SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

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Opinion

At the Scottish Branch A.S.E. Meeting in Aberdeen I was asked, not for the first time, why I considered teachers misguided when they ordered a J2B signal generator. All we sought to do was to persuade teachers that it is now possible to waste money by buying equipment which is too good for school use. This has always of course been possible; it is now being made more probable because of the increasing amount of money - albeit not enough for their requirements - which teachers are allowed to spend. A single item of apparatus which five years ago might represent half the annual expenditure, was out of the question; now that it may only amount to 20% of the sum available, it looks an attractive proposition.

At the meeting there was plenty of this type of apparatus on display; four-beam display oscilloscopes; automatic sampling counters accurate to one part in 100,000; fluidised thermostatically controlled sand-baths. If the enthusiast can satisfy his conscience that these items will be adequately used in his department good luck to him, but before taking the decision he should bear in mind one point which is not often considered. How long is he likely to remain in his department to make use of it? Promotion these days is rapid; it is not uncommon for a probationer to be appointed a principal teacher. Moreover, the more exotic his choice of apparatus, however good it may be, the less likely is his successor to be able to make use of it. Is the enthusiast to deny himself promotion for the sake of seeing that the equipment he has gathered around him is properly used?

Apart from seeking our advice when any extraordinary apparatus is asked for, the local authority has another way out of this dilemma. They can appoint the enthusiast to the post of Adviser in Science, and in this way he not only rides herd over other enthusiasts in the county, but he can ensure that equipment already in the schools is placed where it can best be used. If the idea that apparatus belongs to the local authority rather than an individual school is a revolutionary one for teachers to accept, they may soon have to get accustomed to it. The Certificate of post-Higher Studies, preparation for which is nearly complete in Physics, will certainly require circulation of either the equipment or the pupils. One local authority is already arranging a central store of sixth form apparatus. Other authorities could make a start now by appointing an Adviser in Science. It is pertinent to ask why, when the City of Glasgow (secondary school population 55,000) has appointed an assistant to their Science Supervisor, authorities such as Lanark (33,000), Ayr (20,000), Stirling (11,000) and Dundee (10,000) have no Science Adviser.

Chemistry Notes

CLEAPSE have carried out an interesting survey in the comparative costs of producing distilled and de-ionised water. The factor which operates against many schools purchasing de-ionising equipment is that they already have a perfectly good working still and see no point in spending money to replace equipment which is not /

is not worn out. For those considering a change-over, several points have to be considered.

The still requires intermittent attention during operation in that it must be put on and off, and containers have to be replaced when full. Distilled water is not immediately available, and through lack of foresight it may happen that there is none when a class requires it. By contrast, de-ionised water is immediately available from the equipment and as far as school requirements are concerned, in unlimited quantity. If it is found at the start of a lesson that a cartridge is exhausted, it takes only a few minutes to insert the spare. In many cases a spare cartridge is provided as part of the initial purchase. Only if the teacher neglects to return the exhausted cartridge for regeneration is he likely to be without de-ionised water. Periodically the still will require to be dismantled for the removal of scale.

When costs of producing both types are compared, de-ionising turns out to be the cheaper method unless the school is situated in a hard water district, which is uncommon in Scotland. At 2s. 5d. per therm. the cost of distilling one litre of water with a gas still is about 1½d. Only when the total anion content of the water, expressed as parts per million of calcium carbonate, rises to 100 - 150, does a litre of de-ionised water cost 1½d to produce. This cost is that of regenerating the cartridge, and of course takes no account of the capital outlay. To enable some comparison to be made, the anion content of Glasgow water is 10; of Edinburgh, 32 p.p.m., and the cost of production of de-ionised water is proportional to the anion content. For Glasgow the cost per litre of de-ionised water, depending on the make of equipment used, could be as low as 0.05d., but generally would be around one farthing.

This, however, is not the whole story. The cost of regenerating cartridges is borne by the teachers' annual requisition, which does not have to pay for the gas which he uses in his laboratories. Thus, as long as the local authority pays the gas bill directly, and pays for replacement cartridges through the chemistry requisition, there is no incentive for the teacher to change to de-ionisation, unless he is in the fortunate position of not having a ceiling placed on the amount he can spend. A teacher who, in an area where it is to the ratepayer's advantage to change to de-ionisation, makes this change, should in all fairness have the cost of cartridge regeneration discounted from his annual chemistry requisition.

Physics Notes

Taking radiographs using radioactive sources or the Griffin and George X-ray unit (see Trade News) is a straight-forward procedure and of historical as well as intrinsic interest. Using Polaroid Type 57 film, an exposure of 2 - 2½ hours duration to a 5μC radium source at 3cm distance will produce a well-defined positive print. Latch-keys, paper clips, small nuts or washers laid on top of the film are satisfactory objects to radiograph. After exposure, the developer, which is contained in the packet, is squashed and the developer rolled out over the film, preferably using a squeegee roller. This must be done carefully and with an even pressure; otherwise the developer will be unevenly distributed.

After /

After waiting 10 seconds the packet can be opened up and the print extracted. The print size is 11.5 x 9cm, but at the distance given, only the central portion will be exposed.

A cheaper and faster alternative, although it gives a smaller negative only, is to use Phil-X dental X-ray film. This is supplied in a sachet, one end of which contains the film; the other containing the developer and fixer pods. Using a 5μC radium source at 1cm distance a satisfactory exposure can be obtained in 1 hour. To print, the one-holed tab projecting from the sachet is pulled out completely; this releases the developer which is then squeezed down into the film end of the sachet. After allowing 30 seconds developing time, the two-holed tab is pulled out and the fixer similarly worked down onto the film. After a further minute - 30 seconds if you are in a hurry - the sachet is stripped open under a running tap and the film extracted. After a quick wash, it can be shown to a class, preferably by projection since the negative measures 4 x 3cm. Information on source and prices for both types of film is given in the Trade News section of this Bulletin.

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Suppliers of radioactive sources have asked us to point out that the registration procedure required by the Scottish Education Department cannot be carried out by them when the sources are ordered. A school must apply to the Schools Branch, St. Andrews House, Edinburgh, for Form IRN (S) (Cert.) for completion and return. This registration allows a science graduate teacher to hold a total of not more than 30μC of activity in the school in the form of sealed sources, no one of which must have an activity of more than 10μC. It is possible that the X-ray unit referred to in the Trade News section of this Bulletin will also come under this registration procedure, although a decision on this has still to be taken.

A teacher who wishes to use open sources, or sources stronger than 10μC, must undergo a 25 hour course in the handling of radioactive materials. One such course has already been held in the West of Scotland, and others are being arranged. These sources must again be registered with the S.E.D. on form IRN (S); the total activity which may then be held on the school premises is up to 4mC. The storage and use of any radioactive source in schools must conform to the principles laid down in the S.E.D. Memorandum to which we referred in Bulletin 13, and which is in course of preparation.

Microscope Tests

While the procedures outlined in "Microscope Tests" in Bulletin 7 have formed the basis of our test procedure, the tests have had to be modified to take into consideration the more exacting standards of post "O" Grade work. The account given below explains these additional tests which were used in examining the microscopes summarised in the supplement to this Bulletin.

As all higher priced microscopes have a wide range of accessories it has been difficult to assign a price to any one model so that costs can be compared. What we have done therefore is to take the microscope specification given in Bulletin 9 and evaluate the cost of an instrument which will bring it up to that specification /

specification, i.e. it includes all items regarded as essential on a pupil instrument but excludes those listed "desirable" and those for which the provision is one or two per class. In some cases, due to varying magnifications, etc., the assembled instrument will be above the minimum specification, but the cost will still be the minimum for which the specification can be achieved. The price given will be a list price and does not take into account any discounts which may apply for educational use.

Microscope Test Schedule.

1. Resolution 1a. This test is the ability to discern the diagonal markings on the surface of "Pleurosigma angulatum" at magnifications of about x400 to x600. The magnification is given in brackets after the test results which are designated:

A..... The markings can be resolved easily under differing conditions of light intensity and source.

B..... The markings can be resolved only with careful adjustment of light source and intensity.

C..... The diagonal markings cannot be distinguished using normal lighting - daylight or artificial - and the facility of the microscope to alter it.

1b. This test is the one mentioned in Bulletin 7, i.e. a Flatters and Garnet test plate "Stauroneis phoenocenteron" diatom. This test was divided into two tests both in daylight (unless the microscope had fixed built-in illumination)

(i) EMT 100 Taken at a magnification of x100 or as near this as possible, The results of the test are designated:

A..... Resolution of individual spaces in lines of "canals".

B..... Recognition that spaces existed.

C..... Resolution of main longitudinal and lateral canals only.

D..... Indication that these canals exist, i.e. blurred lines visible.

E..... Loss of the longitudinal canal.

(ii) EMT 300 Taken at a magnification of x300 or as near this as possible. The results of this test are designated:

A..... Resolution of main longitudinal and lateral canal, side "canals", - and that the canals are discontinuous.

B..... As above without resolving the tiny perforations.

C..... As above without resolving the lines of side canals.

D..... As above without resolving the spaces in the lines.

2. Magnification This is accepted as the product of the specified values of eyepiece and objective used.

3. Field of View For one eyepiece (usually x10) the diameter of the field of view is measured using a standard millimetre gauge. The product of this value and the magnification used is a constant referred to as the FV factor.

4. Safety Stop /

4. Safety Stop — This is a device which limits the proximity of the objective to the stage, to prevent breakage of slides and possible damage to the object lens. It may be "adjustable" or "fixed". Where object lenses are retractable on being spring loaded, this is indicated by the letter "R" inserted before naming the objective lens.

5. Operation — This section describes points of difficulty in the operation of the instrument, which are individually described.

6. Objectives and Eyepieces — Unless otherwise stated the objectives are taken to be achromatic with standard R.M.S. thread. Similarly, eyepieces are taken to be Huygenian, and have an outside cylinder diameter of 23.4mm. The numerical apertures of objectives are given when specified.

7. Body — This may be either 'metal' or 'plastic'; 'fixed upright', 'fixed inclined', or 'tiltable'; 'monocular' or 'binocular'. The body may be rotatable with or without a lock and it is presumed NOT to have a draw tube unless specified.

8. Focusing — "Coarse Standard Body" implies that a helical rack and pinion operated by milled knob(s) raises or lowers the body.
"Coarse Standard Stage" implies a similar arrangement but it is the stage which moves.
"Fine Standard Body" signifies that a vertical lever raises the body against a spring or gravity, by means of a milled knob(s).
"Fine Standard Stage" similarly implies this arrangement to move the stage.

In order to compare the sensitivity of fine adjustment with that of the coarse adjustment the term Relative sensitivity is used. This we define as the ratio of the arc distances of the fine and coarse adjustment knobs necessary to effect the same movement of body or stage.

9. Stage — Shape, colour and texture usually mentioned, also whether it is fixed horizontal or tiltable.

10. Stand — This refers to the limb and base, the usual type of U shaped base and curved limb acting as a handle being described as conventional type. Other types are individually described and the total weight plus normal working height are included here.

11. Mirrors — Unless specified as single, these are assumed to be double-backed, providing two alternative reflecting surfaces. Reflectors are specified as 'white' (paint or paper reflector), 'plane' or 'concave', and may be of metal, glass or plastic. The latter two can be either 'rear' or 'front surface reflecting'; a front surface reflector is liable to tarnishing or scratching. Mirror diameter is also specified.

12. Substage Condenser — These can be fixed or adjustable in glass or rarely in plastic. The numerical aperture is given where specified. "Swing out" means that the condenser mount and iris can be swung clear of the optical path when required. The diameter of the condenser mount is given so that comparison may be made with others /

others with respect to the fitting of phase contrast units.

13. Iris diaphragm — This can be either "true" or "rotating disc" with various apertures. As the iris is often incorporated in the condenser mount, the measurement of Control Ratio (diameter of widest aperture/diameter of smallest) is sometimes difficult - where it can be measured, even approximately, it is given.

14. Phase contrast — As phase contrast units will be reviewed at a later date, all that is mentioned here is the fact that there is or is not a specific unit designed to operate with the microscope in question. Where appropriate the external diameter of the condenser assembly cylinder is given for comparison.

15. Substage Illumination — This can be "built-in" or available as an extra.

16. Case and Accessories — Case material is specified; fitted case implies racks for storage of objectives, eyepieces or slides; case may be latched or lockable. Accessories included in the standard price are listed individually.

17. Assessment — The assessment is into three grades; A most suitable; B satisfactory; C unsatisfactory. In the case of a C grading the instrument does not come up to the specification laid down in Bulletin 9, and the shortcomings are named. In deciding between A and B grades, price and other factors are taken into account. It should be borne in mind that instruments which in our view are too good for schools' use and would therefore normally be higher priced, will be given a B grading.

18. Suppliers — The main agents or school suppliers in Great Britain are given.

19. Service — Details of after sales servicing and repair facilities.

20. Manufacturers' comments

Display Laboratory

The following items have been added to the display laboratory since the previous Bulletin:

Item	Manufacturer
Damped Oscillation	SSSERC
Kinetic Energy Experiment	SSSERC
Phasor Diagram Experiment	SSSERC
Lung Capacity Model	SSSERC
Live Rodent Trap	SSSERC
Monkey and Gun Experiment	SSSERC
Electron Diffraction Analogue	SSSERC
Electron Diffraction Analogue	Teltron
Gas-Filled Triode	Teltron
Water Bath	Techne
Radiograph Film	Polaroid
Phil-X /	

Item	Manufacturer
Phil-X Radiograph Film	Cottrell
374 Scaler/Timer	Airmec
Interchangeable Burette	E-Mil
Gas Laser	Ferranti
Sartorius 2748 Balance	MacFarlane Robson
Fractional H.P. Motor	Eureka Scientific
Wimshurst Machine	Eureka Scientific
Single and Multi-Pole switches	Eureka Scientific
½-Metre Wire Bridge	Eureka Scientific
4 Place Centrifuge	Eureka Scientific
Audio Oscillator	Unilab
Calorimeter Jig	Philip Harris
Weston Standard Cell	Parametron

Trade News

Polaroid are marketing a film pack which can be used to take radiographs using a radioactive source. The film is Type 57, 3000 ASA and is supplied in boxes of twelve at a cost of £2. 16s. 9d., which includes 12s. purchase tax. Instructions on its use are given in the Physics Notes section of the Bulletin.

As an alternative to the above, teachers can use self-developing dental X-ray film, which can be obtained from suppliers of dental equipment, one of which is Cottrell and Co, in Edinburgh. The film is called Phil-X, and is sold in boxes of ten or twenty-five, costing £1. 5s., or £2. 10s. respectively.

A working two-stroke ignition motor which can be dismantled and re-assembled is being imported from Japan as a kit and marketed by Griffin and George. The Fuji motor, catalogue number L45-610, costs £35. Although the instructions suffer in translation, our technician assembled the motor in one hour. It has since been dismantled, reassembled and made to work again, even although one piston ring got broken in the process. Spare parts are supplied with the motor.

An X-ray unit which has been declared safe by the Department of Education and Science, has been produced by Griffin and George, catalogue number L89-600, £30. The main beam dose rate is given as 0.5 mrem/h at 90 cm for a 250 V. A.C. mains input. Experiments which can be performed with the unit include counting with Geiger tube and scaler and the effect of various absorbers, photographic effect using the Phil-X film described above, ionisation in a diffusion cloud chamber, ionisation of a neon lamp bulb, and discharge of an electroscope.

Polaroid have asked us to point out that local education authorities, most of whom are registered as purchase tax traders, can obtain exemption from payment of purchase tax on all film material used in schools. This exemption is not automatic, and a discussion with the local Customs and Excise officer is advised to clarify the procedure. Since the tax on Type 47 film, used with Models 120 and 160 cameras is 4s. per roll, on Type 107 film packs used with Model 180 is 3s. 3d.; and on Type 57 packs, mentioned above is 12s., the amount of tax involved for one authority is not small.

Parametron have produced a miniature Weston standard cell, measuring /

measuring 70 x 20 x 20 mm excluding connecting terminals, which can be used in any position. With solder lug terminals, the cell costs £2. 12s. 6d.; with 4 mm socket/screw terminals, £3. 10s. Current capacity of the cell is given as 10 μA for up to 10 seconds several times per day without permanent deterioration. A feature of the cell is its ability to recover rapidly from accidental short-circuit. We found that after a 10s short, the e.m.f. returned to within 0.2% of its original value within 2s.

As the firm of NGN have ceased production of their vacuum pump, Teltron are supplying a new and more compact Fore Vac Unit, TEL 505B, for £67. As motor and pump are built as a single unit, the equipment is made much smaller and more readily portable. The TEL 505B outlets will connect to any other Teltron fittings, including their High Vac Unit. Another new product from the same firm is their gas-filled triode, TEL 532 at £10. 19s. This is identical with their planar triode. TEL 521, except for being gas filled and can be used to demonstrate thyratron action, as well as being an introduction to the action of the fine beam tube.

A transistorised signal generator intended for pupil use in conjunction with the Serviscope Minor or OS12 oscilloscope has been produced by Unilab, catalogue number 063.642, price £9. The unit has only two controls, a combined off and 3-decade frequency switch, and the variable frequency control. The frequency range is from 16Hz to 30kHz; output is given as two volts peak to peak. Having a relatively high output impedance the generator will not drive loudspeakers, etc., but can be used to examine frequency response of LCR circuits and to obtain resonance curves.

The firm of Techne are selling a water bath control unit, the Tempette TE 1 which will fit over the side of any water bath, provided the depth is 14 cm or greater, and the bath wall under 2 cm thick. The range is from 15° to 95° C and the unit has the incidental teaching advantage that the spiral thermostat is large and the switching action easily seen. The Tempette TE 1 costs £21; a water bath measuring 24 x 24 x 15 cm to go with it costs £9.

A new top-pan balance by Oertling, the TP 30 is being offered at £130. Capacity is 120 g with full digital read out to the first decimal place, the second place being obtained on a knife-edge type vernier. Being top-pan, there are no knobs whatsoever to operate, and weighing is almost instantaneous.

One of the reagents used in the experiment to draw nylon threads, adipyl chloride, has recently undergone a large price increase, so that 100 ml from Griffin and George now costs £5. 5s. An alternative, which in any case is easier to store and handle, is sebacoyl chloride, which can be obtained from the same firm for 20s. per 100 ml. Those who would still want to use adipyl chloride can purchase it in minimum 100 ml lots at £3 from B. Newton Maine Ltd.

In The Workshop

At school exhibitions we have examined several "monkey and Gun" apparati, on most of which the monkey was a huge teddy-bear or similar which it would have been difficult to avoid hitting on some part of its anatomy even had it reached terminal velocity. The apparatus /

The apparatus described below was suggested by Northfield Secondary School, Aberdeen; we have achieved consistent results hitting a metal plate 4 x 5 cm with a steel ball-bearing over a horizontal distance of two metres. Moreover, since the gun is a pea-shooter, pupils can verify for themselves that the initial velocity has no effect on the success of the experiment. Apart from the tendency to swallow the ball-bearing, which may limit the target practice somewhat, the apparatus works as well on an upward trajectory as on the horizontal.

Materials: (All dimensions in mm)

Wooden baseboard, 300 x 110 x 15

Wood or tufnol support, 115 x 60 x 12

Glass rod 400 x 7 inside diameter

Steel ball-bearing, 6.5 diameter

Ex-clock cogwheel, 28 diameter

4 B.A. round-head brass bolt, length 40

18 S.W.G. mild steel sheet. 40 x 40

18 S.W.G. mild steel sheet, 40 x 100

16 S.W.G. brass sheet, 20 x 75

2 solder tags, 2 4mm sockets, nuts and bolts

2 rubber grommets

30 S.W.G. piano wire, length 15 mm.

All the above materials are for the firing mechanism. The target end of the apparatus is standard; our electro-magnet consists of the 125 turn winding of the Unilab LB - 4 inductor with C-core, energised by a 2 volt accumulator, but any coil, core and supply should prove suitable provided it supports the target, which is a 40 x 50 mm plate of the same mild steel sheet. No special precautions such as reducing current to the minimum or taping the end of the core where it contacts the target have been found necessary.

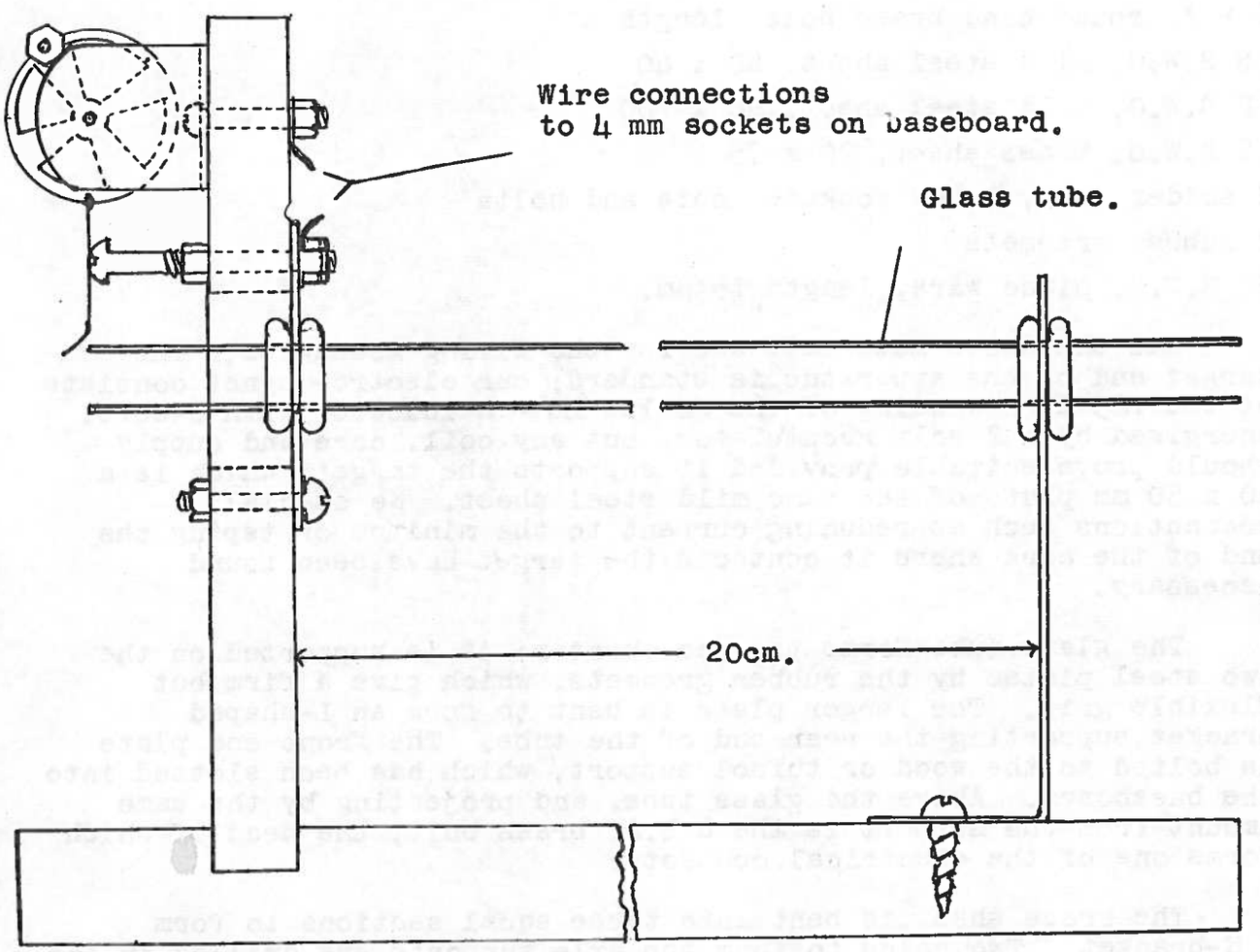
The glass tube forms the pea-shooter; it is supported on the two steel plates by the rubber grommets, which give a firm but flexible grip. The larger plate is bent to form an L-shaped bracket supporting the rear end of the tube. The front end plate is bolted to the wood or tufnol support, which has been slotted into the baseboard. Above the glass tube, and projecting by the same amount from the support is the 4 B.A. brass bolt, the head of which forms one of the electrical contacts.

The brass sheet is bent into three equal sections to form a U-bracket. Two holes to form the axle supports are drilled in the legs of the U. The steel wire is soldered to the cog-wheel, and at an angle of 150°, a 4 B.A. full nut is soldered to the rim of the wheel. When in position in the brass support, the steel wire is vertical and is held against the 4 B.A. bolt by the weight of the nut soldered on the wheel rim. The end 3 mm of the wire is bent above the glass tube as shown in the diagrams, so that on ejection the steel ball just grazes the wire, breaking contact at the bolt-head as the wheel revolves. The wire must be carefully bent to achieve this condition as any greater period of contact will deflect the bullet downwards.

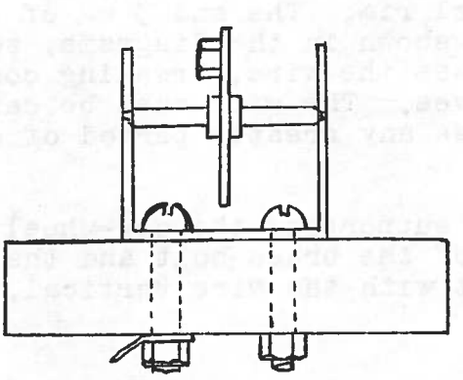
When the U-bracket supporting the cog-wheel has been fixed in position, the position of the brass bolt and the glass tube can be adjusted to give contact with the wire vertical, and with its bent end /

end suitably positioned relative to the tube. One of the bolts fixing the U-bracket carries a solder tag to make the second electrical connection, both of which are brought to 4 mm sockets.

To use the apparatus, the 'gun' is clamped to a bench with the target coil on a neighbouring bench. Sighting is done by looking through the glass tube, the coil being moved until the top half of the target plate is seen through the tube. The ball-bearing is then inserted and fired, and the impact of ball and plate makes a satisfactory ping which indicates even to the firer who may not see it that a hit has been registered. The wheel automatically resets the contact so that a shot can be immediately repeated. A cardboard lid on the floor beneath the target will usually trap the ball and prevent its rolling off under the bench, and if it is feared that pupils may swallow the ball-bearing, rubber tubing can be used to extend the pea-shooter.



Firing mechanism.



Mounting of cog-wheel.

B.S.S.P.E.C., 105 Broughton Street, Edinburgh 1. Tel. WAV 2164

Airmec Ltd., High Wycombe, Buckinghamshire.

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

Cottrell and Co. Ltd., 59 George Street, Edinburgh, 2.

(Sawill) H. J. Elliott Ltd., Treforest Industrial Estate, Pontypridd, Glamorgan.

Evans Scientific Co. Ltd., 192-198 Ilford Lane, Ilford, Essex.

Ferranti Ltd., King's Cross Road, Dundee.

Fielders and Garnets Ltd., Hilkoye House, Bradnor Road, Manchester, 22.

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., 6a, Colme Drive, Dalgety Bay, Fife.

Macfarlane Robson Ltd., 1A St. Vincent Street, Edinburgh, 3.

B. Newton Maine Ltd., North Walsham Wood, North Walsham, Norfolk.

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

Parametron Ltd., 70 Westward Road, Stroud, Gloucestershire.

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

Techne Ltd., Duxford, Cambridge.

Watson Ltd., 259 Acton Lane, Chiswick, London W.4.

Unilab Division, Rainbow Radio Ltd., Mincing Lane, Blackburn, Lancs.

Vickers Instruments Ltd., Haxby Road, York.

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

Airmec Ltd., High Wycombe, Buckinghamshire.

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

Cottrell and Co. Ltd., 56 George Street, Edinburgh, 2.

(E-mil) H. J. Elliott Ltd., Treforest Industrial Estate, Pontypridd, Glamorgan.

Eureka Scientific Co. Ltd.. 192-198 Ilford Lane, Ilford, Essex.

Ferranti Ltd., King's Cross Road, Dundee.

Flatters and Garnett Ltd., Mikrops House, Bradnor Road, Manchester, 22.

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., St. Colme Drive. Dalgety Bay, Fife.

Macfarlane Robson Ltd., 3A St. Vincent Street, Edinburgh, 3.

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