circuit consists of a 555 oscillator/timer (U1), two transistors—a 2N2222 general-purpose unit and a 2N3055 power transistor, Q1 and Q2, respectively—an ignition coil (L1), and a few support components, which are required for U1.

Configured as an astable multivibrator, the 555 oscillates at approximately 500 Hz. The output of U1 at pin 3 is fed to the base of Q1, causing it to alternate off and on in time with U1's output. The collector of Q1 is connected to the base of Q2. As Q2 turns on and off, a rising and collapsing magnetic field is created in the primary winding of L1 (the auto ignition coil). The rapid switching of Q2 induces a sufficiently high voltage in the secondary of L1 to drive the laser tube. Note that a pulsating DC voltage is delivered to the laser, which will cause problems if you try to send data over the beam. So this project is not suitable for voice- or data-transmission applications.

A 6-volt ignition coil was used to keep the operating voltage as low as possible. The circuit was designed to be powered from a 6-volt source. **Warning**: The source voltage to the Laser Power Supply should never be allowed to exceed 7 volts; any higher voltage could damage the laser tube. The Laser Power Supply can also be used to operate up to a 2-mW laser tube from a source of as little as 5 volts as long as the power supply is capable of delivering at least 500 mA. A 6-volt lantern battery can also be used to provide power to the circuit. But, the battery must be fresh and it will not last very long in actual operation.

Construction. In developing the Laser Power Supply, the main criteria was that it contain no special parts. So all of the parts used in the circuit, with the exception of the laser tube, are locally available; the ignition coil from auto-parts distributors, and the electronics components from Radio Shack and other electronics suppliers.

Although the circuit board for the prototype was hand-drawn directly on a copper-clad slug (unetched circuit-board material), a refined full-size template of the original printed-circuit pattern is shown in Fig. 2. A parts-placement diagram corresponding to that printed-circuit template is shown in Fig. 3.

Begin construction by first installing a socket for U1 where called for in the parts-placement diagram, but *do not* insert the IC yet; that's the last thing to be installed. Following that, install the resistors and capacitors. Note that two resistors R1 and R2, are vertically mounted to the board. When installing C2 (the electrolytic unit) be sure that it is properly oriented, as shown.

After installing the passive components, install the transistors. When installing Q1 and Q2, be sure to observe the proper orientation of those components. The emitter and collector terminals of Q2 are clearly marked on the bottom of the package, and the unit will comfortably fit the layout in only one way, because the base and emitter terminals of the unit are slightly off center.

Once you've assembled the printed-circuit board, check your work for construction errors: misoriented components, solder bridges, etc. Note that Fig. 3 shows the printed-circuit board mounted to the ignition coil. The coil must be modified before being connected to the board. The modification to the ignition coil is a modest one. Simply remove the screw inside the tower; that's the screw terminal inside the

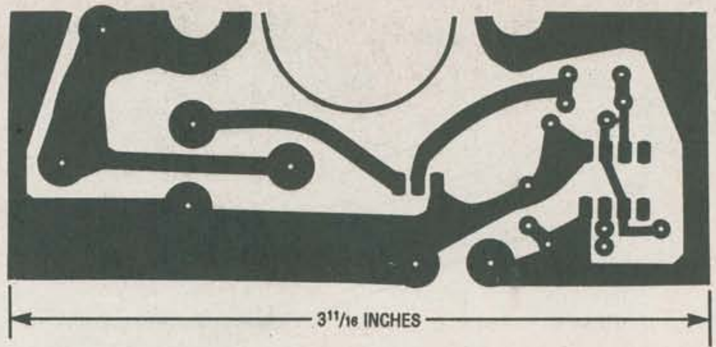


Fig. 2. Here is a refined full-size template of the original printed-circuit pattern that was used to produce the authors prototype.

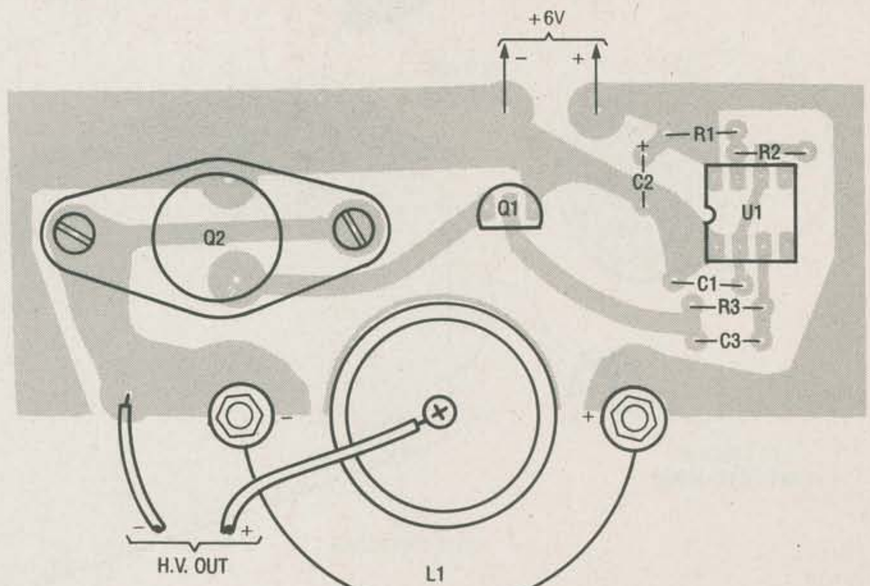


Fig. 3. This parts-placement diagram corresponds to the printed-circuit foil pattern shown in Fig. 2. Begin construction by first installing a socket for U1, but do not *insert the IC yet; that's the last thing to be installed.*

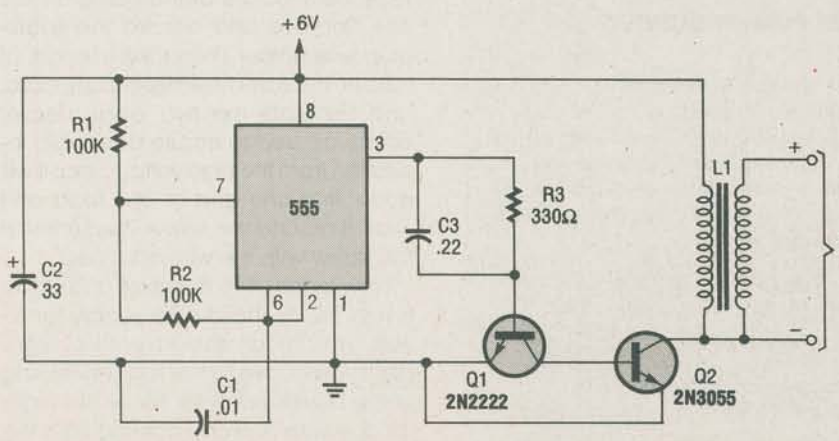


Fig. 1. The Laser Power Supply consists of a 555 oscillator/timer (U1), two transistors—a 2N2222 general-purpose unit and a 2N3055 power transistor, Q1 and Q2, respectively—an ignition coil L1, and a few support components, which are required for U1.

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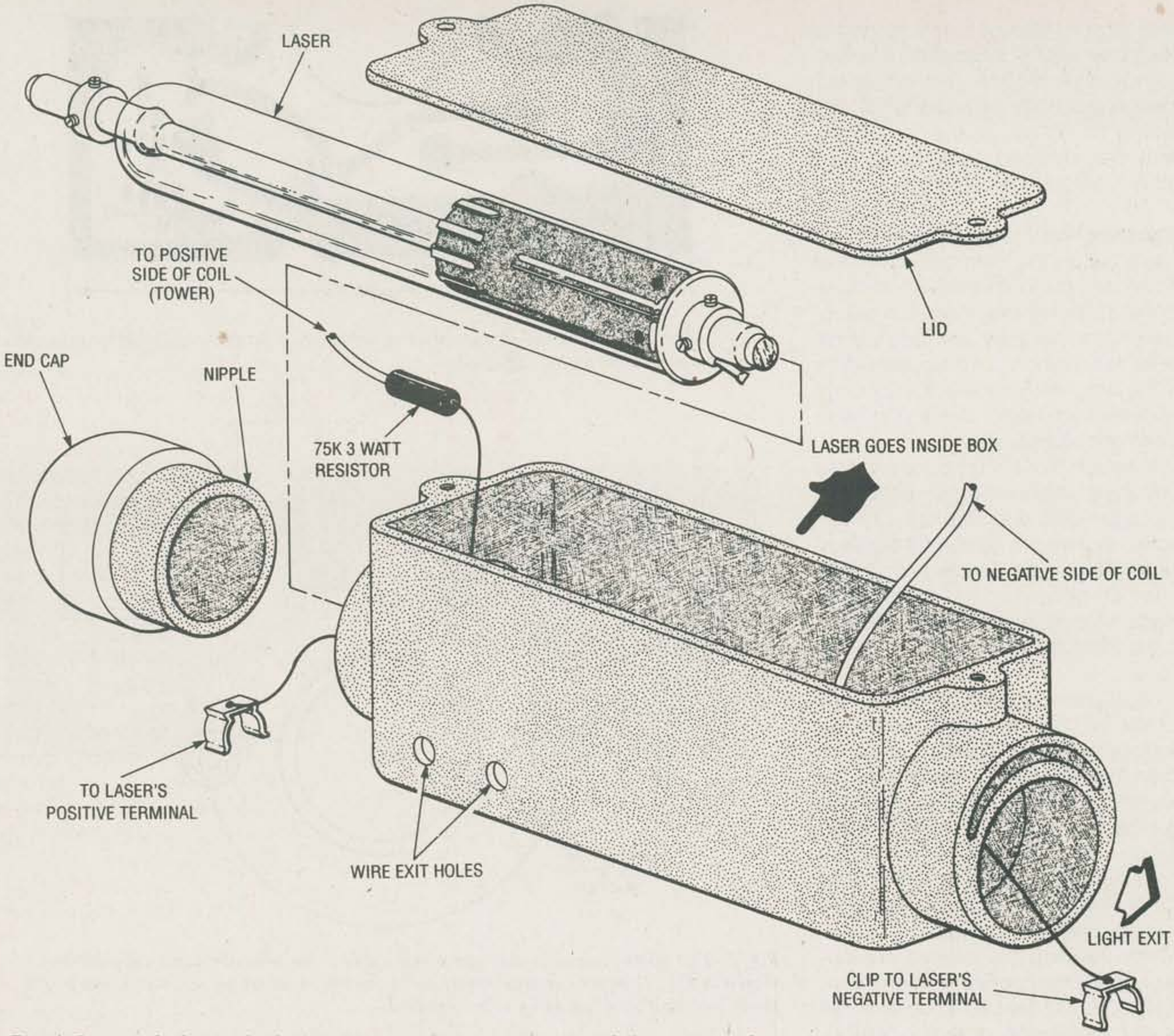

Fig. 4. Prepare the laser tube for connection to the Laser Power Supply by removing the clips from the ends of the tube, and connecting a 75k, 3-watt resistor to the clip that goes to the glass end, and the high-voltage wire from the coil's center terminal to the other end of the resistor. The wire from the negative output terminal of the Laser Power Supply connects to the other clip.

PARTS LIST FOR THE LASER POWER SUPPLY

SEMICONDUCTORS

U1—555 oscillator/timer, integrated circuit
Q1—2N2222 general-purpose NPN silicon transistor
Q2—2N3055 NPN silicon power transistor

CAPACITORS

C1—.01-µF, ceramic-disc
C2—33-µF, 25-WVDC, miniature electrolytic
C3—0.22-µF, polyester

ADDITIONAL PARTS AND MATERIALS

R1, R2—100,000-ohm, ¼-watt, 5% resistor
R3—330-ohm ¼-watt, 5% resistor
L1—6-volt auto-ignition coil
Printed-circuit materials, ½-mW standard size He-Ne laser tube, 75,000-ohm 3-watt ballast resistor, Carlon electrical feed-through box, 5-foot rubber heater cord, wire, solder, hardware, etc.

Note: The following items are available from Meredith Instruments, 6403 N. 59th Ave., Glendale, AZ 85301; Tel. 602-934-9387: Model #09 ½-mW standard size He-Ne laser tube, $35.00; 75,000-ohm, 3-watt ballast resistor, $1.50. Add $5.00 shipping and handling. Arizona residents please add appropriate sales tax.

tube-like structure at the center of the coil. Remove and discard the spark-plug wire holder. Then take a length of rubber insulated heater-supply cord, and separate the two leads. Heater cord was used to ensure adequate insulation from the high voltage that it will carry. Strip one end of one lead and wrap it around the screw. Then reinstall the screw with the wire attached.

Now install U1 in its socket and apply 5 volts DC to the circuit's supply terminals. The circuit should emit a high-pitch whine due to the rapid switching of the power transistor. Move the high-voltage wire (the one coming from the coil center) close to the negative side of the coil. You should get a spark of

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LASER POWER SUPPLY

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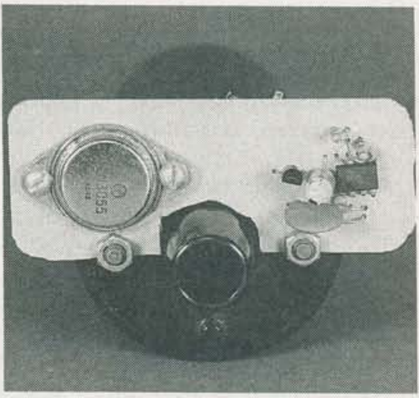
about ⅛ inch. If you do not get a spark, check pin 3 of U1 for the presence of a 500-Hz signal with an approximate 50% duty cycle. If that checks out, check the two transistors for proper orientation and output.

If you get the proper response, remove power from the circuit and disconnect the lead from the center terminal of the coil.

Preparing the Laser Tube. Most laser tubes come with clips attached to the ends (see Fig. 4). Remove the clips , but do not discard them; they will be used to deliver power from the Laser Power Supply to the laser tube. If your tube doesn't have clips, do not attempt to solder wires to the tube ends. The ends contain mirrors that allow the tube to lase. Their alignment will be distorted if heat is applied directly or too close to them. If the tube doesn't have clips, the high-voltage wires will have to be wrapped around the ends. Also, laser tubes might have adjustment screws at their ends that are used to align the mirrors, which are factory set by the tube's manufacturer. Do not attempt to re-align the mirrors.

Now is the time to consider the enclosure. The author's unit was enclosed in a Carlon electrical feed-through box, see Fig. 4, which is normally used for plastic conduit. It was necessary to fashion collars to secure the tube in position. For that task, the author used two pieces of plastic conduit tubing, which were cut to about 1 inch. The 1-inch



Here is the Laser Power Supply board mounted to the auto ignition coil. Note that the board is held in place by screws on the coil's positive and negative power-input terminals. Those screws also make electrical connection from the board to the coil.

lengths of tubing were cemented inside the lead-in holes in the feed-through box. Tiny holes, just large enough for pieces of heavy-gauge bus wire to pass through, were drilled at the conduit/feed-through box joint at both ends of the enclosure. A pair of small holes were also drilled in one wall of the enclosure for the leads that connect the tube to the power supply.

Once the holes have been drilled, insert the laser tube (with clips removed) into the enclosure. Solder short lengths (about 2 to 3 inches long) of bus wire to the clips. Then insert the free ends of the wires through the holes at the conduit/feed-through box joints. Solder one lead of a 75k, 3-watt ballast resistor to the wire that's connected to the clip that goes to the glass end of the tube, and connect one of the heater-cord leads to the other end of the resistor. That lead goes to the hot side of the coil. Solder the other heater-cord lead to the other bus wire. That lead will serve as the ground wire.

Connect the heater-cord leads to the Laser Power Supply, with the lead connected to the 75k resistor going to the coil's center output terminal (refer to Fig. 3). Solder the other heater-cord lead to the appropriate point on the printed-circuit board. Now reattach the clips to their respective laser-tube ends. Once done, again check your work. If all checks out, you are now ready for the "smoke test." But first make sure that the laser is pointing away from you and/or any reflective surface.

To be on the safe side, apply only 5 volts to the circuit. If all has gone well, you should see a tiny red dot on the wall. If not, check the oscillator circuit; it is the only part of the circuit that is critical. If an oscilloscope is available, check for the presence of 500-Hz, 50% duty-cycle (or thereabouts) signal. If that checks out, determine whether the transistors are switching.

High voltage, but not much current, is required to operate a laser. To test for the presence of a high-voltage output from the ignition coil, hold a neon lamp near (or connect one end to) the center terminal of the coil. The lamp will glow in the presence of the fields generated by the coil. Also check the current drawn by connecting an ammeter between the 75k ballast resistor and the laser tube. If no current is being drawn, back track until you find the point where the signal is lost. If current is detected, make sure it's within your tube's parameters. ■