POWER SUPPLIES FOR THERMAL CONDUCTIVITY DETECTOR OF A GAS CHROMATOGRAPH

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Abstract

Three types of power supplies for a Thermal Conductivity Detector (TCD) in a Gas Chromatograph have been fabricated using integrated circuits. These power supplies have been tried in low and high ohms TCD bridges. One of the power supply has been installed in a commercial gas chromatograph and it gave satisfactory results for low ohms bridge.

Introduction

Gas Chromatography is a well known separation technique for analysing components of a chemical mixture (1-3). It is a costly equipment and is much used in analytical chemistry. There are many kinds of detectors (4-6) used in gas chromatography like thermal conductivity detector (TCD), flame ionization detector (FID), electron capture detector (ECD), and flame photometric detector (FPD) etc. TCD or Katharometer is the simplest and most robust detector.

In a TC detector a heated wire in the form of filament is placed in the path of carrier gas (Nitrogen or Helium). As sample passes through the carrier gas, the temperature of wire and hence its resistance changes and signal is measured as resistance of wire.

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Filament wires are usually made of tungsten, gold sheathed tungsten, rhenium-tungsten, nickel and platinium-irridium (7). Thermistors are also used but in low temperature ranges (2).TCD sensitivity depends upon:

i) Constant voltage power supply with current limiting.

ii) High filament resistance and high temperature coefficient.

The resistances are generally four filaments or two NTC thermistors arranged in a Wheatstone bridge configurations. The bridge is energized from a very stable dc power supply with a current limiting. The power supplies used in commercial instruments are still based on discrete components. These power supplies can be made from locally availbale ic's.

An attempt is made to design various kinds of dc regulated power supplies keeping in view the above stated requirements. One of the power supply has been tried in Beckman GC-2 gas chromatograph to replace its old valve and germanuim transistored based power supply. The performance is found to be satisfactory. The behaviour of other supplies is also discussed.

Experimental

Three types of power supplies have been tried.

1. Using 3-terminal voltage regultors like MC7824 and LM317T.

2. Using uA723/NE550 variable voltage regulators with pass transistors for current amplification.

3. Using CA3130 as an error amplifier and CA3086 providing zener voltage for CA3130.

1. *TCD Power supply using 3-Terminal Voltage Regulators.*

MC7824 (24V, 1A regulator) makes simplest power supply. Current can be limited by a series variable resistor or by a second MC7824 as a current regulator. The circuit is shown in Fig. 1. LM317T is another good 3-terminal variable voltage (1.2 to 30V) regulator. One can adjust voltage by use of 5K potentiometer (Fig. 2).

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2. TCD Power Supply using uA723/NE550 Regulator.

uA723/550 is a variable voltage regulator with a maximum current of 50mA (8). A pass transistor like 2N3055 is necessary to increase current. A big heatsink is needed for this transistor. The regulator can be designed in the range of 3-37V. The circuit in Fig. 3 is designed in upper range of 28 $\pm$ 3V. The current limiting is done by Rs (Rs = 0.7/I1 where I1 is maximum current limit). A variable resistor is used for Rs for variable current limit. NE550 is similar but it can go to higher voltage (9). This circuit is suitable for high filament resistances (Rf = 110-150 ohms).

3. TCD Power Supply for Low Filament Resistances.

This power supply is variable from 0.1 to 50V. CA3130 is used as an error amplifier (10). CA3086 is providing zener voltage for CA3130 comparator. Q4 boosts output of CA3130 to drive darlington Q1 and Q2. Q3 limits the current. Since this is a high voltage power supply, filaments get enough voltage even after the usual dropping in the associated circuitry. In fact this supply was designed to replace old tube, Ge-transistor and mercury battery based power supply of Beckman GC-2 gas chromatograph. The circuit diagram is shown in Fig. 4. The filament resistance is 28 ohms. The four filaments were made of tungsten wire of 40 watt bulb filaments obtained from Phillips Electrical Co. of Pakistan Ltd. and were spot welded. The bridge circuit of GC-2 gas chromatograph was not changed. The results were quite satisfactory.

Fig. 1

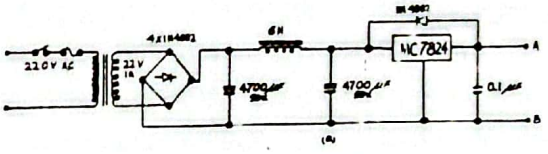


Fig. 2

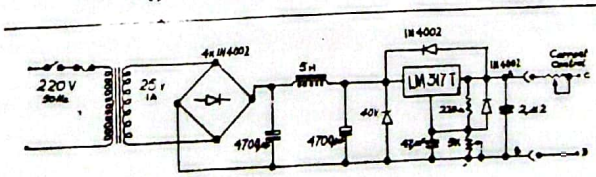


FIG.1 (a) TCD power supply using 3 terminal fixed 24V regulator (MC7824).
(b) Current Control by using a series wire wound potentiometer.
(c) Current Control by means of IC.

FIG.2 Circuit diagram of TCD power supply using LM317T variable voltage regulator.

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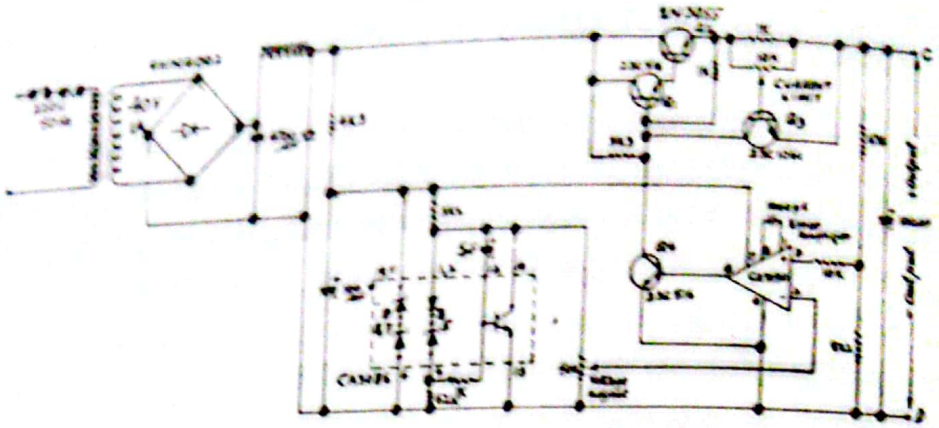


Fig. 3

TCD bridge power supply using uA723/NE550 voltage regulator. The regulator gives a voltage of 28± 3 volts.

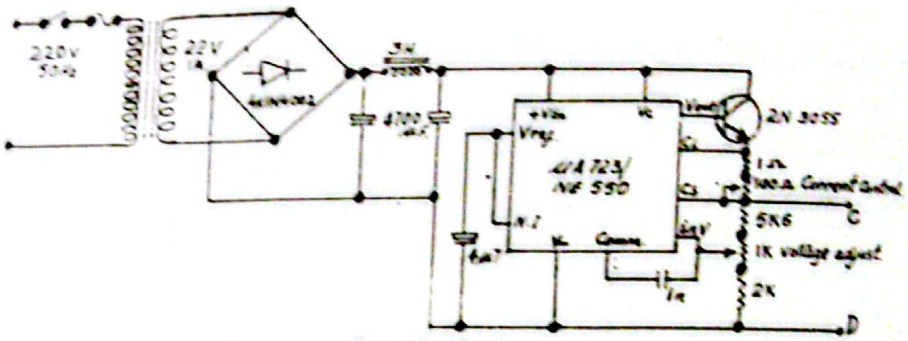


Fig. 4

TCD filament power supply for low resistances (Rf<40 ohm).

Conclusion

The power supplies made from the ic's are much better in performance as regards to line and load regulation. With the design of a precision temperature controlling unit, one can fabricate a simple type of gas chromatograph. Also with these power supplies one can update the old discrete component TCD power supplies in old gas chromatographs.

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