SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 4. March, 1966.

Introduction

The Development Committee of SSSERC held its first meeting on 21st January. In welcoming the members, Professor Childs gave a special welcome to Dr. J.R. Spooner, Director of CLEAPSE. This organisation performs a function similar to SSSERC for the South of England, and it is hoped that close co-operation between the two bodies will help to avoid duplication of work.

The Committee discussed some of the difficulties surrounding the publication of reports on equipment which has been tested, and it is likely that these will be issued in the form of Supplements to the Bulletins to consumers only.

The Committee recommend as general policy that microscopes purchased for use in Biology should not be made available to other branches of science, and that additional microscopes should be purchased and shared between physics, chemistry and any other subject which may require their occasional use. The testing programme in Biology has commenced with an examination of the lower-priced microscopes, an arbitrary level being drawn at £20.

In chemistry, we are examining the syllabus requirements in electro-chemistry, with the dual purpose of reporting on available conductivity apparatus, and on suitable power supplies and meters for this work. In physics, work has started on Millikan's apparatus and will be followed by projection electroscopes and oscilloscopes.

The Governing Body of SSSERC has given its approval in principle to the purchase of a van and the erection of a garage on the premises. This will enable us to take the major part of the equipment at present in the display laboratory on tour throughout the country, and to stage exhibitions at various Centres furth of Edinburgh.

Renfrewshire Education authority, and in particular Mr. J.G. Halliday, their Science Adviser, are to be congratulated on an excellent two-day exhibition of science equipment held to mark the opening of their Science Centre in Linwood. 24 firms exhibited apparatus, and over 150 teachers from Renfrewshire and the surrounding counties attended. Although the Centre itself is confined to two laboratories, the equipment on show spilled over to occupy three other laboratories in the school.

Teachers are reminded of the annual meeting of the Scottish Branch of the Association for Science Education which will be held from 4th - 6th April in King's Buildings, The University, Edinburgh. In addition to a full programme of lectures, with special emphasis on the place of Engineering as a school subject, there are exhibitions of books, manufacturers' and members' apparatus. Last year, 20 manufacturers and a similar number of publishers exhibited, and for many Scottish teachers this will be the first opportunity to see a comprehensive range of Nuffield apparatus.

To any A.S.E. member who intends to exhibit in the members' section and who is faced with transportation difficulties, we in SSSERC would offer the loan of any auxiliary equipment such as power supplies, oscilloscopes, signal generators for the occasion of the meeting. Write or telephone details through to us.

Opinion

As this centre is at present engaged in testing microscopes of a quality and price that schools may require in quantity i.e. pupil microscopes, an important point seems to stand out at once.

A considerable number of microscopes from various countries costing up to £12 each are now available and some are advertised by recognised educational suppliers. Of these instruments there are but few which we would consider suitable for school use and none (as yet) suitable for secondary school work. Some of these microscopes can magnify up to 1200 X but the quality of image in all such cases leaves very much to be desired. We would go so far as to say that microscopes having such poor resolution could adversely effect the teaching of biology by killing the interest that observation of micro-organisms so often stirs up in pupils. I have looked at paramecium magnified about 150 X and was able only to see a blurred outline of the animal fringed with colour and with none of its internal structures visible, let alone recognisable! This was found using a microscope costing between £11 - £12. We feel it a duty therefore to warn biology teachers to be extremely wary of these attractive but cheap microscopes, and not to fall into the trap of ordering these by catalogue, knowing little of their true value. This is where the old saying "test and try before you buy" should be rigidly adhered to.

Where teachers are asked for advice in the private purchasing of optical equipment (which often happens), we think that the keen young biologist should be warned of the dangers already mentioned, encouraged to make use of reasonable hand lenses, and to wait until they can afford a second-hand instrument with good optics, instead of going and buying one of the "low" cost toys which look so efficient. Who can assess the frustrations, disappointments and perhaps even susequent loss of intending biologists?

In the pre-transistor era it was an easy matter to indicate on an electronic 'black box' when the unit was switched on. The manufacturer merely had to wire a 6 volt lamp in parallel with the valve heaters and mount it behind a red plastic or glass screen on the front panel. In very few cases did this system fail to have the desired effect of securing a switch-off when the user had finished.

Transistorised equipment pose a problem which manufacturers if they are aware of it, have made lamentably few attempts to solve. To incorporate a warning light in such equipment would in many cases draw off more power from the battery than the unit itself. Perhaps because in that field of transistorised equipment where most of the money is to be made, there is no need of a warning system, little effort has been expended in developing a very necessary safeguard. 'Pop' radios and record players appear to have a built in noise factor which ensures that even in the quiescent state they make all around aware of their presence.

While we teach our children of the indestructibility of energy and of its manifold transformations, and perhaps the more enterprising among us use solar cells to drive radios or other devices, perhaps we should point out the perversity of a world which, with the backing of a huge space-exploration programme pursues the development of the solar cell but allows the reverse transformation to stagnate to such an extent that we still waste

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over 90% of our electricity in our ordinary domestic lighting. Electro-luminescence would seem to be still in its infancy, and while it is true that mains-operated devices are being marketed there still appears to be nothing for transistor circuits other than the extremely wasteful tungsten filament.

We wonder whether other types of warning device have been tried out; and if so whether any market research has been carried out on their efficacy. It is not going to add much to the cost of an article if one side of the on/off slide switch is painted in red 'Dayglow' colour so that it is revealed when the unit is switched on. Yet only one of more than a dozen transistor devices which we have in the Centre carries this simple warning. If the others are relying on an output or other meter as an indicator then two points are worthy of mention:

(1) Meters may read zero when the unit is still on, e.g. output meters where the output has been turned to minimum, and null deflection meters in the balanced condition;

(2) A meter pointer which can be observed at a glance from several feet away is not the sort likely to be found on the transistorised black box; they belong to the realms of TV fiction and power station switch boards.

Several months ago we wrote to one of the largest battery manufacturers on this problem; their reply was not encouraging, but we would hardly like to think that self-interest dictated that they turn a blind eye on the situation. Meanwhile, as our batteries run down through our own or someone else's carelessness, we wait the bonanza which will follow the discovery that electro-luminescence has important space implications.

As the complexity of our school apparatus grows, it is perhaps understandable that the teacher should be less and less familiar with the innards of his equipment, and more concerned with its use as a tool. He wants to know what it can do, without troubling to learn how it does it. Halfway between these, is the instrument specification. "Will it drive a V1 vibrator?" he asks of a signal generator. It is the function of SSSERC to translate this for the teacher's guidance into "X watts into Y ohms impedance". The knowledgeable teacher will have done this for himself. Yet how often, on examining a manufacturer's advertising literature do we find subjective claims for what should be a purely objective statement. We read leaflets on stroboscopes which do not tell us whether the flash tube is neon or xenon activated, let alone what energy is dissipated per flash. After two letters we did learn from one firm the average power rating of the lamp: "but of course this varies with the flashing rate". We have read of meters called 'high sensitivity' in a catalogue which does not give the full-scale deflection current, or the coil resistance. "High intensity lamp" appears on a leaflet advertising projection equipment, but nowhere could we discover the power in watts. Most frustrating of all, and perhaps most frequent, do we find no quoted cost, but a claim that the article is "reasonably priced". Reasonable to whom? Teachers may not want to know to the exact penny what an apparatus will cost them, and are by now conditioned to expect rises in price between ordering and delivery. But they do wish to know whether the article is to cost nearer £30 than 30/-; nor are these limits ludicrously far apart. There have been cases of teachers purchasing apparatus in the £ range when something costing as many shillings would have served their purpose equally well.

We/

We are approaching, if we have not already reached, the age of the soft sell in science. We offer no prizes for identifying the following examples of the sex motif in scientific selling:

(1) "We're engaged" - picture of a luscious laboratory assistant and her balance.

(2) "Have you seen our hot stripper?" - suitably illustrated.

We shudder to think what may happen if the University of the Air when it does take the air does so on a Commercial channel.

To date, the prize for insulting the science teacher's intelligence must go to one of the larger firms on the occasion of the Annual meeting of the Association for Science Education at Cambridge. It has become the custom of recent years for several firms to give a lecture demonstration lasting about an hour of some of their products. These are well attended and have been much appreciated by teachers. The demonstrations are invariably well carried out and provide the teacher with a valuable means of assessing the equipment. This last was no exception.

One can therefore imagine the feeling of shock when one of the directors of the firm concerned, being called by the Chairman to summarise the proceedings 'for a couple of minutes' delivered a self-congratulatory oration of the 'Here's tae us, Wha's like us' variety much more suited to the annual shareholder's meeting than a gathering of potential customers. When we say potential, the potential was there, but one could feel it dropping regularly as the speech went on - and go on it did, for nearly fifteen minutes - until by the end, polarisation appeared to be complete. The audience reaction might best be summarised in a comment overheard later: "It would have been less bad had it not been so meticulously prepared". Most of the Scottish contingent rightly expressed their opinion by walking out while the speech was in progress.

Trade News

Incorporated in this section are details of equipment shown by various manufacturers at the Annual Meeting of the A.S.E. at Cambridge.

Advance Electronics have commenced production of a new low-priced signal generator, the SG65. Providing sine and square wave output variable up to a maximum of 6 volts, the generator has a frequency range from 10c/s - 100Kc/s cycles per second. Two outputs are provided, into 2KΩ and 4 ohms, the latter being used when driving loudspeakers or the V1 vibrator. A notable feature is a radio-tuner type frequency scale with band-spread tuning. Other manufacturers might consider how easy it is to upset the frequency calibration of a generator by a careless wrench of the tuning knob on the spindle. The first models of the SG65 will be available in June, cost £20, but before this time we shall have a demonstration model in the Centre.

G. Cussons Ltd. are well known as manufacturers of mechanics apparatus, but they have lately extended their activities. On show was a current balance in the true sense of the word, i.e. it measures the force between two parallel wires, costing £39; a fuel/

fuel cell working off hydrogen and atmospheric air and providing an output of 4 amps at ¾ volt, and a Nuffield approved low voltage power supply giving 0 - 25V at 8A costing £29. In mechanics we noticed a Wilberforce pendulum for 12/6d., a Universal speed motor for £35 and equipment for demonstrating circular motion quantitatively.

The Glasgow firm of Charles Frank had on display a wide selection of binoculars, compasses and astronomical telescopes. With Newton's use of the gravitation laws to explain the solar system as one of the end points of Nuffield physics, perhaps this equipment will find a readier sale South of the Border than in Scotland.

R.A. Fox (Biology) Ltd. of Edinburgh aroused considerable interest with their locust breeding and rearing cage. Samples, and information on the culture of drosophila, plasmodia and protozoa were also shown.

We mentioned in Bulletin 2 that no double wound variable transformers existed giving an output greater than 60 volts. A double-wound transformer is isolated from the mains and thus gives a degree of protection not afforded by the normal auto-transformer. The Cressall Manufacturing Co. have brought out a range of double-wound 'Torovolt' transformers. For example, the 55DW gives 0 - 250V at 0.7A and costs £12.9/-; 66DW gives 0 - 300V at 2½A for £24.8/-.

A feature of the Exelo stand (W.G. Flaig and Sons) was the gas syringe apparatus developed under the Nuffield Chemistry project. This comprises a basic stand with different assemblies being mounted on the optical bench principle, and can be used to demonstrate most gas reactions.

E-Mil laboratory glassware now employs an amber stain marking of the graduations which is fired into the glass on an ion exchange principle and hence is virtually irremovable. Examples of the process can be seen in our display laboratory on graduated pipettes and measuring cylinders. Also on display from E-Mil are a new design of plastic stop-cock for burettes, Bee-ka stirring thermometers, automatic volume dispensers which are adjustable and use a polythene squeeze-bottle as the reservoir, and a mercury collector which will get into a 1/8" crack between floorboards and which with judicious filing of the glass could be made to fit an even smaller crack.

Venner Ltd. in conjunction with John Emery of Glenalmond have placed linear air-track equipment in the Centre, set up to verify acceleration proportional to force. This uses an inclined track and diluted gravity as the accelerating force. The track which is 3ft. long is now being manufactured by W.B. Nicolson.

The main interest in the W.B. Nicolson stand and in their lecture demonstration was the mass spectrograph developed by Mr. Llowarch and selling for £77. Ions are evaporated off a heated filament placed in the vacuum system and are deflected through 90° by a permanent magnet - W.B.N. used an ex-magnetron magnet - before being received on a collector electrode. Varying the collector potential determines the mass of ion which will negotiate the bend, and the resulting current is fed through an amplifier to display on a meter or oscilloscope. The experiment is limited to the alkali metal ions, but it is claimed that isotopes Li^6 and Li^7 are distinguishable.

How/

How many measuring cylinders have had to be thrown out because they would not stand up? A chipped base renders the whole unit useless. Gallenkamp have brought out a glass cylinder with polythene base. The 100 ml size costs 5/8d., with a replacement cylinder only costing 5/-.

Teltron Ltd. have developed a solid state detector, using the 20th Century SSN/03K for use with their demountable discharge tube in showing the deflection of alpha particles. Their range of tubes has been increased by the addition of an electron diffraction tube, working off 5 Kv, costing £18. Development work is in progress on an X-ray apparatus and a Bragg spectrometer.

Nuffield Physics have recommended that all scalers shall have a built-in millisecond timing facility similar to the Panax scaler. In consequence, Research Electronics have produced a new scaler Model 905 using two dekatron counters, followed by a relay. Cost is £51 for 6 V battery version, or £57 for mains/battery version. Geiger tube and holder are available for an extra £12.10/-. Research Electronics equipment is available from Philip Harris, Griffin and George, and W.B. Nicolson.

Philip Harris are to open a Scottish office in September. All orders from Scottish schools will then be handled by this Branch office. Mr. Mason, their Scottish representative is moving shortly to a new house in Dalgety Bay, Fife to supervise the preparation of the new premises.

Flatters and Garnet showed a full range of microscopes, biology models and microscopic preparations. The firm have recently moved to new premises outside Manchester and their new address can be found in the appendix to this Bulletin.

A.R. Bolton have gone into liquidation and their agencies are being taken up by other firms operating in Scotland.

The Griffin and George stand was notable for the interest shown in their direct reading balance, the G+G201, selling at £88. We hope to add this model to the increasing range of balances on display in the Centre at an early date. A comprehensive selection of Griffin Nuffield apparatus was also shown.

Morris Laboratory Instruments were showing a wide range of equipment for the Nuffield physics syllabus, much of which will be familiar to teachers who have visited our display laboratory. Their dynamics trolleys are made of moulded plastic, and they have also started production of a linear air-track with vehicles, etc.

May and Baker have opened a depot at Cumbernauld, and request that all Scottish orders placed after March 1st should be addressed there.

Display Laboratory

The following additions have been made since Bulletin 3.

ITEM	MANUFACTURER
Tidal Aquarium	S.S.S.E.R.C.
Worcester Circuit Board	S.S.S.E.R.C.
Respirometers	S.S.S.E.R.C.
Low Input Impedance Amplifier	S.S.S.E.R.C.
Binary Adder/Subtracter	S.S.S.E.R.C.
Stopclock	Venner
Photo-diode	W.B. Nicolson
Linear Air Track	W.B. Nicolson
Scaler/Timer	Labgear
Rate-meter	Labgear
Radioactivity Demonstration Set	Labgear
Demonstration Meter INDC	White Electrical
4 mm Connector Leads	White Electrical
Westminster Electromagnetic Kit	Philip Harris
Crystals Kit	Philip Harris
Laboratory Glassware	John Moncrieff
Laboratory Glassware	E-Mil
Observation Incubator	Curfew Appliances
Multimatic Photocopier	George Anson
Dyeline Photocopier	George Anson
Overhead Projector	Fordigraph
Dynamics Carts	Rollo Industries
Electric Motor Kit	Rollo Industries
Solenoid	Rollo Industries
Reactance Components	Unilab
Signal Generator	Heathkit
Electronic Trace-Doubler	Heathkit
Loop in Earth's Field	Andrew H. Baird
Semi-Micro Kit	Eureka
Holness Gas Generator	Eureka
Small-Scale Organic Prep. Apparatus	Eureka
Centrifuge	Eureka
Electric Bunsen	Electrothermal
Heating Mantles	Electrothermal
Immersion Heaters	Electrothermal
Japanese Meters	G.W. Smith and Co.
Solid Materials Kit	Philip Harris
Demountable Transformer	Philip Harris
Variable Auto-transformer	Service Trading Co.
ESM X 40 Microscope	Bausch and Lomb
ESM X 100 Microscope	Bausch and Lomb
STZ 100 Zoom Microscope	Bausch and Lomb
SSM 15 Stereo Microscope	Bausch and Lomb
Disposable Syringes	Johnson
R10 Analytical Balance	Oertling
J10 Chain Dial Balance	Oertling
Sartorius 2433 Balance	Macfarlane Robson
Dial-o-Gram Balance	Shandon Scientific
Current Balance Kit	Griffin and George
Laboratory Glassware	Pyrex

Chemistry Notes

Although our experiments on electro-chemistry are incomplete, one point which appears to stand out is that many chemists are demanding over-elaborate power supplies for use in these experiments. If it proves possible, despite what many teachers say, to obtain satisfactory results on conductivity titrations using D.C., and we in SSSERC are optimistic on this point, then I suggest serious consideration of the humble Nife cell as a means of providing the necessary power.

In electrolysing melts, we can claim to have confirmed the presence of lead, cadmium, copper, iodine, chlorine (by smell) using 12 volts supplied by a battery of 10 Nife cells, each cell measuring $2\frac{3}{4}$" x 1" x $3\frac{3}{4}$" and costing £1 for 5 cells inclusive of postage from Proops Brothers Ltd. The cells are supplied dry but with solid KOH and filling instructions. A charge of 0.6 amps for 6 hours is adequate, and unlike the lead-acid type, these cells are virtually indestructible.

For convenience in use we have assembled them in racks of 10, with permanent coupling links made from 18 gauge bright steel sheet. Crocodile clips are the best means of connecting on to the battery, and in carrying out conductivity titrations we found it unnecessary to use a rheostat to adjust the initial current. It was simpler to tap up or down the battery until one found the number of cells needed to give a current around the scale maximum.

Physics Notes

Teachers sometimes enquire whether we think a double-beam oscilloscope is a necessary tool in the physics course. To decide the question, we ordered the Daystrom Heathkit Electronic Switch Kit, No. S-3U and had it assembled by our own technicians. With this, on a single beam tube - currently the Serviscope Minor - we can show accurately the phase relation between voltage and current for a capacitor, the variation of capacitative reactance with frequency, and the exponential voltage and current waveforms of a capacitor on square wave input.

As far as we can tell, it would appear that this device is adequate for school requirements. The principle on which an electronic switch operates is that it generates a square wave at high frequency, and that the two inputs to be displayed are then used to modulate the top and bottom of the square wave respectively. If the oscilloscope brilliance control is properly adjusted, the vertical portions of the square wave, which are traced at high speed are invisible by contrast with the relatively slow speed envelopes on top and bottom. In a similar manner the high frequency of the square wave in relation to the envelope frequency means that a large number of square wave cycles will be displayed, and the top and bottom traces will then appear as solid rather than broken lines.

Altering the amplitude of the square thus acts as a separation control varying the distance between the two beams. On the Heathkit instrument the square wave frequencies are given as 150, 500, 1500, 5000, and 15,000 c.p.s. The two inputs have separate gain/

gain controls, and as well as an output terminal carrying the composite signal, there are two synchronising outputs so that an oscilloscope with provision for sync injection can be synchronised to either input.

Those who think that the risks of poisoning from mercury vapour in the laboratory are minimal might care to try a most impressive demonstration from the Griffin and George lecture at the Cambridge A.S.E. meeting. In a darkened room set up a mercury vapour lamp facing a fluorescent 'Dayglow' paper screen. Then hold the polythene bottle in which G. and G. supply their mercury in the path of the beam and squeeze gently. The shadow cast by the rising mercury vapour could be seen through-out the lecture room. Perhaps still more effective, hold a finger previously dipped in mercury in the light beam. And even for those who don't scoff at mercury poisoning, it is a lovely example of Fraunhofer absorption.

Following our note in Bulletin 3 on the use of the EF98 valve at low anode voltage comes a note from Jordanhill College of Education saying that the double triode 12AT7 with both halves strapped together will work on an HT supply of 12 volts. Current is of the order of 1 mA, and cut-off on the grid is about -2 volts.

In The Workshop

The Nuffield Foundation Physics Project has shown a fertile imagination in naming its products distinctively after various English towns. At times it runs riot, as in the Great Malvern, Little Malvern and Malvern Link Electrostatics Kits. Here we have been more restrained, although we do have the Edinburgh Smoke Tunnel. As we think the apparatus described below sufficiently distinctive to justify a name, we offer it, without offence to Auld Reekie, as the Musselburgh Smoke Cell.

Materials:

No. 27 two-holed stopper	Griffin and George
6 mm dia. glass bead	" " "
Lyvia Plastic adhesive tape	Electricians
Polyglaze	D.I.Y. Shops
Lens-ended bulb, 2.5V	Halfords

The wider part of the stopper is used, being cut across with a razor to give a vertical height of 13 mm (use of a detergent helps in cutting the rubber). The cut surface is then smoothed with glass paper. A horizontal hole is drilled in the stopper using a No. 2 cork borer - (5 mm diameter) - passing through the 1st stopper hole and into the next - again use detergent and a piece of wood placed in each hole in turn to prevent distortion of the rubber. The clean glass bead is then pushed into position between the stopper holes.

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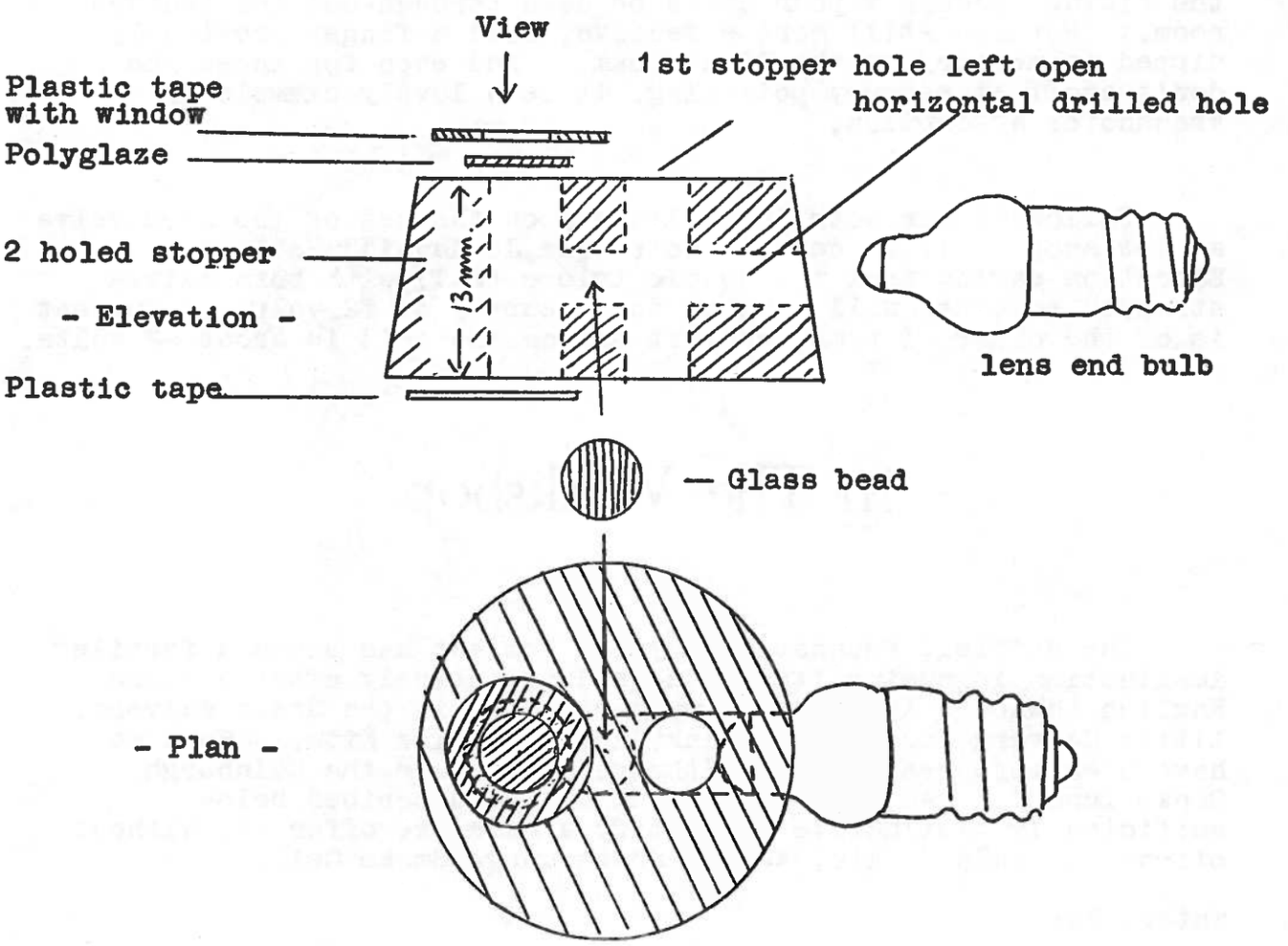
In a short length of Lyvia tape cut a circular hole 5 mm diameter with a No. 2 cork-borer. Cut as 8 mm disc of Polyglaze with a No. 4 cork-borer, place centrally over the second stopper hole, and fix in position with the Lyvia tape so that hole and disc are concentric. Overlapping pieces of tape can then be trimmed off. Finally a piece of the plastic tape is used to close off the lower end of the smoke chamber hole. Illumination is provided by the lens-end bulb with suitable electrical supply placed in the horizontal hole. It will be found that the rubber will hold the bulb quite firmly. Smoke is introduced into the smoke chamber and sealed at the base. The cell is then placed on the microscope stage and viewed using X 40 - X 150 magnification.



S.S.S.E.R.C., 103 Broughton Street, Edinburgh, 1. Tel. WAV 2184.

Advance Electronics Ltd., Roebuck Road, Hainault, Ilford, Essex.
George Anson and Co. Ltd., 62 Hanover Street, Edinburgh, 2.
Andrew H. Baird Ltd., 33-39 Lothian Street, Edinburgh, 1.
Bausch and Lomb Optical Co. Ltd., Aldwych House, London, W.C.2.
A.R. Bolton Ltd., Bankhead Drive, Sighthill, Edinburgh, 11.
Cressall Manufacturing Co. Ltd., Cheston Road, Aston, Birmingham, 7.
Curfew Appliances Ltd., Ottershaw, Chertsey, Surrey.
G. Cussons Ltd., The Technical Works, Lower Broughton, Manchester, 7.
Electrothermal Engineering Ltd., 270 Neville Road, London, E.7.
E-Mil, H.J.Elliott Ltd., Treforest Industrial Estate, Portypridd, Glamorgan.
Eureka Scientific Co. Ltd., 192-198 Ilford Lane, Ilford, Essex.
W.G. Flaig and Sons, Exelo Works, Margate Road, Broadstairs, Kent.
Flatters and Garnet Ltd., Mikrops House, Bradnor Road, Manchester, 22.
Fordigraph Educational Aids, Ofrex House, Stephen Street, London, W.1.
R.A. Fox (Biology) Ltd., 17 Marshall Street, Edinburgh, 8.
Charles Frank Ltd., 67-75 Saltmarket, Glasgow, C.1.
A. Gallenkamp and Co. Ltd., Technico House, Christopher Street, London, E.C.2.
Griffin and George Ltd., Braeview Place, Nerston, East Kilbride.
Philip Harris Ltd., Ludgate Hill, Birmingham, 3.
Heathkit, Daystrom Ltd., Gloucester.
Johnson's Ethical Plastics Ltd., 32 Ajax Avenue, Slough, Bucks.
Labgear Ltd., Cromwell Road, Cambridge.
Macfarlane Robson Ltd., 3A St. Vincent Street, Edinburgh, 3.
May and Baker Ltd., Carbrain Industrial Area, Cumbernauld.
John Moncrieff Ltd., St. Catherine's Road, Perth.
Morris Laboratory Instruments, 96-98 High Street, Putney, London, S.W.15.
W.B. Nicolson Ltd., Thornliebank Industrial Estate, Glasgow.
L. Oertling Ltd., Cray Valley Works, St. Mary Cray, Orpington, Kent.
Proops Brothers Ltd., 52 Tottenham Court Road, London, W.1.
Pyrex, James Jobling and Co. Ltd., Wear Glass Works, Sunderland.
Research Electronics Ltd., Bradford Road, Cleckheaton, Yorkshire.
Rollo Industires Ltd., St. Andrews Works, Bonnybridge, Stirlingshire.
Service Trading Co., 47-49 High Street, Kingston-on-Thames.
Shandon Scientific Co. Ltd., 65 Pound Lane, Willesden, London, N.W.10.
G.W. Smith and Co. Ltd., 3-34 Lisle Street, London, W.C.2.
Teltron Ltd., 239 Acton Lane, Chiswick, London, W.4.
20th Century Electronics Ltd., Centronics Works, King Henry's Drive, New Addington, Croydon, Surrey.
Unilab Division, Rainbow Radio Ltd., Mincing Lane, Blackburn, Lancs.
Venner Electronics Ltd., Kingston By-Pass, New Malden, Surrey.
White Electrical Instrument Co. Ltd., 10 Amwell Street, Rosebery Avenue, London, E.C.1.