SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 114 August, 1979.

Contents

Introduction

Our cost index of consumable apparatus and materials, for which the baseline is 100 in May 1974, stood in May 1979 at 218.4. The percentage increase since May 1978 was 15.6% and that in the six months from November 1978 to May 1979 was 11.6%. This reflects closely the general quickening in the pace of inflation over the period.

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Our foreign readers are hereby reminded that they are required to remit £1 (one pound) by cheque, international postal order or other means, if they wish to receive our bulletins for session 1979/80. No further notice will be issued, nor is it necessary to notify us if you wish to stop supplies reaching you - this will happen automatically if the subscription is not paid within a reasonable time. Neither can we submit invoices directly to the reader, or deal through subscription agencies unless they have been instructed to remit the subscription in the above manner and do so. It will be obvious that the £1 barely covers the cost of posting bulletins overseas and so we cannot justify incurring the administrative expense of raising invoices etc.

Safety Notes

There has been a report of an explosion when a 12V immersion heater supplied by Griffin (XHP-340-J) was being used to melt ice. It is possible that with age and usage a slight crack may have formed in the upper sealant, thus permitting water to enter if the heater were allowed to cool in water. Heating on a later occasion may have caused the pressure build-up.

Griffin have now issued the following warning:-

"Do not use the heater fully immersed in liquid if it shows any sign of mechanical damage. Liquid leaking inside could cause a pressure build-up when next heated".

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Longmans have given notice of an error in their text "A Modern Course of Organic Chemistry" by J.R.Gerrish and R.C.Whitfield. On page 198 there is a description of a preparation of N-phenylethanamide (acetanilide) and the ratio by volume of the reagents required is given as $2cm^3$ phenylamine (aniline) to $30cm^3$ ethanoic anhydride (acetic anhydride). This is incorrect and if these proportions are used, a violent reaction will occur when the product is poured into cold water. The correct ratio is $2cm^3$ phenylamine to $3cm^3$ ethanoic anhydride. If anyone has copies of this text they should ensure that the ratio is altered immediately.

Biology Notes

Since 1973 the 'Transit of Animals' Order has imposed certain duties upon carriers of livestock to ensure that animals travel with a minimum of stress. It is only possible to consign unaccompanied livestock by British Rail on a 'Station to Station' basis. British Rail have recently found it necessary to review their arrangements and a new list of stations has been compiled which are designated for handling livestock. Since April 1979 all livestock consignments have been handled through these stations. A list of Scottish stations able to accept livestock is given below. Other parcels stations have ceased accepting livestock. Teachers and others ordering livestock can greatly help suppliers by ensuring that they state their nearest British Rail Station from the list below.

Aberdeen
Achnasheen
Airdrie
Annan
Arbroath
Ardrossan South Beach
Aviemore
Ayr
Balloch Central
Barrhill
Bellshill
Berwick upon Tweed
Blantyre
Bridge of Weir
Brora
Burntisland
Cambuslang
Carstairs
Coatbridge Central
Cowdenbeath
Crianlarich
Croy
Cumbernauld
Cupar
Dalmally
Dalmeny
Dalry
Dingwall
Drem
Dumbarton Central
Dumfries
Dunbar
Dunblane
Dundee
Dunfermline Lower
Dunkeld
East Kilbride
Edinburgh Waverley
Elgin
Falkirk Grahamston
Forres
Fort William
Fraserburgh
Girvan
Glasgow Central
Glasgow Queen Street
Gleneagles
Gourock
Greenock Central
Hamilton Central
Helensburgh Central
Helmsdale
Huntly
Invergordon
Inverkeithing
Inverness
Inverurie
Irvine
Johnstone
Keith Jct.
Kilmacolm
Kilmarnock
Kilwinning
Kingussie
Kirkcaldy
Kirkconnel
Kyle of Lochalsh
Lairg
Lanark
Larbert
Largs
Lenzie
Leuchars
Linlithgow
Lockerbie
Longniddry
Mallaig
Markinch
Maybole
Midcalder
Milngavie
Montrose
Motherwell
Nairn
North Berwick
Oban
Paisley Gilmour Street
Perth
Pitlochry
Polmont
Prestonpans
Prestwick
Rannoch
Saltcoats
Shotts
Stirling
Stonehaven
Stranraer Harbour
Tain
Thurso
Troon
Uddingston
Wemyss Bay
West Calder
Wick
Wishaw

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In Bulletin 113 we described various methods for microscope illumination. Part of this article dealt with the use of daylight illumination. It has been pointed out to us by a Science Adviser that we should perhaps have made it clearer that direct sunlight is always to be avoided as a source. Otherwise there is a small but significant risk that the sun may be focussed into the eye of the

observer. The blink reflex would make it extremely unlikely that any serious harm would befall the observer's eye. However even this small risk is avoidable and only diffuse daylight should ever be used as a source.

Chemistry Notes

Measurement of the Heats of Combustion of the alcohols using a simple can calorimeter with a small spirit lamp is one series of experiments which is commonly neglected because of the inaccuracy of the results so obtained. The results obtained for an homologous series usually have the correct rank order but efficiencies are often as low as 50 per cent. As we mentioned in Bulletin 113 we have recently been testing calorimeters, both of the simple d-i-y type and the more sophisticated commercially produced variety. We found that, used with care, the commercial versions gave results which were acceptably close to the theoretical values. We also found that certain home-made designs gave very good results given good technique and some simple common sense precautions.

In simple 'can-calorimetry' aluminium, because of its high thermal conductivity, has been traditionally favoured as the material for the can. However aluminium beakers and cans have become expensive, and in any case, the area and thickness of the base of the can would seem to be important factors, in determining the efficiency of heat absorption. An aluminium beaker with a wide base would be the ideal, but we have found that reasonable results can be obtained using 2lb syrup tins with a relatively large mass of water (300g). With such a mass of water the temperature gradient between it and the environment remains small and heat losses are minimised. Making the base of the tin concave leads to a further increase in efficiency. The burner flame can be placed higher so that the calorimeter partially surrounds it (Fig. 1.) so trapping the products of combustion more effectively. A by-product of this modification is that the base of the tin is made thinner, further facilitating the heat transfer to the water.

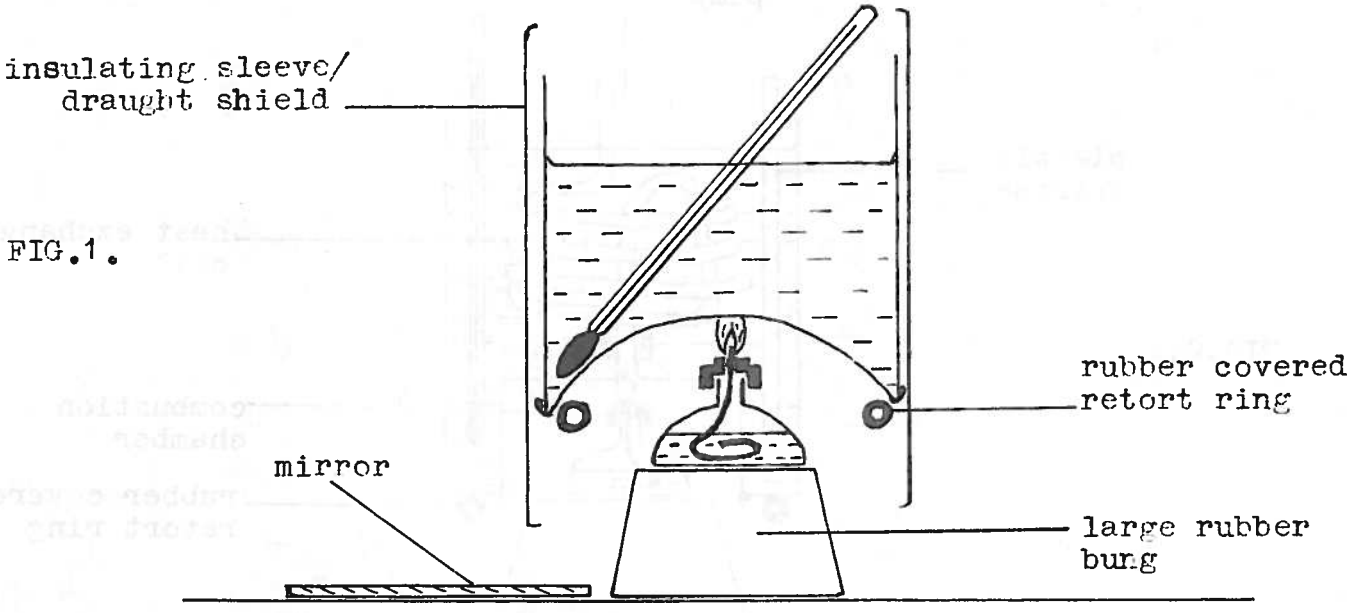


FIG.1.

In order to obtain a good performance with this simple dented can, good technique was necessary. The calorimeter was insulated by sitting it on a rubber covered retort ring and by fitting a sleeve cut from a 500cm^3 plastic bottle. This sleeve could also be lowered to act as a draught shield. A small flame was used and the calorimeter lowered until the flame just touched the surface of the base. A mirror on the bench beside the apparatus was useful in checking on the height of the flame. Stirring was carried out with a short length of plastic tubing and with the -5 to +50^{o}C x 0.1^{o}C thermometer.

Some allowance was made for heat loss by starting with cold water fresh from the tap which was at a temperature approximately 3^{o}C lower than that of the room. The fuel under test was allowed to burn until the water temperature rose to approximately 3^{o}C above room temperature. In this way there was some compensation for the heat loss during the time the apparatus was above room temperature, by the heat gain whilst it was below the ambient temperature. This is, of course, a crude method of making the allowance, but it is based on reasonable assumptions and is certainly better than making no allowance for heat losses.

It was found that the material used for the wick of the spirit burner had an effect on the results. The fibreglass wicks, supplied with the small spirit burners available commercially, gave the most consistent results and these small burners are recommended.

Because fuel evaporates rapidly from a recently extinguished burner, weighings need to be made as soon as possible after removing and extinguishing the burner. The use of an extinguishing cap reduces the error from this source but is not essential if the apparatus is close to the balance. For obvious reasons, all measurements should be made out of strong sunlight. Before starting a new determination any water which had condensed on the base should be dried off, as its evaporation will absorb a considerable amount of heat.

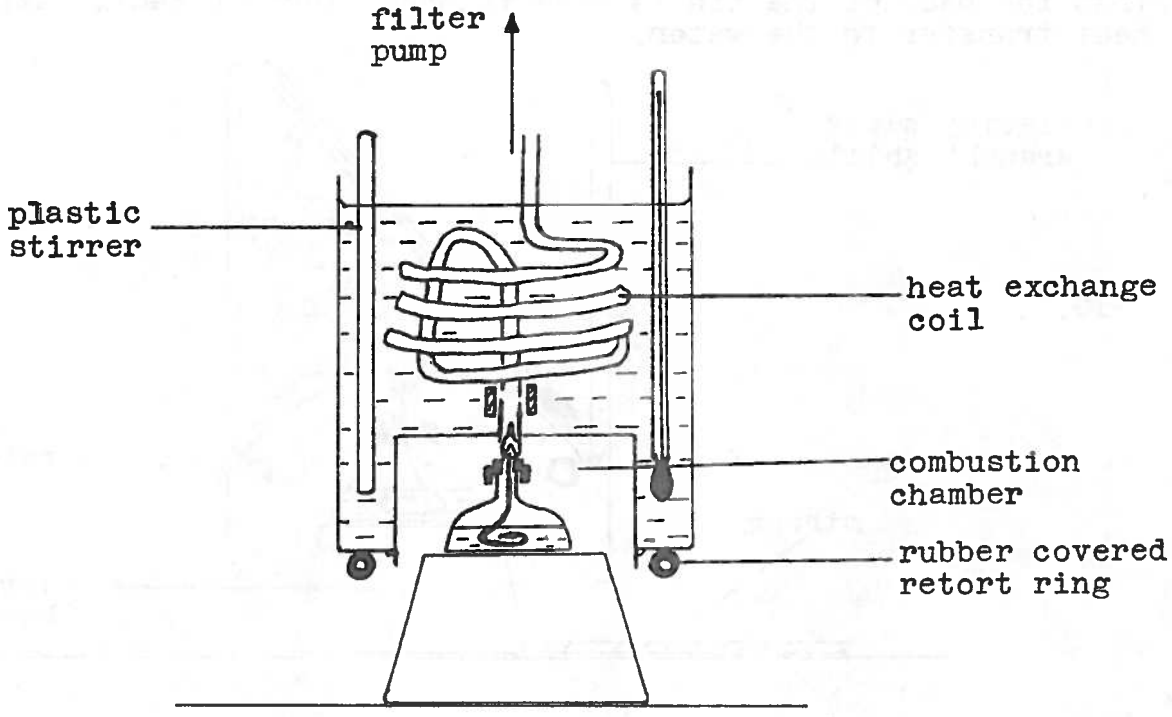


FIG.2.

The simple calorimeter shown in Fig. 1. gives reasonable results but the fitting of a combustion chamber and heat exchanger (Fig. 2), further improves the efficiency so that results then compare favourably with those obtained for two commercially produced calorimeters (Table 1).

The construction of the d-i-y versions shown in Figs. 1 and 2 is described in detail in the 'In the Workshop' section of this Bulletin.

Fuel \ Apparatus	Commercial Versions A	Commercial Versions B	SSSERC coil calorimeter	Dented 21b syrup tin
Methanol ($-726kJ\ mol^{-1}$)	709	688	699	654
Ethanol (95%) ($-1367kJ\ mol^{-1}$)	1259	1151	1213	1187
Propan-1-ol ($-2017kJ\ mol^{-1}$)	1856	1754	1798	1692
Butan-1-ol ($-2675kJ\ mol^{-1}$)	2636	2461	2547	2396
Carbon ($-394kJ\ mol^{-1}$)	367	341	338	-

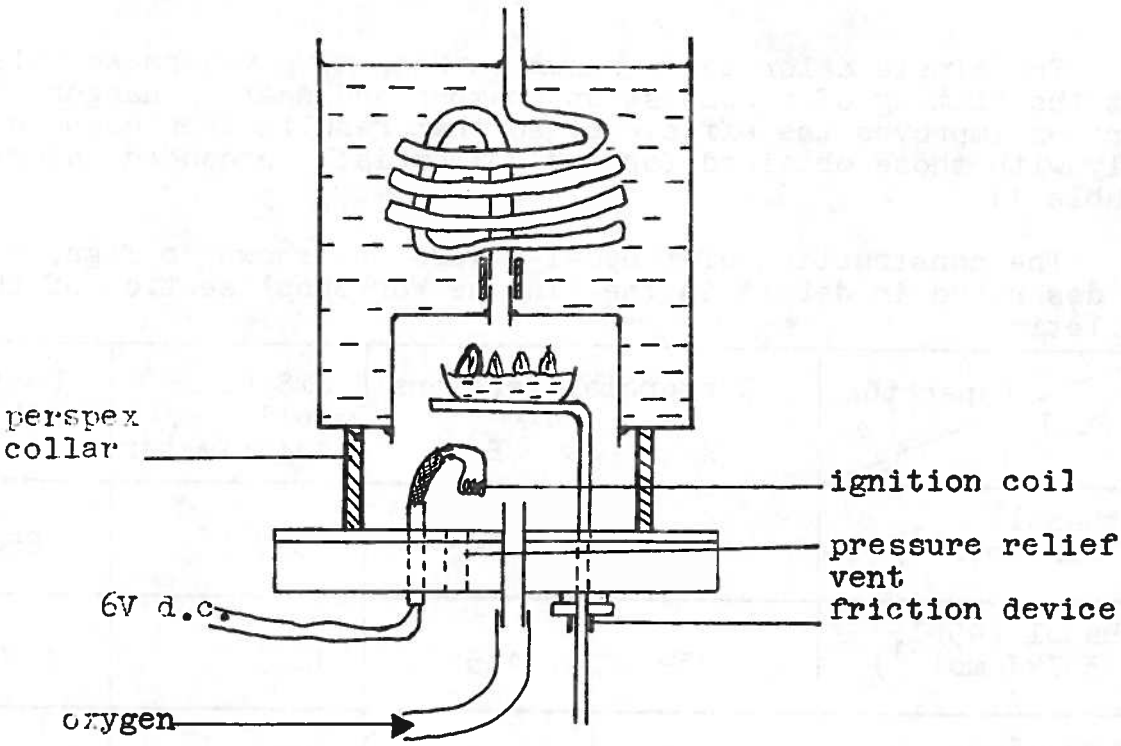
Table 1. The experimental results shown are mean figures from several determinations.

As with the simple dented can model, the use of the version shown in Fig. 2. requires some attention to details of technique. The outlet of the heat exchange coil is attached to a filter pump in order to draw the hot products of combustion through it. Too high a flow rate results in incomplete heat transfer and too slow a flow in only partial extraction of the hot 'exhaust' gases. The optimal rate of air flow depends on the size of the flame, as well as on the size and geometry of the exchange coil: this will have to be found by trial and error and a rough mental note made of the pump speed. Alternatively the rate could be measured by an air flow meter of the 'Meterate' type or gauged roughly by rate of bubbling through a wash bottle. With a small glassfibre wick a suitable air flow in our calorimeter was found to be 600-700cm^3/min.

This exchange coil model can be used as are the can types by simply placing the calorimeter on a rubber covered retort ring with the lamp below it. Stirring can again be by a short piece of plastic tubing and thermometer. In addition the coil may be agitated about its rubber connection.

Alternatively, the calorimeter may be used with a base and fittings designed to enable solids (e.g. graphite) and foodstuffs to be burned in an atmosphere of oxygen. (Fig. 3). When a liquid fuel, such as an alcohol, is being used, or when no oxygen is required, the gap in the perspex collar is left open and the burner raised on the crucible holder so that most of the lamp is inside the combustion chamber.

FIG.3.



Some foodstuffs and oils will burn in a current of air and if this proves to be the case, oxygen MUST NOT be used. If oxygen is used, the gap in the perspex collar should be covered with sellotape. It is important that the oxygen supply and the water pump be turned on before the ignition coil is switched on. Once the material has ignited the coil is switched off and the oxygen supply reduced so that the fuel does not sputter. The crucible is swung sideways to clear the coil and then upwards into the combustion chamber. When a suitable temperature rise has been obtained the oxygen supply is turned off. However the air current through the exchange coil is maintained so as to absorb any residual heat. Replacement air is drawn through the hole in the base and through any gaps around the perspex collar.

The calorimeter should simply rest on the perspex collar and base and MUST NOT be clamped. It is essential that it is free to lift off in the event of an explosion. One other final word of warning. All tin cans used to hold water will rust, but if dried after use they will last for a long time.

Trade News

As far as we have been able to ascertain the Russian made pupil meters marketed by Z and I, Ideas for Education, Henry's Radio and E. J. Arnold are, or shortly will be, off the market. Now for the good news. At the time of writing Z and I were offering the Russian H3020/1 chart recorder at a special discount price of £70. Interested parties should contact the firm about the current stock position.

Watson B.Easson, Microscope Servicing Co have moved to a new address which will be found on page 12. Their telephone number has also changed and will only be manned from 2 p.m. each day.

Control System Services, the servicing and repair firm, have also moved and their address is on page 12.

Philip Harris have produced a new metal Heat of Combustion apparatus C42805/2, which comes complete with two spirit burners, two thermometers, a stirrer and a bubbler unit which doubles as a check on the rate of air flow and on whether the heat exchanger is being used efficiently. There is in the base a supply inlet for oxygen, an igniter coil and crucible support. The combustion chamber has for walls a collar of perspex fitted with a free standing door. Priced at £48.68 the calorimeter contains no glass and in the explosions deliberately engineered by us, the door flew off and even the empty calorimeter did not lift. Attaching this door to the base by a hinge of PVC tape was adequate restraint. We have found this calorimeter to be very satisfactory and possibly Philip Harris would in the future consider selling it without the base, as there are many who only want to make measurements on those fuels which require neither oxygen nor electrical ignition.

CLEAPSE Bulletin 45 (Summer Term 1979) contained items of trade news of interest to our readers. These included the news that T.A.C. now produce a 6mm glass reinforced cement board which is stronger than Supalux, a common replacement for asbestos cement board. The major laboratory suppliers will probably stock it but it is now available from builders' merchants at £8-9 for an approx. 8' x 4' sheet.

Other news was that Corning were about to produce a range of reasonably accurate spirit-filled thermometers -10 to 110°C short, long stirring etc. These will be available through the normal suppliers. Philip Harris are already listing two spirit-filled types -10 to +50°C x 0.5°C, Cat. No. C79330/1 and -10 to 110°C x 1°C, C79331/3.

Harburn Hobbies named in some of our equipment lists as suppliers of small motor/dynamos have moved to a new address given on page 12.

Griffin and George now offer separately the gas and liquid-tight three-way taps used in a great variety of d-i-y apparatus. They are listed as 'stopcocks, plastic 3-way' Cat. No. SYA-580-L at £2.55 for 5. Also new to the Griffin catalogue is the plastic mesh material 'Polynet' very useful for protecting glassware against breakage. This is listed as SAT-620.

Moramber burettes are available from Mackay and Lynn, Macfarlane Robson and from McQuilkin and Company. The new burette MA156 with PTFE stopcock key and fluorocarbon resin tap body ensures a leakproof and indestructible system which will not jam. The other advantage is that the jet and cane are joined to the stopcock unit by 'O' rings and nuts enabling easy replacement of these parts. The 50cm^3 size sells at £4.60 and at £3.85 if ten are purchased.

Hazard warning signs conforming to those specified in the Packaging and Labelling of Dangerous Substances Regulation 1978 are available on vinyl adhesive tape from Jencons (Scientific). Each tape is 66 x 25m contains only one type of symbol and is priced at £5.71. The symbols are Oxidising (H26/18), Corrosive (H26/19), Harmful (H26/20), Irritant (H26/27), Toxic (H26/21), Explosive (H26/22) and Highly Flammable (H26/28).

In The Workshop

The constructional details of the three pieces of apparatus described in the 'Chemistry Notes', and shown in Figs. 1,2, and 3 in that section, are given here.

In order to make the syrup tin version shown in Fig. 1 of the 'Chemistry Notes' a concavity of approximately 30mm in depth has to be made in the base of the tin. This is easily affected by carefully beating the base with a wooden, round-headed mallet. It is important to beat round the sides of the base as well as in the centre in order to obtain uniform stretching. This calorimeter can be supported on a rubber covered retort ring of internal diameter 75mm, e.g. Asschem 261/0320/02 (other sizes are available). The miniature spirit lamps recommended for use with this and the other calorimeters are available from several suppliers e.g. Griffin PJT-540-010B, Harris C42900/7.

The dimensions of the heat exchange coil model (Fig. 2 in the Chemistry Notes) are not critical, but it is important that there should be enough room for a stirrer between the combustion chamber and the wall of the calorimeter casing. In our model the combustion chamber was made from a small can 55mm in diameter and greater than 40mm high. The larger can making up the calorimeter casing was a 'Marvel' tin 90mm in diameter and 100mm high.

A 6mm hole is drilled in the centre of the base of the small can and a short (ca. 15mm) length of 6mm external diameter copper tube soldered in. This small can is trimmed to a height of 40mm and a hole equal to its diameter cut in the base of the large can using curved tin snips. The small can is then soldered inside the large one with a small (ca. 5mm), external overlap.

The exchanger coil is made by annealing a length of 6mm copper tube and winding it on a former of 50mm diameter. The lowest loop is pushed upwards inside the finished coil in order effectively to lower the whole spiral. The exit end of the coil is left as a straight chimney to project a few centimetres above the surface of the water. The whole coil is then connected by a short length of rubber tubing to the projecting copper tube on the top of the combustion chamber.

The apparatus can be used in the way shown in Fig. 2 of the Chemistry Notes, with the calorimeter assembly resting on a rubber covered retort ring and with the spirit burner on a large bung. However if it is required to be used for foodstuffs and other solids requiring oxygen and/or an ignition system, then the base and perspex collar shown below are required. (Fig. 1).

The base is of 20mm blockboard with a layer of 'Supalux' (or other heat resisting material) held by four No. 8 woodscrews. The support bar (A) is of 12.5mm aluminium rod and allows the assembly to be held on a retort stand boss. The ignition coil support (B) is 6mm copper tube which carries two 18 swg copper wires sheathed in fibreglass flameproof sleeving. The ignition coil proper is made from 100mm of 28 swg nichrome wire wound round a small electrical screwdriver as a former, leaving 20-30mm unwound at each end. These straight ends are then silver-soldered to the copper connecting wires.

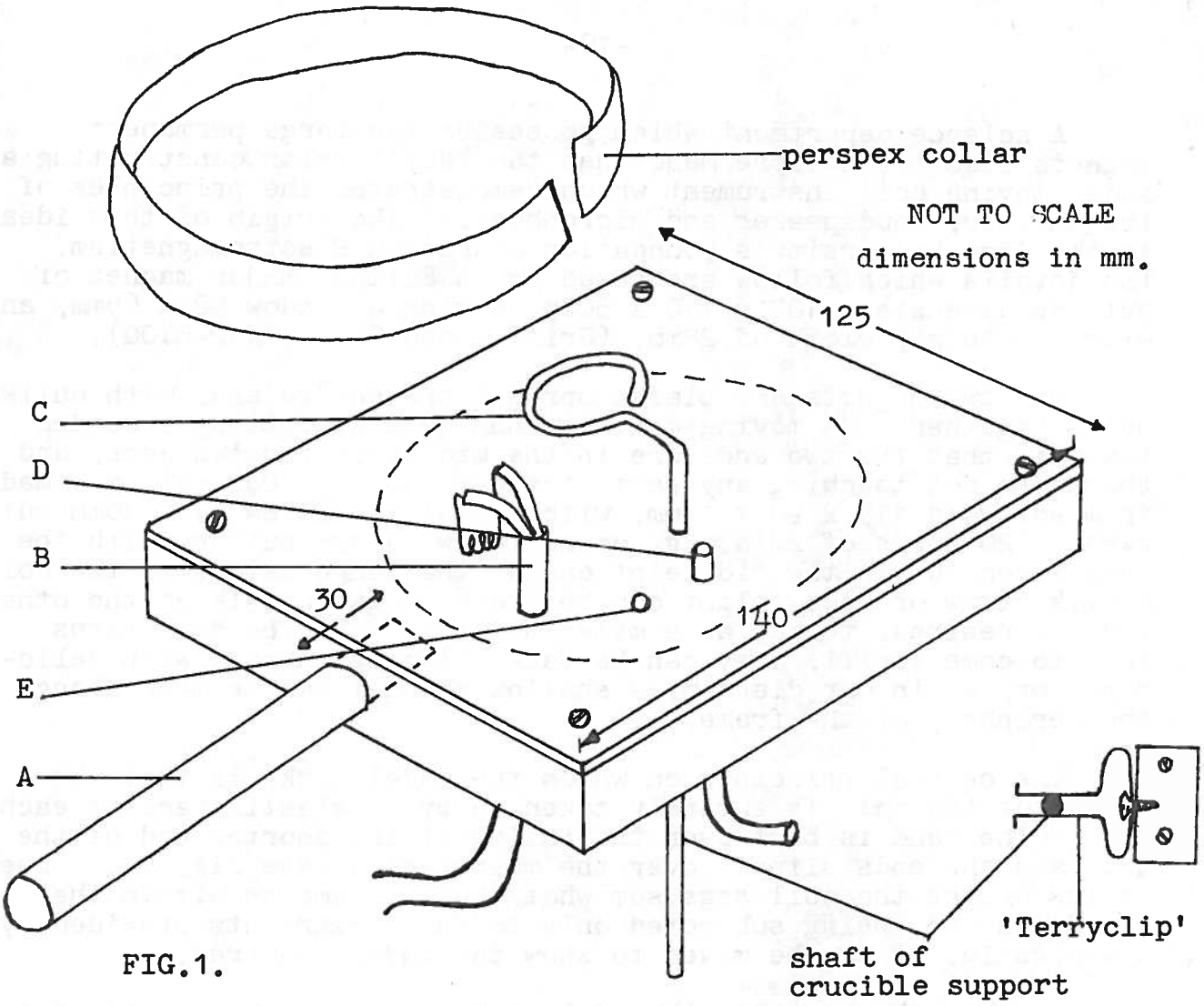


FIG.1.

The coil should be arranged with a clearance of 15mm or more from the base so that a crucible may be swung under it on the crucible holder (C). This is a mild steel rod of approx. 6mm diameter with a short length of capillary brass spacer as a bearing, where the rod passes through the base. Suitable brass spacers can be stripped from scrap electronic components e.g. wafer switches, volume controls. To allow the use of this apparatus as a fuel calorimeter some method of supporting a spirit burner on the crucible holder is required. This can be provided by opening out a metal cap from a screw top bottle by first making a series of radial cuts with tin snips. Sufficient friction is given to the crucible support by a small 'Terryclip' with flattened jaws which is mounted on the underside of the base (see inset).

A strip of 3mm perspex, 40 x 270mm, is heated to 130-140^{o}C in an oven. Wearing leather gloves it can be removed and wrapped around a metal can of 90mm diameter which is then immediately cooled with cold water. The collar must not be cut from tube. The method of construction described above leaves the collar with a small gap. This allows entry of air when the calorimeter is used without oxygen. It is closed when oxygen is used but only with a piece of sellotape, which will blow off in the event of an explosion.

The oxygen inlet (D) is made from a 70-80mm length of 6mm copper tube passing through a hole drilled in the base and projecting approximately 10mm above it. Another hole of similar size (E) is drilled in the base alongside this inlet. This acts as a pressure relief device allowing the escape of excess oxygen.

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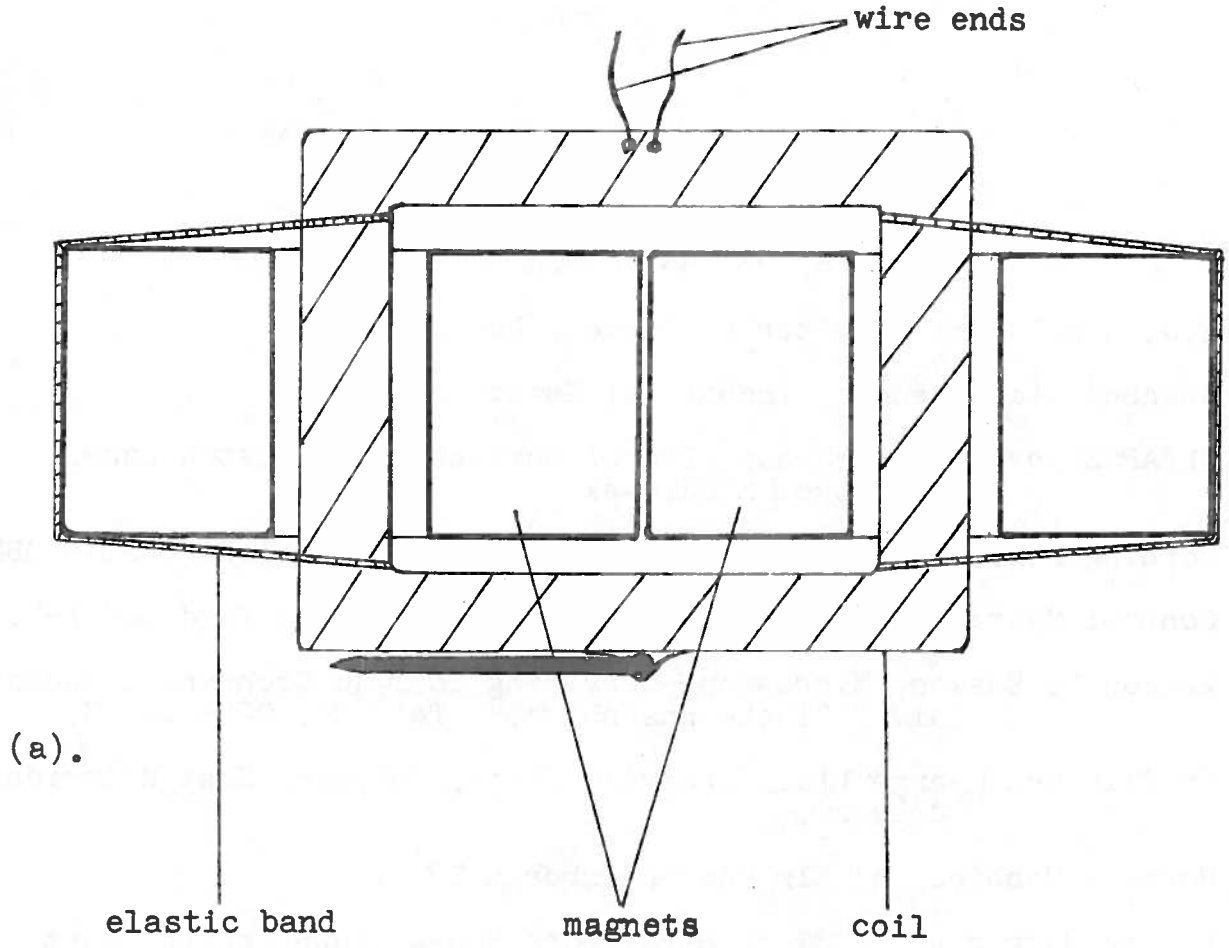
A science department which possesses two large permanent magnets like the Eclipse Major has the facility for constructing a model moving coil instrument which demonstrates the principles of the ammeter, loudspeaker and microphone. The origin of this idea is the Open University's Foundation Course on Electromagnetism. The details which follow are based on an Eclipse Major magnet of outside dimensions 102 x 110 x 50mm, having a window 52 x 65mm. and with a pole gap width of 28mm, (Griffin and George XJP-840Q).

The two magnets are placed upright and end to end, with unlike poles together. A moving coil is then made by fitting a wooden frame so that the two ends are in the middle of the two gaps, and therefore not touching any part of the magnets. Our coil was made from softwood 115 x 90 x 14mm, with a central window 64 x 90mm cut away. 20 turns of 22 s.w.g. enamelled wire are put on, with the ends taken out in the middle of one of the longer sides of the coil. A milk straw or wood splint can be stuck on the middle of the other side if desired, to act as a meter pointer. If the coil turns tend to come adrift, they can be taped along each edge with sello-tape, or, as in our diagram, a shallow channel can be made along the periphery of the frame.

The central principle on which the model works is that the weight of the coil is entirely taken up by an elastic band at each end. The band is bent over the inside of the shorter end of the coil and the ends slipped over the magnet pole (see Fig. 1). Due to its weight the coil sags somewhat, but it remains within the field gap and, being subjected only to the constraints provided by the elastic, it can be moved to show the model required.

To show the ammeter, the coil is connected to a variable d.c. supply. As current is increased the coil, and the milk straw if one has been connected, rotates through 30-40°. Because the coil is virtually a short circuit, it is advisable to use for this experiment a supply having an overload cut-out, as this will prevent the coil from overheating.

For the other two models, the field of one of the magnets must be reversed, and to keep the like poles together we made a U bracket of 16 s.w.g. aluminium sheet. Using a 6V d.c. supply, the coil is connected to the a.c. side of the White rotary resistor. Rotating the resistor will result in the coil moving bodily up and down in sympathy with the turning of the supply. Finally, if the coil is connected to an oscilloscope input and given a starting push, the screen will show a damped oscillation as the movement dies away. A long persistence version will show the effect better, although an ordinary oscilloscope will serve. The e.m.f. being induced is the microphone effect.



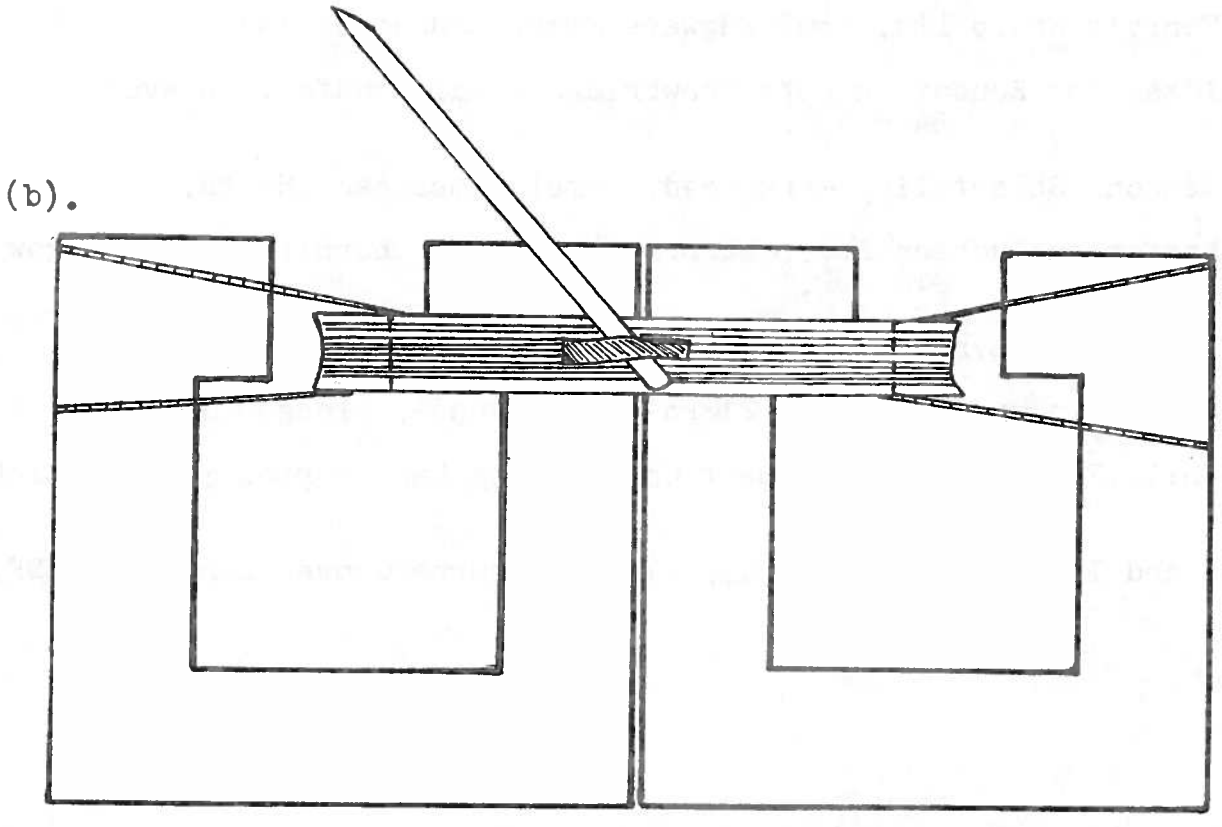


FIG.1. (a) plan (b) elevation.

S.S.S.E.R.C., 103 Broughton Street, Edinburgh EH1 3RZ.
Tel. No. 031 556 2184.

E.J. Arnold Ltd., Butterley Street, Leeds 10.

Asschem Ltd., Redding Industrial Estate, Falkirk.

CLEAPSE Development Group, Brunel University, Kingston Lane, Uxbridge, Middlesex.

Corning Ltd., Laboratory Division, Stone, Staffordshire ST15 OBS.

Control System Services, 231 Manningham Lane, Bradford BD8 7HH.

Watson B. Easson, Microscope Servicing Co., 16 Cochrane Crescent, Alva, Clackmannanshire. Tel. No. 0259 60913.

Griffin and George Ltd., Braeview Place, Nerston, East Kilbride, Glasgow.

Harburn Hobbies, 67 Elm Row, Edinburgh EH7 4AQ.

Philip Harris Ltd., 34-36 Strathmore House, Town Centre, East Kilbride, Glasgow.

Henry's Radio Ltd., 303 Edgware Road, London W2 1BW.

Ideas for Education, 87a Trowbridge Road, Bradford on Avon BA15 1EE.

Jencons Scientific, Mark Road, Hemel Hempstead, Herts.

Macfarlane Robson Ltd., Burnfield Avenue, Thornliebank, Glasgow G46 7TP.

Mackay and Lynn Ltd., 2 West Bryson Road, Edinburgh EH11 1EH.

McQuilkin and Co. Ltd., 21 Polmadie Avenue, Glasgow G5 OBB.

White Electrical Instrument Co., Spring Lane North, Malvern Link, Worcs.

Z and I Aero Services Ltd., 44a Westbourne Grove, London W2 5SF.