SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 12. March, 1967.

Contents

* * * * * *

Introduction

Reciprocal arrangements are in hand between SSSERC and CLEAPSE, our opposite number in the South of England, to make the test reports on apparatus produced by one organisation available to members of the other. At present our reports are issued on loan only to our own members, and are confidential. As our Bulletin has a much wider circulation to all leading manufacturers of school equipment, and to places like New Zealand, Rhodesia, Israel and most European countries, we cannot publish confidential information through this medium. This may explain to puzzled or exasperated teachers why best buys, or even comparisons between different versions of the same apparatus are not found in the Bulletin. Meanwhile, the expected rush for such test reports as we have issued has failed to materialise; we have had a trickle of requests, but nothing more. We would emphasise that a teacher seeking guidance on the purchase of an apparatus which we have tested should borrow our report on each version and compare these, after which he should be in a better position to decide the make which best fulfils his particular need.

* * * * * *

At a recent meeting of the Development Committee it was decided that future testing in physics should include power supplies and oscilloscopes, in biology clockwork clinostats, while in chemistry ion migration experiments and the determination of electrode potentials are to be examined.

Following on his recent promotion to the staff of Dundee College of Education, Mr. Haddow has resigned from the Development Committee and his place has been filled by co-option of Mr. Russell. Broughton Secondary School, Edinburgh.

* * * * * *

Due to the exhibition being held in Hawick on Saturday, 11th March, the Centre will be closed on that day. The Centre will also be closed on Good Friday, March 24th.

Chemistry Notes

The sparking of eudiometer tubes has usually been done in the past with an induction coil and battery power supply. Physics teachers will be more than willing to pass the induction coil on to their colleagues because its use in producing gas discharges is banned in view of the danger from X-ray emission at the electrodes. For teachers without access to an induction coil a new and attractive alternative presents itself. This is the Radaflash gas igniter, marked commercially for this purpose, and obtainable from Philip Harris, price £3. This uses a ceramic, lead zirconate titanate, which exhibits a strong piezo-electric effect and will under strong pressure produce a spark in air 5 - 10mm long. A note on the material appears in the School Science Review No. 164, page 207.

* * * * * *

We have received a note from the High School of Stirling pointing out an error in principle in the article "Conductivity Experiments" in Bulletin 10. The main point of the experiments on electrolysing fused salts, is not, as we have stated, evidence of decomposition and identification of the products, but to show that although ionic substances do not conduct in the solid state, they do so when the inter-ionic bonds are broken by heating or by the addition of water. This view is fully borne out by Circular 512, which states "In this part of the work we are not so much concerned with the products of electrolysis as with the presence or absence of ions", and we apologise for the error in the article referred to.

This being the case, it would appear pertinent to spend less time in electrolysing a variety of fused salts, and more in the attempt to pass current through the solid, perhaps even to the extent of experimenting with a single crystal, and not a powder.

* * * * * *

From St. Michael's School, Kilwinning comes the following useful tip. A current of 0.1amp for five minutes on the last 5mm of a carbon electrode in copper sulphate solution will deposit enough copper to allow wire to be soldered directly on to it. An attempt to pull the joint apart resulted in a broken electrode.

* * * * * *

A sub-committee of CLEAPSE Chemistry Panel have prepared, in conjunction with the British Standards Institution, a preliminary list of about one hundred chemicals most commonly used in schools, with the intention of writing a standard of purity for each. It was felt that manufacturers often quoted degrees of impurity only where these were most readily determined, without considering the uses to which the reagent was to be put. In some cases the standard of purity, and consequently price, may be unnecessarily high, and the technical grade of chemical is also something of a mystery. Teachers who have decided views on the standards they require for individual chemicals are invited to air them to us, when they will be passed on to the sub-committee.

Trade News

Teachers using the Griffin and George 1966 catalogue should note that since this has taken up to two years to produce, the prices in it are largely out of date. A general estimate is that current prices are some 10 - 15% higher than those quoted. It is safe to say that the only firm prices available from any schools supplier are those for the Nuffield syllabuses. Griffin and George are prepared to give up to date quotations by phone or letter at any time.

Difficulties in production of the Griffin and George 201 balance have led to certain alterations in the design, for example the hover zone indicator has been removed. It is hoped to manufacture /

to manufacture a balance which can be customer erected. Production of the new style balance commenced in December.

Oertling have reduced the cost of their V10 balance to £139. The balance will have a vernier for third place reading, instead of the special micrometer scale used on their analytical balance, and the release knob is not duplicated on both sides of the case. The J10 chain dial balance by Oertling now has magnetic damping and an improved case, but remains at the former price of £25 plus £5.10s. for case.

Forth Instruments have asked us to intimate that they are agents for Panax equipment.

In view of the introduction of their new Griffin Beck GN23 microscope, retailing at £18.10s., Griffin and George are not now offering the Russian SHM1 microscope. The GN23 design is based on the Czech Meopta microscope and can be obtained with either mirror reflector or 12V illuminator, the latter version costing £19.19s.

Research Electronics have moved to a new address given in our appendix list.

Polaroid are now marketing a new version of their Land camera, the model 180, which differs from the 120 model only in that the film is in the form of a pack instead of a continuous roll. To develop a print it is pulled completely free of the camera and peeled off after the normal ten second developing time.

At the request of the Nuffield Physics organisers, Kodak have produced a monobath which allows 35mm film to be processed in daylight in the cassette in which it is supplied. The monobath both develops and fixes, and seven minutes after taking the photograph, a wet negative is available for projection. Also supplied is positive printing paper which can be processed in subdued daylight without the need for a darkroom. Accessories used with this system are Nuffield Item No. 171, £3.5s. from Philip Harris; 120cc bottle of Monobath costs 4s. 3d. from Kodak, and the recommended film is PX135 - 20, twenty exposure cassette, 5s. 10d. from the same source or any photographic materials shop.

The test papers for protein, sugar and haemoglobin listed in our Bulletin 10, are available from Philip Harris, at the prices quoted.

Oxoid Limited are marketing a new product, "Agaroid", which is a plastic-skinned sausage containing a prepared sterile medium for bacterial culture. The end of the sausage is sliced off with a sterile knife, the sausage is touched on to the area to be tested, or source of bacteria and a thin slice taken and placed in a petri dish for incubation. Four slices can be accommodated in one petri dish and up to thirty slices can be taken from each sausage. Five different media are obtainable and the minimum pack of six Agaroids costs £1.10s. A pack can be made up of six similar or any combination of the five media. Once broken, the whole sausage must be used, although it might prove possible for the loss of some of the medium to reseal the polythene with a flame and some form of pincers.

Sound and Science are offering a Zoological Laboratory Set in wooden fitted cabinet for £8.10s. It comprises a dissecting microscope stand with wide arms, x10 and x20 lenses, two scissors, two tweezers, two chuck-type seekers in which the needles are easily replaceable, scalpel, plastic tray, specimen bottles and preserved specimens of frog, fish, crab and silkworm.

A recent catalogue from the same suppliers lists several items of interest to biologists. e.g. a water circulation "Hippo" pump, designed for miniature water fountains so that it pumps 15 l. per minute to a head of up to 2m. The pump is driven from a 24V supply, and included in the price, £4.10s., is a suitable mains transformer which will require to be boxed in, as it has open terminals. The pump is suitable for recirculating water in the artificial stream of the Nuffield Biology Project. There is no flow rate control, but a screw clip on the outlet hose will do the job. Other items from the catalogue are (i) x50 pocket microscopes in two sizes, 9.5 or 11.5cm, either size costs 8s. 6d.; (ii) x5 dissecting lens, 27mm diameter, 8s. 6d., with stand £1.10s.; (iii) mechanical stage graduated in mm in both directions, adequate for slide coverage but not for accurate measurement below ½mm, £2.5s.

A split trace oscilloscope from Advance Electronics, selling at £80, uses electronic switching to give the double beam effect. Switching speeds are linked to the time base speeds, which can be triggered from either channel. Sensitivity on both channels is 100mV/cm. A 12.5cm diameter P.D.A. tube is used. The number of this instrument which has already been ordered for the Engineering departments of several schools, is OS25.

Also from Advance Electronics is a scaler/timer to the Nuffield Physics specification model number SC2, selling at £60. Timing is to 1ms, and can be controlled mechanically or by photo-electric methods. H.T. supply for Geiger tube operation is adjustable from 200 to 500V.

In addition to the low voltage power supply. PP15, mentioned in Bulletin 8, the same firm have now produced a range of such units covering the Nuffield Physics requirements. These are an E.H.T. supply, PP12, with output voltage meter for £35, an H.T. power supply PP13, for £29.10s. and an L.T. power supply, 8A, 25V maximum on A.C. or D.C. with variable transformer control, PP14, for £28. All these units can be seen in the Centre.

Physics Notes

One of the difficulties attendant on the use of the Polaroid camera has been that of reproducing the prints for distribution to a class, or alternatively magnifying the print by projection so that the tracks could be analysed. A relatively simple method which comes from Hunter High School, East Kilbride, is to use an eyelet punch of appropriate size to punch the centre of each image of the magnetic puck. When the print is passed round the class, each pupil runs a pencil into each hole in turn while the print is held over a blank page, thus reproducing the essentials of the photograph quickly. With a small enough hole, each pencil imprint becomes a dot, allowing rapid analysis.

* * * * * *

Our thanks are due to the few teachers who wrote pointing out an error in our mathematics in the article on the constant load balance, wherein equation (3) should read: $Pa = Wb.\cos\theta$. The remainder of the argument was not invalidated by this mistake.

* * * * * *

A new catalogue of Physics Apparatus from Philip Harris includes all the Nuffield Physics range, and also many extraneous items, which are necessary for the Scottish alternative syllabus. Many teachers will, like us, be grateful for the first alphabetical index to the Nuffield range to appear in any commercial manufacturer's list. Of interest are Economy Kits of the Nuffield range; these are abridged kits which have all the essential items of apparatus but leave the assembly to be done by the school. The saving in cost varies greatly from item to item, but can be well over 50%.

In The Workshop

A unit using dynamics trolleys to verify that $P.d = \frac{1}{2}mv^2$ and designed in Falkirk High School has been assembled and tested by us. Velocity is indirectly measured by timing the passage of a blanking card fixed on the trolley through a light beam. Within the limits of experimental error and with the necessary calculation to obtain direct proportionality, linear graphs passing through the origin were obtained for all the following relations:

P:t, with m and d constant
d:t, with P and m constant
(P.d):t, with m constant
m:t, with (P.d) constant

A frame is constructed from Dexion or Handy Angle to a size which will fit over a trolley runway. Near one end is a wooden lath, held under tension by two rubber cords which run along the sides of the frame to hooks at the far end. The trolley is butted against the lath. A quick release device allows the lath to catapult the trolley forwards, and stops at each side of the frame arrest the lath. By mounting a lamp and photodiode on a bridge built over the frame, the timing of the trolley immediately after it has parted from the lath can be obtained. The lath stops can be adjusted to various settings, allowing the distance d for which energy is fed into the trolley to be varied. The positions of the hooks at the far end of the frame is also adjustable, allowing the cord tension P to be varied. Finally the trolley mass can be varied by stacking trolleys or by adding 500g masses to the trolley.

Even with the long pieces of cord used, the tension varies between ± 13% of its mean value when catapulting through the greatest distance, and maximum and minimum tension values require to be measured by spring balance and a mean value taken whenever dependence on P is being investigated. When fixing the cord, a tension of 5-6 newtons in each cord is suitable and both cords should have equal tension as near as can be judged to avoid an uneven pull. Since the various fixing holes on the frame for the lath stops and the cord hooks are equally spaced, moving both stops and hooks "in step" allows d to be varied while keeping P constant.

We found some evidence of friction in the longer times recorded when the timing apparatus was situated further from the catapult, but no friction compensation was used, and some of our experiments were carried out on the bench itself, without a runway. For this reason we used a mobile bridge carrying the

timing apparatus, tall enough to allow three stacked trolleys to pass underneath and which could be placed in position relative to the lath stops so that timing started within 1-2cm of the end of the catapult action. Doubtless there is still some loss in speed during the 30cm for which the trolley is timed, but we did not consider that this seriously affected the results, and an error of ± 10% was typical.

The times measured with a 30cm length of blanking card varied between 0.15 and 0.7s; a Venner clock was used.

Materials	Suppliers
2 x 10ft. lengths 1¼" slotted angle	Handy Angle
4 anchor plates	Handy Angle
12 fixing bolts and nuts	Handy Angle
2 x 5cm squares 18 S.W.G. mild steel	Ironmongers
2 S hooks from 10 S.W.G. wire	Ironmongers
2 S hooks from 16 S.W.G. wire	Ironmongers
1 2" x 5/16" bolt, nut and washer	Ironmongers
1 wooden lath, from plywood, 5 x 25 x 430cm	Ironmongers
4 yds rubber cord, N2/1425(b)	W.B. Nicolson
String	

The slotted angle is cut into two lengths of 191cm and two of 40cm, which will finally be bolted together with the anchor plates to form a rectangular frame. The vertical edges of the angle should be on the inside of the frame on the longer sides, and on the outside at each end.

Using a No. 20 twist drill, two sets of holes are drilled in the longer lengths, to Fig. 1. taking care to mirror image the two pieces, which is best done by clamping the two lengths together and drilling through the two adjoining sides in one operation. In one of the shorter lengths a hole is drilled centrally to take the 2" bolt which first must have the end 20mm turned down on the lathe to make a smooth pin; this provides the lath release. The lath stops are made from the two mild steel squares, which are first folded diagonally to leave a 2mm gap between the two faces, and then cut and drilled as in Fig. 2. Two bent pieces of 10 S.W.G. wire, or any other form of pin, can be used to hold the stops on the slotted angle.

A Y piece of string attaches the lath to a 5/16" washer which slips over the pin end of the large bolt to hold the lath under tension. The quick release is achieved by prising the washer up with a thumb nail. A 30cm length of stiff card should be stuck on the trolley surface and bent up to form a blanking card. The S hooks are used to attach the rubber cord at each end, the thinner hooks being on the lath.

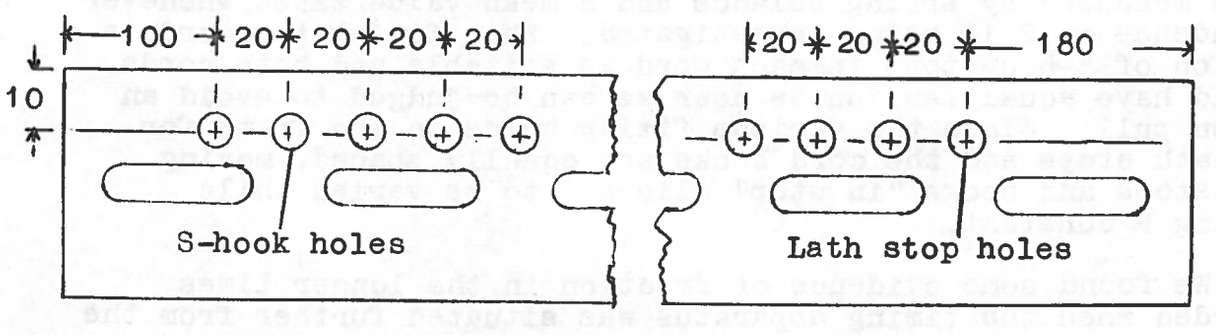


Fig. 1.

Drilling of slotted angle. Continue for 10 holes at 20mm

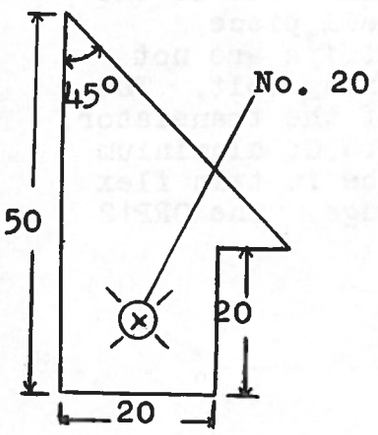


Fig. 2. Lath stop

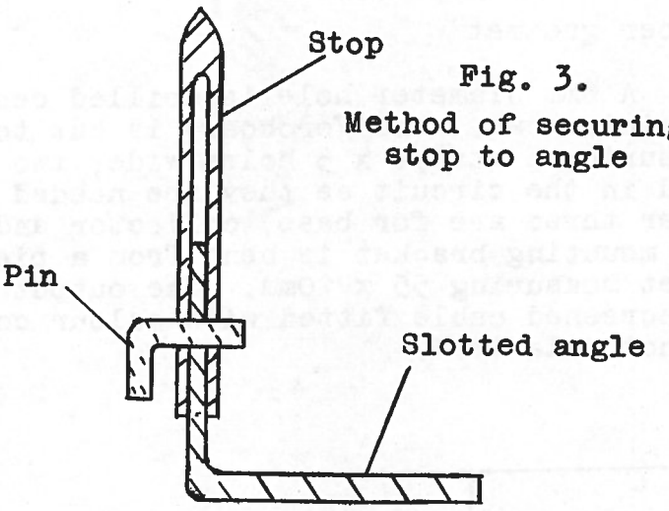


Fig. 3.
Method of securing stop to angle

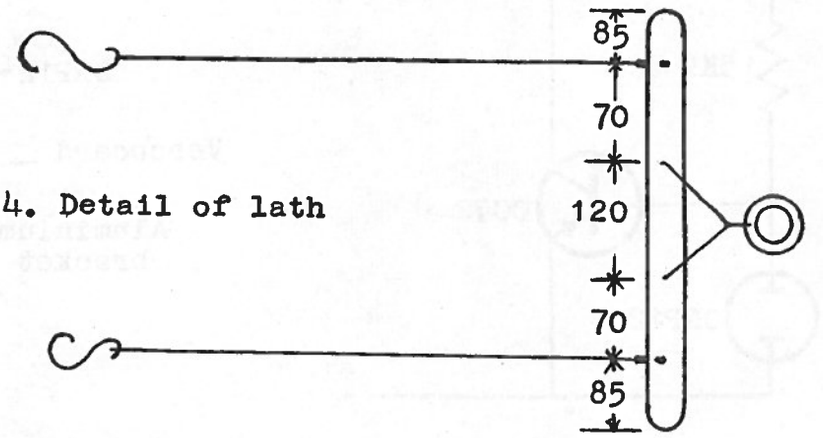


Fig. 4. Detail of lath

* * * * * *

The photo-electric control used with the trolley frame described above was made up in the Centre, and offers a cheaper alternative than the commercial version. As well as controlling the Venner clock, when it must be connected with the correct polarity, viz. + to com. +, - to Clock Operate, the circuit will control Labgear and Panax scalers under the following conditions.

Labgear

"S/C Start" terminals shorted; control to "S/C Stop", either polarity — counts when blacked out

Panax

"Make to Count" terminals shorted; control to "Make to Stop" either polarity — counts when blacked out

"Make to Stop" terminals open-circuited: - to top, + to bottom "Make to Count" — counts when illuminated

Materials

Aluminium can, 65 x 30mm diameter, with screw-on top, e.g. for medical tablets, etc, dimensions not critical.

ORP12 or similar photo-cell, e.g. P1070, 8s. 6d. from Sound and Science

OC72 transistor, e.g. 2s. 11d. from R.S.C.

15KΩ, ¼W resistor — Radiospares

2 4mm plugs	Radiospares
Veroboard	Sound and Science
Rubber grommet	Radiospares

A 6mm diameter hole is drilled centrally in the base of the aluminium can. The Veroboard is cut to make a small piece measuring 5 strips x 5 holes wide; two of these strips are not used in the circuit as they are needed for the fixing bolt. The other three are for base, collector and emitter of the transistor. The mounting bracket is bent from a piece of 16 S.W.G. aluminium sheet measuring 55 x 10mm. The output leads can be in twin flex or screened cable fitted with colour coded 4mm plugs. The ORP12 is not polarised.

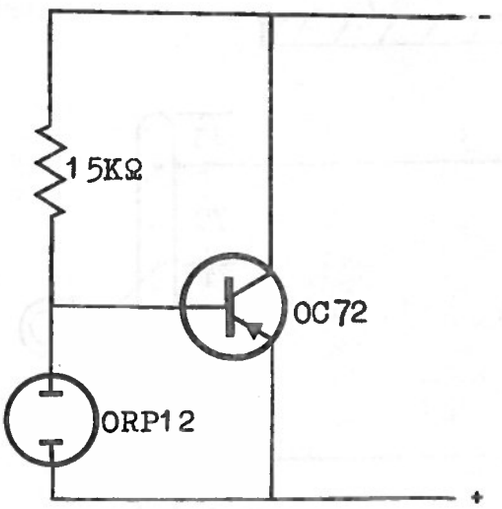


Fig. 1. Circuit diagram.

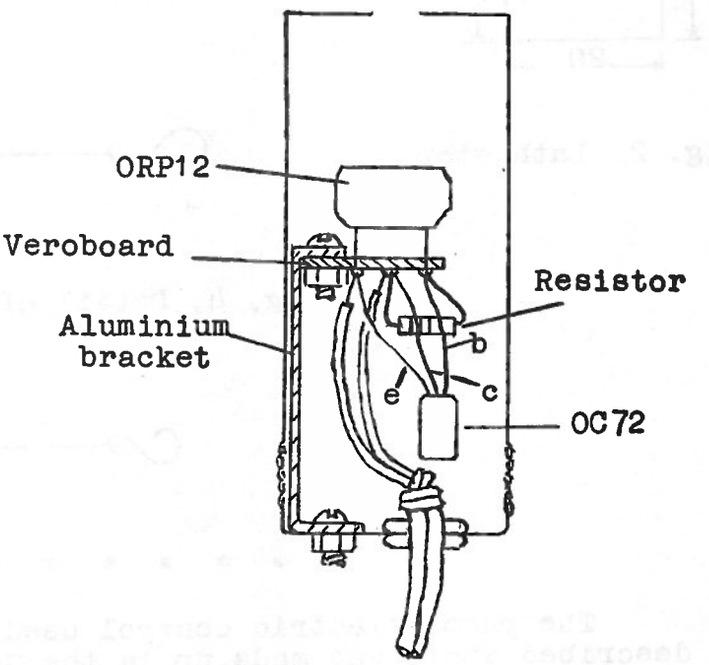
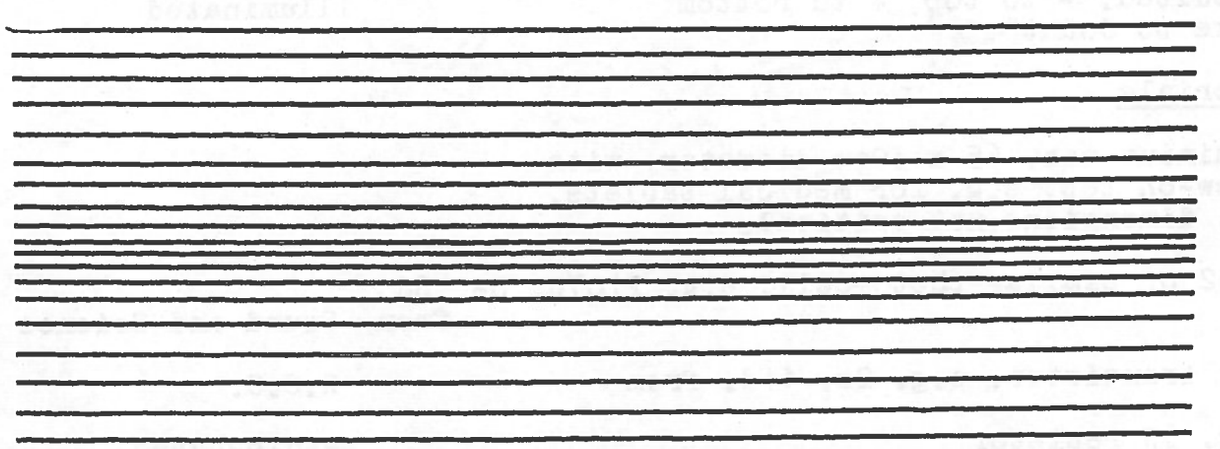


Fig. 2. Mounting details.

Dimensions are not critical but the face of the ORP12 should be 20mm or more from the light entry hole.

* * * * * *

An improved form of auxanometer which does not require a smoked drum, but records on ordinary paper and will give a carbon copy if needed, has been designed in the Centre. Growth is recorded at hourly intervals, and the length of trace corresponding to each hour can be as much as 25 - 30cm, so that strips 2cm wide can be cut off the record and given to each pupil to paste into their notebooks. A print of an actual trace - not a copied drawing is given below as a specimen.



The lever system is standard on the short arm side, but the recording end carries a spring which keeps the recording pencil or pen firmly pressed against the paper on the drum, which revolves at one revolution per hour. When the cut-away portion of the drum (see diagrams) comes round to the recording pencil, the tension is released and the lever drops by gravity by an amount proportional to the previous hour's growth of the plant. Since the lever drops freely, the system can be adjusted to give the minimum of pull on the plant, as there is only friction at the lever pivot to be overcome. When the pen again touches the drum periphery, the record remains constant at this level for the next hour. The pressure is sufficient to record through the paper to a carbon copy, and the length of trace depends only on the drum diameter. Also irregularities on the drum face do not affect performance because of the spring loaded pen, and although in our design the drum was rolled from sheet metal and soldered on two trepanned discs, a suitably adapted tin would perform equally well. The motor is a government or manufacturer's surplus, sold by N.R. Bardwell for 17s. 6d. Patent rights have been applied for in respect of this apparatus.

Materials

Aluminium rod 210 x 20mm diameter.

Aluminium or dural sheet, 16 S.W.G., 700 x 20mm.

Copper sheet, 22 S.W.G., 150 x 320mm.

Brass sheet, 10 S.W.G., 120 x 220mm.

Brass rod, 11 x 38mm diameter.

Mild steel sheet, 10 S.W.G., 250 x 25mm.

Copper strip, 22 S.W.G., 12 x 80mm.

Wooden baseboard, 750 x 140 x 15mm.

Nuts and bolts, wood screws.

The aluminium rod is cut into two lengths of 9 and 12cm to make two fitting halves of the pivot support. The shorter length is drilled centrally on the lathe with a $\frac{1}{2}$" centre drill to a depth of 6cm. The same length of the other half is turned down to a 12mm diameter so that it fits inside the first. The side of the tube is drilled and tapped to take a 4BA locking bolt, and the bottom end of the rod is drilled and tapped to take a OBA bolt which secures the pivot to the baseboard, see Fig. 1. A slot is cut to take the lever arm, and the pivot is made from a 2BA 25mm bolt, threaded for only half its length. Other and probably as good methods of pivoting the lever will occur to teachers; this was used because of the facility it gave for adjusting lever height.

Details of the lever arm, which tapers from 22mm to 17mm at the pencil end, are given in Fig. 2. The brass collar which holds the pencil is 12.5mm outside, 8.3mm inside diameter, and 8mm long. A 6BA bolt is tapped into the collar to secure the pencil, and the collar itself push-fits into a 12.5mm diameter hole in the lever. The 22 S.W.G. copper strip is bolted to the arm with two 6BA bolts and a third is filed to a point to bear on the backing plate. The brass rod acts as a counterweight on the short arm and is slotted to a depth of 15mm so that the lever can be pushed into the slot. The rod is drilled and tapped for a 4BA locking bolt. Sawcuts 6mm deep are made in the lever arm at distances which will give linear magnifications of 5, 7, 10 and 20 of the plant growth.

Two 10cm diameter discs are trepanned from the brass sheet to form the ends of the recording drum; the lower disc only is centrally /

centrally drilled with J letter drill (7mm) to fit the motor spindle. If the Bardwell motor which we specify is to be used, a non-standard nut will be needed to fit the spindle and this we will supply to any school free of charge. A section is cut from both discs as in Fig. 3. and the edges rounded.

The 22 gauge copper sheet is bent round to form a cylinder fitting the discs and soldered so that both discs are flush with the cylinder. The free edges of the copper are bent inwards, the leading edge at an angle of about 45°, the trailing edge at 80° respectively to the tangent, see Fig. 3.

A slot 30 x 5mm is cut down the centre line at one end of the mild steel strip and 50mm from this end the strip is bent at right angles to form the back plate. Two wood screws through the slot anchor the plate to the baseboard; the slot allows the position of the plate to be adjusted to give suitable amount of pressure on the lever arm and pencil. A rubber strip 150 x 20mm cut from cycle inner tube is stuck with Evostik to the front face of the plate.

The Bardwell Motor has three fixing bolts which should be loosened one at a time only, since they keep the motor in position. These are on the top face of the motor, and brackets will be needed to secure the motor to the base board. A general view of the drum etc. is given in Fig. 4. The recording paper, with carbons if required, is secured tightly round the periphery of the drum by four paper clips, top and bottom of the leading and trailing edges of the cylinder.

If it be thought that construction of the drum as described above is beyond the facilities or time of a particular school, reasonable results can be obtained from a 2lb syrup tin. Cut out a rectangle 70 x 15mm from the side of the tin, then cut back a further 25mm at each corner, so that the flaps can be folded to form leading and trailing edges as shown in Fig. 3. The cut edges should be filed to remove burrs and lessen the risk of cut fingers. The lid is drilled centrally as before to take the motor spindle, and the design would be improved if a metal disc were bolted to the lid to strengthen it, as the mount is otherwise somewhat flimsy.

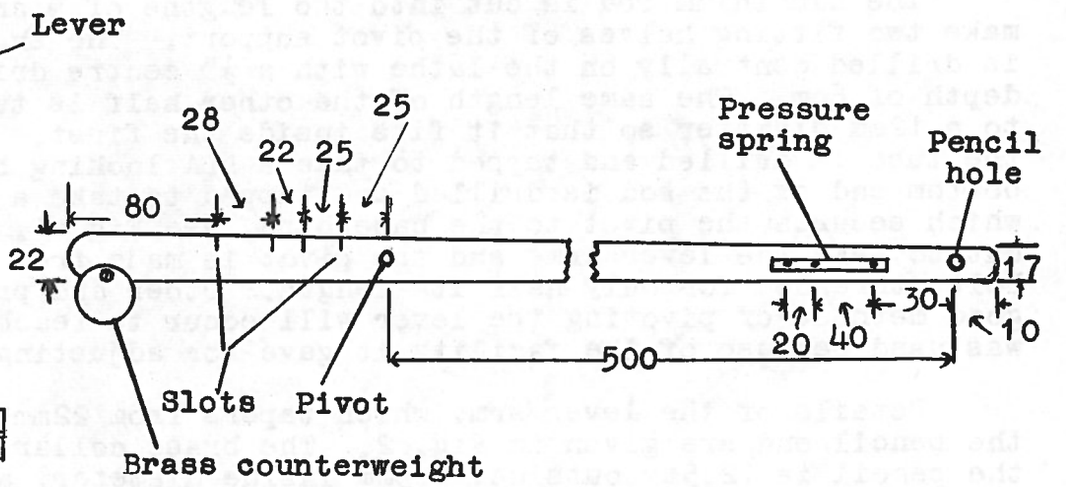


Fig. 2. Lever arm details.

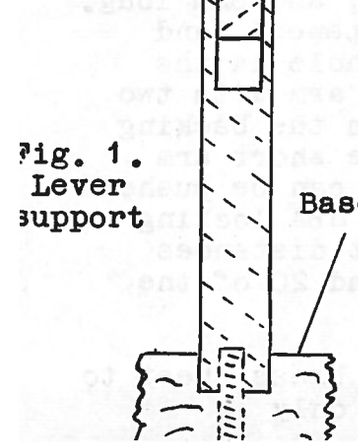
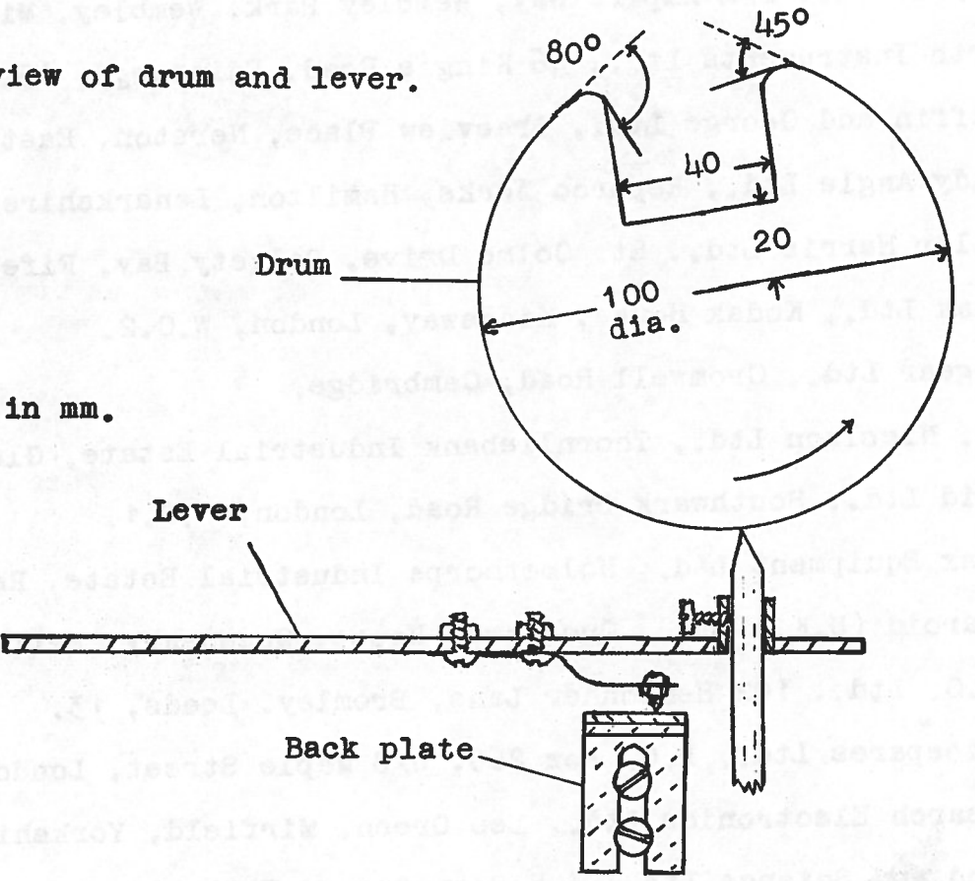


Fig. 1. Lever support

Fig. 3. Plan view of drum and lever.



All dimensions in mm.

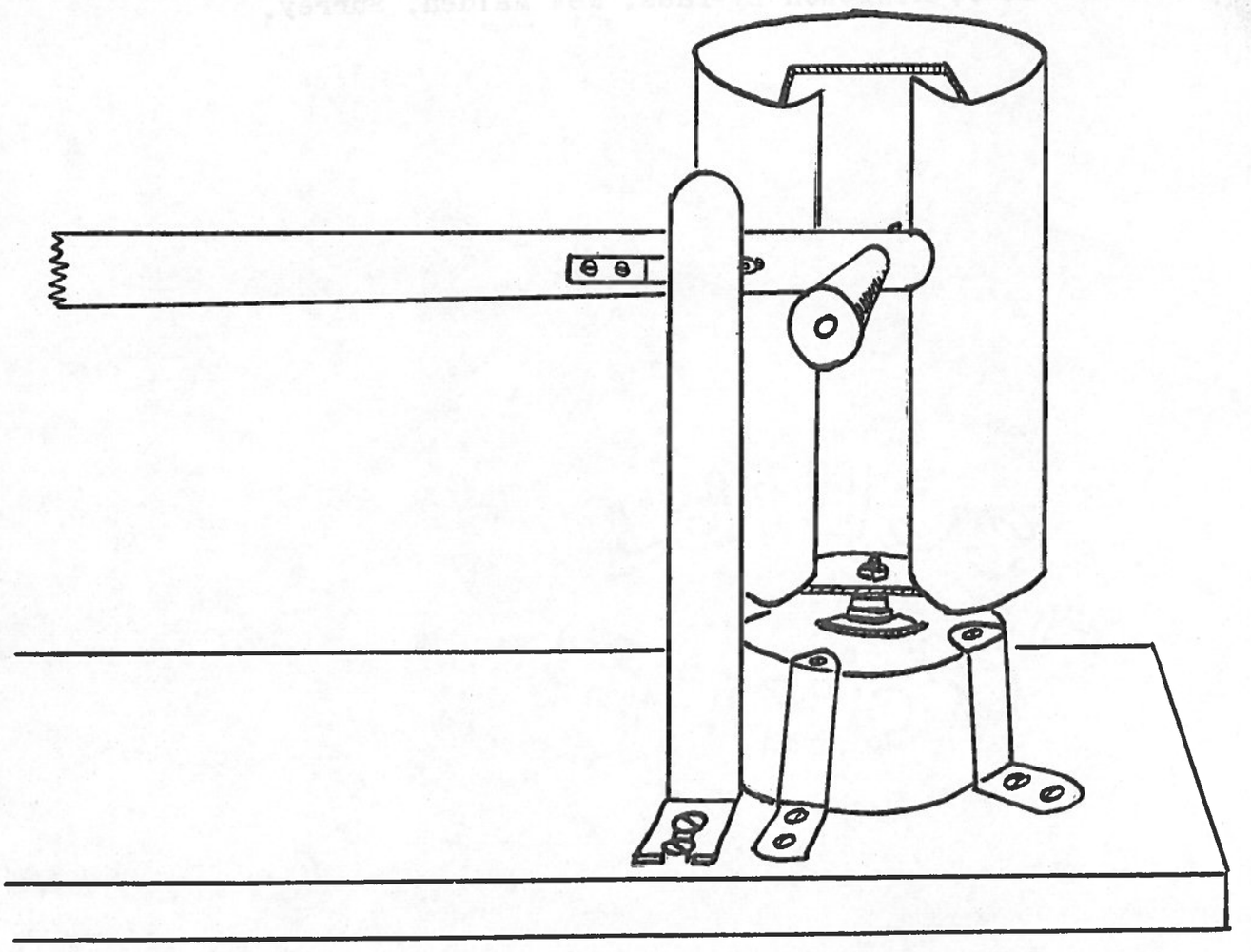


Fig. 4. General View

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

Advance Electronics Ltd., Roebuck Road. Hainault, Ilford, Essex.

N.R. Bardwell Ltd., Sellers Street, Sheffield. 8.

Dexion Ltd., 2/4 Empire Way, Wembley Park, Wembley, Middlesex.

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

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

Handy Angle Ltd., Reparco Works, Hamilton, Lanarkshire.

Philip Harris Ltd., St. Colme Drive, Dalgety Bay, Fife.

Kodak Ltd., Kodak House, Kingsway, London, W.C.2.

Labgear Ltd., Cromwell Road, Cambridge.

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

Oxoid Ltd., Southwark Bridge Road, London, S.E.1.

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

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

R.S.C. Ltd., 102 Henconner Lane, Bromley, Leeds, 13.

Radiospares Ltd., P.O. Box 268, 4/8 Maple Street, London, W.1.

Research Electronics Ltd., Lee Green, Mirfield, Yorkshire.

Sound and Science Ltd., 3-5 Eden Grove, Holloway, London. N.7.

Tenner Electronics Ltd., Kingston By-Pass, New Malden, Surrey.