

# Build a LAVA LAMP

*Watching the hypnotic motion of a Lava Lamp is fun, but did you ever wonder how one works? Here's the answer, and a guide that shows you how you can build one yourself.*

BY RALPH HUBSCHER

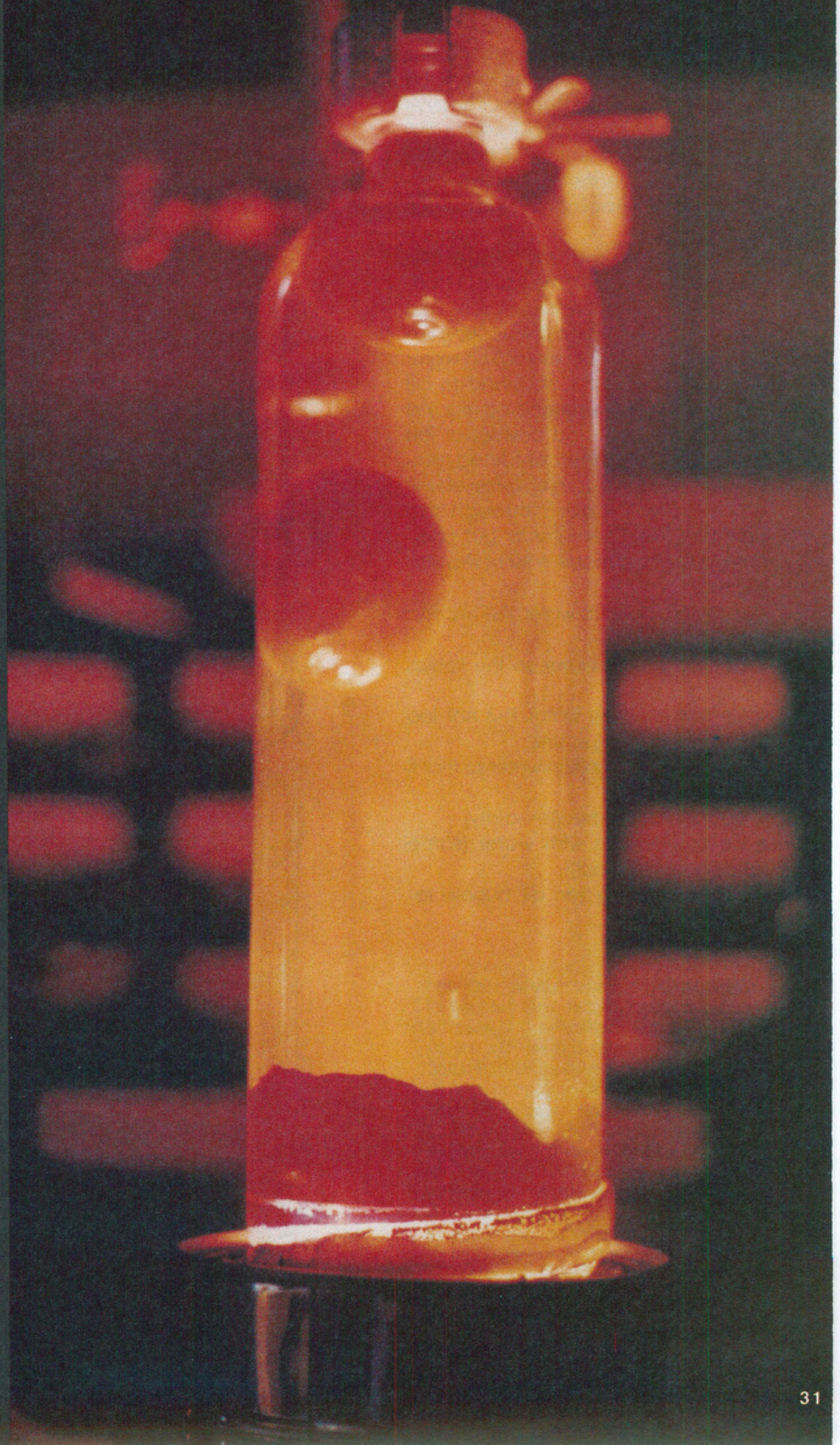
**W**hile hiking in the mountains this past summer, I stopped at a small restaurant for a spot of refreshment. I wound up with more, however; I left with an idea.

The owner had a unique decorating scheme, but what caught my attention were the decorative, table-lamp like devices that occupied each table in the establishment. They consisted of a cylinder-shaped bottle with a very short neck. In it, one red liquid moved leisurely up and down in a second, colorless liquid. The bottle was mounted on a stand and illuminated, and a decorative roof-like cap hid the bottle cap.

The red liquid bulged, formed bubbles and balls which rose very slowly and changed shape. Near the surface they sometimes coalesced with other balls, but always sank, only to go through the routine again. It was quite a spectacle and, like watching fish in an aquarium, you could look for hours.

Of course, the lamps were versions of the "Lava Lamp" that was so popular in the late 1960's and early 1970's. But as that psychedelic age faded, so did the lamp's popularity. Eventually, they were consigned to the farthest corners of closets or dark recesses of musty curio shops.

While Lava Lamps have made a bit of a comeback of late, why buy something when building one presents more of a challenge, and a lot more fun? I



decided that I'd try to figure out how they were made and build my own.

### What's Inside a Lava Lamp?

Examining the lamp, a few facts became clear. Obviously two immiscible fluids had been poured together, one of them dyed for contrast, and heat was applied at the bottom to make the bottom liquid warm up and expand. When expanded, that liquid's specific gravity is lower, and therefore it tends to move upward to where it is cooler. Once the liquid reaches the top of the container, it cools off, becomes heavier again, and starts sinking towards the bottom and the source of heat. The source of heat is the light bulb that illuminates the vessel containing the two fluids.

The first thing that must be determined is the nature of the liquids. I started out assuming the transparent fluid was water. The second fluid looked like SAE 50 motor oil, but oils float on water while this liquid sank, so it had to be something else. I remembered reading about some imported devices of this type and that they contained poisonous and dangerous chlorinated hydrocarbons. I looked through the Handbook of Chemistry to get alternate ideas, and made a list of requirements.

Assuming fluid 1 is water, the second fluid should:

- be insoluble in water, so the liquids remain separate
- be heavier than water, but not too heavy, in order to just sink
- not be emulsifiable in water so that it separates rapidly
- be non-flammable (for safety)
- be compatible with water (some substances will react)
- be stable in air (an air bubble remains on top)

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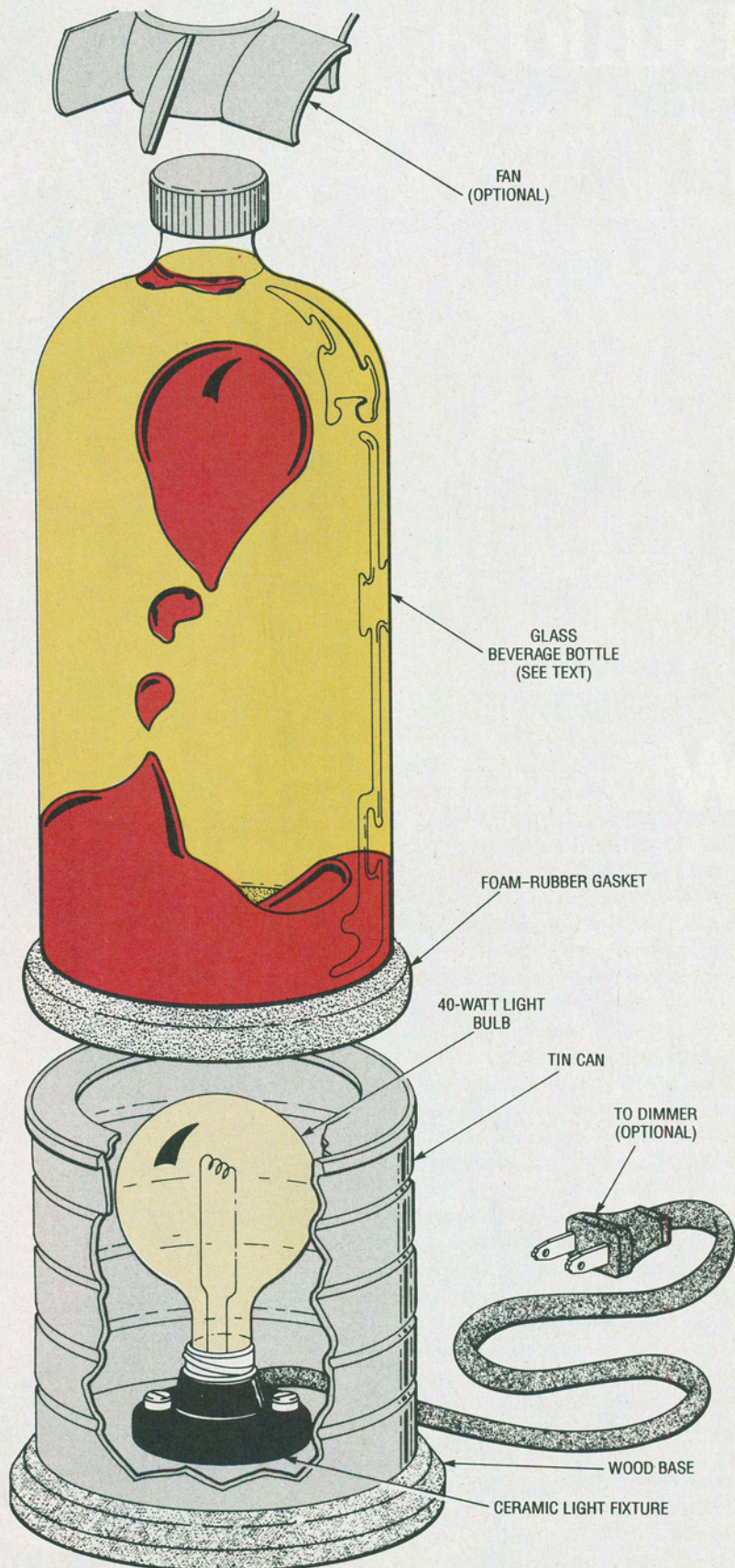


Fig. 1. Here are the major components of the Lava Lamp. Heat from the light bulb warms the benzyl alcohol in the glass container, causing bubbles to rise to the top, where they cool and eventually drift downward again.

- not be very poisonous (in case of breakage)
- not be chlorinated (in case of breakage)
- have a high boiling point (in case of breakage)
- be somewhat viscous so as to form "oily" bubbles
- be reasonably priced
- have a greater coefficient of expansion than water

That list of requirements is quite demanding. In fact, as any chemists out there will quickly realize, it eliminates about 999 out of 1000 possible compounds. After a thorough search, I came up with five chemicals which might be worth a try, but none of them were without a question mark. The list can be found in Table 1.

### MATERIALS LIST FOR THE LAVA LAMP

Benzyl alcohol  
Water  
Table salt  
Glass beverage bottle, 10-inches or taller  
Tin can, pint-size or larger  
Plywood (see text)  
Foam rubber, 1/4-inch (approximate) thickness  
Ceramic light fixture  
Light bulb, 40 watts  
Rubber grommet, AC plug with line cord, small fan (optional, see text), light dimmer (optional, see text), hardware, etc.

### PARTS LIST FOR THE LIGHT DIMMER

TR1—ECG 5603, NTE 5603, 2N6071, or equivalent Triac  
D1—ECG 6408, NTE 6408, or equivalent Diac  
R1—3000-ohm, 1/4-watt, 5% resistor  
R2—500,000-ohm potentiometer  
C1—0.1- $\mu$ F, ceramic-disc capacitor  
SO1—AC socket  
PL1—AC plug with line cord  
F1—5-amp fuse  
S1—SPST switch  
Wire, solder, hardware, etc.

Looking that list over, I decided to try benzyl alcohol. That substance, as well as the rest of the chemicals mentioned in this article, can be obtained through just about any reasonably stocked chemical supply house (check your local telephone book). Although benzyl alcohol is a little more soluble in water than the rest of the chemicals that are

TABLE 1—CHEMICAL CHARACTERISTICS

Chemical	Specific Gravity	Boiling Point (°C)	Solubility in Water
Benzyl alcohol	1.043	204.7	slightly soluble
Cinnamyl alcohol	1.04	257.5	slightly soluble
Diethyl phthalate	1.121	298	insoluble
Ethyl salicylate	1.13	233	insoluble
Nitrobenzene	1.205	210.9	very slightly soluble

TABLE 2—SALT CONCENTRATIONS

% Salt	Specific Gravity
1	1.0053
2	1.0125
4	1.0268
5	1.0341
6	1.0413

listed in Table 1, it seemed to work well so I stayed with it.

Before we proceed, some words of caution are in order: **While benzyl alcohol is a relatively harmless chemical, all chemicals are poisonous to one degree or another—you can kill yourself with salt. Of course, you must not drink it and skin contact should be avoided, if possible. Further, if benzyl alcohol should get into your eyes, wash it out with plenty of water while you hold your eye open using both hands, and then call a physician immediately! Finally, breathing benzyl alcohol should be avoided, (although it has such a high boiling point that hardly any of it evapo-**

rates). By the way, the oxidation products of benzyl alcohol—benzaldehyde and benzoic acid—are used as food additives, specifically as artificial almond flavoring and as a preservative, respectively.

A suitable red oil-soluble dye was found quickly. An old red felt pen was cut up (without spillage) and the dye-containing felt strip in it was placed in a jar with some benzyl alcohol. The dye was an excellent choice. It was stable in air and light, and insoluble in water—just perfect.

The red-dyed benzyl alcohol was then poured into a heat-resistant beaker, water was added, and the blend was heated on a hot plate. Nothing happened! Apparently, the specific gravities of the two liquids were too far apart and the liquids simply stayed where they were originally. I decided to try adding sodium chloride (table salt) to the water to increase its specific gravity. Table salt's affect on the specific gravity of water is shown in Table 2.

My initial tests showed that 5% and 6% salt concentrations were too high—the benzyl alcohol just floats to the top when heated and stays there. But a 4.8% salt solution worked fine. To get that concentration, I dissolved 48 grams of salt and filled up a container to 1 liter.

I now had all the components for my Lava Lamp. Benzyl alcohol (specific gravity 1.043 g/cm<sup>3</sup>) settles on the bottom of the vessel filled with a 4.8% salt-water (brine) solution (specific gravity approximately 1.032g/cm<sup>3</sup>). When the vessel is heated, the benzyl alcohol expands enough to become lighter than the brine and red bubbles rise to the top. There, the bubbles cool off, become heavier than the brine again, and sink. The cycle then repeats.

**Construction Details.** The first step is to find a suitable vessel. Use a glass beverage bottle shaped roughly as  
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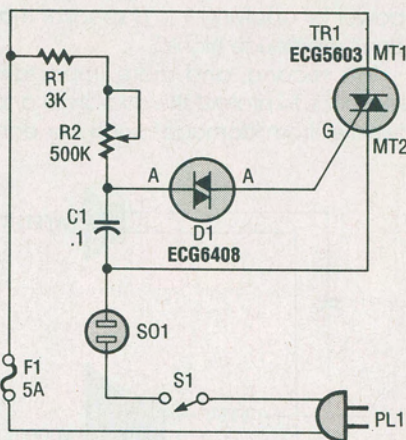


Fig. 2. Using a light dimmer is one way to control the amount of heat applied to the Lava Lamp. Nearly any dimmer circuit, including the one shown here, can be used.

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## LAVA LAMP

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shown in Fig. 1. It should be about 10-inches high, although the taller the bottle the better. Fill it partially with brine, add about 150 milliliters of benzyl alcohol (dyed red), and then fill the bottle up with brine. Leave about 1-inch of air on top to buffer expansion; note that the bubble size is influenced by the amount of air space.

Open a 1 pint (or larger) tin can, remove the lid completely, and remove the contents. Clean the can thoroughly and cut (or drill and file) a hole in the bottom. That hole should be as large as possible, but a metal lip must remain; that lip will be used to support the beverage bottle chosen when the can is inverted. Be sure to remove any sharp edges from the hole before proceeding.

Cut a circular piece of wood, about 4–5-inches in diameter, from a piece of scrap plywood of suitable size. Mount a ceramic light fixture at the center of the board. Drill a hole in the side of the can (toward the open, top end) that's large

enough for a power cord. Fit the hole with a grommet, feed a length of power cord through the hole, and connect the wire to the terminals on the fixture. Screw a 40-watt bulb into the fixture. Invert the can (open end down), place it over the fixture and bulb, and center it. Glue the can to the board using epoxy cement.

Create a gasket from a thin piece of foam rubber and place it on the can's lip. The gasket's function is to keep light from escaping around the bottom of the bottle. Place the bottle on the can assembly, plug in the light source, and soon your lamp should be bubbling away.

**Improvements.** If your bottle is tall enough, or you don't have the lamp running all the time, your Lava Lamp may work well exactly as described. However, the key to the lamp's operation is the temperature within the bottle. It is best to operate the unit at the lowest temperature possible since at lower temperatures, separation appears to be best and sticking to the walls is reduced. And if things get too warm, after a while the benzyl alcohol will simply

accumulate at the top. That's particularly likely to happen if the bottle is too short.

There are a couple of ways of combating this. One is to use a cooling fan at the top. Another is simply to turn off the lamp and let things cool down. But perhaps the best approach is to use a simple lamp-dimmer circuit to regulate the temperature. One suitable circuit is shown in Fig. 2, but just about any lamp dimmer could be used. With the lamp dimmer, the unit can be turned on at full brilliance to get things warmed up, and then the wattage can be reduced to the point where things run continuously.

If the lamp doesn't get things going fast enough to suit you, almost instant warming up can be had by means of a hot-air blower or hair drier. The hot air should be directed only toward the red layer of benzyl alcohol that sits on the bottom when the lamp is cool.

If available, a trace of antioxidant, such as BHT or BHA, can be added. In some of my experiments, I used some fluorescein sodium, a pink dye that gives the salt water a beautiful greenish color that contrasts even better with the red. ■

## CHEMICAL CAUTION

I want to warn other readers that one of the chemicals listed in Table 1 of the article "Build a Lava Lamp" (Popular Electronics, March 1991) is quite dangerous. Nitrobenzene is deadly through inhalation, skin contact, or ingestion, and the article does not make that evident.

S.D.

*Powell River, BC, Canada*

*You are correct. However, the chemicals listed in that Table were only candidates for further investigation by the author and none, other than benzyl alcohol, was either pursued or used in the project. Based on the information we have received from you and other readers since publication, we strongly caution and urge that the use of nitrobenzene be avoided.—*  
*Editor*