

TAP 409-2: Flame probe construction

What these are for

These devices enable the measurement of a pd in space, by providing a supply of ions to a conductor, one end of which is attached to a voltmeter. The other end of the voltmeter is usually earthed.

One method of construction is to use large diameter hypodermic needles, which can act so as to supply both the gas, which is then lit to provide ions, and an electrical path to the voltmeter. However large diameter needles are hard to come by, so you can use very narrow diameter tubing, available from modelling shops. You may also see some pedagogic advantages to keeping the ion supply and the electrical contact separate, to help in the explanation of the workings of a flame probe.

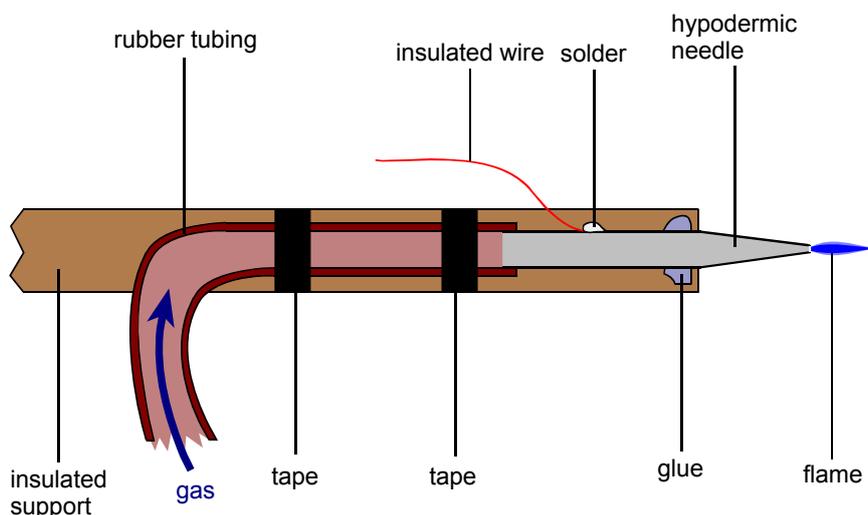
Making a single probe

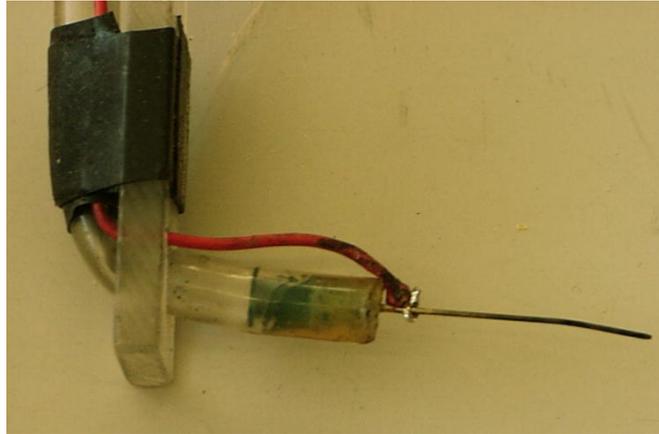
The device needs to allow a variable supply of gas to a metal tube about 1 mm in diameter. Rubber or PVC tubing is used to connect the tube to the gas supply. An insulated wire is used to provide the electrical path to a voltmeter and the whole is taped to a long insulated rod (e.g. Perspex, polythene or wood) that is held in a clamp (wooden if possible). A Hoffman clip on the gas supply tubing enables the pressure to be adjusted until a small flame (2 to 3 mm) is obtained at the tip.

(Hint: Start with the clip open so that the gas flows relatively freely and be patient before trying to light the gas; it takes some time to clear the air out of the tubing. Before lighting the gas, reduce the flow, as too high a pressure blows the flame away.)

Both the gas tubing and insulated wire to the voltmeter need to be long (about 2 m) so that the probe can be moved easily without disturbing the flame.

One design uses a 25 gauge hypodermic:



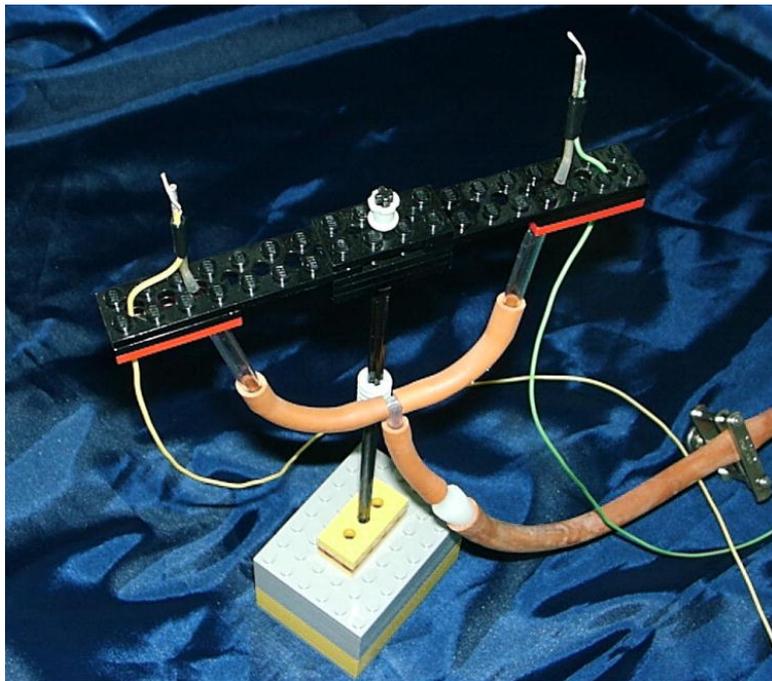
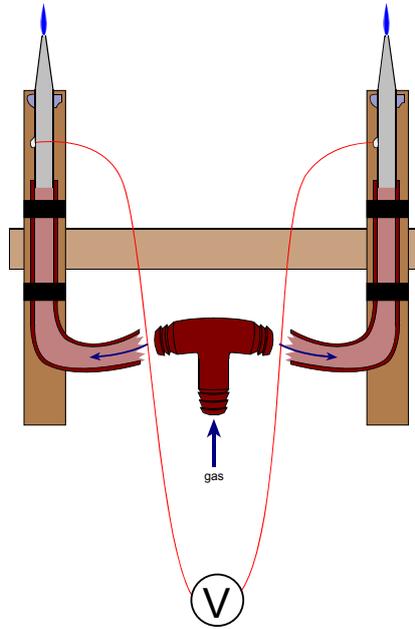


A second design uses narrow diameter tube (1 mm internal diameter aluminium tube works well, and seems to be readily available from modelling shops). Reducing the diameter of the tubing can be achieved from a combination of heat shrink tubing and extruded soda glass tubing, as shown in the detail below.



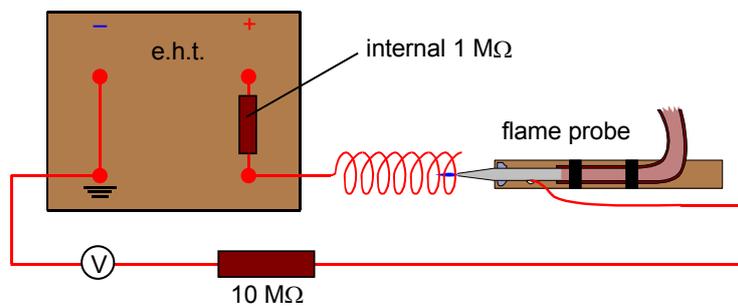
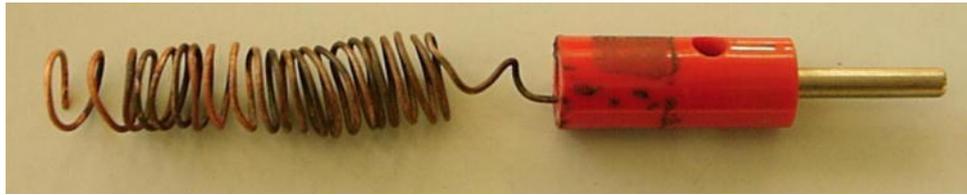
Making a dual probe

A dual probe consists of two single probes, able to be rotated, and separated by a fixed, but variable distance:



Making the calibrating coil

A single coil of thick bare copper wire, mounted in a 4 mm socket will suffice. The inside diameter and length of the coil should be sufficient to enclose a small flame and at least 1/3 of the metal probe forming the end of the flame probe.



Important features

- That there be a variable supply of gas, to produce as small a flame as possible.
- That this gas supply is led out to a narrow tube, to further control the flame.
- That a conductor, connected to a long lead, be in electrical contact with this flame.
- That the whole can be rigidly mounted in such a way that its position in a field is easily changed.



Wire carefully, EHT voltages

School EHT supplies have an output limited to 5 mA or less which makes them safe. In this experiment, very low currents are sufficient so the extra resistor (e.g. 50 MΩ) can be included in the circuit if it is built into the supply.

Note the high voltage on the capacitor plate, the naked flame on the flame probe and the sharp point on the hypodermic needle.

External reference

This activity is taken from Advancing Physics teacher and technician notes A2 disc.