# SCOTTISH SCHOOLS SCIENCE

# EQUIPMENT RESEARCH

# CENTRE

Bulletin No. 76. January, 1975.

# Contents

# Introduction

To every teacher in a laboratory, and to every technician in a science department: could you, in the fashionable cliche, at this moment in time, give satisfactory answers to the following questions? If there happened today in the science department a serious accident involving a pupil or a colleague, and you were the only responsible person in the vicinity, would you know what to do? Do you know where the first aid cabinets are, and their contents? Have you an established procedure for securing expert medical attention for the victim, and does it do this as quickly as possible? Does it for example, require you to hunt for the lady supervisor/deputy rector/school dentist/janitor before doing anything? If the quickest way is to transport the victim to an emergency medical centre, do you know where it is, and how to get there? If you are a head of department, are you sure that your assistants know the answers to these questions? If any of the questions raises a doubt or uncertainty in your mind, should you not discuss it with your colleagues? After all, you may be the patient.

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We have issued the second of our experimental guides to the C.S.Y.S. Physics memoranda, that on Electro-magnetism. This time we have used the circulation list which the Scottish Centre for Mathematics, Science and Technical Education uses in issuing the memoranda. Any U.K. subscriber to SSSERC who wishes to have a copy of the experimental guide will be sent one free of charge upon notifying us.

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The following exhibitions have been arranged for the present term.

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|---|---|---|
| 21st Jan. | Aberdeen College of Education | SSSERC apparatus (for college students) |
| 1st-3rd April | Edinburgh University | SSSERC apparatus (A.S.E. annual meeting). |

This is not an unduly heavy exhibition programme and we invite applications from teachers or others for an exhibition of their own choice.

Originally we had another exhibition scheduled for this period; one on apparatus for RSLA science in conjunction with an in-service course proposed by a College of Education. The course has had to be cancelled for lack of support, and this for the second successive year. One wonders what the reasons are for this lack of response. Such evidence as we have does not suggest that teachers are satisfied with courses for this group of pupils. Is it resignation? Or is it that staff shortages are such that teachers feel they cannot ask for leave of absence to attend such courses? Either way, it would be regrettable if the failure to get these courses off the ground were interpreted as meaning that teachers were satisfied with RSLA science.

# Opinion

Who writes the catalogue blurb on which the manufacturers depend to sell their wares to the science teacher? Is it the advertising agency, the sales staff, or the research and development engineers? We subscribe to various technical journals whose adverts. are aimed at technicians and engineers in industry, research and tertiary education and whose pages are fairly copiously decorated with beautiful girls attempting to sell the various products. So far the sex-sell has not invaded the schools market to any extent, although I remember an A.S.E. meeting conspicuous for a scattering of dolly birds in mini-skirts amongst the stands of one supplier. The experiment was not repeated, so perhaps it was thought to be a mistake. Are school teachers thought to be less susceptible to this type of approach?

We see no objection to dolly birds, provided they know their stuff, nor to catalogues which effuse superlatives - they can always be used as source material with the pupils - provided they give us the hard facts we want to know. Unfortunately this is not always the case. A search through the catalogues will bring to light the following deficiencies, all of which have created frustration here in the short space of 2-3 weeks.

1) Stroboscope manufacturers fail to tell us the energy per flash, so that we may be able to assess whether it is suitable for air puck photography. Indeed it is sometimes impossible to tell whether a xenon or other tube is being employed.

2) In the course of a paragraph describing a mounted torroidal (sic) rheostat, we learn all its dimensions, but not its power rating.

3) In a similar paragraph on an electro-mechanical vibrator we learn its dimensions, including the fact that the 4 mm terminals are 19 mm apart, but nothing at all about its method of attachment to the equipment it is expected to drive. Is it a screw thread, 4 or 2 BA or some other size and pitch? Is there a means of applying a truly axial pull for generating longitudinal waves? The catalogue, which tells me the colour of the paint employed, is sadly silent on these points.

Perhaps the engineers could be brought more into the picture when the sales pitch is being written. Then I will be a little surer that the facts I want to know are there, even if I have to sort them out for myself, as in the next example. "Such a device could be a feedback shift register pseudo-random number generator using modulo two feedback."

# Chemistry Notes

A satisfactory melting point apparatus can be made from a scrap 500 g or 200 g brass weight, or from a block of aluminium such as is used in semi-micro work. The block can be suitably drilled to take a thermometer and one or two melting point tubes. Referring to the diagrams, one side of the lifting knob of the brass weight is cut off to provide space for drilling the holes. The depth of drilling should be such that the solid in the melting point tube is opposite the mercury bulb of the thermometer. The dimensions we give in fig. 1 are suitable for a 500 g weight.

In use the block of metal sits on top of an upturned tin can which has had a central hole taken out of the base, of size suited to the metal block being used, and slits cut at the side as shown in fig. 2. A 41G hypodermic syringe needle, length 40 mm, is soldered into a small hole in the side of the can at an angle of about 45°. Small ventilation holes are also cut in the base of the can. The position of the needle should be such that a jet of flame 30 mm long impinges on one side of the metal block when this is placed over the large hole. The orientation of the block should be such that the melting point apparatus is on the opposite side from that receiving the flame.

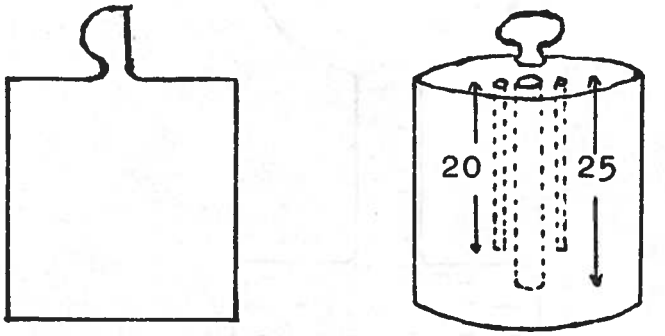
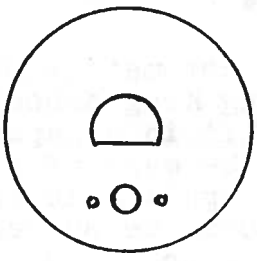
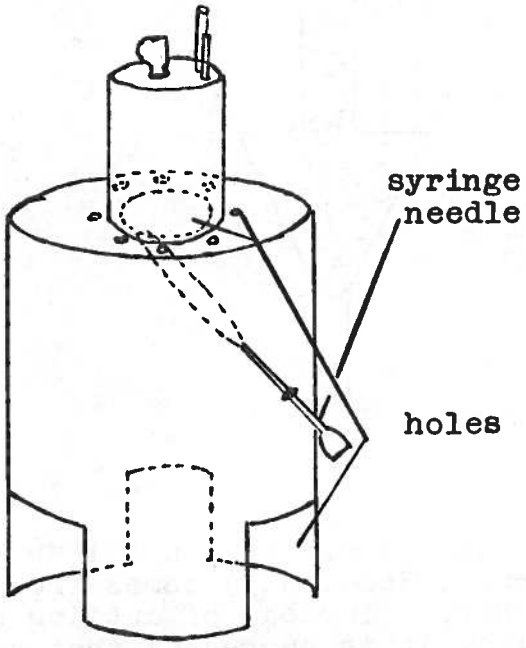



Fig. 1

Dimensions in mm.





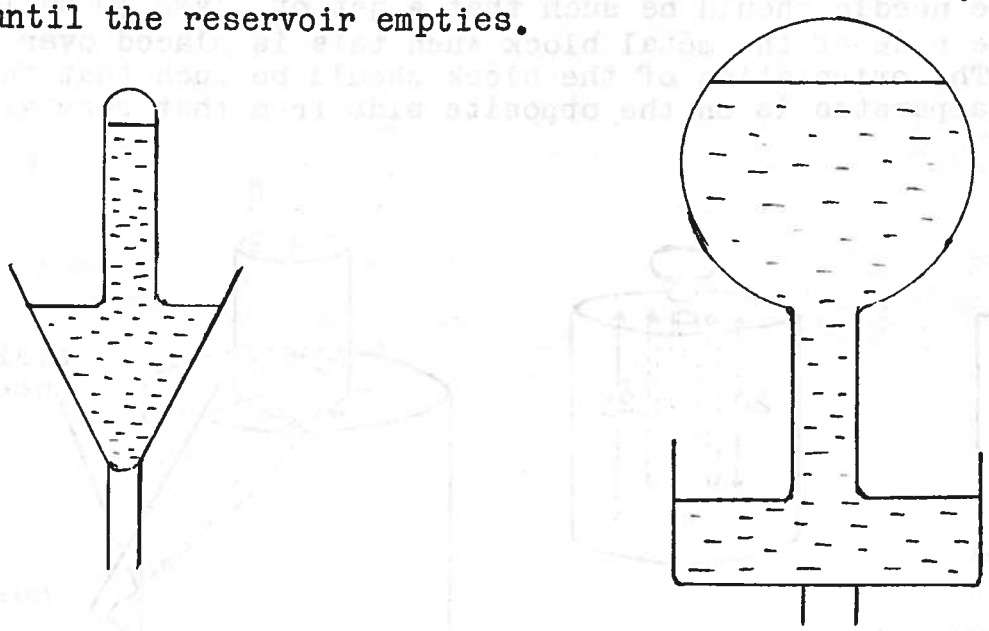

In our version, with town gas turned fully on, the flame length was 30 mm and just touched the bottom of the block. With natural

gas we could get a flame length of up to 55 mm but again 30 mm was found to be stable and satisfactory. With propane or butane the flame is very smoky but the experiment can still be carried out. By using the syringe needle instead of a burner better flame control and uniform heating rate are obtained. The time required for the block to reach 80°C was 7 minutes on town gas and 8 minutes on natural gas. For 155°C the times were 19 and 22 minutes respectively. Results obtained for acetamide (76-81°C) and benzoic acid (121-124°C) were:

| | | | | | |
|---|---|---|---|---|---|
| Acetamide | 83 | 82 | 81 | 82 | 81°C |
| Benzoic acid | 124 | 124 | 121 | 121 | 121°C |

* * * * * * *

A method of providing automatic washing of a precipitate in a filter funnel is sketched below. The system can be used for any type of filtration, and can be left unattended. The amount of washing is controlled by the size of reservoir, which could be an aspirator with exit tube instead of the flask or test tube shown, and the rate of washing is varied by altering the size of the reservoir outlet. The water level in the funnel is maintained automatically at a constant level until the reservoir empties.



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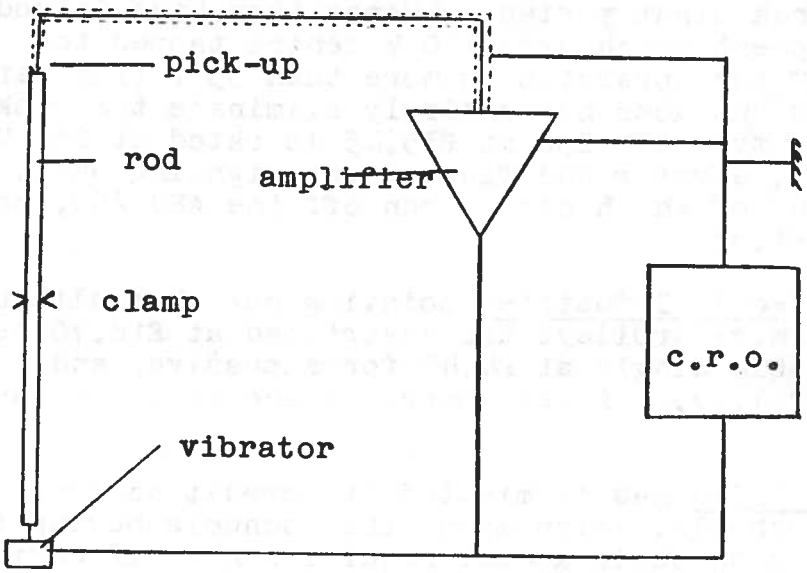
This variation on filter paper chromatography, (Integrated Science, Section 5) comes from a Hong Kong school via a Scottish teacher. Instead of cutting a 'tail' in a paper circle to act as a wick, it is suggested that a wick be made of a twisted spill from another circle, which is pushed through a hole in the centre of the paper into the eluent. For specimens, he suggests drawing round a 2p coin with pencil and spotting various colours of felt pen round the circle. The eluent can be water, or better, a mixture of equal parts by volume of water and methylated spirit. We found it an advantage to reduce evaporation by covering the whole apparatus with a larger beaker, or by resting a crystallising dish or evaporating basin upside down on the paper. The experiment would seem to be very suitable as practical homework for first year pupils, using a cup as container for the eluent, and a large bowl as a cover.

# Physics Notes

The following experiment may be of interest to anyone investigating the velocity of sound in a rod, by any of the techniques described in Bulletin 49, or elsewhere. It is a modification of a method described some time ago in the American Journal of Physics. Briefly, the rod is made the feedback element in a high gain amplifier, so that, provided the phase relations are right, the system oscillates with the fundamental resonant frequency of the rod predominating.

The diagram below should be largely self-explanatory. The rod is held vertical by a retort clamp at its mid-point, with its lower end resting lightly on the stem of an electro-mechanical vibrator. On the top is placed a gramophone pick-up, complete with arm, in its usual playing position. The pick-up support is held in a retort clamp so that tracking is prevented; otherwise it will eventually shake itself off the end of the rod. The pick-up provides the input to an audio power amplifier, wherein the vibrator replaces the normal loudspeaker. The output is also connected to a c.r.o. for examination and measurement of the frequency. As the amplifier gain is increased the system will oscillate. The phase question is easily settled by reversing the connections at one end of the amplifier. When the system is in the correct phase for oscillation, it will oscillate at a lower value of amplifier gain and will show a sinusoidal waveform. If out of phase, oscillation requires higher gain, the waveform is distorted and higher pitched, due to the complex resonances being generated. For a copper rod 1 m long we found fundamental resonance at 1750 Hz, giving a value of $3.5 \times 10^3$ m/s for the velocity of longitudinal waves in copper.




# Biology Notes

We would like to draw the attention of teachers to an article "How safe are microbiology texts?" by Wyatt and Wright in the

"Journal of Biological Education" 1974 Vol.8 (4) 216 - 218. In this article some practical microbiology texts recommended for school use are evaluated for safety and it provides information on certain organisms of which teachers should be aware. This article may appear to some to be alarmist. However it bears reading more than once, and after several readings, in our opinion it appears eminently sensible. There is little in the article which the well informed, safety conscious teacher of microbiology does not already know. It probably will not lead him or her to change their established procedures or choice of organisms, which will already cover the points discussed. However, in our experience, quite advanced microbiological work is being carried out by teachers who have had little or no formal training in microbiology. They may not be aware of the potential hazards of some of the commonly used micro-organisms named in the article and, if they keep their sense of proportion, they could profit from reading it.

Among the micro-organisms the authors give warnings on are Proteus; Pseudomonas; Serratia marcescens; Escherichia coli and Salmonella typhimurium strain LT-2.

# Trade News

We commented in Bulletin 57 on the need for electrical safety in aerating and heating aquaria, and suggested the use of earth leakage protection devices, such as those made by D.W. Blakley. They have written to us pointing out that these devices, which cut off the supply immediately a fault develops may be tripped by a fault in the supply system, which could occur at night, or during week-ends or holidays, so that livestock might perish. Hence they have introduced a range of aquarium equipment which uses 110 V centre tapped to earth, so that no part of the apparatus is more than 55 V from earth potential. This reduces but does not entirely eliminate the risk of shock. The cheapest, type AEU 250 at £35.45 is rated at 250 VA and comprises transformer, aerator and fluorescent lighting unit. A 100 W aquarium heater, two of which can be run off the AEU 250, costs £1.17, and a thermostat £1.62.

We have a note from Rollo Industries pointing out that although their popular tartan dynamics trolleys are advertised at £16.70 per set, they are also available singly at £4.40 for a passive, and £5.84 for an exploding trolley. A set comprises one exploding and three passive trolleys.

The firm of Lasky's Radio has terminated its credit account facility for individual schools, which means that schools buying from the firm will either do so on their annual requisition or if buying through petty cash, by cash with order.

Fortronics are Scottish agents for equipment sold by I. for E.

Available from the Plastics Institute is a booklet 'Plastics in Schools - Safety and Hazards' at 10p. It contains advice on the

handling of the solvents and chemicals used in the study of plastics and includes a list of chemicals, their hazards, precautions in their use, and first aid. The booklet is designed so that by using two copies a wall chart can be formed.

There are on the market writing pens the ink of which is claimed to be autoclavable. Their cost is about £1 each, which we thought was a high price to pay unnecessarily. So we tested Magic Marker ink in a pressure cooker for 15 minutes at one atmosphere excess pressure. The ink had faded slightly but was still very legible and we estimate would remain so for 5 or 6 autoclavings. The ink had already be routinely subjected to dry heat on locust egg tubes which are oven baked for sterilising. The pens are generally available in stationers and are made by Speedry Magic Marker.

The phase version of the Olympus HSC microscope which is now supplied by Griffin and George, but is not in their '74 catalogue has been given the catalogue number L07-324. The phase version is a complete instrument in its own right with phase condenser, a ×40 phase objective and a centring telescope, the whole costing £133.70. It can also be used for brightfield work, but it should not be confused with the more sophisticated phase kit, L07-390, costing £149, which requires an existing stand on which to fit the phase condenser and objectives.

We understand that there are considerable problems associated with the supply of ×20 objectives for the Olympus STN microscope. This is now available only as an addition to the ×4 and ×10 objectives, and some orders have been subject to considerable delays. We would be interested to hear from teachers who have had, or are having, such problems.

The tiny microlamps which we use on some of our energy conversion models are still available from Collison-Goodwell at much increased prices. The 1 V, 5-6 mA type 2012 now costs 64p, and the 1.2 V, 10-15 mA type 2017, 53p.

We have recently bought a pocket multi-range meter, type LT101, from West Hyde Developments. Its ranges are 10, 50, 250 V and 1 kV a.c. and d.c.; 1 and 100 mA d.c.; 150 kΩ. The meter impedance is 1 kΩ/V. Provided one accepts these for what they are, check-out meters, and does not attempt to connect them into an experiment to measure electrical parameters, they can be very useful instruments particularly for the school technician who is often called upon to check for broken connections or dud cells. The LT101 carries easily in a pocket, and costs £3.80.

Grove Industries have for sale a 350 W mains immersion heater for use in beakers etc., at £2. A 12 V, 4 A calorimeter heater from the same firm costs £1.80; unfortunately this is the wrong shape for use with the 1 kg metal blocks. They also offer a 15 V, 75 W radiant heat source for use with Nuffield radiation apparatus at £1.75.

A 'Junior' oscilloscope camera which takes Polaroid type 87, 3000 ASA film is obtainable from Shackman Instruments. The camera can be bought in a variety of hood sizes to fit most of the oscilloscopes usually found in schools. As the camera is not clamped in any way, but merely held against the face of the 'scope during exposure, it would seem a simple matter to use a foam plastic surround to adapt it to any except TV size oscilloscope tubes. The camera costs £25.50.

The following gas burners from Rhodes Flamefast may be of interest.

A bench blowpipe, model BL1 costs £24 and operates well with town gas, natural gas, propane or butane. It has a heavy base and gives easy flame adjustment for glass blowing, heating crucibles etc. A ribbon burner, model RB1, designed for natural gas, costs £6. The high cost is explained by the need to eliminate flame lift-off, which happens if the narrow slit type of burner is used. The ribbon flame is produced by a steel tube with a line of small holes.

Glass Appliances are a subsidiary of Shandon Southern Instruments, and any Shandon equipment required for a Scottish school should be ordered from them.

The kit for anodising aluminium is no longer available from the Aluminium Federation. A list of substances required and details of the process were given in Bulletin 16.

# In The Workshop

This method of demonstrating the thermo-electric effect is one which we have borrowed via Didacta from East Germany. The principle is very simple; a nickel and a copper rod are joined to make a closed circuit. The junctions are maintained hot and cold, and sufficient current flows in the copper to generate a magnetic field which can be detected, and used to support a 2 kg mass.

We used a 12 cm length of 12 mm diameter nickel rod which we obtained from Henry Wiggin as a free sample for experimental purposes. We doubt if the firm would be prepared to extend the same consideration to every school which might want to assemble the demonstration and we have therefore bought short lengths of rod from the firm which we will sell to schools at £1 per length, guaranteed to be 10 cm or greater, and therefore adequate for the apparatus.

Two holes 8 mm diameter are drilled in the rod 60 mm apart to take the same diameter copper rod, which is bent into a U-shape as in Fig. 2. These holes are drilled only halfway into the nickel; this is enough to hold the copper, which is brazed into the holes. At right angles to these holes another smaller hole is drilled right through the nickel rod to take a tube for water coolant. This should be positioned a few mm from one of the junctions, and between them; the size of hole must fit the copper tube which is to carry the coolant and which is soldered to the nickel. In our case this was 5 mm.

In this form the apparatus can be tested. The nickel rod is held in an asbestos-lined clamp with the copper U horizontal and a water flow connected up. The other junction is heated by bunsen burner. A plotting compass held above or below the copper should then show the magnetic field. The same field may be shown more convincingly by using it to hold together two plates of mild steel which have been grooved so that they fit over the straight limbs of the copper U, and suspending a weight from the lower plate, while supporting the upper. In this way we have been able to support 2 kg suspended from the lower plate. The steel plates measure 90 x 50 x 12 mm thick, and if they are to support a weight it is necessary that they are in good contact over their adjacent faces. Hence grooves must be cut to take the copper rod. Semi-circular grooves, slightly larger than

the copper rod diameter, are cut with a drill, by clamping the two plates tightly in a machine vice before drilling. It is also worth while to abrade the flat surfaces with carborundum to ensure good contact. In the middle of each plate is fitted a countersunk 4 BA bolt, 30 mm long. The protruding ends of these are bent over to form a hook, so that the copper plate can be hung on a wire support, and a weight can be hung from the lower, which is held in contact with its fellow by the magnetic field generated by current in the copper.

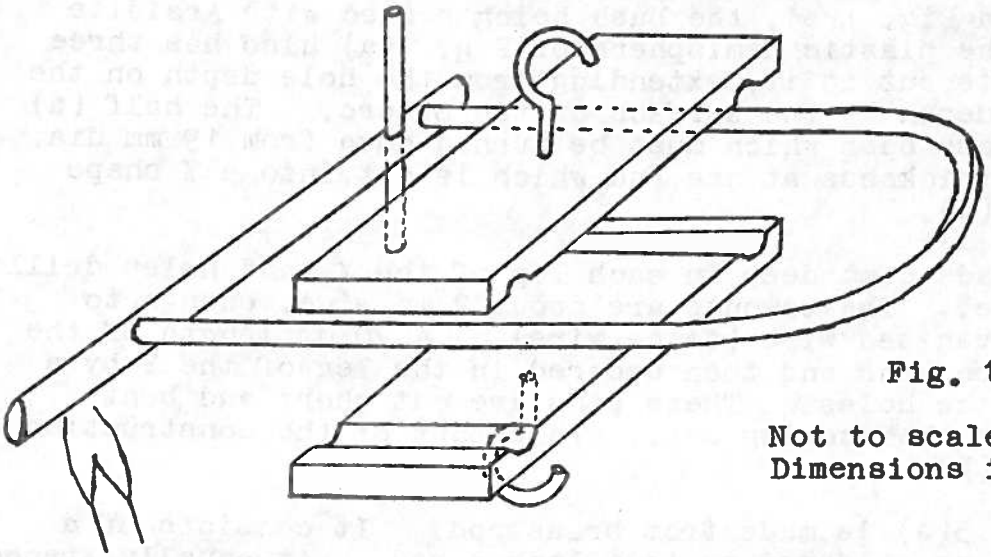


Fig. 1. General layout

Not to scale.
Dimensions in mm.

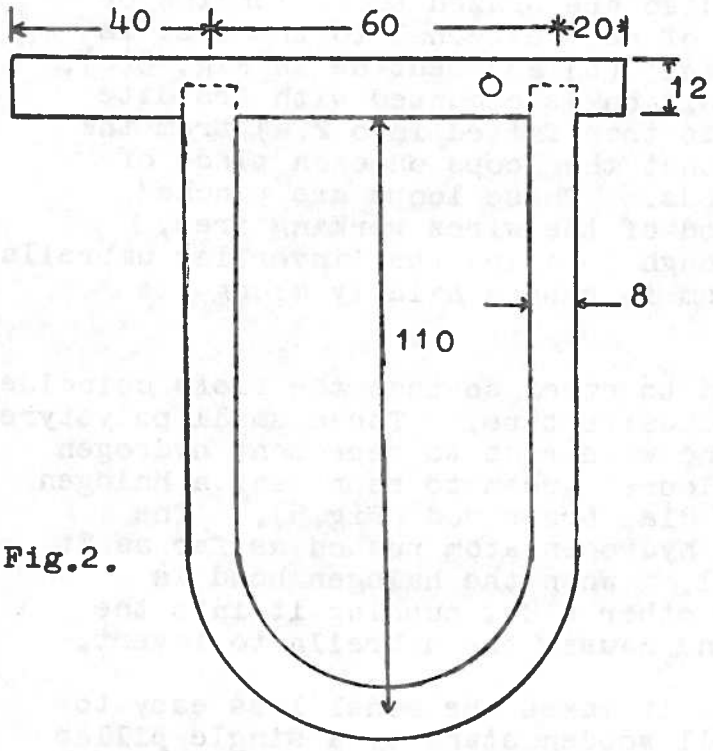



Fig.2.

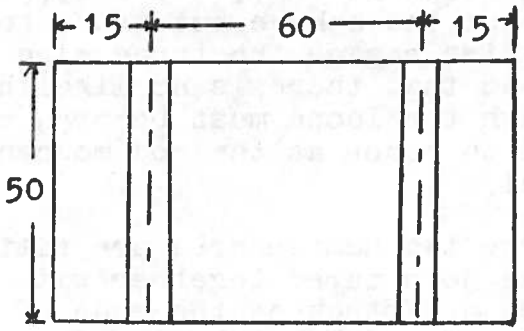



Fig. 3. Steel plate

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It is desirable to be able to illustrate the 'inversion' which takes place in the methane molecule when a hydrogen is replaced by a halogen atom, and there have been many attempts to make a mechanical model which illustrates this. The one which we publish here was designed in Stirling High School and we consider it the most successful, as well as being comparatively easy to construct.

The basis of the model is an expanded polystyrene sphere, 63 mm dia. and available from Philip Harris. To get two accurate hemispheres, two of these are cut slightly above size, and the flat faces ground down on glasspaper until they fit together to give a whole sphere. Each is then clamped in the lathe chuck, flat face inwards, and a 7 mm dia. hole drilled right through, at right angles to the plane face. The halves are then turned about, i.e. flat face outwards in the chuck, and in one a 20 mm dia. hole is taken out about 2 mm deep and in the other a 40 mm dia. hole 10 mm deep. In the second of these, Fig. 1(b), three slots 6 mm wide are cut, equally spaced round the circumference down to the full 10 mm depth of the central hole. This half is also fitted with a brass bush to the dimensions given in Fig. 1(b), the bush being sealed with Araldite into the hole. The plastic hemisphere of Fig. 1(a) also has three equally spaced slots cut in it, extending from the hole depth on the inside to a 10 mm depth at the surface of the sphere. The half (a) has a 7 mm dia. brass bush which must be turned down from 19 mm dia. rod, leaving 4 mm thickness at one end which is cut into a Y shape as shown in Fig. 2(a).

Sawcuts are made 6 mm deep in each leg of the Y, and holes drilled transverse to these. The sawcuts are about 2 mm wide, enough to take 16 s.w.g. galvanised wire (fence wire). A 70 mm length of the wire is looped at one end and then secured in the leg of the Y by a panel pin through the holes. These pins are cut short and bent slightly to prevent them coming out. This part of the construction is shown in Fig. 2(b).

The part Fig. 3(a) is made from brass rod. It consists of a brass disc, brazed or soldered on to a longer rod. At equally spaced points round the periphery of the disc are brazed three lengths of 24 s.w.g. piano wire. The length of each external to the disc is 20 mm; each end is hooked as in Fig. 3(b) and bent as in Fig. 3(c). Part 2(a) with the wire rods in position is cemented with Araldite into hemisphere 1(a). Part 3(c) is then fitted into 2(a) from the centre of the sphere outwards, so that the loops on each piece of piano wire engage the three wire rods. These loops are pinched tight so that there is no likelihood of the wires working free, although the loops must be open enough to allow the 'inverting umbrella' effect to occur as the rod mechanism is pushed axially along its channel.

The two hemispheres are fitted together so that the slots coincide and the join taped together with adhesive tape. Three small polystyrene spheres are stuck on the ends of the wire rods to represent hydrogen atoms. Two other spheres, one coloured green to represent a halogen atom are sealed on lengths of 3 mm dia. brass rod (Fig.5). The model is assembled with the fourth hydrogen atom pushed as far as it will go into one end of the channel. When the halogen bond is brought into the molecule from the other side, pushing it into the channel expels the hydrogen atom and causes the umbrella to invert.

It may be convenient, although it makes the model less easy to store, to have it mounted on a small wooden stand by a single pillar cemented to one of the hemispheres so that the channel is horizontal.

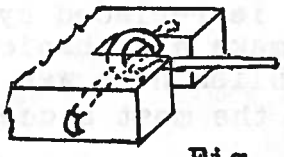

Fig. 2(b).

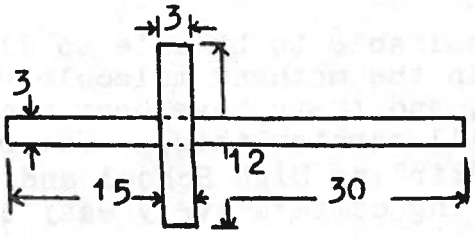


Fig. 3(a).

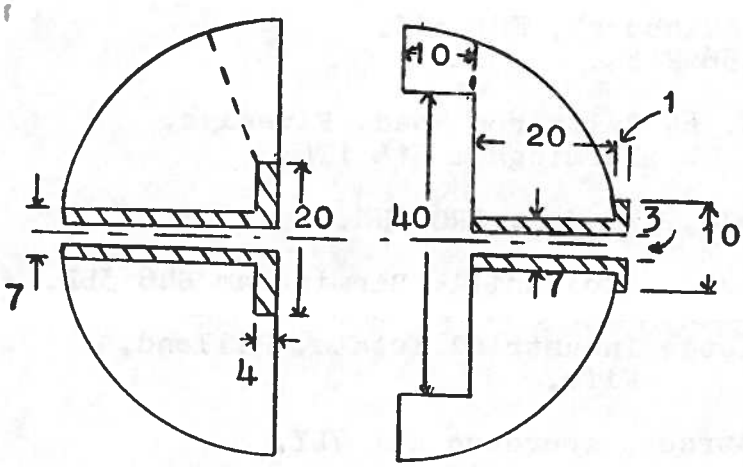


Fig. 1.

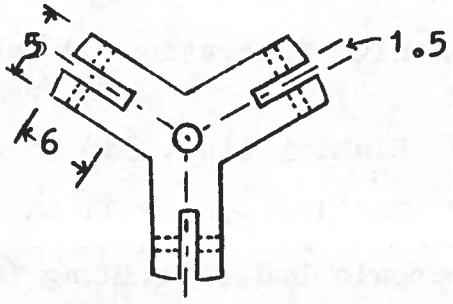


Fig. 2(a).

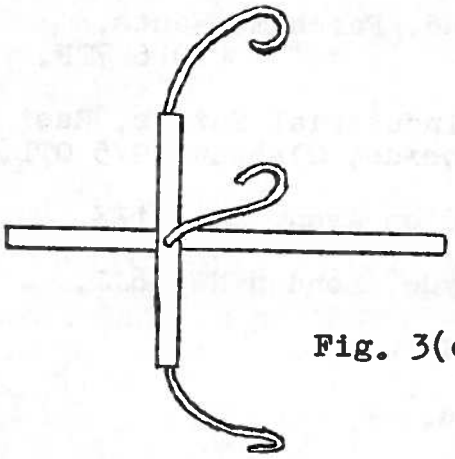

Fig. 3(c).

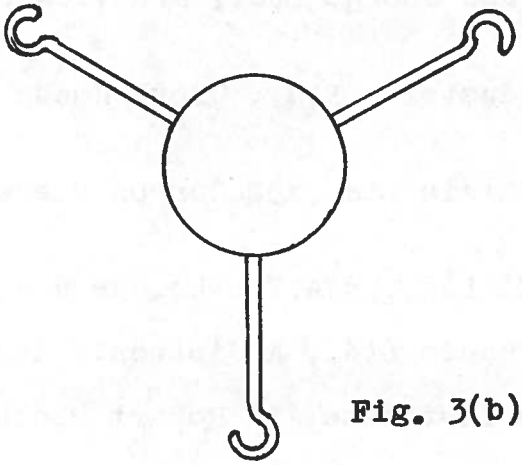

Fig. 3(b).

Figures not to scale.
Dimensions in mm.

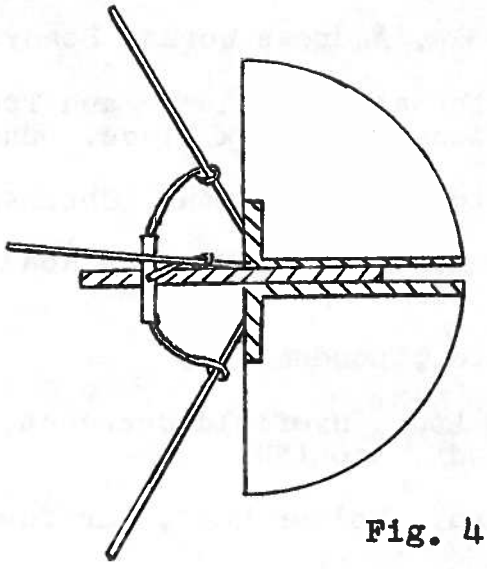

Fig. 4. Fitting of figs. 1(a) and 3(c).

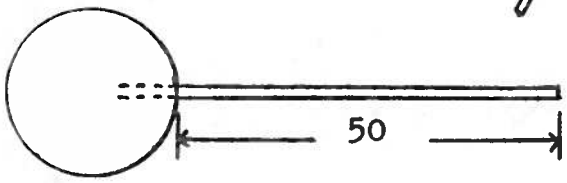


Fig. 5.

S.S.S.E.R.C., 103 Broughton Street, Edinburgh, EH1 3RZ.
Tel. 031 556 2184.

Aluminium Federation, Broadway House, 60 Calthorpe Road, Fiveways, Birmingham B15 1TN.

D.W. Blakley Ltd., 335 Whitehorse Road, Croydon, CRO 2HS.

H.F. Collison-Goodwell Ltd., High Street, Coleshill, Birmingham B46 3BL.

Fortronic Ltd., Building 14, Donibristle Industrial Estate, Hillend, Fife.

Glass Appliances Ltd., 488 Holburn Street, Aberdeen AB1 7LY.

Griffin and George Ltd., Braeview Place, Nerston, East Kilbride, Glasgow G74 3XJ.

Grove Industries Ltd., Grove House, Grove Road, Fareham, Hants, PO16 7TF.

Philip Harris Ltd., 30 Carron Place, Kelvin Industrial Estate, East Kilbride, Glasgow, G75 0TL.

I. for E. Ltd., 87A Trowbridge Road, Bradford on Avon, BA15 1EE.

Lasky's Radio Ltd., Audiotronic House, The Hyde, London NW9 6JJ.

Plastics Institute, 11 Hobart Place, London SW1W OHL.

Polaroid Ltd., Ashley Road, St. Albans, Herts.

Rhodes Flamefast Ltd., Pendlebury Industrial Estate, Bridge Street, Swinton, Manchester M27 1FJ.

Rollo Industries Ltd., St. Andrews Works, Bonnybridge, Stirlingshire.

Scottish Centre for Mathematics, Science and Technical Education, College of Education, Park Place, Dundee DD1 4HP.

Shackman Instruments Ltd., Mineral Lane, Chesham, Bucks.

Shandon Southern Instruments Ltd., Frimley Road, Camberley, Surrey, GU16 5ET.

Speedry Magic Marker Ltd., London N.5.

West Hyde Developments Ltd., Ryefield Crescent, Northwood Hills, Northwood, Mddx. HA6 1NN.

Henry Wiggin and Co. Ltd., Holmer Road, Hereford, HR4 9SL.