Newton C. Braga

FUN PROJECTS FOR THE EXPERIMENTER volume 2

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FUN PROJECTS FOR THE EXPERIMENTER - volume 2
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ÍNDICE

PREFACE

During more than 30 years, as a collaborator with American, European and Latin American electronics magazines (*), the author has published a large assortment of practical circuits using common parts.

In 1999 he included the first selecion in a volume published by Prompt Publications in USA. The idea was to proceed with the seris, publishing many volumes more.

But, Prompt closed his activities and the idea was forgotten altough the first volume became a best seller.

Now with his own publishing house (NCB Publications) the author returned with the idea of make many volumes more of the series. So, the second volume is here proceeding with the same idea: give simple projects to the experimenters who want learn electronics using common parts and with no need of special knowledge about electronics.

So, as in the first volume, many of the projects collected by the autor are included in this volume, most of which you can build in one evening (*)

(*) many of the projects you can access in the site in Portuguese - www.newtoncbraga.com.br and in English - www.newtoncbraga.com in the section Mini Projetos (Mini Projects). Mini-Projects is the title of a column publsihed by the author during several years in a Brazilian Electronics Magazine and now included in his sites in Portuguese and English.

The projects range from fun types through practical types to amusement types. Of course, there are other devices that can be used to teach you something about circuits and components.

An important feature of thses projects are the Ideas to Explore, intended for students looking for projects in sciente or to use in practical research. This ideal can be complemented by our book Science Fair and Technology Education Projects, also published in English by the autor.

We can consider this book as a source book of the easiest and fun-to-make of hundreds of projects created and published by the author during his life (see more about Newton C. Braga in “about the author” in his site).

But, as the projects are in a wide range of types, we should separate the electronics experimenters in two groups: the ones who want to improve or expand some other area of their electronics interest, such as computers, radio, instruentation, audio, security and even mechatronics; and the ones who want to learn something about electronic circuits and devices or want new ideas to use in science projects.

Most of the projects described herein can be stand-alone as indivudual acessories; weherever possible the circuits have been designed so that they can be ganged with one or more other projects. For exemple, many projects of audio effects or generators can be ganged with audio amplifiers or high-power output stages.

All the projects are simple, with few low-cost components that can be made in one evening of work.

To make it easy for the reader to choose the projects we added codes after each title to indicate the kind of experimenter for whom they are intended: the code "P" (Practical) indicates a project built to practical use. The code "E" (Experimental) indicates that the project is intended for the experimenter to teach something about circuits or devices. Or course, you can also find projects with both codes (E and P) which can ether be ounted to teach something or/and be used for a practical end.

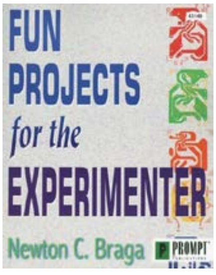
The presentations of the projects are practical. Electronics components are listed with each circuit diagram. But secondary parts such as sockets, chassis, enclosures, miscellaneous hardware and so on, are not specified, since the reader is free to choose these non-critical items according to his preferences and demands.

The manner in which the circuits work and can be modified is explained in practical terms so the reader can acquire some knouledge of practical electronics as he progresses through the book.

Although many of the projects we enjoyed constructing as they are described here, you may think or possible modifications. We just recommend that you go ahead and modify the circuits to your personal ends. There is a wide latitude in circuit modifications and most of them will be of value to the experimenter who wants to see how things work, even though each project's primary intend is for the builder who desires a functional item of equipment as the result of his work.

As the book includes easy-to-build projects, the author hopes it will help you to learn many of the fundamentals of electronics in a easy and fun way, and, if you're a student provide a source for school projects.

Newton C. Braga



VOLUME 1 - FRONT-COVER – PUBLISHED BY PROMPT PUBLICATIONS IN 1999.

MATCHBOX RADIO (E)

This small crystal set can be housed in a matchbox and is abble to tune the local strong AM stations using as antenna a long wire.

As the circuit has no active components as transistors or valves to increase the sinal strenght only an earphone can be excited as final transducer. The power isn't enough to drive a loudspeaker and hear is weak even tunning strong stations.

The antenna should be as long as possible to intercept a great amount of radio waves' energy and gives a reasonable output power to the earphone. We recommend an antenna with lenghts no less than 20 feet to best results.

Ground connection is very important to increase the circuit performance. The ground connection can be done using the earth pole or neutral in the power supply AC line, but this requires special care to avoid dangerous shock hazards and it is not the recommended away to use your radio.

Without the need of specialized assistance we recommend as ground connection a metal tubular or plate piece introduced deep into the ground. A 10 x 10 inches plate or a 30 inches long bar can be used for this task. Another away to get a ground connection is to clip the alligator clip ito any large metal piece around you as a door or window metal square.

You can use this receiver to show as a radio that doesn't need batteries or other power-supply can be made and also say that this kind of set was the only one that exists at your grandfather's time. You can also explain that this radio function as the antique crystal sets or galena radios invented in the last century.

Of course, many of the used components are modern as ceramic capacitors, germanium diodes and ferrite rods and also the earphone and they were invented only some tens of years after the original crystal set that used a galena crystal to detect radio signals.

Figure 1 shows the squematic diagram of the matchbox radio using modern components.

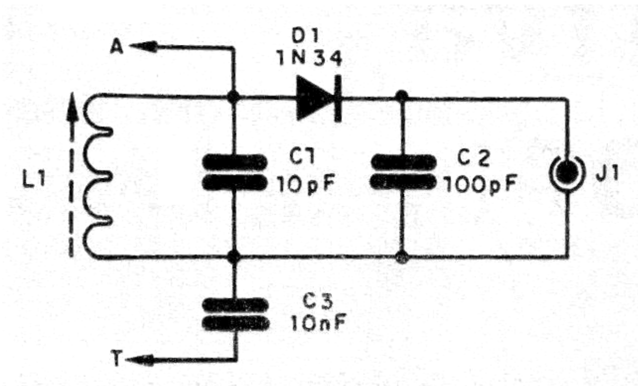


FIGURE 1 – SCHEMATIC DIAGRAM OF THE RADIO

The circuit should fit into a small matchbox or plastic box, with a hole drilled in the side to acommodate the ferrite core as shown in figure 2.

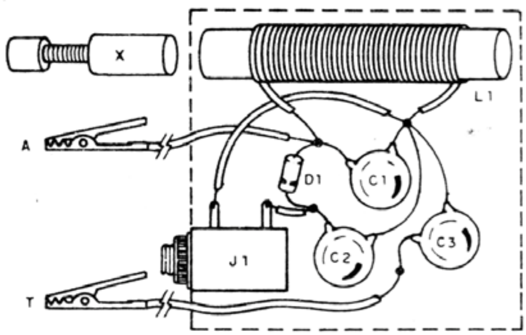


FIGURE 2- MOUNTING USIN A SMALL BOX LIKE A MATCHBOX

L1 is a antenna tuning coil wound on a cardboard tube with a internal ferrite rod and is made winding 80 to 100 turns of 28 AWG enameled wire.

The ferrite rod has a diameter between 0,5 and 1 cm and should slide into the tube as tunning is made adjusting its position.

All capacitor are ceramic disc types. The same circuit will work as well, or even better, using nearly any RF germanium diode. Old germanium transistor can also be wired as diodes. To connect a germanium transistor as a detector diode you only have to ignore the collector lead.

The crystal earphone is recommended but any magnetic high impedance earphone with impedances between 2,000 and 10,000 ohm can also be used. Low impedance earphones, as used in walkmans and small transistorized radios will not operate in this project. They are not sensitive enough to operate from the low power signals sourced by this radio output.

Using the set: connect the alligator clips to the antenna and ground. Slide the ferrite rod into the antenna tube until you tune a station.

Parts List - Matchbox Radio

D1 - 1N34 or equivalent - any germanium diode
L1 - Antenna coil - see text
C1 - 47 pF - ceramic capacitor
C2 - 220 pF - ceramic capacitor
C3 - 1,000 pF - ceramic capacitor
XTAL - Crystal earphone or high impedance magnetic phone
A. G - Alligators clips

IDEAS TO EXPLORE

a) To learn more about the circuit and components or to get better performance:

- Use an audio amplifier connected to the output of this radio to get better performance. The probe amplifier descibed in this book can be used to increase the audio output.
- Wire the antena alligator clip to your TV antenna connector. What can you expect making these connections? Will the radio function?
- If there is a very strong radio station near you can try to wire to the output a small transistor audio output transformer and a loudspeaker.

b) Science projects:

- Explain how a crystal set operates.
- What is a galena crystal and why it can be used as a detector?
- What is the difference between a galena crystal and common germanium or silicon diodes?
- Explain how this set can source electric energy to the earphone to be converted in sound and from where comes this energy.
- Explain why a low impedance loudspeaker can’t be excited by the signals found in this radio output.

HEAT DETECTOR (E, P)

Heat loses in electronic appliances or at your home can be easily detected using this simple device. You can also use this circuit to detect temperature variations in experiments involving biology, chemistry or physics.

Critical points in a project as hot resistors, transistor or other components who convert electrical power into heat and cause many problems can be also detected using this circuit.

But the particular attraction in this circuit is that temperature sensing device (the diode) can be quite remote from the indicating device (the ammeter). Thus the sensor can be placed outdoors to detect outside temperature changes, coupled by two thin insulated wires to the detector circuit indoors.

As the amount of current flowing through a circuit depends upon the amount of voltage applied and also the amount of resistance in the circuit, any point with anormal resistance will produce heat enough to cause damages to the components.

The proposed circuit shows when the temperature in any point of a circuit rises to values high enough to manace components.

The circuit can also be used at home to detect heat loses. Invisible holes or apertures in windows, doors or in the floor causes heat loses that increases the amount of power necessary to sustain the desired indoor temperature in any ambient.

The circuit uses as a passive temperature transducer a common silicon diode. As the amount of current through a diode reverse biased depends upon the temperature of the junction, this kind of component can be used as a sensitive detector to temperature variations.

The amount of current through the diode is very low so we need amplification. The current is amplified by a transistor driving a microammeter. P1 adjusts the zero point to the center of the scale, as the needle has to oscilate right and left, according the temperature goes up and down.

Figure 1 shows the schematic diagram of the heat detector.

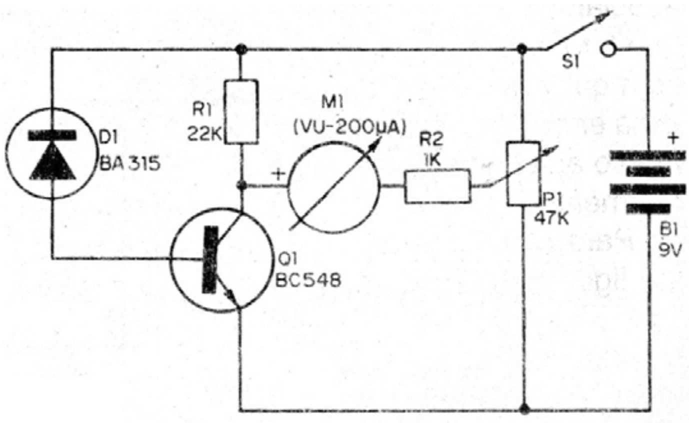


FIGURE 2 – SCHEMTAIC DIAGRAM OF THE DETECTOR

Components are placed on a terminal strip used as chassi is shown at figure 2.

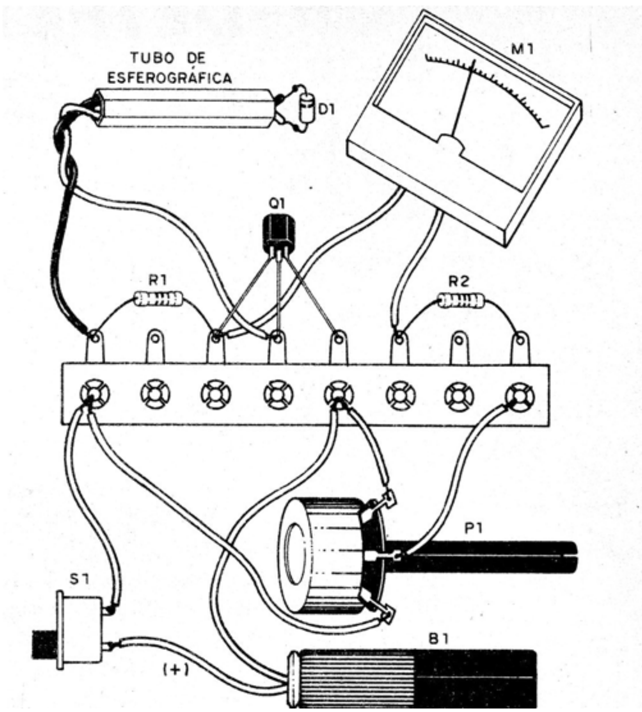


FIGURE 2 – MOUNTING USING A TERMINAL STRIP

The sensor, any common silicon diode, is mounted at the end of a pen tube. Take care with the position of the diode since it is a polarized component as the battery and the transistor. Depending on the application, you can protect the diode with an epoxi cover.

Any microammeter with current ranges from 100 to 500 uA can be used in this project. You can find ammeters in non-functioning old amplifiers were they are used as VU-meters.

Now you are going to test the circuit: adjust P1 to have a center scale position of the needle in M1.

Put the sensor between your fingers and wait about 40 or 50 seconds to achieve the termal equilibrium. The heat of your body will be detected and you will see the ammeter needle moviment indicates the temperature rise.

Don't touch the terminals of the diode as this will cause modification of the resistance with a false indication temperature variation (protect the diode with an epoxi coat if necessary).

Using the detector: put the sensor near (don't touch) the place where you want to detect heat variations and wait about 40 seconds or more to allow the sensor to change its own temperature according the ambient and observe the ammeter needle.

Parts List - Heat Detector

Q1 - general purpose NPN silicon transistor
D1 - 1N914 or equivalent - general purpose silicon diode
R1 - 22,000 ohm, 1/4-watt, 5% - resistor
R2 - 1,000 ohm, 1/4-watt, 5% - resistor
P1 - 47,000 ohm - potentiometer
S1 - SPST - slide or toggle switch
B1 - 9 V - battery
M1 - 0 - 200 uA - microammeter - see text

IDEAS TO EXPLORE

a) To learn more about circut and devices an some questions:

- Why can't be used a foward polarized diode as sensor in this experiment?
- Can you explain how the current flow through the diode alters with the temperature?
- Replace Q1 by a Darlington transistor as the BC517 and get much more sensivity to the circuit.
- Replace D1 by a NTC or a PTC (between 20,000 and 100,000 ohm and increase the sensivity of the heat detector. NTCs and PTCs or Temperature Sensitive Resistors are components in which the actual resistance offered by the device in a circuit depends on its temperature. The NTCs have a negative temperature coefficient. This means that resistance decreases as temperature increases. PTCs, on the other hand, have a positive temperature coefficient, and operate in the opposite

manner - resistance increases as the temperature increases. Both types can be experimentd in this project. Wire between the base and emitter of Q1 a 10,000 ohm trimmer potentiomer to adjust the polarization according the sensor new characteristics.

b) Science and different uses for the circuit:

- Endothermic or exothermic experiments in chemistry can be easily monitored with this circuit. You can easily measure heats of reaction making an experiental calorimeter and using this circuit to detect temperature changes. A simple calorimeter for reactions in aqueous solution can be constructed from a Styrofoam coffee cup. For hot or nonaquous solution reactions you can use a thermos bottle with a wide mouth.
- Operation of heaters, refrigeration systems in laboratory experiements can be monitored placing the sensor far from the circuit.
- Variations of temperature of living beens and ambients in several kind of biological experiments can be monitored with this circuit.
- Experimentation in thermometry and thermology can programmed using this circuit.
- You can use this circuit as a thermometer but the microammeter scale can only be calculated in terms of equivalent temperatures by direct comparison with another thermometer at different temperatures. Adjusting P1 you can set the zero temperature at the zero scale reading on the meter. But remember that temperature measurement scales (Fahrenheit and Celsius) are linear systems as the diode is not a linear device over a wide range of temperatures.

ENERGY SNIFFER(E)

Many important research laboratories all over the world are working hard trying to find new alternative sources of electric energy.

You can also make some interesting experiments in this field using this electric energy sniffer. Home-made electric experimental cells can be tested using this project that will tell you if your new discovery is good enough to power some small electric appliance or device as LEDs, small DC-motors, transistor radios, etc.

An excellent work to demonstrations in your school can also be performed with this energy detector and some suggested simple alternative sources of electric energy or alternative cells.

The project consists in a simple home-made galvanometer i.e. an instrument that can be used to detect current flow through a circuit.

It is very easy to explain how it works: when electric power is produced it appears as a voltage between the poles of a cell and this causes a current flow in any circuit wired to these poles. If the energy detector is placed in series, the current flow through the galvanometer's coil will produce a magnetic field that acts on the needle (a razor blade).

The razor blade tends to place its position according the generated field force lines making a moviment that can be easily observed. That means that any razor blade moviment is an indication of current flow and also energy beeing produced by the cell.

The energy sniffer can detect current flows as low as few microamperes and is suitable to be used with experimental cells with voltage ranges between 0.2 and 2.0 volts.

Figure 1 shows how the energy sniffer is built with a razor blade

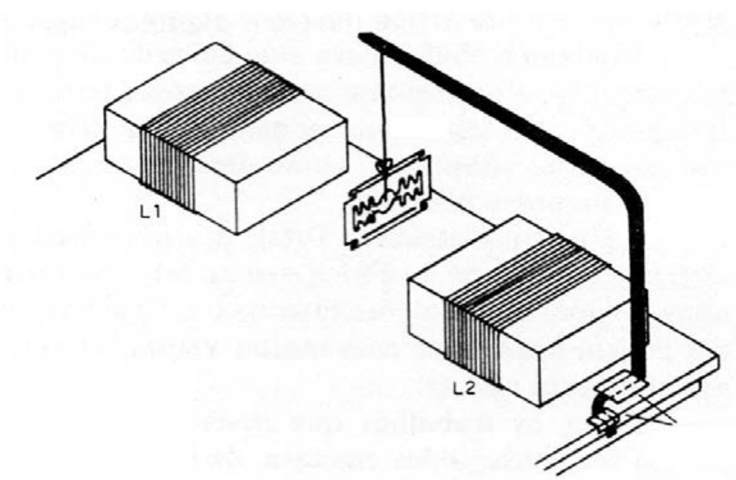


FIGURE 1 – USING A RAZOR BLADE