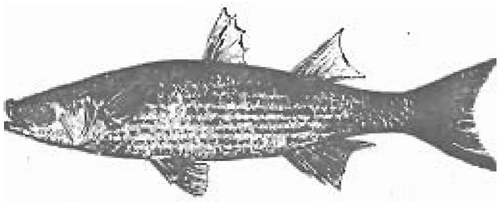
Aquarium Heater Control for Fish Fanciers

AND PHOTOGRAPHERS, CHEMISTS, AND ANYONE ELSE WHO NEEDS STABLE, PRECISE TEMPERATURE CONTROL



WHILE virtually all IC's were originally designed for commercial applications, quite a few have filtered down to the hobbyist and experimenter. One of the more interesting IC's to follow this route is RCA's CA3059 trigger circuit for the control of thyristors. Almost by itself, this IC is a complete electronic control system for immersible and non-immersible heaters. This means that the tropical fish keeper, the amateur and professional photographer, and the chemist can now have an inexpensive, highly accurate heater control.

The CA3059 eliminates the instabilities present in the typical bimetallic thermostatic heater by replacing the mechanical contacts with a triac and employing a totally electronic interface. Among its many features, the IC includes zero-voltage switching; which means that triggering for the triac is provided only at the points where the 60-Hz line power voltage crosses the zero axis. Hence, rf noise is eliminated without having to resort to bulky and expensive line filters.

BY A. E. DONKIN

The electronic heater control described here will maintain any preset temperature within its range of control to very tight limits. With the components specified, the system will handle output loads (heaters) rated at up to 200 watts. However, a higher power triac can be substituted to cope with higher power requirements.

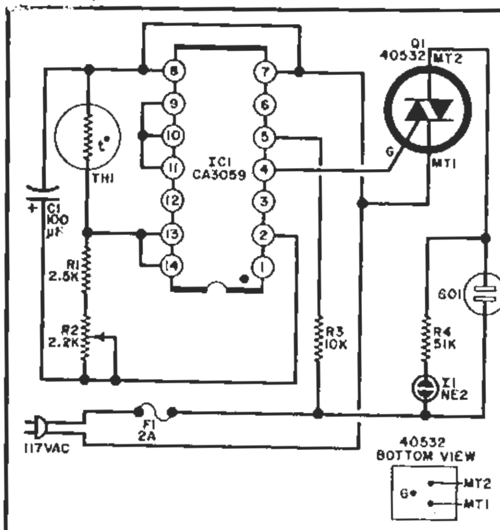
Theory of Circuit Design. The CA3059 is a fairly unique integrated circuit. In addition to its triggering circuit, the IC also contains a power supply and a differential amplifier. This minimizes the external circuitry to a handful of components as can be seen in Fig. 1.

The only external components needed are thermistor temperature sensor *TH1*, temperature control resistor and potentiometer *R1* and *R2*, triac *Q1*, and the dropping resistor and filter capacitor *R3* and *C1* for the power supply. The power line is fused by *F1* as a safety measure, and neon lamp/resistor assembly *I1/R4* are optional items that give a visual indication of the operational status of *Q1*.

In operation, the heater to be used with the system is plugged into *SO1* and the line cord is plugged into any convenient 117-volt ac receptacle. Both temperature sensor *TH1* and the heater are then immersed in the same water or solution (but no less than 2" apart), and *R2* is adjusted to the position that will maintain the water at the desired temperature.

Assuming that the water was originally cooler than desired, the system should trigger on as soon as the heater and *TH1* are immersed and power is applied to the circuit. While the system is active and triggering *Q1* into conduction, *I1* will light to show that power is being applied to the heater.

At some time during the heating process, the water will attain the desired temperature, at which time *TH1* will initiate action to stop the IC from trigger-



PARTS LIST

C1—100-µF, 35-volt electrolytic capacitor
F1—2-ampere fuse
I1—NE2 neon lamp
IC1—CA3059 integrated circuit (RCA)
Q1—40532 triac (RCA)—see text
R1—2200-ohm, ½-watt resistor
R2—2500-ohm, linear-taper potentiometer
R3—10,000-ohm, 2-watt resistor
R4—47,000-ohm, ½-watt resistor
SO1—Chassis-mounting ac receptacle
TH1—Fenwall JA33J1 thermistor
Misc.—8"-long glass tube; perforated phenolic board and push-in solder clips; Bakelite chassis box; fuse holder; ac line cord with plug; solid and stranded hookup wire; lamp bezel with lens for I1; insulating tubing and air hose; solder; hardware; etc.

Fig. 1. Only a few external components are needed with IC1 to make control.

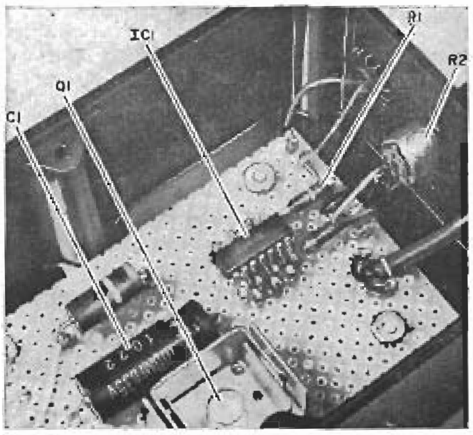
ing *Q1* into conduction and shut off the heater. As long as the water temperature remains constant at the preset level, the system will remain passive. However, if the water temperature should fall below the preset level, *TH1* will sense the event and initiate the process for resuming triggering *Q1* and turning on the heater.

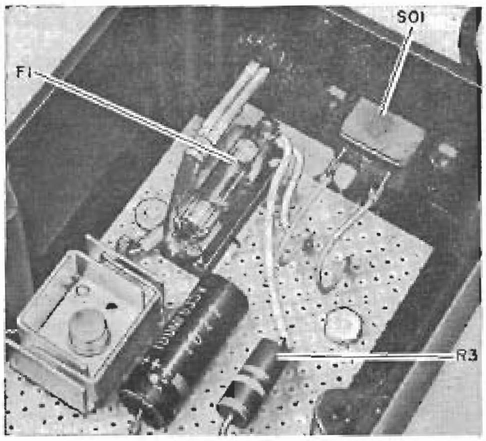
Assembly. There is nothing critical about the layout and wiring of the main circuit just as long as proper soldering precautions are exercised. In Fig. 2 can be seen how the prototype was assembled using a small piece of perforated phenolic board and push-in solder clips. Interconnecting wiring was routed along the bottom side of the board.

The sensing element probe assembly consists of a 0.01"-diameter disc thermistor mounted inside a glass tube one end of which is sealed. To make this assembly, use a high-heat *flame* to bring the end of the glass tube to red-hot temperature and draw out the softened glass until it seals itself. Then hold the sealed end of the tube in the flame again until the sharp point rounds off.

Twist together two 36" lengths of flexible stranded hookup wire. Slip a 3" length of insulated sleeving over the end of one wire, and solder both conductors at this end to the thermistor leads. Slide

Fig. 2. Simplicity of circuit is responsible for easy layout of components on perforated board. Note that, since line voltages are exposed in several places in circuit, insulating Bakelite box should be used for the chassis enclosure.





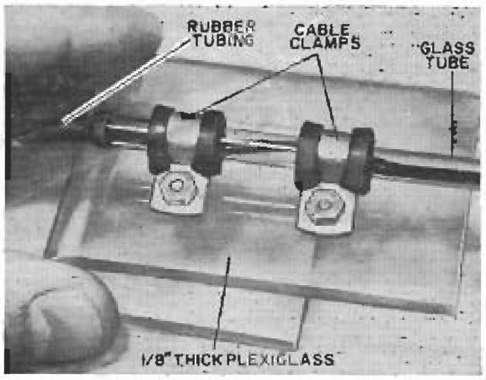


Fig. 3. Sensing probe assembly mounts on plastic bracket with cable clamps and #6 hardware. Do not overtighten clamps or the glass tube will break.

the sleeving down over the thermistor lead. Then check to make sure that the thermistor's leads do not short out against each other with the sleeving in place.

Now, carefully slide the thermistor into the open end of the tube until it sits against the closed end. Fashion a mounting bracket for the probe assembly from ⅛"-thick Plexiglass and mount the probe assembly to it with a pair of plastic-lined cable clamps as shown in Fig. 3. Then slip a 6" length of plastic or rubber air hose over the free and of the twisted wires and force it down over the open end of the glass tube for about ¼" as shown. Connect and solder the free ends of the wires to the appropriate points on the circuit board.

Test and Use. After the control system is assembled, an easy test to check out its operation can be performed with the aid of a 40- or 60-watt incandescent lamp as the load. (Note: Since line voltage is used at several points in the circuit, exercise extreme caution when working with the circuit without the cover on.) Turn up the heat control, *R2*, until the lamp lights.

Bring the sensing probe near the lighted lamp; after a short lag, the lamp should extinguish as a result of the heat transfer from the lamp to the thermistor. Keep the probe assembly near the lamp after it goes out, and a few seconds later, the lamp should again trigger on. If the probe is held near the lamp for a considerable time, the lamp should cycle on and off.

Now you are ready to put the control system into service. If you already have a bimetallic thermostatic heater, turn its control up for a high temperature. Plug it into *SO1* on the control box. (If you do not have a heater, use one of the non-controlled submersible heaters found in pet stores.)

Advance the heat control to the desired setting, making sure that the probe and heater are both immersed in water. Wait until the water temperature stabilizes before making any small adjustments of the control.

If the control system is to be used just for tropical fish aquariums, rough setting of *R2* will suffice. However, for more critical photography bath and chemical solutions, it is advisable to calibrate the control setting with the aid of an accurate thermometer. ◈

CONTACT PROTECTS PANEL MARKINGS

Dry-transfer lettering kits have made a simple job of prettying up front panels of home-made projects. But keeping the markings from wearing away or scratching off is a big problem. However, there is a simple way of ruggedizing the markings to bear up under even extra-heavy usage. After finishing off the front panel and applying the lettering and markings, cut some transparent Contact (a flexible adhesive-backed vinyl) to dimensions ½" larger than the length and width of the panel. Strip off the protective backing and tack the Contact, adhesive side up, on a flat surface. Now, carefully lower the front panel onto the Contact, roughly centering it. Do not attempt to lift the Contact off the panel from this point on or the lettering and markings will be destroyed. Remove the tacks and firmly burnish down the Contact, pricking any air bubbles with a sharp pin as you proceed. Finally, use a sharp knife to trim away the excess Contact flush with the panel edges. —*Richard A. Kunc*