SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 2. December, 1965.

Introduction

The Governing Body have appointed Mr. F.D.R. Belford, Principal Teacher of Biology in Musselburgh Grammar School as Assistant Director of the Centre, and he will take up duty in mid-December.

Due to the shortage of staff and pressure of work, it will not now be possible to make the complete tour of L.E.A. visits which I promised in Bulletin No. 1. The programme of equipment evaluation has only just got under way, with tests being carried out on low voltage immersion heaters and solid block calorimeters. I much regret having to take this decision, as it is important to collect teacher opinion from as wide an area as possible. It is hoped to resume these visits in spring, and meanwhile teachers with specific problems are asked to write in to the Centre.

The Centre will be closed on Saturday, December 25th and Monday, December 27th and on January 1st and 3rd, 1966.

Opinion

The issue of comprehensive schools, for which local authorities have to submit plans to the Secretary of State by March, 1966, may seem to have little to do with the activities of S.S.S.E.R.C. But if comprehensive schooling is to be anything more than a political catch-phrase, its implications for Science departments are very significant and wide-spread indeed. I have taught in so-called comprehensive schools where children of a wide range of abilities were segregated on the basis of a primary school mark, intelligence test or some other yardstick, and there after met the other streams occasionally on the sports field, weekly at assembly, daily in the lunch time scramble, but intellectually, never. If this is what the politicians mean by comprehensive schooling, all it amounts to is a re-grouping of the school population in different buildings, and all the stushie which the issue has raised, particularly south of the border, will be seen to have been so much hot air, with the intellectual status quo being maintained.

If, however, comprehensive schooling means - as I hope it does - that every child is educated in a subject in keeping with his proven ability <u>in that subject</u>, then we have a very different state of affairs. The first essential is that classes throughout the school must be set, at least in as much as there are streams within the school. Thus if a school runs what I would consider to be the minimum of three streams of ability: Good, Average and Poor, there must of necessity be three classes running simultaneously in each subject so that a pupil may be placed in which-ever group his ability in that subject qualifies him for.

Setting implies an all-round increase in the equipping of each science department, coupled with a less economic use of the apparatus.

If a physics department is running three sections on Waves, many more ripple tanks will be called for, and these after being intensively used for two periods will be laid up for the rest of the week. Arguments about 'staggering' break down when applied to ripple tanks, which have to be in general use over a period of weeks. Much of the new equipment is 'general' in nature, e.g. electromagnetic kits, circuit boards, signal generators. Alternating with chemistry is no solution; one might as well alternate with art or geography. Any alternation must compromise the ideal of comprehensive schooling, and compromises the pupil who is good at one subject and poor in the other.

There /

There are advantages in this pattern of work. Large-scale demonstrations are possible in a lecture theatre, or by use of C.C.T.V. Team-teaching would increase. By co-ordinating the time tables of several schools - this must surely happen in Glasgow sooner or later - the scope of live C.C.T.V. would be enlarged several times. By setting up a science centre, and supplying responsible technicians for maintenance and distribution, a local authority could serve half a dozen schools with the same equipment. Again this would be co-ordination of time-tables. But the apparatus would be fewer in quantity, more intensively used, and having a shorter life, could be scrapped without a qualm after two or three years. Obsolete equipment, gathering dust on the top of cupboards for fifty-one weeks in the year would disappear from the labs.

If the idea of sharing equipment between schools does not appeal to teachers, they may be forced to consider the alternative, which is centralisation. If an 'A' level or post-Higher syllabus ever gains wide acceptance, one or other of these alternatives will have to be adopted and in support of sharing, let me point out that one local authority, a scattered country area, already operates a system of 'paired' schools in respect of science equipment.

Those teachers who watched BBC's programme on Eton School several weeks ago, may have wondered whether the reviewer's comment on pupil experiments - "no fiddling little groups" - was an official statement of teaching policy or not. Instead, we learned "the laboratories are equipped with demonstration apparatus big enough for every pupil to see." I do not wish to discuss here the demonstration versus pupil experiment debate, because I believe, and I think that most teachers, including those at Eton School, would agree with me, that both have their uses. We would differ only in the proportions in which the two techniques ought to be applied to the syllabus.

The reviewer's remark does, however, contain a profound truth that is far too often forgotten by teachers ordering equipment. Demonstration apparatus should indeed be big enough for every pupil to see. Yet how many of us have stood before a class with a 2" diameter centre zero milliammeter propped in a clamp - or worse, lying on the bench with pupils crushing each other in an effort to see - while we waggled a wire between the poles of a magnet? How many teachers, in a lesson where hard concentration is needed, ask their pupils to gaze at a screen only one tenth the size of that on which they watch 'Coronation Street', and more than likely from a greater distance?

For the first example there is no excuse. Large demonstration meters with interchangeable scales at reasonable prices are readily available, and every physics and chemistry laboratory should have one. Or one can obtain meters where the illuminated scale can be projected on a screen. Details are to be found in the Trade News Section of this Bulletin.

One word of warning should be sounded on the subject of large demonstration meters; do not expect the same response as you get from your 10,000Ω per volt Avo. Because of the physical size of the instrument the power needed to move the pointer is greater and hence the meter resistance is considerably less - a typical figure is 200Ω /v. The meter may therefore, give excessive damping when used in a high impedance circuit e.g. when demonstrating parallel resonance.

The case of the oscilloscope need be no more difficult to solve, provided teacher opinion can be sufficiently conditioned to accept it. There exists a bandwaggon effect which ensures that when a product has been sufficiently discussed, publicised and in general approved, it achieves a ready sale. The graphs in the Sales Manager's office must conform very closely to the black body radiation curve.

With /

With the best engineering skill available the 5" diameter Oscilloscopes now being bought in large numbers are not good enough for class demonstration. Large screen Oscilloscopes are expensive and highly specialised tools. The Lan-Electronics 19" Oscilloscope can give one, two or four beam display, and costs £240. Similar in price is the Airmec 17" Display Oscilloscope. Two articles in the May and September issues of Educational Electronic Equipment give full details. Neither of these provides the facility of simultaneous viewing by pupils and teacher while he faces his class.

For a small increase to £251, the teacher can obtain the master and slave system of Constructions Radio-electriques, distributed in this country by Claude Lyons, wherein the pattern on the teacher's small 'scope is reproduced large size on the pupils' viewing screen. The teacher can therefore operate all controls while addressing his class, and simultaneously see the results. The master scope has a double beam, three inch diameter tube, amplifier, and either DC or AC input. The slave is a simple beam, magnetic deflection, seventeen inch oscilloscope with amplifiers on both X and Y. Except for the time-base, it is in fact an oscilloscope by itself.

Expensive although this is, I believe it to be necessary. I have already asked several firms to examine the possibility of producing a large-screen oscilloscope using TV tubes, and as much of television circuitry as was common to both. The results were not encouraging. No firm seemed to think that this was economically possible in a price range of £70 to £100. Conversion of an existing TV set to oscilloscope is not difficult, but must be left to the lucky few who are electronics enthusiasts, and have the time to do it.

Still more expensive, but more versatile, is C.C.T.V. Excluding price, this has much to commend it as a science teaching aid. Not only can the camera be focussed on the small screen oscilloscope, but it will 'blow up' small milliammeters, biology dissections, or test-tube reactions. And this, of course, leads us back to large-audience demonstrations, team-teaching and all other concomitants of comprehensive schooling.

If a teacher wants his pupils to discover Ohm's Law, it follows that he needs several resistors. There are three possible ways of obtaining these;

(1) He can buy them from suppliers of physics apparatus - typical being Philip Harris at 15/-;

(2) He can buy carbon resistors at 6d each (2 watt rating) from Radiospares and will then require his lab. assistant to attach these to some form of baseboard carrying terminals of his own choice;

(3) He can buy a 4oz reel of Nichrome wire, calculate the required length and again use his lab. assistant to mount this with terminals.

Method (1) has the advantage that when the apparatus has been delivered, it is immediately usable. It has also a guaranteed accuracy which, provided the teacher chooses his values correctly, is likely to change little in use. He will of course have to face the pedagogic difficulty of having his kids concentrate on getting the right answer, rather than on the experimental technique.

As he might expect with methods (2) and (3) the saving in cost has to be paid for in the laboratory assistant's time. The carbon resistors of method (2) have a current limitation which may make them unsuitable for the meters already in the department (although Radiospares provide WW resistors of 5 watt rating from 15 Ω upwards for 1/- each).

The /

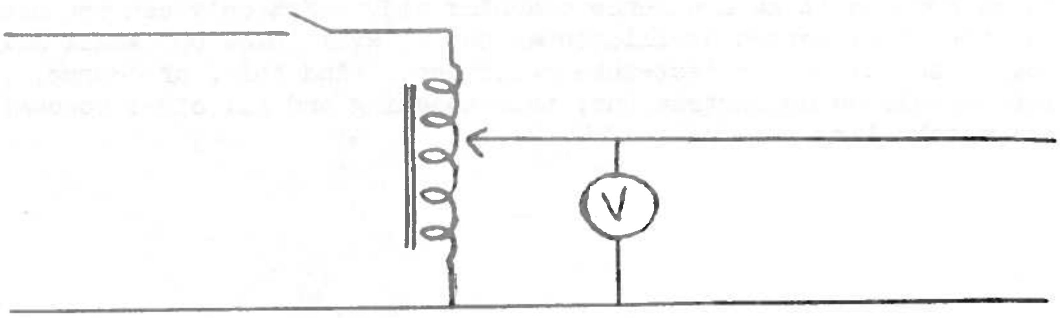
The Nichrome wire of method (3) requires hard soldering or spot welding to make a good joint. It is likely that soft-soldered or screwed-down ends will have enough contact resistance to make them unreliable.

With method (1), one is in fact buying a standard resistance, the rightful place of which is in the teacher's store-room, where it can be used to check the accuracy (assuming this is ever needed) of cheaper resistors, or of pupil meters. For the pupils, resistors (2) and (3) should be adequate; they have the advantage of cheapness to the point of being able to throw them out without a qualm if they get broken or disconnected.

These remarks have been prompted by two quite separate events, the first being the appearance in a list of apparatus to meet the needs of the Higher Engineering syllabus of a Wheatstone Bridge capable of measuring from 10mΩ to 1MΩ correctly. For what do they require this enormous range? If you need a 1MΩ resistor, I hope it would be a carbon one, in which case an Avometer will give a sufficiently accurate value for its resistance.

The second event is perhaps more serious. I have been taken to task by a teacher who followed my advice on the purchase of a variable transformer, and got what he claimed with some justification was a lethal instrument. Due to a misunderstanding he did not obtain the item I had recommended, which was a component free of all connecting leads. Instead he got - and incidentally paid a great deal more for - an instrument encased in a metal box with On/Off switch, output voltmeter, and input and output leads, both of which were twin flex.

After fitting a 3-pin plug he was disturbed to find that one side of the output was 240v live to a true earth - the water tap - when the unit was switched OFF. It is easy to see from the diagram of the unit how this could occur;



It only required that the teacher should wire his mains plug the wrong way round for him to achieve the result he did. The supplier could be faulted for not using a double-pole switch with three core input cable and for not earthing the metal case. The point which I wish to make here is that one can buy immediately safe equipment, e.g. a double wound variable transformer where output and input have no direct connection, but that it is expensive. For the item in question, <u>Claude Lyons</u> supply D.W. Variacs at $2\frac{1}{2}$ amp rating for £10.16/-, but these have an output voltage limitation. 60V is the maximum secondary voltage which Claude Lyons provide on double winding. On a single wound transformer, one side of input and output will always have a direct connection and carry an inherent risk. Alternatively one can buy a component much cheaper, and wire it up oneself to make it safe. The basis of safety must surely be understanding, not the locked door. Chemistry teachers face the same problem; is it better to teach the dangers of explosives or to keep one's mouth shut and hope that kids never hear of weed-killer and sugar? I have no doubt in my own mind which course to pursue. I would still buy the variable transformer component:- <u>Service Trading Co</u>. 260V, $2\frac{1}{2}$ amp at £5.12/6 open, or £5.17/- shrouded - and wire it up to make it safe, boxing it in if necessary. This is a sensible use of the lab. assistant - one hopes that he will gain some understanding by doing so.

Display Laboratory

When reading below the list of equipment at present on display at the Centre, teachers should remember that it takes about four weeks to print each Bulletin, and that there may have been changes in the laboratory in that time. Most of the equipment on display is on loan from manufacturers who are of course at liberty to withdraw it to suit their own requirements.

ITEM	SUPPLIER
Westminster Electromagnetic Kit	Philip Harris
Westminster Electromagnetic Kit	Morris Laboratory Instruments
Worcester Circuit Board	Philip Harris
Worcester Circuit Board	Morris Laboratory Instruments
Ticker Timers	W.B. Nicolson
Ticker Timers	Griffin and George
*Polaroid 120 Camera	Polaroid
*Frictionless Puck Kit	Philip Harris

*The above two items are complete to allow two dimensional strobe photography.

Ripple Tank	Morris Laboratory Instruments
Van de Graaff Generator	W.B. Nicolson
Van de Graaff Generator	Griffin and George
Expansion Cloud Chamber	W.B. Nicolson
Diffusion Cloud Chamber	Griffin and George
Straw Balance Kit	Philip Harris
Joule Meter	Philip Harris
1kg Solid Block Calorimeters	Griffin and George
Low Voltage Immersion Heaters	Griffin and George
Low Voltage Immersion Heaters	Philip Harris
Scaler with 1/100 S Timer	Research Electronics
Millikan's Apparatus	W.B. Nicolson
Serviscope Minor	Telequipment
Tutor Microprojector	Leech (Rochester)
Meopta Microscope	Griffin and George
S H M 1 Microscope	Morris Laboratory Instruments
Science Master Microscope	Prior
Stereomaster Microscope	Prior
Advanced Student Microscope	Prior
Diamac Microscope	Griffin and George
Olympus Microscope	Gallenkamp
3 cm Wave Apparatus	Unilab
Whitley Bay Smoke Cell	Morris Laboratory Instruments
Energy Conversion Kit	Morris Laboratory Instruments
Conductivity Apparatus	Griffin and George
Boyle's Law Apparatus	Philip Harris
Projection Electroscope	W.B. Nicolson
Medium and E.H.T. Power Units	W.B. Nicolson
Cottingham J Apparatus	W.B. Nicolson
Expansion Cloud Chamber	Philip Harris
0.1 c/s Oscillator	Unilab

Trade News

John Moncrieff Limited, manufacturers of Monax glassware are now selling direct to schools. Delivery is by their own transport and is weekly to the main centres in Scotland. They also provide attractive discounts on large orders. It has always seemed to us good sense to buy beakers and such like by the gross every five years or so, rather than a few dozen each year. Stored in their original cartons they can be dumped almost anywhere. The discounts applicable on the gross value of the order are as follows;

£10-£25	-	10%	£75-£100	-	25%
£25-£50	-	15%	£100-£250	-	30%
£50-£75	-	20%	Over £250	-	35%

Where an Adviser in Science can gross up orders over the whole county, the saving could be considerable.

Avo instruments have been reduced in price, and their educational discount scheme has been discontinued. The new nett prices for Avo models are now;

Model 8	-	£21. 8/-
Model 7	-	£19.15/-
Multiminor 4	-	£ 7. 2/6

The sole agents for Avo instruments in Scotland are Elesco Electronics. The same firm are sole agents for Taylor instruments, and are agents for Panax equipment. If bought through Elesco Electronics the firm will service any item of these firms at their Glasgow premises, normally within fourteen days of receipt. We suggested to Elesco Electronics that they might be prepared to supply a stand-by instrument to a school during the period of repair; this had been tried in the past with none too satisfactory results.

The firm are, however, prepared to supply an Avo Multiminor or a Taylor 127A, which is similar to the Multiminor, as stand-by for an additional charge of around 12/6.

Fraser Electronics are the Scottish agents for Edwards High Vacuum. The parent firm has recently under-gone a major reorganisation and the servicing of their pumps has been much speeded up. The average service time for a pump, returned to Edwards, is one month. Fraser Electronics are examining the possibilities of setting up their own service department for Edwards equipment, and also whether a regular maintenance contract would be welcomed by teachers. As the vacuum pump is one of the most badly-treated items of equipment in a science department, we think this could prove invaluable. What is envisaged is a complete stripping down of the pump, say every two years, with replacement of worn parts. Such an overhaul would probably have to take place in the firm's premises, because of the special facilities required. We hope to include an article in the next Bulletin on the care of vacuum pumps. The firm advise us that the Speedivac pump Model 1SC30 is now obsolete and spare parts will soon be unobtainable. The recommended replacement is the ES35.

W.B. Nicolson have introduced a radium source for use with their expansion cloud chamber. This eliminates the need to 'charge' up the central needle for three days prior to use. Schools which already have their cloud chamber will be supplied with the new source free of charge upon application.

Mullard /

Mullard Ltd. manufacture an output pentode, EF 98 which has an operating anode voltage of 12V. With the surplus grids strapped to the anode, this can be used with low voltage power units to investigate triode valve characteristics. There is therefore no need to purchase 300V power units, in pupil quantity for valve work. The EA 50 diode, also by Mullard, will similarly work on low voltage. Details and results for the EF 98 will be given in our next bulletin.

Labgear, whose Scottish agents are Elesco Electronics, have under development a scaler which will have a built-in 1kc/s oscillator to give timing facility. The firm are also to deposit with Elesco Electronics a scaler, ratemeter, and radioactivity demonstration kit for use as stand-by during servicing. Quantity discounts on Labgear equipment are available from Elesco Electronics, and can be grossed up over the year.

W.B. Nicolson will have on display at the ASE Meeting in Cambridge, a mass spectrometer developed by Mr. W. Llowarch, price £77.10/-. The firm have also introduced a Linear Air Track with vehicles and two photodiodes which will operate direct into Venner clocks, selling at £18.15/-. Another new item is a low voltage immersion heater, and a range of 1 kg solid block calorimeters in different metals.

Gallenkamp are marketing a Japanese made Olympus microscope with three magnifications of 75, 150, and 300, selected not by the usual method of a rotating turret objective but by simple turning of a knob on the side of the barrel.

The knob has a positive click-in action, automatically giving the correct magnification setting.

Radford Electronics have increased the prices of their power supplies to the following;

Low Voltage Labpack, Type ML	-	£22.10/-
L.T. Smoothing Unit, Type ALT	-	£ 7. 5/-
H.T. Smoothing Unit, Type AHTHR	-	£ 8. 5/-
H.T. Smoothing Unit, Type AHTH	-	£ 8.15/-
Hipack	-	£37.10/-

On the Labpack, fuses have been replaced by a magnetic cut out operating at 9A.

A.R. Bolton are Scottish agents for Radford Electronics.

White Electrical Instruments manufacture large-size demonstration meters, type INDC with interchangeable scales. The basis unit, selling at £16.10/-, has a full-scale deflection of 5mA and resistance 20Ω. Scales cost £3.10/- for most ranges of D.C. amps. and volts, and are marked on both sides.

Avo Instruments manufacture an educational meter with transparent scale for use with an overhead projector. A simple voltage or current meter, with interchangeable scales, costs £25.

In The Workshop

As a demonstration apparatus, the Nuffield approved version of Boyle's Law, at present marketed only by Philip Harris, P100/109 at £15.15/- has this to commend it, that the trapped air column is ½in. diameter, being enclosed by oil, and that pressure is registered in lb in^{-2} absolute on a gauge 3 in. diameter. In other words, it is big enough for all pupils to see and read, from a distance. Having paid 15 guineas for it, however, teachers may justifiably jib at having to pay a further £2.19/9 for a foot pump and adaptor as also recommended by Nuffield particularly since the latter seems to find no other application in the Nuffield project.

Some teachers in fact, may already have discovered that a cycle pump is adequate.

Cut off a six inch length of rubber pressure tubing (3 mm internal, 12 mm external diameter). Into one end fit a cycle Schrader valve, the locating lugs of which have been filed or ground off, up as far as the screwed thread. Clamp firmly with the Jubilee clip supplied with the apparatus, fitted so that its outer edge is flush with the end of the rubber tubing. The riffling on the inlet tap of the equipment provides an adequate seal on the other end of the tubing provided this is pushed far enough on. 8-10 pump strokes are sufficient to bring the apparatus up to maximum pressure (50 $lb.in^{-2}$). We found no difficulty in jamming the Schrader valve needle in the open position. A series of readings can then be taken with reducing pressure, controlling the outflow with the apparatus stop-cock.

The Nuffield version of the Brownian movement apparatus, called the Whitley Bay smoke cell, is designed for pupil use. In the project, the experiment is of such crucial importance that it is considered necessary that each pupil shall handle and fill the smoke cell and adjust his own microscope to see the results. This demands an easily dismantled cell, and a built-in light source so that the tedious business of adjusting the light beam - difficult enough for the teacher on demonstration models - is eliminated. An acceptable version is being sold by Morris Laboratory Instruments at £4. Examination of their model suggests a way in which a laboratory assistant could make these up, in pupil quantity, simply and cheaply. The account which follows is a modification of a suggestion by the Superintendent of the Department for Education and Science Laboratories.

Materials required;

Twin fuse-holder	-	Radiospares.
Festoon lamp-bulb	-	Radiospares.
Glass rod	-	Stock.
Rubber grommet $\frac{3}{8}$" x $\frac{1}{4}$"	-	Radiospares.
Soda-glass tube	-	Stock.
Small piece Polyglaze	-	D.I.Y. shops or Horticultural seedsmen.
Two lengths connecting wires (Min. Stranded)	-	Radiospares.
Adhesive	-	Bostik No.3 or similar.

Procedure;

In the middle of the longer edge of the paxolin fuse holder base, cut or file a $\frac{3}{8}$" diameter semi-circular groove - this acts as a mounting for the rubber grommet which forms the cell base. Cut a 1" length of glass rod - used here as a cylindrical lens - and clip into the fuse holder nearer the groove. The festoon bulb clips into the other holder. The recommended connecting wire is flexible enough not to exert any drag on the finished cell when placed on the microscope stage, but does suffer from the disadvantage that it is easily broken at the soldered joints on the fuse-holder terminals.

Constructing /

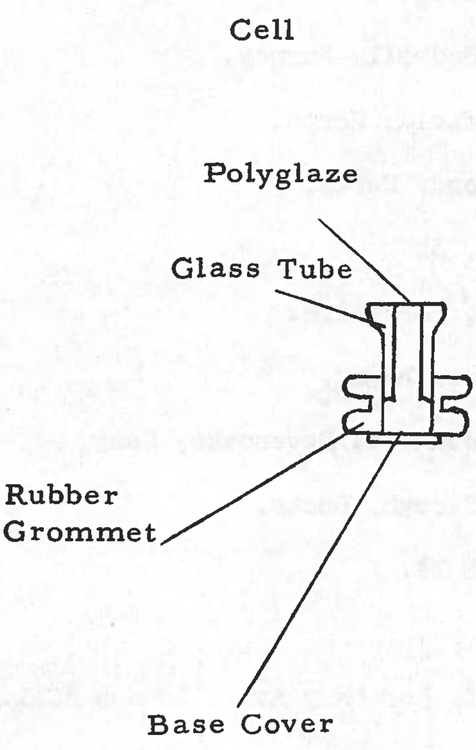
Constructing the cell;

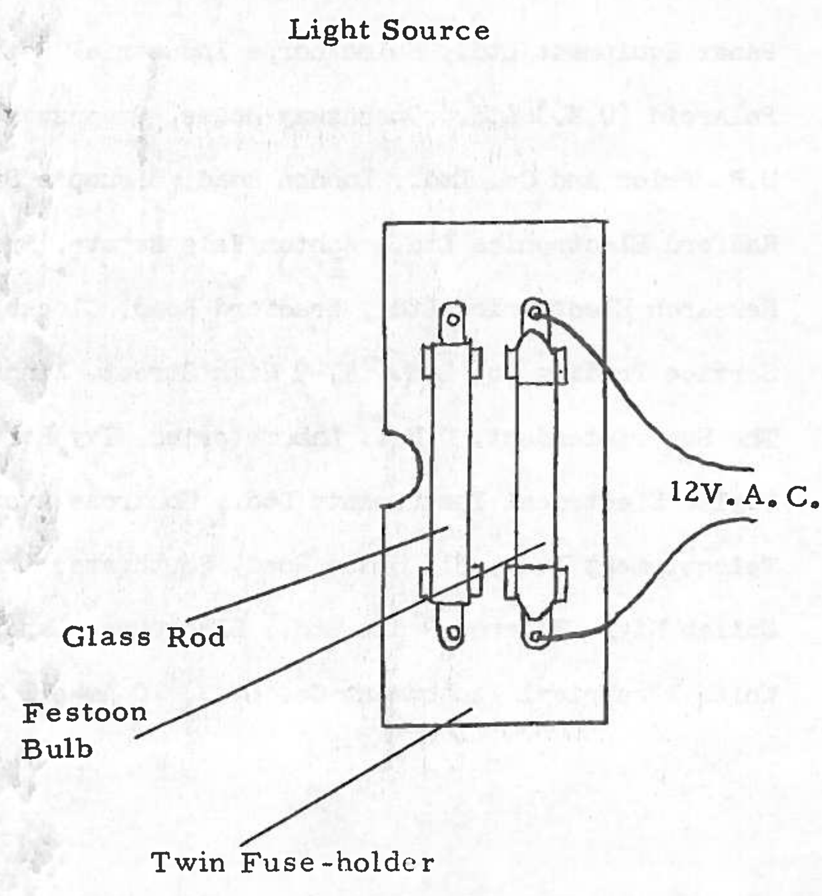
Heat one end of the soda-glass tube and splay out with the reamer tool, then flatten this end. Although not strictly necessary, the rim can be ground flat with the Technical Department's fine grinding wheel. The aim is to produce a central hole about 3mm in diameter, with a flat rim of the same width; the dimensions are not critical. If the rim has been ground, clean all abraded glass from inside the tube and from the rim with pipe-cleaner. Cut this end off to give a tube 1 cm long. We used a hot glass rod for this, rather than thumb-bending the tube, which is difficult with this short length. Any uneven break can be abraded down with wire gauze. Clean both faces of the Polyglaze to remove any finger prints or other dirt, and thereafter handle only by an unwanted corner of the material. Cut out a disc of a size to fit the tube rim, letting it fall on a clean paper sheet. Rub the adhesive sparingly round the tube rim and press down on the polyglaze disc. It is essential that the disc should make an air-tight seal on the rim, and that its inner surface should remain clear, as it is difficult to clean once fixed in position. The rubber grommet forms the base of the cell, and only requires a disc of some sort to be sealed on one side. We have used paxolin, polythene, even Sellotape. The only requirement is that the seal should be airtight.

As with the commercial version, smoke from smouldering tow is drawn into a squeeze-bulb pipette and transferred to one or both halves of the cell, which are quickly joined. The grommet then fits into the groove on the lamp assembly, and the whole is ready to be placed on the microscope stage. By a happy coincidence the grommet fits into the hole in the Russian SHM1* microscope, thus providing automatic centring. This is not the case with the Czech Meopta** microscope which has a small hole but it is possible to use the cell with this instrument. For teachers buying the smoke cell, it should be noted that the MLI version will not fit the Meopta microscope, there being insufficient clearance between stage and objective.

* The SHM1 is distributed by Morris Laboratory Instruments at £15.2/6.

** The Meopta can be obtained from Griffin and George, £17.10/-.





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

Airmec Ltd., High Wycombe, Bucks.

Avo Ltd., 92-6 Vauxhall Bridge Road, London SW 11.

A.R. Bolton Ltd., Bankhead Drive, Sighthill, Edinburgh, 11.

Educational Electronic Equipment, Milton Publishing Co., 31 Percy Street, London W 1.

Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex.

Elesco Electronics Ltd., 1103 Argyle Street, Glasgow, C.3.

Fraser Electronics Ltd., " " " "

A. Gallenkamp and Co. Ltd., Technico House, Christopher Street, London EC 2.

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

Philip Harris Ltd., Ludgate Hill, Birmingham, 3.

Labgear Ltd., Cromwell Road, Cambridge.

Lan-Electronics Ltd., 97 Farnham Road, Slough, Bucks.

Leech (Rochester) Ltd., 227 High Street, Rochester, Kent.

Claude Lyons Ltd., 76 Old Hall Street, Liverpool, 3.

John Moncrieff Ltd., St. Catherine's Road, Perth.

Morris Laboratory Instruments, 96-8 High Street, Putney, London SW 15.

Mullard Ltd., Mullard House, Torrington Place, London WC 1.

W.B. Nicolson Ltd., Thornliebank Industrial Estate, Glasgow.

Panax Equipment Ltd., Holmethorpe Industrial Estate, Redhill, Surrey.

Polaroid (U.K.) Ltd., Queensway House, Queensway, Hatfield, Herts.

W.R. Prior and Co. Ltd., London Road, Bishop's Stortford, Herts.

Radford Electronics Ltd., Ashton Vale Estate, Bristol, 3.

Research Electronics Ltd., Bradford Road, Cleckheaton, Yorkshire.

Service Trading Co. Ltd., 47-9 High Street, Kingston-on-Thames.

The Superintendent, D.E.S. Laboratories, Ivy Farm, Knockholt, Sevenoaks, Kent.

Taylor Electrical Instruments Ltd., Montrose Avenue, Slough, Bucks.

Telequipment Ltd., 313 Chase Road, Southgate, London N 14.

Unilab Divn. Rainbow Radio Ltd., Blackburn, Lancs.

White Electrical Instrument Co. Ltd., 10 Amwell Street, Rosebery Ave., London EC 1.