LASER LIGHT SHOW

Amaze your friends and family with the dazzling displays you can create with your own laser light show.

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HAVE YOU EVER BEEN IMPRESSED by a professional laser light show at a nightclub or a concert? Now you can impress all of you friends by creating your very own laser light show! This easy-to-build project works with any laser to create unlimited complex geometric patterns.

Safety Notice: The laser beam that is projected by this device is harmful if aimed directly into the human eye. **Never** look directly into the laser beam, nor aim the laser at anyone else. The unit should be used only by adults or with adult supervision. It is not a toy and must be used only in a safe and responsible manner.

When assembled, this laser product must conform to the safety regulations of the C.D.R.H. (Center for Devices and Radiological Health) of the Food and Drug Administration. The regulations classify lasers by power, mechanical requirements, and so on. (Detailed information on these requirements are available from the Center for Devices and Radiological Health, Office of Compliance, 2098 Gaither Road, Rockville, Maryland 20850.)

Mechanics and optics

The project consists of a base unit and a wire-linked remote control. The base unit houses the mirrors, motors, and motor-drive circuits, in addition to a solid-state laser assembly. The handheld remote unit contains an on/off switch and speed-control circuits.

The light show projector creates fascinating patterns by reflecting a laser beam from three "wobbly" mirrors. Each mirror adds a unique spiral pattern to the beam, and the patterns combine to create complex geometric shapes. Each mirror is mounted slightly off-axis on a small DC motor, and each motor is driven by a separate speed-control circuit. As the speed of each motor is adjusted, the size and shape of the spiral laser pattern is altered.

The circuit

Refer to the schematic of the laser light show in Fig. 1. An

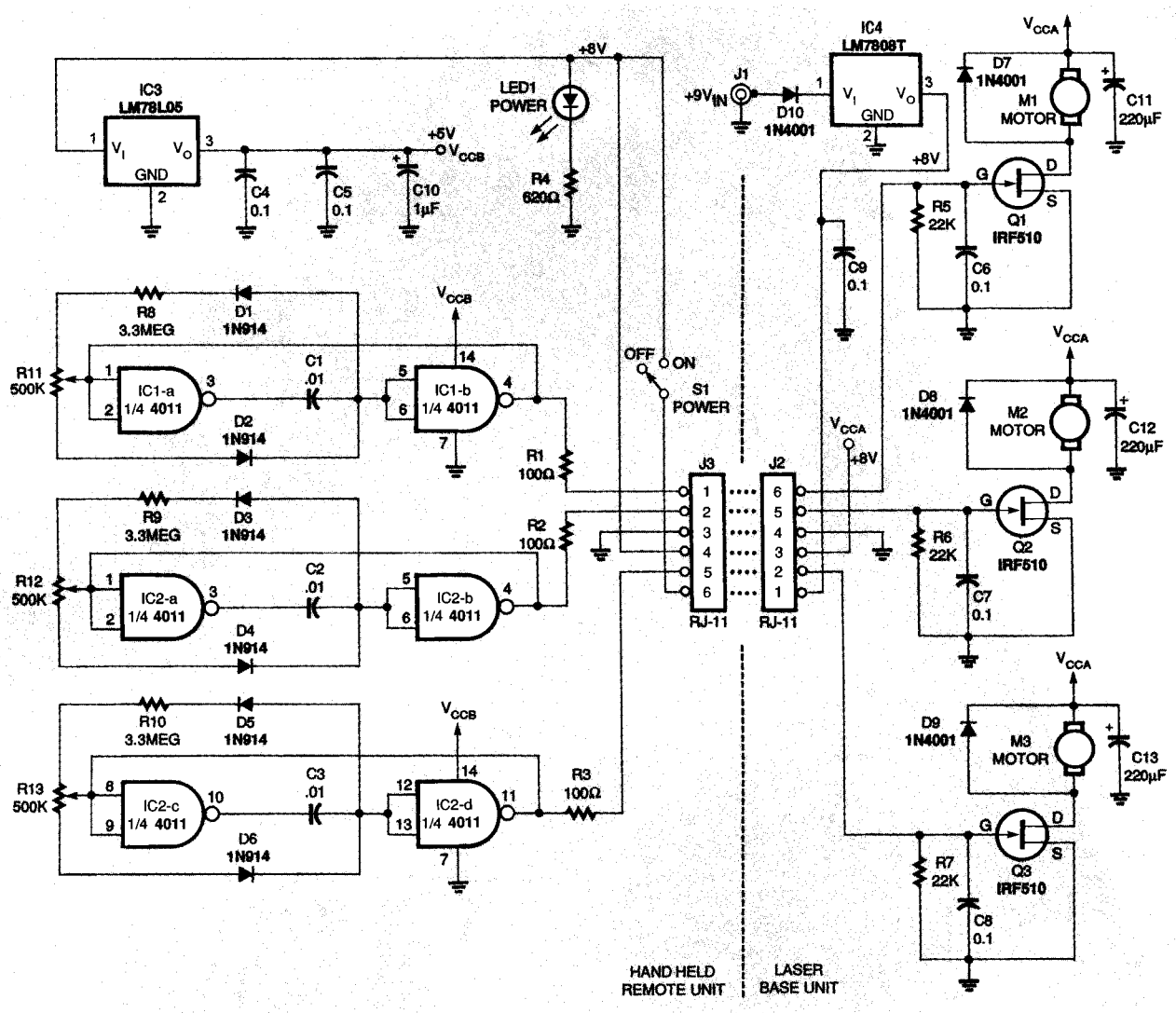


FIG. 1—SCHEMATIC OF THE LASER LIGHT SHOW. An external DC wall-outlet adapter powers the circuit at J1; the LM7808 voltage regulator produces a constant +8 volts to power the rest of the circuit.

external DC power adapter plugs into connector J1 to power the circuit. Diode D10 provides reverse-polarity protection for the voltage regulator, IC4. The LM7808 voltage regulator and capacitor C13 convert the transformer voltage to a constant regulated +8 volts to power the rest of the circuit. This main power is fed to the handheld remote through an RJ-11 modular cable and jacks J2 and J3 and is switched on and off by S1. Light-emitting diode LED1 indicates when power is on.

On the handheld remote side, the LM78L05 (IC3) regulates the 8-volts down to 5 volts to power the CD4011 quad NAND gate ICs. Although IC1 and IC2 would operate fine at 8-volts, powering them from the output of IC3 helps to isolate the oscillator circuits from the electrical noise produced by the DC motors. The remote section has three identical oscillator circuits that produce pulse-width modulated signals to control the speed of the DC motors in the base unit. Each oscillator consists of two NAND gates from a CD4011 (wired as inverters), and a 0.01-microfarad capacitor that determines the oscillation frequency.

Two signal diodes and a 500-kilohm potentiometer control the duty cycle, or on time of each pulse-width modulator. With the 3.3 megohm resistor in the circuit, the duty cycle can be varied from 0% to only about 20%. (Without the 3.3 megohm resistor, the potentiometer can vary this on time from 0% to 100%.) The 0% to 20% duty-cycle gives a good speed range with the motors used in the author's prototype unit. You might have to experiment with the values of R8, R9, and R10 depending on the motors that you choose.

The three motor-control signals pass through connector J3 and a six-conductor modular cable to J2 on the base unit. In the base unit, each pulse-width modulated signal controls the motor speed by switching an IRF510 N-channel MOSFET transistor. The 100-ohm resistor and the 0.1µF capacitor filter noise in the cable and the 22-kilohm resistor connected to the gate of each MOSFET keeps

the transistors biased off if the remote is unplugged. Each DC motor has a 1N4001 diode wired across it to suppress reverse voltage spikes. The 220 μF capacitor supplies instantaneous current when the MOSFET turns on and also provides extra power filtering.

Construction

The easiest way to build the laser light show is to use PC boards. We've provided foil patterns for the two boards, but if you don't want to make your own boards, pre-etched and drilled boards can be purchased from the source given in the Parts List.

Start by assembling the handheld remote unit. Figure 2 is the parts-placement diagram for that board. Use two 14-pin DIP sockets for IC1 and IC2. Mount the LED to the PC board with a 3/4-inch plastic spacer. This will allow the LED to protrude through a hole in the plastic cover.

To connect the three potentiometers, cut nine 4-inch pieces of stranded hookup wire and solder the wires from the PC board to the potentiometers, as shown. Do the same for switch S1. Last, install IC1 and IC2 in their sockets, observing the proper orientation of pin 1.

Drill a row of three holes in the top of the case for the three potentiometers. Mount the PC board in the bottom half of the case with any suitable hardware. Determine where the LED will protrude through the top of the case, and drill a %-inch hole in that spot. Drill another 3/16-inch hole for S1 in any open location on the cover. Test fit the case's end panels, and cut an opening in one end to allow access to modular connector J3. Mount the three potentiometers and switch S1 on the case cover. Align the cover so that the LED fits through its hole, and secure the two halves of the enclosure together. Set the remote unit aside for now and begin assembling the base unit.

Refer to Fig. 3 for the parts-placement diagram of the base unit. When installing the electrolytic capacitors C11, C12, and C13, be sure to follow the proper polarity orientation. Jack J1 is a 2.1 millimeter power connector that attaches to the PC board and accepts power from a wall transformer. You can either install J1 or you can attach the wires from a DC-output wall-outlet adapter directly.

Install the three MOSFET transistors on the board. Be sure that the metal tabs are oriented as shown in Fig. 3 before soldering them in place. Note that MOSFET transistors are ESD-sensitive, so always take precautions to discharge static electricity from your body by touching grounded metal be-

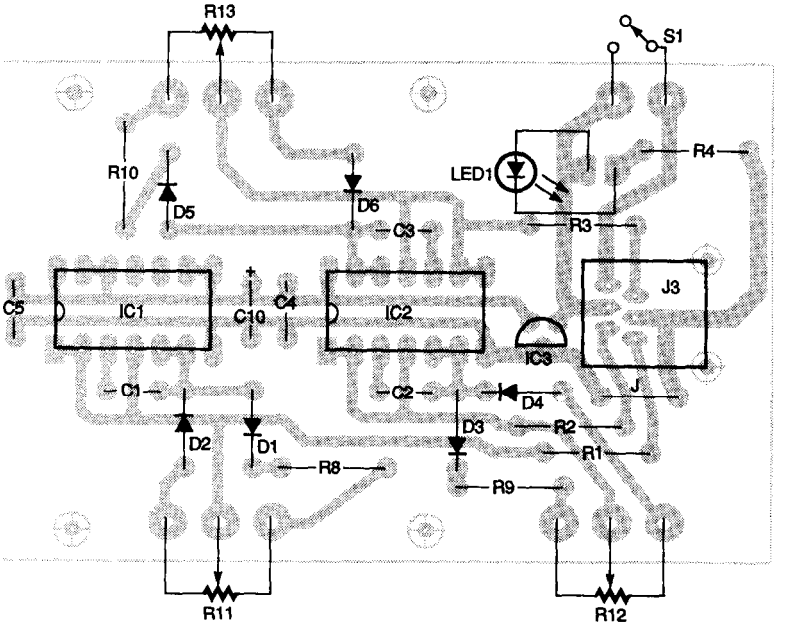


FIG. 2-HANDHELD REMOTE parts-placement diagram. Use 14-pin DIP sockets for IC1 and IC2.

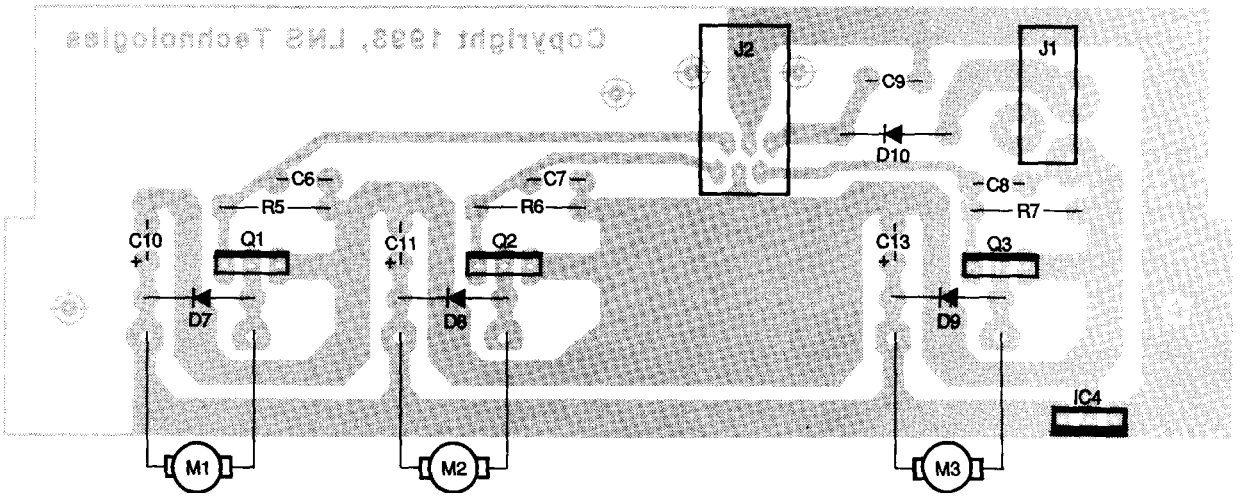


FIG. 3-BASE UNIT p&-placement diagram. You can install power jack JI or attach the wires from a DC-output wall-outlet adapter directly.

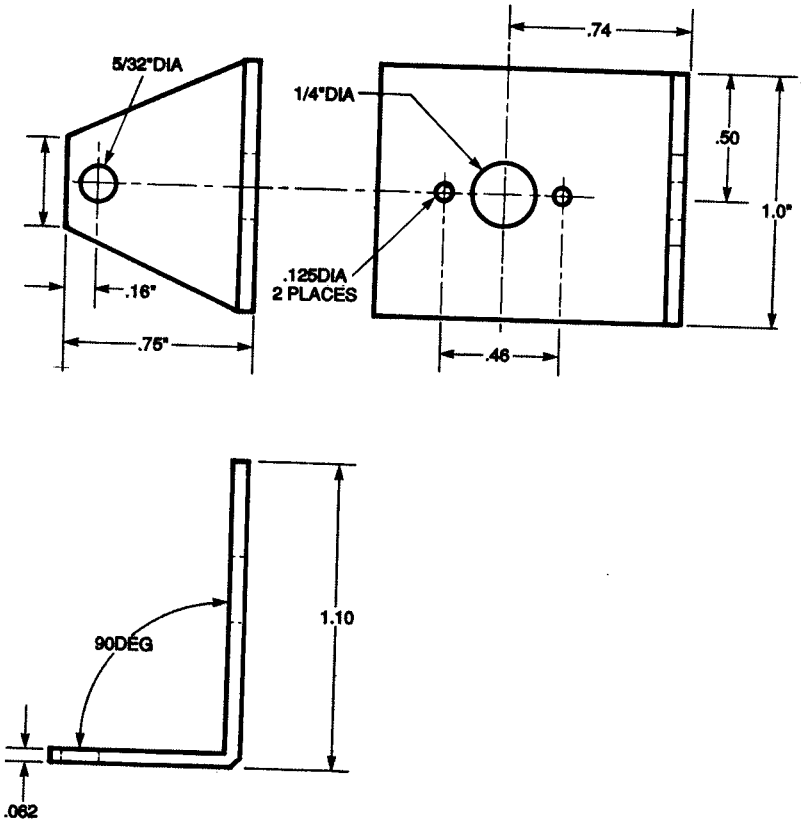


FIG. 4—RIGHT-ANGLE ALUMINUM brackets. These are attached to the motors and can pivot on the base for alignment adjustments.

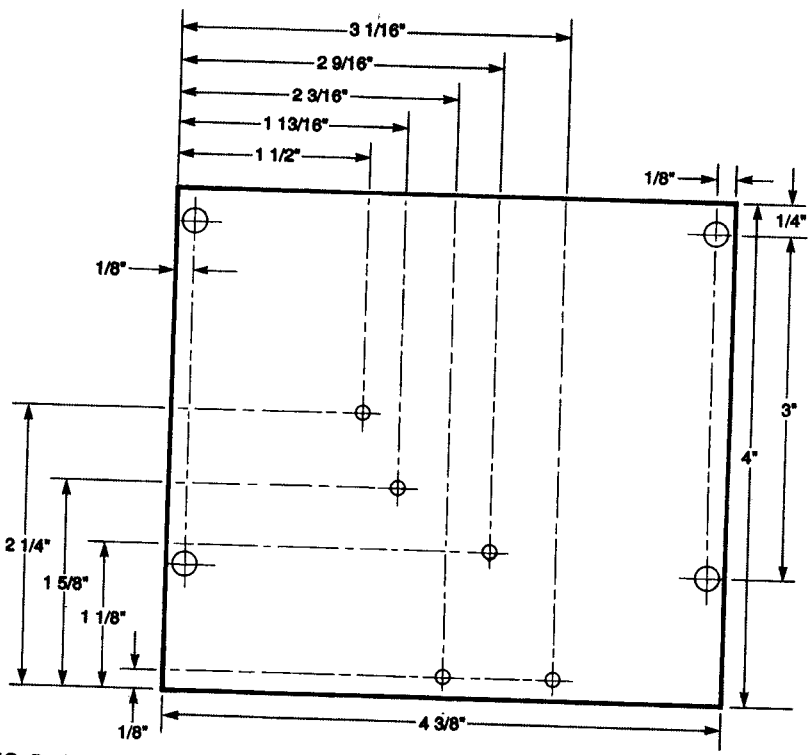


FIG. 5—IF YOU ARE MOUNTING THE BASE UNIT in a plastic enclosure, you will need an aluminum baseplate cut and drilled to these dimensions.

fore you handle them. Next install the voltage regulator IC4, observing the proper orientation of the metal tab. Solder six

PARTS LIST

All resistors are ⅛-watt, 5%.
R1–R3—100 ohms
R4—620 ohms
R5–R7—22,000 ohms
R8–R10—3.3 megohms
R11–R13—500,000 ohms, panel-mount potentiometer

Capacitors
C1–C3—0.01 µF, ceramic disk
C4–C9—0.1 µF, ceramic disk
C10—1 µF, 16 volts, tantalum electrolytic
C11–C13—220 µF, 16 volts, electrolytic

Semiconductors
IC1, IC2—CD4011 quad 2-input NAND gates
IC3—LM78L05, 5-volt regulator (TO-92 case), Motorola or equiv.
IC4—LM7808T, 8-volt regulator (TO-220 case), Motorola or equiv.
Q1–Q3—IRF510 N-channel MOSFET transistors, International Rectifier
D1–D6—1N914 diode
D7–D10—1N4001 rectifier diode
LED1—red light emitting diode, T-1-¾

Other components
J1—2.1 mm power jack
J2, J3—6-pin RJ-11 jacks
M1–M3—DC hobby motor
S1—SPST subminiature toggle switch, PC mount

Miscellaneous: 9-volt DC, 300 mA wall outlet adapter; plastic enclosures (remote, Serpac A-21; base unit, Serpac A-31); knobs for potentiometers; three aluminum motor brackets (see Fig. 4); three 1-inch diameter round plastic mirrors and three plastic mounting disks; two PC boards; two 14-pin IC sockets; 3-foot, 6-conductor modular cord; No. 24 gauge stranded wire; hardware; glue; solder.

Note: The following items are available from LNS Technologies, 20993 Foothill Blvd, Suite 307R, Hayward, CA 94541-1511, 1-800-886-7150:

- **Complete kit of parts for the Laser Light Show (LSHOW-KIT) includes two PC boards, brackets, mirrors, enclosures, motors, and all components listed above (laser not included, see below)—$99.00**
- **Solid State Laser Kit (LASER-KIT)—$89.00**

Add $5.00 S&H to all orders. California residents add local sales tax. MC/VISA orders accepted.

pieces of 6-inch long stranded hookup wire to the board as shown for connecting the three DC motors later on.

Final assembly

The three motors and their mirrors must be mounted securely and aligned accurately to properly deflect the laser beam. The right-angle aluminum brackets shown in Fig. 4 attach to the motors and can pivot on the base for alignment adjustments. If you don't purchase the kit for the laser show, you'll have to fabricate these brackets yourself. If you are mounting the base unit in a plastic enclosure like the author's prototype, you will also need the aluminum baseplate shown in Fig. 5. Otherwise, you can simply attach the three motor brackets to a wood base as long as you match the hole spacing to the base plate shown in Fig. 5.

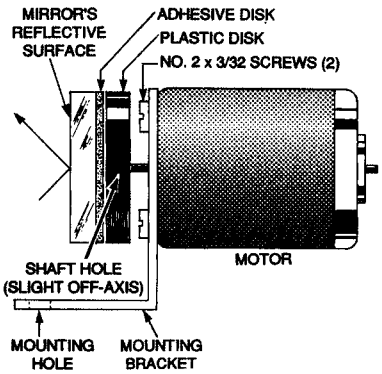


FIG. 6—AN ALUMINUM BRACKET is attached to each motor with two No. 2 × 3/32 self-tapping screws. The mirror-mounting disk should be pressed onto the motor shaft as far as possible without contacting the screws.

You need three 1-inch diameter mirrors for your light show. Do not use glass mirrors. They are too fragile and can break or shatter and cause injury. At most plastic supply houses or hobby shops, you can purchase mirrors made of plastic. Ask the clerk to cut the material into 1-inch circles or carefully cut your own. You also need three 1-inch round disks to attach the mirrors to the motors. Here you can use wood or plastic. Whatever material you choose for the mirror mounts should be approximately 1/8-inch thick.

Before mounting the plastic mirrors to the disks, you must drill a hole in the center of each disk. The hole should be a bit smaller than the diameter of the motor shaft to make for a snug fit and it should be drilled at a very slight angle. The angled axis will give the mirror a slight wobble as it spins. A small amount of wobble is necessary for proper operation, but an excessive amount will prevent proper alignment.

Put together the motorized mirror assemblies by attaching the mirrors to the mirror mounts. Use quick-set epoxy, cyanoacrylate adhesive (super glue), or double-sided foam tape and make sure the reflective side faces away from the motor. Repeat the procedure for all three mirrors and mounts, and wait at least an hour for any adhesive to set.

Next attach an aluminum bracket to each of the motors, as shown in Fig. 6, with two No. 2 × 3/32 self-tapping screws. Press a mirror onto each motor shaft. The mounting disc should be pressed onto the shaft as far as possible without hitting the motor screws. If the mirrors spin freely, remove them and then reinstall them using a few drops of adhesive to permanently bond them to the

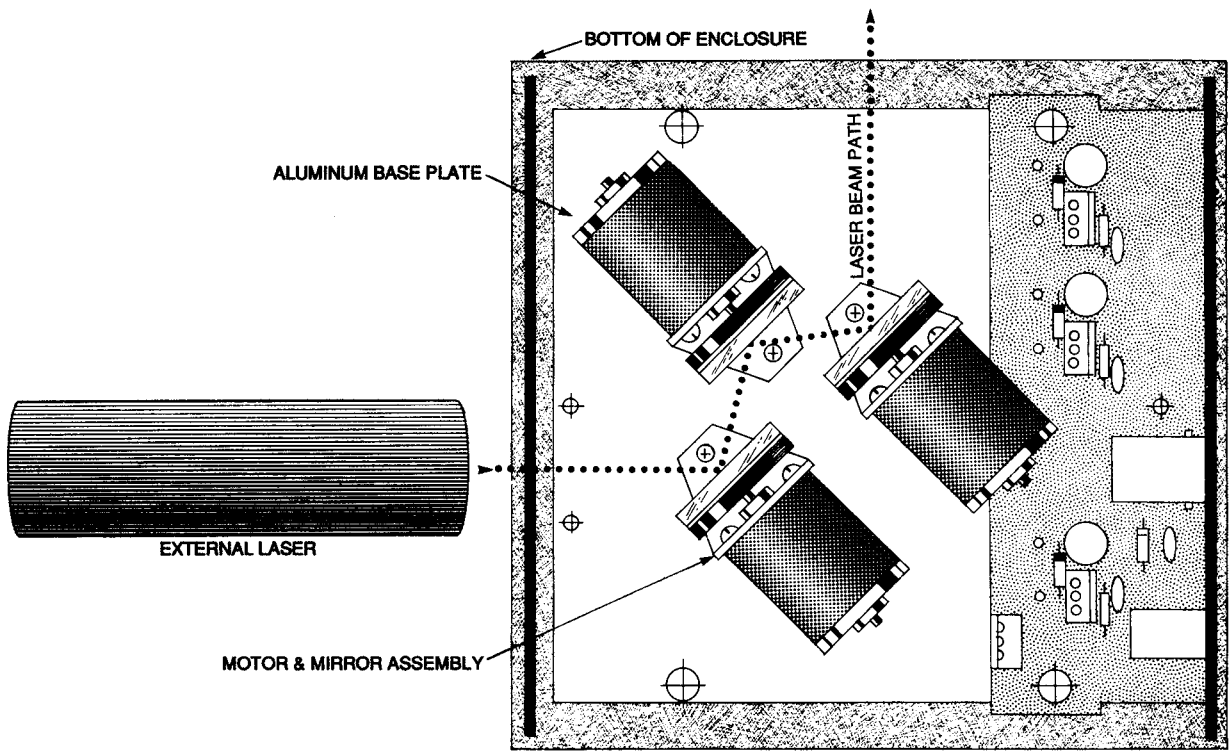


FIG. 7—THE MOTOR ASSEMBLIES can pivot on the baseplate to allow for alignment of the laser beam.

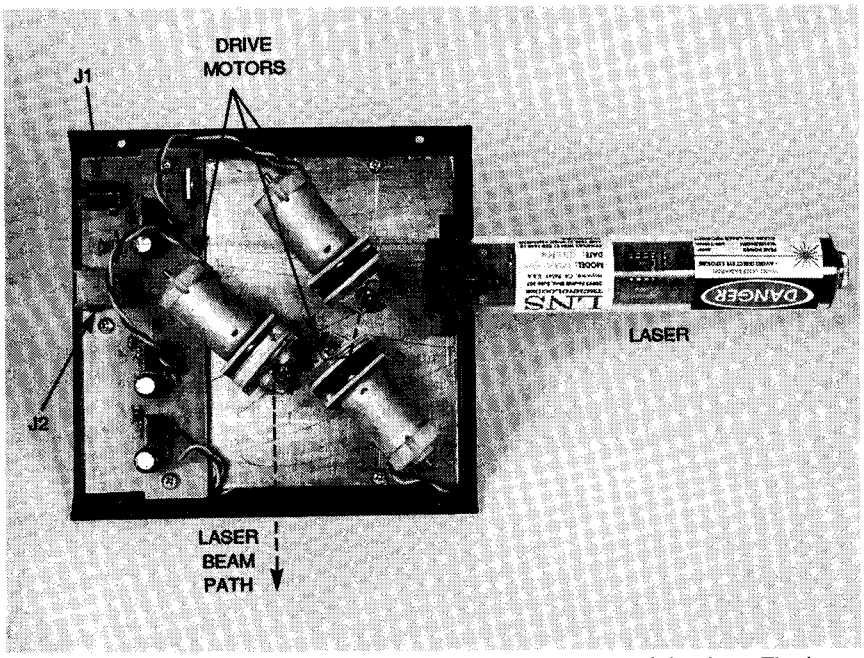
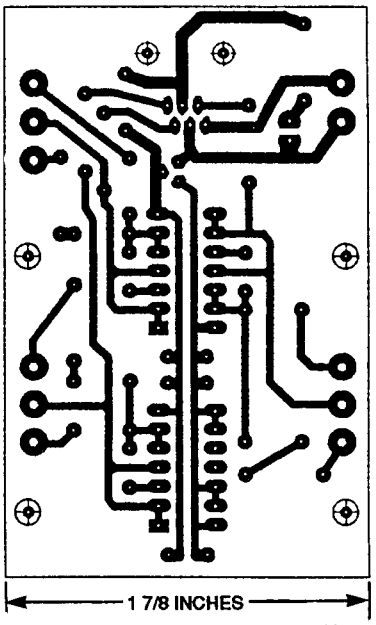


FIG. 8—LASER BASE UNIT. Any laser will work with the laser light show. The laser shown here is a solid-state unit from an available kit.



REMOTE CONTROL FOIL PATTERN.

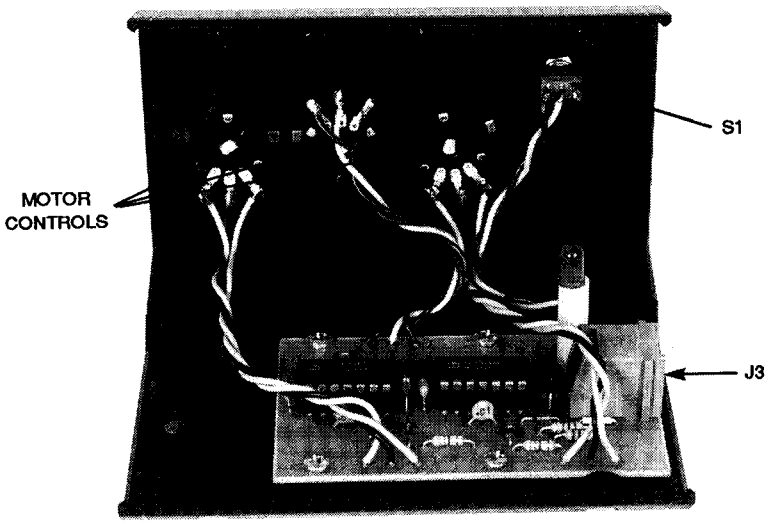
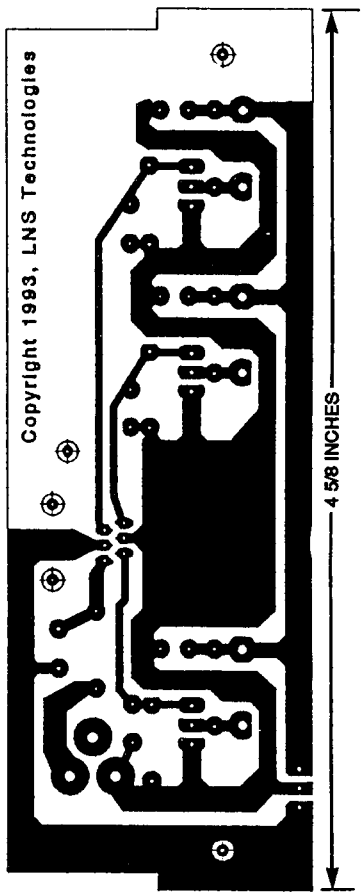


FIG. 9—THE REMOTE CONTROL UNIT lets you vary the speed of the three motors in the base unit individually.



LASER BASE FOIL PATTERN.

motor shafts.

After everything has dried, carefully inspect each motor and mirror assembly. Make sure that the plastic mount, the mirror, and the motor are all firmly attached to each other. Any loose part could fly off and injure somebody. Make sure each mirror turns freely. Do not run the motors if anything is binding or rubbing. Correct any problems now.

Mount the motor assemblies on the baseplate as shown in Fig. 7 and partially tighten the mounting screws. A final alignment will be done later with the laser in place. Solder a pair of wires from the base-unit board to each motor (see Fig. 3). Before soldering, the leads can be trimmed in length to fit the case. It doesn't matter which wire goes to which terminal on each motor.

Any laser will work with the laser light show, as long as the device can be mounted so that the laser beam can be bounced off the mirrors as shown in Fig. 7. The author used a solid-state laser for which a kit is available (see the Parts List). That laser

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make sure that the mirror cannot accidentally hit the laser when it does turn. Loosen the

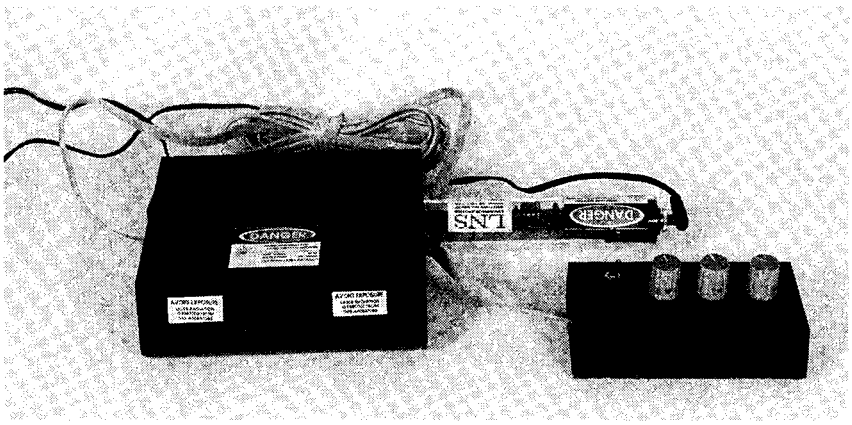

FIG. 10—THE LASER LIGHT SHOW consists of a wired remote control and the laser base unit that holds the rotating mirrors.

comes with a plastic mounting bracket that fits the two mounting holes for it on the aluminum base plate. If you are substituting a different laser, solid-state or otherwise, you must provide a suitable power supply and mounting bracket for it. Figure 8 shows the inside of the finished base unit, and Fig. 9 shows the inside of the remote control unit. Figure 10 shows the completed assembly.

Alignment and operation

Do not attach the cover to the base unit until you have checked the operation of the motors and have finished the alignment of the mirrors. During check-out and alignment, follow all laser safety precautions and *never* let the beam shine into anyone's eyes. Wear eye protection when running the motors without the enclosure cover in place.

Connect the handheld remote to the base unit with a 6-conductor modular cord. Next, plug the wall outlet adapter into an outlet and into J1. The toggle switch on the remote turns the unit on and off, and the motors will spin with varying speeds as you adjust the three potentiometers.

With the laser device positioned as shown in Fig. 7, and without the motors running, apply power to the laser and make sure that the beam strikes the first mirror as shown, and bracket-to-base mounting screws and adjust the position of each motor so that the laser beam is reflected from the first mirror to the second mirror and then to the third mirror and out the side.

Next, fine tune the beam alignment by slowly turning each mirror by hand. As the mirror turns, the beam will be deflected. Adjust the position of each motor so that the deflected beam never leaves the surface of any mirror.

Adjust the last motor so that the laser beam will correctly exit through the hole in the enclosure cover when it is installed over the base.

Once everything is aligned, aim the laser light show at a blank wall or screen. As you vary the speed of each motors you'll see the endless variety of spiral forms that are created. If something was not assembled correctly, stop the motors before you try to adjust anything. When you are satisfied with the light show's alignment and operation, shut both the unit and the laser off and install the cover on the base unit.

This project should provide hours of fun and excitement. Everyone who sees it will want to take a turn at the remote control unit. Use your imagination in a dark room—with some background music and a little smoke you can create some truly sensational shows! Ω