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CONTROLLER USES TRANSISTOR AS A TEMPERATURE SENSOR*

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UNPUBLISHED PRELIMINARY DATA

A simple dc proportional temperature controller may be constructed by taking advantage of the predictable variation of transistor parameters with temperature. For the controller shown here, the variation in collector current with temperature under constant base-emitter voltage conditions was used to provide an oven temperature sensor with power gain. Only two more transistors are necessary to complete the controller which has a 10-watt drive capability.

The 2N3128 sensor is a silicon micro-transistor that is placed in thermal contact with the temperature-controlled point. Its small size (0.05" × 0.05" × 0.035") insures that thermal lags caused by the transistor are held to a minimum and allows easy mounting with a spot of epoxy cement. The range of the sensor is its entire operating temperature range (up to 150°C).

The silicon emitter follower and output transistors, Q_2 and Q_3, provide sufficient gain to supply power to a 50-ohm heater from a 24-volt power supply

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without unduly loading Q_1. Also, the two emitter-base junctions in series provide a convenient, low-dissipation operating point for the sensor transistor.

The circuit, mounted within the oven cavity, was used to hold the temperature in a small crystal oven at 70°C. Since any heat dissipated by the circuit components is contained within the oven, the controller is 100% efficient.

Operation is like that of any feedback control system. With constant base-emitter bias on Q_1, if the oven temperature increases, the collector current increases. This causes a decrease in the collector-emitter voltage of Q_1, and hence a decrease in the collector current of Q_3. The decreased current means that less heat is dissipated in the combination of the 50-ohm heater and Q_3, and the oven cools toward the set point. Increasing the base-emitter voltage of Q_1 causes the set-point temperature to decrease.

Performance of the system was comparable with one incorporating a conventional proportional controller with a thermistor temperature sensor followed by a three-transistor amplifier. For moderate variations in the ambient temperature, the oven temperature varied by less than 0.2°C.

With the controller circuit mounted in the oven, the maximum oven temperature is limited by the junction temperature rise in the output transistor, Q_3. For higher oven temperatures, Q_3 should be mounted on a heat sink to insure that its maximum junction temperature rating is not exceeded.

Figure Caption

Fig. 1. Simple temperature controller with transistor sensor.

Top

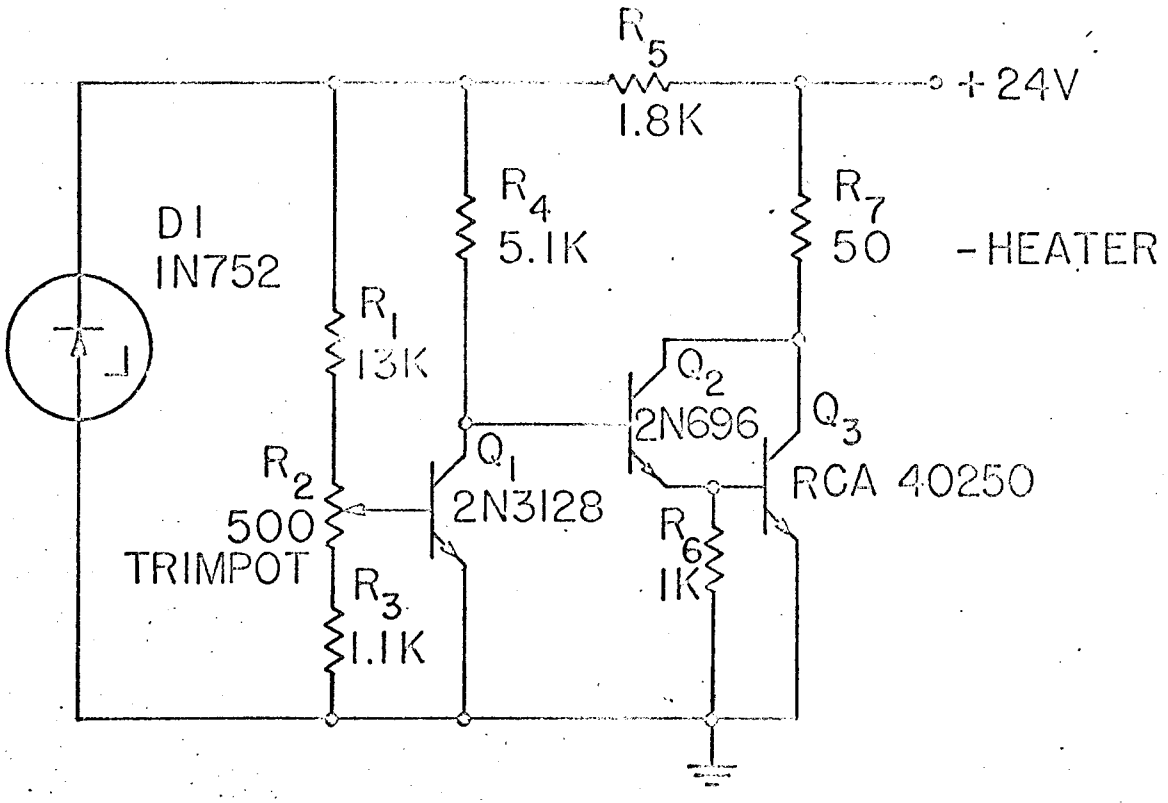

Fig. 1
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