SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

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Introduction

In Bulletin 18 we criticised the biologists for allowing the flood tide of educational evolution to carry them into a quiet backwater to stagnate. In particular we mentioned the non-appearance in a catalogue of physiological apparatus of any recording device more modern than a smoked drum, attributing this to the Nuffield "A" level Biology Project. The comment drew a letter from the materials coordinator of the Nuffield Project saying that "as the trials are still in progress any blanket comment about equipment is premature and no item can be specially designated "For Nuffield A-level Biology!" No statement of this type has been approved by the project nor will it be until the final text of the course emerges from a careful appraisal of the whole trial work."

In view of this we can only apologise for having made public what was primarily a mistake on the part of the manufacturer concerned, and wait to see what the iron curtain will reveal when it is finally lifted. Meanwhile we offer on page 9 to Nuffield and others, one simple experiment which records on a modern oscilloscope.

* * * * * * *

Teachers in Scotland may not know the extent to which this Bulletin goes abroad. We have an overseas mailing list of over 80, covering all five continents and including most European and Commonwealth countries. Most of these contacts have been built up informally by educationists visiting Scotland. The traffic so far has been all one-way, so that it is a particular pleasure to announce that the gas generator described on page 7 of this issue was developed by a school in South Africa, and the design forwarded to us by Mr. H. Getliffe, Inspector of Education for Natal. We hope that this will be the forerunner of many ideas to come from abroad where I am sure that there are as many good ideas circulating and which never get into print as there are here.

Opinion

In the past few years the Science Fair has become a permanent if sporadic feature of school life. Why do teachers, harassed as they are with staff shortages, add to their burdens by undertaking the supervision of one or more projects for the Fair? Is it the prestige of having the school appear on television? In this respect it is a pity that the general knowledge "Top of the Form" quiz should attract a much greater share of the limelight. It is better material for presentation, it has greater possibilities for audience participation, it can call on all the partisan spirit of a school audience.

By contrast the Science Fair programme comes over with difficulty, if at all. The examination of candidates apparently takes place before the programme goes on the air, and viewers are condescendingly treated to a few probably well rehearsed questions followed by a woolly summing up by judges. Are the judges afraid to grill the candidates in public, or have they been told not to? Why/

Why treat the children with kid gloves?

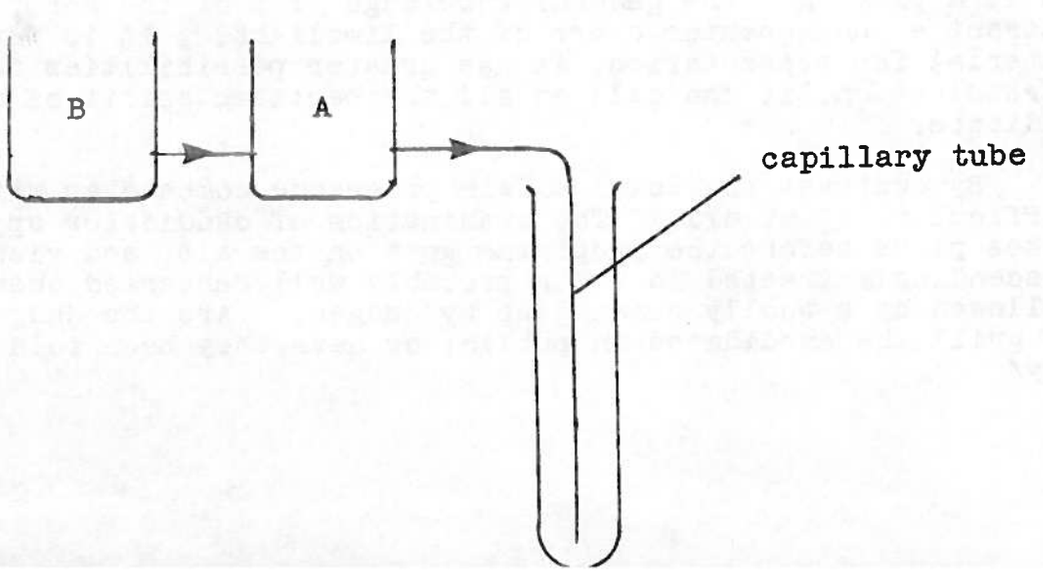
When I visited the recent Fair at Strathclyde University I found plenty evidence that the best of the exhibits and exhibitors could stand up to any amount of close questioning. A commendable feature of many of the exhibits was the degree of audience participation involved; these were projects of a statistical nature. Less commendable in the statistical projects was the fact that having got their statistics, few pupils knew what they represented, or how to analyse them to get significant results. or even to decide if they were significant results. In only two projects did I see a standard deviation calculated. Pupils embarking on a statistical project should be made to realise that the collecting of statistics is not an end in itself, but merely an end to the beginning.

Of one thing there was no doubt; all the exhibitors enjoyed their project and enjoyed talking about it at the Fair. It is sometimes a pity that examination marks cannot be awarded - and I mean S.C.E. marks, not B.B.C. ones - for enjoyment. If Science Fairs and appearances on television make the Scottish pupil more articulate and less self-conscious when talking with his elders, then they are to be encouraged irrespective of the quality of the research.

Physics Notes

Teachers of the post-Higher physics syllabus looking for a project on which pupils could work might like to consider the construction of a density gradient column. Briefly. this is a column of liquid about 1m high in which the density varies in a linear fashion from top to bottom. Small solids dropped into the column float at a level appropriate to their densities which can be determined from a calibration of the column using a minimum of two marker floats of known densities to give two points on the calibration graph.

The column is made up of two miscible liquids of different densities e.g. methanol/water in such a fashion that their relative proportions vary in a linear manner with depth. The technique for filling the column is obviously important, and is shown in schematic fashion in Fig. 1. The less dense liquid A is continuously stirred, and empties via a capillary tube into the column. As it does so liquid B enters and is mixed with A, so that as the column fills, the proportion of B is increased.



It is necessary to eliminate convection in the filled column by surrounding it with a water bath. In a commercial version of the apparatus manufactured by Techne, the bath temperature is thermostatically controlled to within 0.1°C and density differences of 0.04 mg. cm^{-3} can be detected. We think it likely that surprising accuracy by school standards might be achieved without thermostatic control by simply using the water as a heat sink so that the hydrostatic stability of the column would be maintained even for slow temperature fluctuations.

These notes are based on information supplied by Techne, who will send further details to schools requesting their Technical Notes Nos. 10 and 12.

* * * * * * *

In the Nuffield macro-Millikan apparatus, a pith ball is suspended from a glass spring between two parallel plates. Application of a P.D. across the plates results in the ball either rising or falling slightly. The movement is deduced from a comparison of a marker stuck on the nylon thread which joins the ball to the spring and a mirror-backed scale supported on the upper plate. Our difficulty with the apparatus was that having been displayed and re-packed a few times, the longest piece of glass spring we could salvage was quite inadequate to show the effect.

A more robust alternative, shown by Hawick High School at last year's A.S.E. meeting, is to suspend the ball from the short arm of the Nuffield straw balance. The U bridge on which the balance rests must be supported in a clamp above the plates. With the lever magnification which this achieves a P.D. of a few hundred volts is sufficient to show the effect.

Display Laboratory

The following items have been added to the laboratory since this section was last included in Bulletin 17.

Item	Manufacturer
Progressive Wave Machine	SSSERC
Stationary Wave Machine	SSSERC
Gas Generator	SSSERC
Pulse Beat Display	SSSERC
Atmometers	SSSERC
Mechanical Resonance Apparatus	SSSERC
Model Mass Spectrometer	SSSERC
Atomic Theory Model	SSSERC
Macro-Millikan Apparatus	SSSERC
Resonant Pendulum	SSSERC
Range of Laboratory Plastic Ware	Xlon
Mercury Cleaning Apparatus	Jencons
Ratemeter	Forth Instruments
Gas Generator	Griffin and George
Standard Resistance Box	Jay-Jay
Interference and Diffraction Slide	Cornell
Overhead Projector	3M
Thermo-Fax Photocopier	3M

Trade News

The Swift series 950 microscopes. marketed by Pyser-Britex, no longer qualify for duty remission as we announced in Bulletin 18. Duty remission on imported goods is not obtainable unless there is no comparable British product, and the Board of Trade maintain that this is no longer the case in respect of the microscope.

Morris Laboratory Instruments have established a Scottish representative whose address is given in our address list. While orders should still be sent direct to the London headquarters, Mr. Brown hopes to carry a stock of spares and replacements at his Hamilton home, and any requests for after-sales service should be addressed there.

The firm of Elesco-Fraser are no longer agents for Labgear equipment. Now the sole Scottish distributors are Telecare. Prices of Labgear apparatus have recently been raised as follows:

D4151	Scaler	£63.10. -.
D4155	Radioactivity Demonstration Set with Sources	£27.10. -.
	Without Sources	£15. -. -.
D4162	Photodiode and light source	£3.15. -.
D4161	Solid State Detector Amplifier	£14.10. -.

The Esso loan service to secondary schools of scientific equipment of which we gave details in our first Bulletin, will cease in July. Similarly their offer of Fuel Cell and radio has been discontinued.

Cambrian Chemicals who supply small lecture bottles of compressed gases have moved to new premises, the address of which is given in our address list.

The sale of Japanese Mabuchi D.C. motors has been discontinued by Proops for some time and we have been seeking an alternative source of supply. Although Proops assure us that the motors will soon return to their catalogue, teachers can obtain these from the Edinburgh firm of Modelcraft as below:

Model No.	Working Voltage	Current mA	Speed rev/min	Price
15	3	200	6700	4s. 7d.
15R	6	190	9700	8s. 2d.
25	3	180	9100	5s. 1d.
35	3	130	6800	6s. 1d.
35R	6	140	7100	10s. 8d.
45	3	170	7400	7s. 8d.
55	3	120	5500	9s. 8d.

All motors are fitted with four-holed mounting base. The most useful types for motor or generator work in our opinion are Nos. 15, 15R and 35R. Types with the suffix R are higher voltage types and more suitable for use as generators in energy conversion experiments.

W.G. Pye are manufacturing a new range of four mirror galvanometers with 15 cm straight scale and sensitivities, 11, 27, 45 and 170 mm μA^{-1} respectively. Cost of any model is £23.10s.

A thermistor thermometer and associated temperature scale will be a welcome addition to the White INDC demonstration meter, and will fulfil a long-felt need for a demonstration thermometer. One scale gives -10 to + 110°C; the other is calibrated 5 - 0 - 5°C and in conjunction with the amplifier unit can be adjusted to give any 10 deg. C range/

range between 10 and 30°C with an accuracy of 0.25°C or better. Both dials complete with corresponding amplifier and probe cost £15.15s; spare probes can be bought for £5.5s.

R. and J. Beck have produced for £35 a phase contrast unit with their Diamex and Four-Seven range of microscopes. The annulus can be used with any standard x10 objective for dark ground illumination.

While there are many ball-and-spoke versions of atomic model on the market, we have seen few which can be built up to illustrate different crystal lattice models. One such in plastic is offered by Crystal Structures, and comprises four different types of connector, viz. 5-way, 6-way and 8-way with or without a through connector, together with rods of different lengths and colours which can be cut to size. Connectors cost 5/- per dozen, and the rod price per 100 varies from 2s.9d. for 1 in. length to £1.17s.6d. for 2 ft. length. The minimum order acceptable to the firm is £1.10s., and there is a handling surcharge on orders below £5. Orbital models are also available from the same firm. The following, although not the full range, will give some idea of costs:

sp hybrid	15s.	p orbital	£1. 7s. -.
Loose p orbital	10s.	s orbital	£1. 5s. -.
Tetrahedral frames	10s.	d_{xy} orbital	£1.17s. -.

A leaflet from Thorn Electronics advertises the production of a 10μCi Krypton-85 beta source, claimed as one of the safest radioactive sources. The provisional price of these sources is £2.10s. which compares favourably with weaker Strontium-90 beta sources, although being in the form of a 1 in. dia. polystyrene disc they may be less adaptable than the familiar 4 mm plug-in types.

Plysu 5 gallon plastic containers, intended for keeping paraffin, but ideal for storing distilled water etc. can usually be obtained from local ironmongers. The price in Edinburgh is around £1.2s.6d.

Jencons have produced a mercury cleaning apparatus which can be run off a water suction pump provided that the head of water is greater than 7m. Clean mercury can be run off, and dirty added without interrupting the operation of the cleaner. At £7.12s. this apparatus may be more suited, and more enonomically used in a county science centre than in an individual school, but there seems no reason why schools should not send their mercury to their centre for cleaning.

Some of the former employees of Flatters and Garnett who went into liquidation some months ago have formed themselves into a company to continue working in the biology field. The firm is called G.B.I. (Labs), and a catalogue is available on request.

A new range of decade resistance and capacitance boxes have been produced by Jay-Jay. Resistors are accurate to 0.25%. To give some idea of prices, a three decade 11,100 by 10Ω costs £7.12s; a similar five decade box £13.12s. A three decade capacitance box to 0.111μF by 100pF costs £10.8s.

We have received notice from Andrew H. Baird that the prices of their range of Russian apparatus have been raised. In particular the prices of the demonstration ammeter and voltmeter, S36A and S36V, given under Item 27 of the Physics Equipment List in Bulletin 19, should now read £13.17s.6d. for either meter. The firm have also asked us to point out that the voltmeter sensitivity is 20mV F.S.D. and not 75, as was stated.

We/

We have received a Cornell slitfilm demonstrator which may be a valuable demonstration aid for teachers discussing interference and diffraction effects. The slit film is a glass-bound negative, 8 x 10 cm, carrying 21 different arrangements of single, double and multiple slits in a variety of widths and spacings. It is manufactured at present only in U.S.A. by the National Press. and costs 2.10 dollars, cash with order.

The cost of the Oertling TP30 top-pan balance is now £145.

Our tirade against smoked drum apparatus in Bulletin 18 has drawn a reply from Scientific and Research Instruments who have sent details of a student kymograph which is ink recording, and includes a stimulator. The catalogue number is 1020, cost £68.

Chemistry Notes

From the Vale of Leven Academy we give this elementary method of determining the molecular weight of heavy volatile liquids, capable of giving 5% accuracy or better, depending on the balance used.

A 50 ml specific gravity bottle is weighed empty. A few drops of chloroform are added and the bottle is immersed to the neck in a boiling water bath for sufficient time - 1-3 min - to vaporise all the liquid. It is removed and cooled quickly, dried and reweighed. The increase in mass which is around 200 mg is that of chloroform vapour at 100°C; the volume of vapour can be determined by weighing the bottle full of water. Thus with a balance reading to 1 mg, accuracy of a few % is possible, the limit being set by the practical difficulty of ensuring that no chloroform condenses in the bottle stopper.

Errors will be greater with a two place balance, and here one can use a 250 ml conical flask with a glass wool stopper, but must have an oven. preferably thermostatically controlled, in which the whole flask can be heated. Results will always be high due to condensation; our errors varied between 1 and 6%, better results being obtained with the S.G. bottle and 1 mg balance.

* * * * * * *

A novel way of repairing split mercury threads in thermometers is suggested by Gallenkamp in their News Review. Where teachers have formerly heated the thermometer in the hope of rejoining the thread in the expanded bubble at the top of the apparatus, the firm recommends the opposite of freezing the bulb using their freezer aerosol which will quickly produce temperatures of -50°C. The method is safer since there is no risk of a burst thermometer due to excess pressure.

In The Workshop

Low pressure filtration of the small quantities of material used in semi-micro work can be carried out using the apparatus described below/

below. The materials required are:

20 ml disposable syringe..... Johnson
Sample specimen tube, 24 x 75 mm. TW-650..... Gallenkamp

The hinged lid and base of the specimen tube are cut off, leaving an open cylinder. The nozzle of the syringe is cut off by saw or hot knife, and the end is ground flat on 320 or finer gauge emery cloth on a flat metal surface. About 15 holes, using a No. 54 twist drill are made in the end, leaving an uncut rim 3 mm wide round the edge, see Fig. 1. Small filter discs are cut from standard filter papers using a No. 15 cork borer (22 mm dia.)

The open cylinder of the specimen tube is fitted over the end of the syringe held in an inverted position, Fig. 2. One or two filter discs are seated against the holes and moistened while the piston is in the pushed home position. The liquid to be filtered is poured into the tube and the piston drawn gently down. If a more gentle suction action is required an air space above the piston can be included before starting to filter. It is necessary to check that the quantity of liquid being filtered does not exceed the syringe capacity exclusive of any dead space at the top.

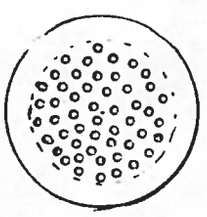


Fig. 1

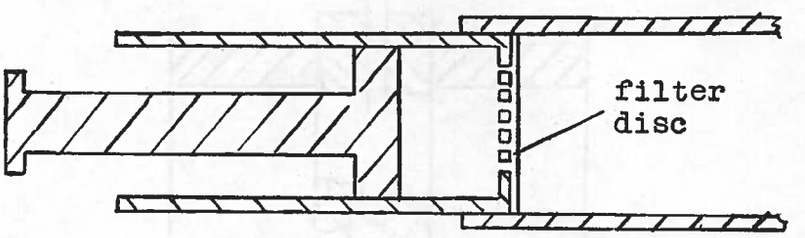


Fig. 2

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The gas generator described on page 8 is apart from one small modification identical to the one developed for individual pupil use at the Westville Boys High School, Natal. It is claimed that even when fitted to deliver hydrogen sulphide the amount escaping to the atmosphere is small. Furthermore by including glass beads below the solid reagent as we have done we believe that this amount of escaping gas will be reduced, and that moreover it will only appear in the atmosphere some considerable time after the unit has been used, by which time one hopes the generator has been replaced in the fume cupboard.

The materials required are:

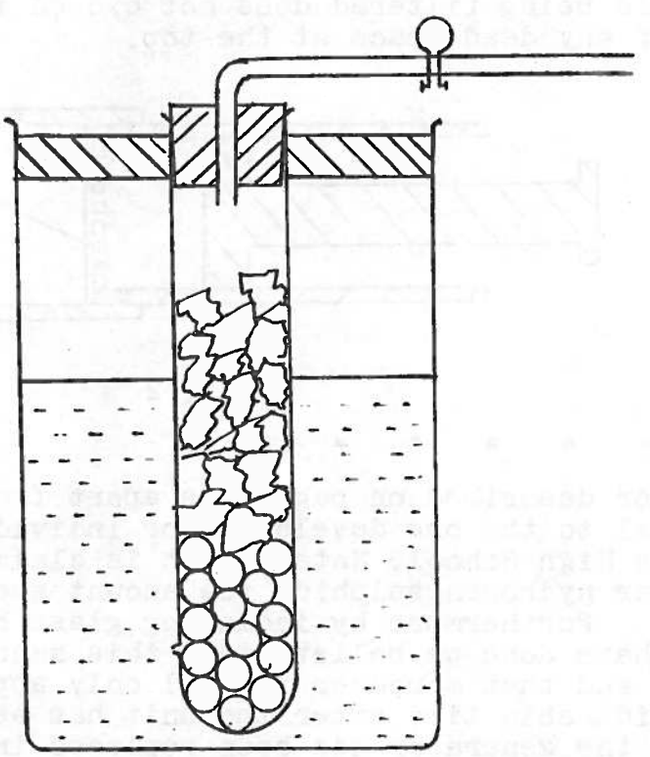
Wide-mouthed glass jar. e.g. jam or pickle jar - our own version is a Maxwell House coffee jar;
Cork shive to fit the jar;
Test tube, 150 x 25 mm, e.g. S38-800/55.....Griffin and George
One-holed stopper, No. 21;
Glass beads, 5 mm dia. or similar;
Glass and rubber tubing;
Screw or Mohr clip.

The cork shive is cut centrally to accommodate the test-tube. The latter has a hole melted in it at a point close to the base. This can be done by stoppering the tube and applying a fine flame from a blowpipe to the base. As the glass softens the pressure building up inside due to the heating blows a hole through the glass. Glass beads are placed in the test-tube to a depth of 2-3 cm, followed by the solid reactant. Acid to half fill the jar is added, and the whole assembled as in the diagram. While the test-tube etc. is/

is gas-tight, this is not true of the outer container.

The glass beads have been included to provide a dead space between them for any gas which is generated after the liquid level has dropped below the solid reactant either due to wetting of the solid by the acid or to small particles of solid falling off the main body. Only if the latter process is considerable, as sometimes happens for example with zinc in the generation of hydrogen, will the gas level drop to the hole and gas escape to the outer container. This will eventually leak through the cork shive into the atmosphere.

It will be appreciated that the rate of generation and total amount of gas produced by this apparatus are small, so that the equipment is suitable for individual small scale experiments rather than the filling of gas jars. We did attempt to assemble a version in which the outer container was gas tight, but found that with frequent use the pressure built up until the stopper blew off.



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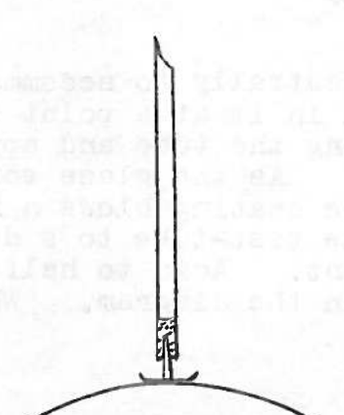
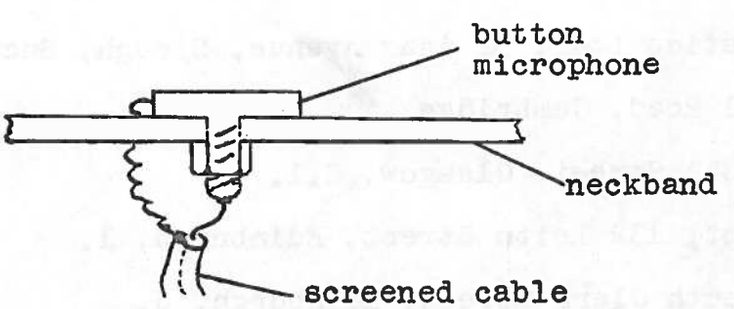
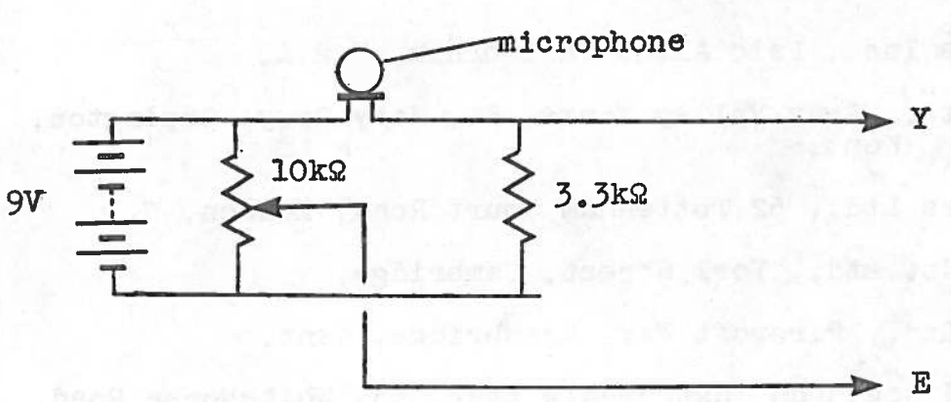
Two elementary pieces of apparatus are described which will illustrate the pulse beat. The first of these is a pupil apparatus and consists of a milk straw 6 cm long, cut at one end on the slant to form a pointer. The other end is plugged with plasticene into which a drawing pin is inserted. The pin is then balanced on the site of the radial artery at the wrist, which is held relaxed on the bench. The tip of the pointer will move back and forth at each beat.



For a demonstration experiment which will also show the dicrotic notch, the long persistence version of S51E or OS15 oscilloscopes are preferable, although the normal screen version of either will show the effect. The button microphones which are the basis of the apparatus are obtainable from Miller's Wireless Depot, 2s. each post free. Stocks are adequate to provide one per school, but being a surplus item it is doubtful if the offer can be repeated when the present stock is exhausted. The microphone is bolted on to a 2 cm wide rubber band, in our case cut from a car inner tube, which must be arranged so that it can be strapped in light tension round the subject's neck, with the microphone over the carotid artery. Cloth or other fabric would serve equally well for the band, provided it incorporated an elastic band in its length so that a steady tension can be applied.

Screened cable is used to connect the microphone to the remainder of the circuit, which is given in the diagrams. The purpose of the 10kΩ potentiometer is to permit the vertical position of the oscilloscope trace to be adjusted to the middle of the screen, in conjunction with the Y shift control. If power is being obtained from a battery of 1.5V cells, e.g. a grid bias battery, then the potentiometer can be dispensed with and the earth connection to the oscilloscope tapped on to a suitable point on the battery. The oscilloscope is set on very slow speed time base. and maximum sensitivity with D.C. input. It is the static pressure on the microphone which determines the vertical position of the trace. hence the need for a potentiometer or battery tap to accommodate various neck sizes. The subject must remain quite still - talking is forbidden - and it helps if he/she can be persuaded to hold the breath for the duration of the oscilloscope trace.





S.S.S.E.R.C., 103 Broughton Street, Edinburgh, 1. Tel 031-556 2184

Andrew H. Baird Ltd., 33-39 Lothian Street, Edinburgh, 1.

R. and J. Beck Ltd., Bushey Mill Lane, Watford, Herts.

Cambrian Chemicals Ltd., 73 Cherry Orchard Road, Croydon, CR9 6AG.

(Cornell) National Press Inc., Palo Alto, California, U.S.A.

Crystal Structures Ltd., 339 Cherry Hinton Road, Bottisham, Cambridge.

Elesco-Fraser Ltd., 36 St. Vincent Crescent, Glasgow, C.3.

Esso Petroleum Co. Ltd., Victoria Street, London, S.W.1.

Forth Instruments Ltd., 46 King's Road, Portobello, Edinburgh, 15.

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

G.B.I. (Labs), Heaton Street, Denton, Lancs.

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

(Jay-Jay) Educational Measurements Ltd., Brook Avenue, Warsash, Southampton. SO3. 6HP.

Jencons (Scientific) Ltd., Mark Road, Hemel Hempstead, Herts.

Johnson's Ethical Plastics Ltd., 32 Ajax Avenue, Slough, Bucks.

Labgear Ltd., Cromwell Road, Cambridge.

3M Co. Ltd., 90 Mitchell Street, Glasgow, C.1.

Miller's Wireless Depot, 132 Leith Street, Edinburgh, 1.

Modelcraft Ltd., 82 South Clerk Street, Edinburgh, 8.

Morris Laboratory Instruments Ltd., 136 Wellhall Road, Hamilton, Lanarkshire.

National Press Inc., Palo Alto, California, U.S.A.

L. Oertling Ltd., Cray Valley Works, St. Mary Cray, Orpington, Kent.

Proops Brothers Ltd., 52 Tottenham Court Road, London, W.1.

W.G. Pye and Co. Ltd., York Street, Cambridge.

Pyser-Britex Ltd., Fircroft Way, Edenbridge, Kent.

Scientific and Research Instruments Ltd., 335 Whitehorse Road, Croydon. Surrey.

Techne Ltd., Duxford. Cambridge.

Telecare Ltd., 66 Osborne Street, Glasgow, C.1.

Thorn Electronics Ltd., Hookrise South, Tolworth, Surrey.

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

Xlon Products Ltd., 323a Kennington Road, London, S.E. 11.

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