# SCOTTISH SCHOOLS SCIENCE

# EQUIPMENT RESEARCH

# CENTRE

Bulletin No. 56 June 1972.

# Contents

# Introduction

With the raising of the school leaving age this year there is considerable preparation going on in schools to organise suitable courses for the pupils concerned. This is apparent from the requests we have had for exhibitions of Integrated Science Second Cycle apparatus. Acting on this knowledge we have decided to concentrate on the display of a large selection of such apparatus in our display laboratory from the beginning of July till the middle of September. We have already in the past put on special exhibitions of this apparatus in a few counties and teachers appreciated the ideas they got for the construction of apparatus in various projects. May we repeat previous invitations and state that teachers may visit the Display Laboratory without appointment on weekdays between 9 a.m. and 5 p.m. and on Saturdays from 9 a.m. till 1 p.m.

Whilst on the subject of Second Cycle apparatus we should like to refer to kits supplied by some firms, e.g. Technical Studies Kits from Griffin and George. These kits are not specifically aimed at the Scottish Integrated Science Topics. When considering the purchase of such kits, therefore, great care should be exercised in assessing their educational value. It would be worthwhile considering what objectives other than content would be attained by their use.

We have frequently had inquiries from teachers, especially physicists, about W. B. Nicolson apparatus and spares. In our Trade News section we have an announcement regarding a firm, H. F. Applegate (Scientific Instruments), which can supply W. B. Nicolson's physics apparatus.

# Biology Notes

Blood Flow Model The model shown on page 2 was adapted from a Nuffield 'A' level Biology design, to enable blind pupils to appreciate the nature of blood flow in arteries and veins, and the reasons for the differences in flow, and in vessel structure. The blind children hold their hands under the nozzles at the ends of the vessels to feel the flow; however, the model should also prove useful in teaching sighted pupils. Water is first pumped through a rigid walled vessel to see the jerky nature of the flow, and then through an elastic-walled vessel to see how the flow is partly evened out, though still pulsing. Finally, it can be seen how a capillary bed lowers the pressure and almost completely smoothes the flow out.

The diagrams should be self-explanatory, but some further notes are given below.

Fig. 1. Central Board.

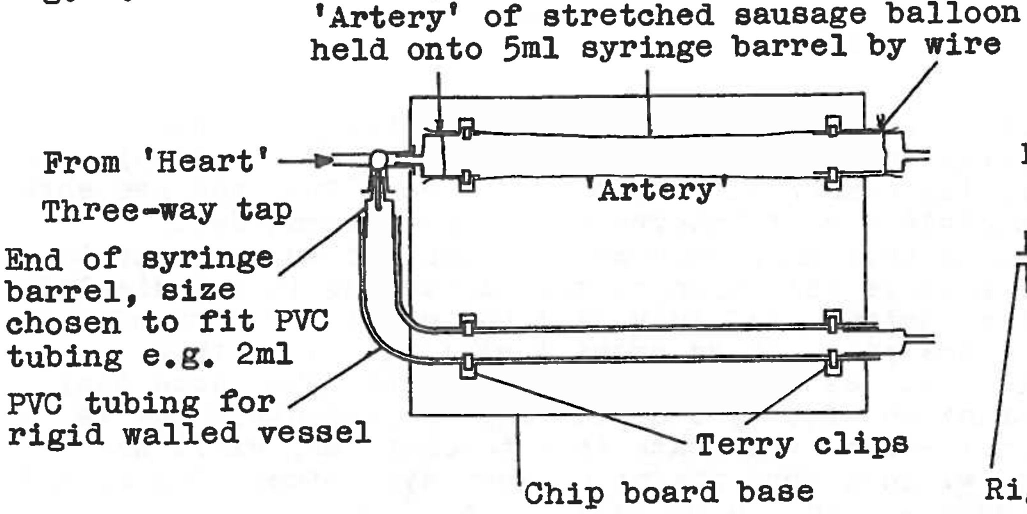



Fig. 2. 'Capillary Bed'.

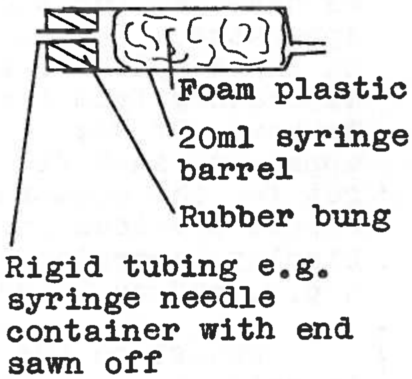



Fig. 3. 'Heart'.

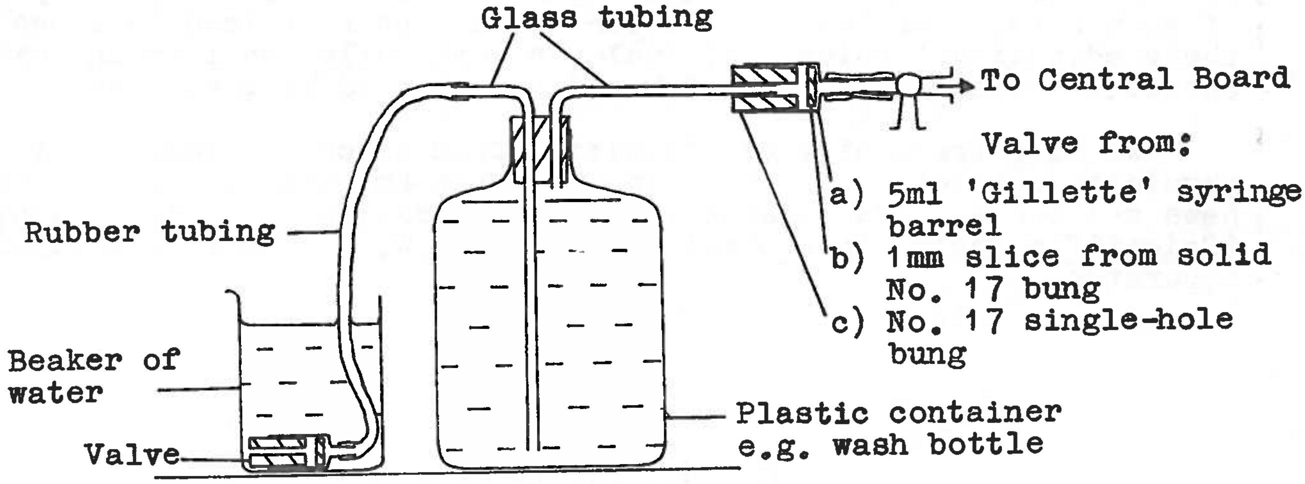



Diagram 1. The sausage balloon material should be of such a length that it is slightly stretched when the syringe barrels at each end are fixed into the terry clips. It is important to use wire to hold the balloon to the syringe barrels, as the pressure build-up can be considerable when the 'capillary bed' is in position.

Diagram 2. The sponge plastic (polyurethane foam) is compressed tightly into the 20ml syringe barrel. The exact amount of plastic, and hence the extent of its compression, will have to be found by trial and error. It should cause a slow, almost steady flow to emerge from the nozzle when the heart is pumped. If the foam is too compressed, however, the sausage balloon will 'blow up' with water.

Diagram 3. In the construction of the valves it is important that the 1mm thick slice of solid bung, which is used as the washer, is cut quite raggedly, and that this cut surface faces the syringe nozzle. In this way, fluids can pass via the irregularities of the cut surface when it is pressed against the end of the syringe. On the other hand, when the washer is pressed against the bottom of the No. 17 bung the two machined surfaces are brought into contact, thus giving an effective seal. Because these valves are gas-tight as well as liquid-tight, they should have other applications.

In setting up the model, the 'heart' must first be filled with water. It is also necessary to rest the central board on an object such as a small box, so that the 'vessels' are at the same height as the 'heart', and to position a bowl to collect the water issuing from the 'vessels'.

* * * * *

Osmotic Pressure with Visking Tubing Visking tubing is not the easiest of materials for pupils to handle, and a great deal of time is commonly spent in making the bags for osmosis and diffusion experiments. Fig. 1 shows a more or less permanent arrangement for holding the tubing; this simplifies much of the procedure.

Fig. 1.

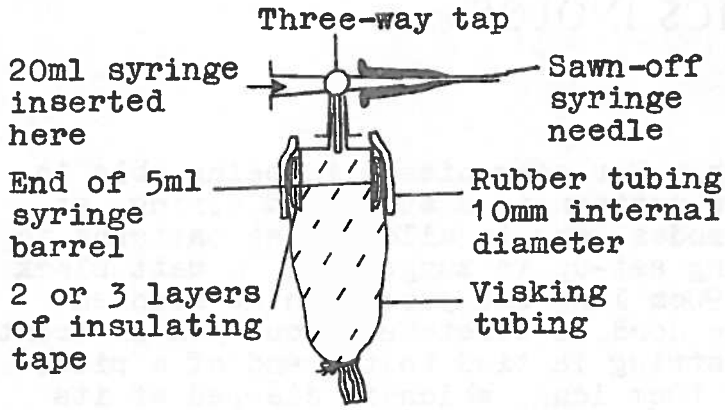
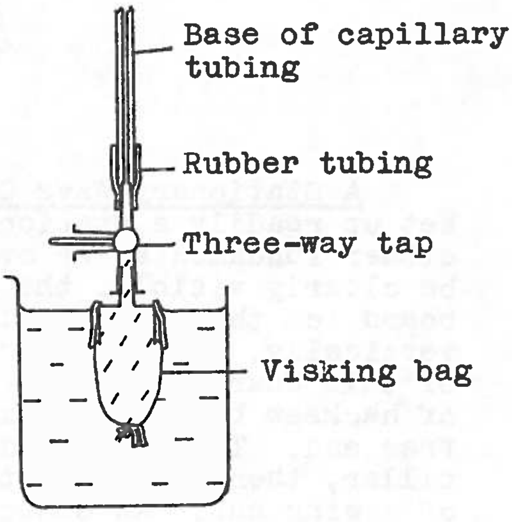



Fig. 2.




The apparatus - minus three-way tap and syringe - is stored in 2% formalin solution. We have stored ours in this way for several months, and so far there is no sign of any deterioration in the visking membrane. It must, of course, be thoroughly rinsed before being given out to pupils. To operate it, first connect an empty 20ml syringe to the other female connection of the tap, and use this to remove all air from the tubing. Turn the handle to seal the tubing off, and remove the syringe and fill with concentrated sucrose solution. Re-connect the syringe to the tap, turn the handle to connect to the visking tubing and inject solution until the tubing is clearly under tension. Turn the tap handle to face the syringe, thus releasing excess pressure inside the tubing; then turn the handle down again to seal off the solution, disconnect the syringe, and rinse the apparatus.

The sawn-off syringe needle is then fitted, and the apparatus left in a 100ml beaker of water for the pressure to build up. After 30-40 minutes, pressure should have built up sufficiently to cause a jet of liquid to shoot out of the syringe needle when the tap is opened.

Fig. 2 shows how the apparatus is used to make an osmometer. In this case the tap is first connected to the capillary tubing, which is held vertically in a retort stand. The visking bag is then connected to the tap as shown, and filled with solution as before. In this case, however, after the solution has been injected the syringe is disconnected with the tap handle still turned vertically up, so that excess pressure is released and consequently liquid does not shoot up the capillary tubing when the bag is connected to it.

The apparatus can also be used in digestion/diffusion experiments, e.g. with starch/glucose mixtures, provided that it is thoroughly rinsed out after use.

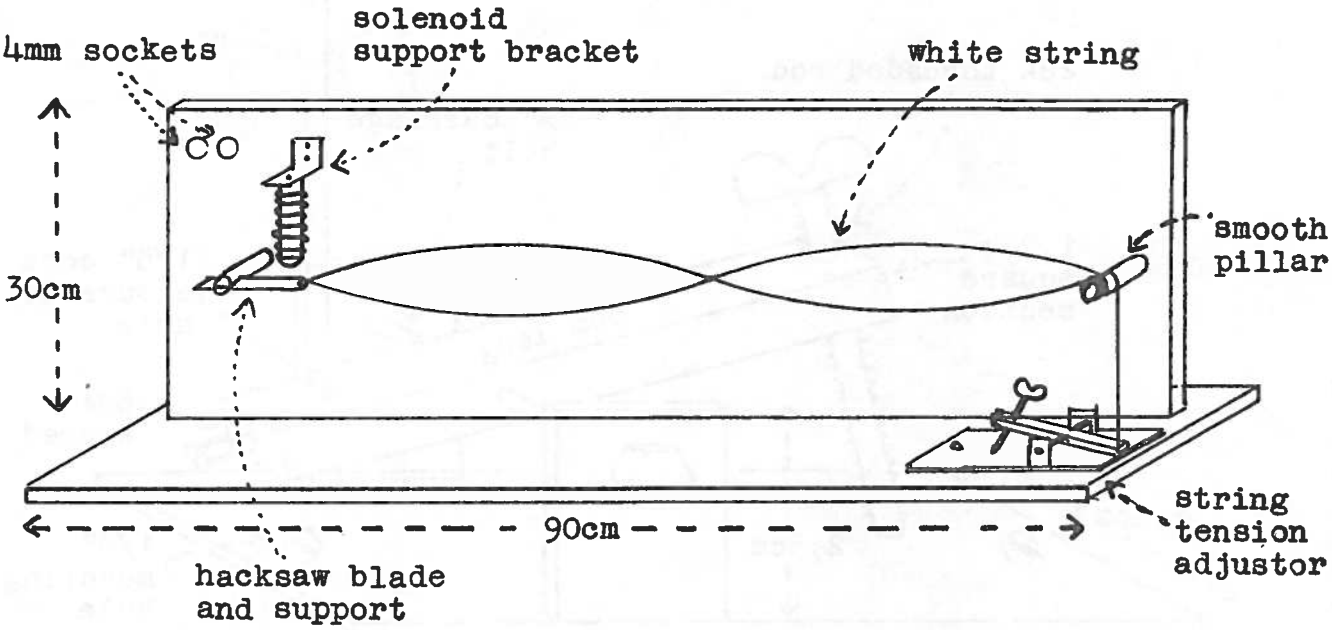
# Physics Notes

<u>A Stationary Wave Generator</u> For convenience in being able to set up readily a stationary wave pattern in a stretched string, at either fundamental or overtone modes, and to allow these patterns to be clearly visible, the following set-up is suggested. A matt black board 1cm thick, approximately 90cm long and 30cm high is mounted vertically, and a piece of white cord is stretched about 3cm in front of this board. One end of the string is tied to the end of a piece of hacksaw blade, approximately 10cm long, which is clamped at its free end. The other end of the string is passed over a smooth grooved pillar, then down to a tensioning bracket which is adjustable by means of a wing nut. An electromagnet coil is positioned above the hacksaw blade and when 50Hz alternating current is passed through the coil, the magnetic field causes the blade to vibrate up and down one hundred times per second. This vibration is passed to the string and at suitable tensions it breaks into resonant oscillations at half wave multiples. The general arrangement is shown in Fig. 1 on page 5.

Our solenoid was wound on an old PMG type relay core 6cm long using approximately 70 metres of 26 SWG enamelled copper wire, giving a coil resistance of 7Ω. It is driven by 15V from a transformer.

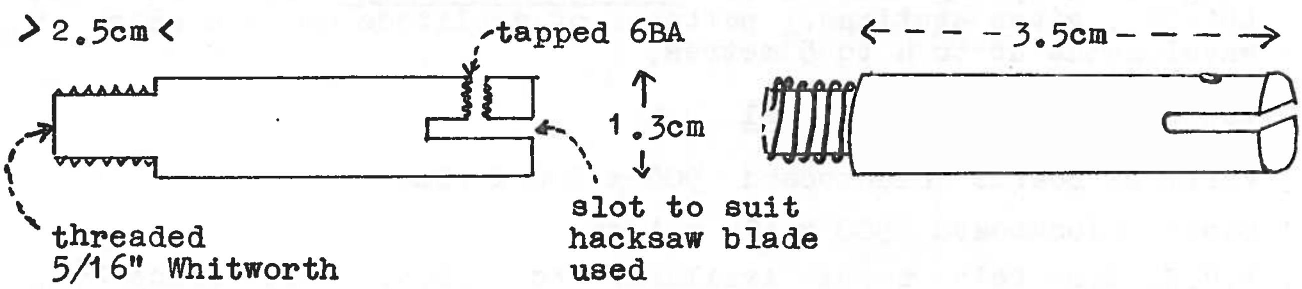
The solenoid is supported directly above the hacksaw blade by means of a bracket, the mounting holes of which are slotted to allow vertical movement of the solenoid above the bracket when adjusting for maximum vibration and minimum noise.

Fig. 1. Stationary Wave Demonstration Board.



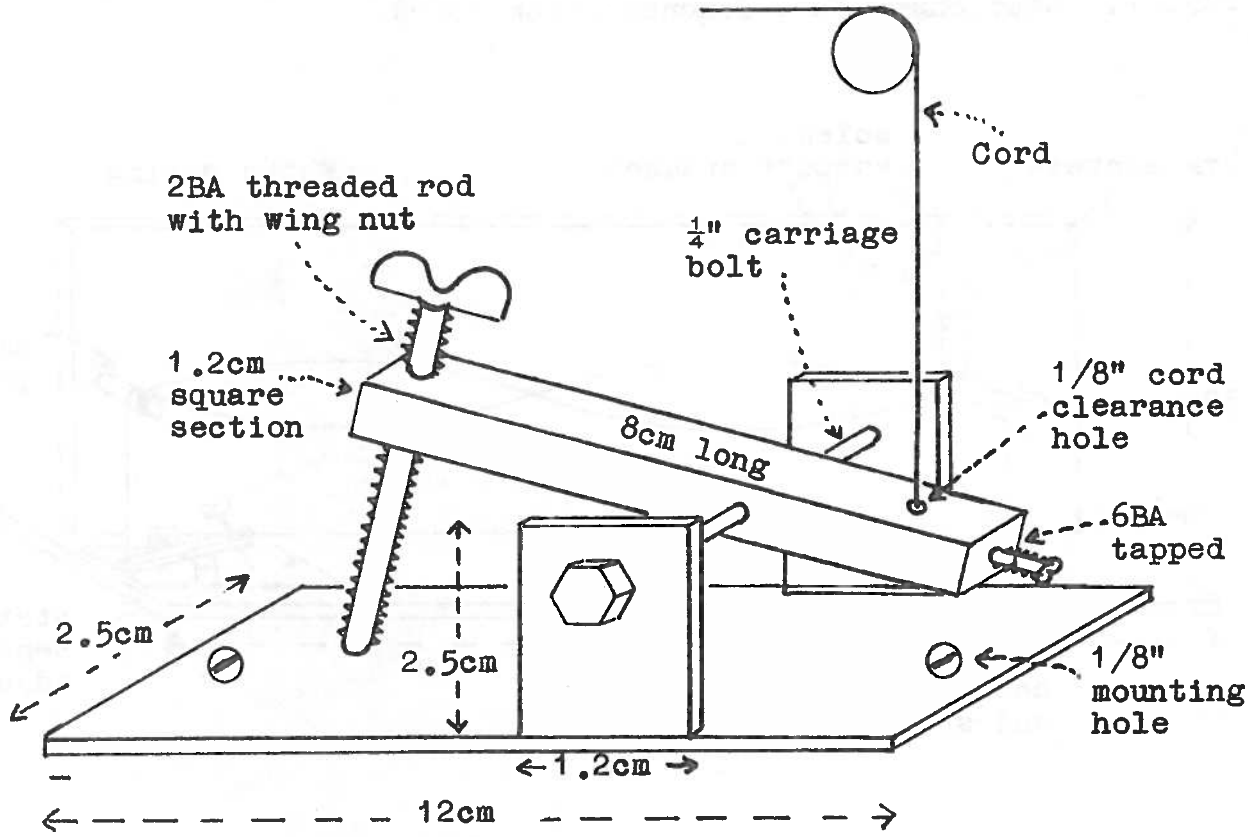

The length of the hacksaw blade is quite critical, as the vibrating length must be close to a quarter wave length at the velocity of sound in the steel. For this reason the pillar supporting the blade is slotted and the blade is pulled through in steps until the resonant length is found. For the blade used in the prototype (Eclipse Blue High Speed 300 x 13 x 0.65mm) a protruding length of 7cm was found to be optimum. Detail of the Blade Mounting Pillar is given in Fig. 2.

Fig. 2. Blade Mounting Pillar.




The type of cord or string used has a large effect on both the amplitude and number of overtone positions which can be achieved. The best cord of those available can be selected only by trial and error and Macrame Twine No. 10 was found to be suitable. If possible a white-coloured string should be used to give good visibility against the black background of the mounting board. A simple but effective means of adjusting the tension of the string is shown in Fig. 3 over.

Fig. 3.




After final adjustments of coil and blade positions, the fundamental mode of vibration, as well as the 1st, 2nd and 3rd overtone modes, could be easily obtained, while higher modes were obtained occasionally with less stability.

The set-up will be recognised as a fixed frequency, fixed length, Melde type apparatus, the use of twine giving a large amplitude pattern. For even larger amplitudes the use of a hand vibrated long steel spring such as the Griffin and George Wave Form Helix L61-253, gives stationary patterns of amplitude up to a metre at wavelengths up to 4 to 5 metres.

Materials used in our model

Vertical Board: blockboard 900 x 300 x 10mm

Base: blockboard 900 x 120 x 17mm

P.M.G. type relay core: Available from S.S.S.E.R.C. Price $2\frac{1}{2}$p.

Hacksaw blade: Eclipse blue high speed 300 x 13 x 0.65mm

Cord: Macrame Twine No. 10

Pillar supporting blade: brass rod 6cm long, 1.3cm diameter ($\frac{1}{2}$")

Smooth pillar: brass rod 6cm long, 1.3cm diameter ($\frac{1}{2}$")

Tensioning plate: scrap brass (see Fig. 3)

Solenoid bracket: mild steel plate 8cm x 3cm

The following items of surplus equipment are now available at the Centre. Orders may be given by telephone or letter and the items will be reserved until the official order is sent and which should be marked "Confirmation".

Item 301 Signalling lamps. Tilting reflector type. £2.00

Item 302 Signalling lantern. Portable, battery operated. 25p.

Item 303 Wavemeter. G79. 160-220 MHz. £1.00.

Item 304 Distortion Test Set. Teletype TS-383A/GG. 115v AC. 50p.

Item 305 Filter Unit. 30 MHz low pass. 10p.

Item 306 Oscillator Unit. Type 76. 98-152 MHz. C.W. and M.C.W. £1.00.

Item 307 C.R.O. Monitor. Type S11/1, with time-base unit. £3.00.

Item 308 Amplifier. Type 8B by McMichael Radio. Contains six units. Each unit contains one 500µA centre zero meter, a 200Ω ten turn potentiometer, a twenty-one position attenuator, ceramic wafer switch, valves and other components. £1.00 per unit or £5.00 the whole.

Item 309 Plastic trays. White "Perspex" 4ft x 2ft and 2in deep. £1.00.

Item 310 Air speed indicators. (Sensitive differential pressure gauges) calibrated 60-340 knots. 25p.

Item 311 Divers underwater communication apparatus. Consists of 240ft of lifeline and coaxial cable, divers bone conduction transceiver. Surface equipment is headset and microphone and 3v operated audio amplifier with send/receive switch. In crates. £2.00.

Item 312 D.C. Motors. 20v, 6.5A, 2,400 R.P.M., 1/10 H.P. Shunt wound, continuous rating. £2.00.
220v, 2,600 R.P.M., 1/60 H.P. Governed. £1.00.

Item 313 A.C. Motors. Bench motor by Rathbone. 4 switched speeds. Tapered shaft each end to accept accessories. 240v A.C. 50 cycles. £2.00.

Item 314 Power Units. Type 6B. McMichael Radio. Component value £1.00.

Item 315 Horns. 20v D.C. High note. 10p.

Item 316 Capacitor. 30µF. 2,500v D.C. 13in x 10in x 7½in. Untested! 50p.

Item 317 R.F. Power and Modulation Meter. CT.214. 30-400 MHz. 0-20 and 0-200 watts. 37lbs weight. £2.00.

Item 318 Foot operated switches. Large. 5p.

Item 319 Incomplete Transmitters. One 150 KHz-1.5 MHz, One 225 MHz-400 MHz — £1 the pair.

Item 320 Audio Amplifiers. 2 watt output into 400Ω. 240v A.C. powered. £1.00.

Item 321 Marconi TF 142E Distortion Factor Meter. 0-50%. 600Ω input. Weight 23kg. £3.00.

Item 322 Cambridge Instrument Co. P.E. Amplifier. Weight 12kg. £1.

Item 323 Parmeko A.P.32112 and A.P.198346 Micrograms. Contain 17 watt audio amplifier, output at 600Ω or 31.6 volts. Garrard 301 turntable. Most are less pick up arm. Weight 38kg. £3.00.

Item 324 S.T.C. Oscillator type 74008-B(TFG). 300Hz-150kHz. 24V and 130V D.C. power required. Weight 50kg. £1.00.

Item 325 A.P. 12649A Audio Amplifier 300W. Weight 40kg. 50p each. A.P. 12652 A.G.C. Panel. Weight 40kg. 50p each.

Item 326 Electrostatic Voltmeters. 0-6kV. 25p each.

Item 327 Cambridge Dynamometer Test Set A.C. 0-25A. 0-500V. 10-150Hz. 0-5kW. £3.00.

Item 328 Elliot Precision Voltmeter. 0-15 and 0-30V. AC/DC. £2.00.

Item 329 F.E. Becker and Co. Post Office Box. 50p.

Item 330 Marconi CR 300/1 Receiver. Weight 36kg. £5.00.

Item 331 Marconi TF329F Circuit Magnification Meter. Weight 30kg. £3.00.

Item 332 De-humidifier Unit. 115V A.C. Contains compressor type refrigerator and fan. Weight 30kg. £2.50.

# In The Workshop

Modifications to Dynamics Trolleys The following suggestions have been received from Berwickshire High School, Duns, as a means of improving the usefulness of dynamics trolleys such as the MLI type 95-106/1, which are used in ticker-tape experiments concerning conservation of momentum and energy.

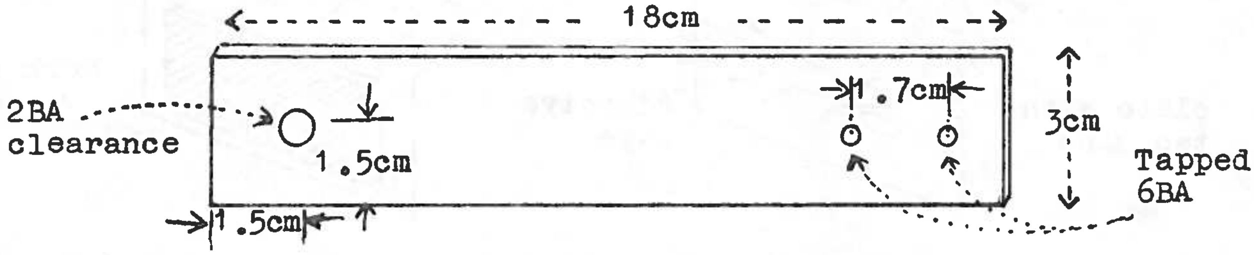
1. The mass of all carts is brought up to a uniform 1kg, by tacking on to the sides of the trolleys strips of heavy metal such as lead sheeting. This means that carts are then interchangeable as regards mass, and doubling or tripling mass can now be done by sitting one cart on another or simply by adding suitable 1kg masses.

2. A swivelling arm, 18cm long, is bolted to the top of each cart, and the wedge-type tape holder is removed from the cart and screwed to the end of this arm. Details are given in Fig. 1. This means that for all experiments the tape is drawn along about 10cm out from the edge of the cart, and in experiments involving two carts there is no difficulty in arranging for the tapes to be on opposite sides of the carts.

3. The two retaining pins on top of the cart at the single wheel end are fixed firmly into the cart. These pins then act as solid retainers for any end plate which may be hung over the end of the cart.

4. A set of end plates is made, each plate fitting over the single wheel end of the trolley. A set of four plates is suggested for each pair of trolleys in use. The four plates suggested are:
   (a) a plate with two protruding pins
   (b) a plate covered with thick cork
   (c) and (d) plates holding identical permanent magnets.
   Plates (a) and (b) are used for collisions where the masses are required to remain together after collision, while plates (c) and (d) are used for "repulsive" collisions. Details of end plates are given in Figs. 2 and 3.

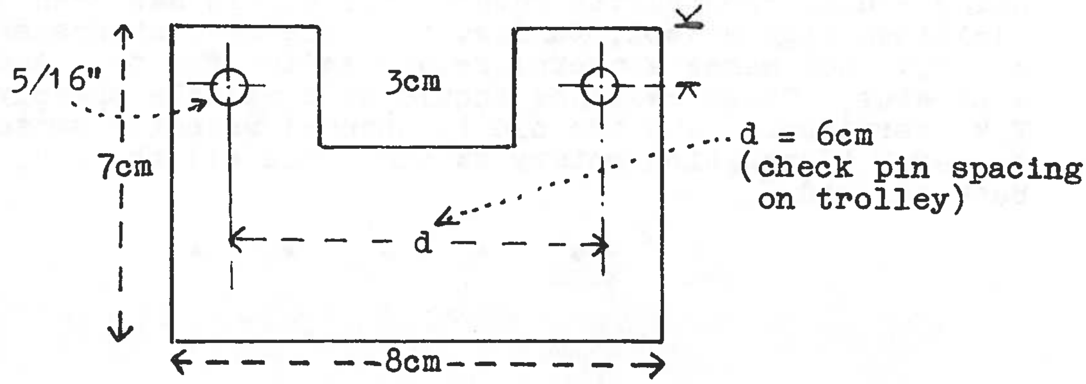
Fig. 1. Details of extension arm, made from rigid sheet material such as dural.




A hole is drilled through the cart, about 75mm in from the single wheel end, on the centre line, using a No. 12 drill to give 2BA clearance. A 2BA countersunk head screw, 6cm long ($2\frac{1}{4}$") is inserted from the bottom of the cart and the swivel arm is held on this screw by use of washers and locknuts. The wedge type tape holder is held in place on the far end of the arm by two 6BA screws $\frac{1}{4}$" long and after the wedge is in position these screws should be filed off under the arm to prevent scratching of the body of trolley as the arm swivels across it.

<u>Details of end plates</u> The plates should be made from rigid metal such as mild steel plate, 1mm thick. Each plate measures 8cm by 7cm. A wide slot is cut in one end of the plate to prevent it rubbing on the wheel which protrudes through the trolley. Fig. 2 shows the dimensions of the plate before bending.

Fig. 2. End Plate Dimensions.



The holes drilled should be wide enough to give clearance to the two retaining pins without sloppiness, a 5/16" or lettered "O" drill being suitable.

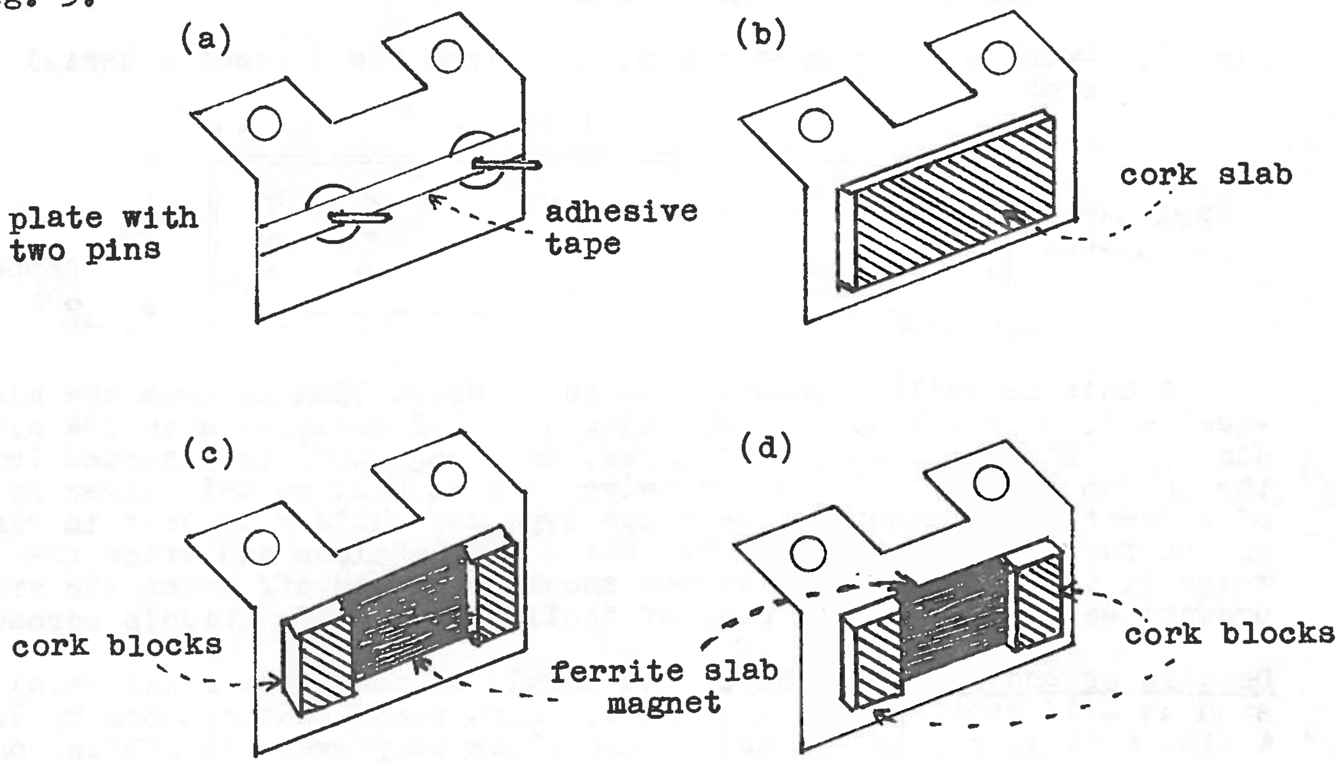
The plate is bent at 90°, so that the horizontal section fits over the retaining pins and allows the vertical plate to hang down over the end of the trolley and tight against it.

Fig. 3 shows how the completed plates appear. The drawing pins may be cemented to the face of the plate, or pushed through a strip of adhesive tape which is then wrapped around the plate.

The cork slab is cemented to the face and its thickness should be greater than the protruding length of the pins which will stick in it.

The magnets are cemented to the face, and to prevent the magnets from touching during an "over energetic" collision two pieces of cork, thicker than the magnets can be mounted beside the magnets to act as buffers. Suitable magnets are the ferrite slabs 50mm x 19mm x 6mm, obtainable from <u>Griffin and George</u>, L71-224, at 35p each.

Fig. 3.

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In Bulletin 54 a Simple Harmonic Motion apparatus was described using a home constructed rotary switch. It has been suggested from Linlathen High School, Dundee, that the wave change switch from an old T.V. set makes a useful rotary switch for this and other apparatus. These switches should be available cheaply from the local T.V. serviceman, and the old 13 channel selector switches will give a useful 13 position rotary switch, once all the T.V. components have been removed.

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# Trade News

H. F. Applegate (Scientific Instruments) have taken over all the existing stocks of W. B. Nicolson's physics equipment and will soon be in a position to supply spares and servicing. Ticker tape, ½inch and carbon circles are now available. While stocks last, they are offered at 1971 prices and as stocks run out Applegate are themselves manufacturing this range of physics apparatus (including Nuffield Physics Apparatus). Until a new catalogue is published reference numbers from the original 1968 catalogue can be quoted in orders. To have your name put on the mailing list at Applegate, send the firm your name and address.

Scientific Instruments Ltd., Glasgow, do repairs to W. B. Nicolson and Advance Equipment. Other equipment can be dealt with but first of all check if the firm will accept for repair.

Jencons of Hemel Hempstead supply the Mityvac, a small hand operated vacuum pump which can be used for Buchner filtration work, starting a siphon, etc. Mityvac, Cat. No. H138/7, Model D with vacuum gauge costs £5 and Cat. No. H138/8 Model B without vacuum gauge costs £2.50.

Fortronic (Fife) stock a range of transistors, resistors, capacitors, etc. They hope to extend their range which to some extent will depend on the demand for certain items by schools. They are prepared to supply kits for the meter amplifier and thermometer described in Bulletin 55.

Cheaper Mercury than the general suppliers offer is available from Belgrave (Mercury) Ltd. Their laboratory B.M.I. grade is suitable for most school uses and the price in February 1972 was £2.26 per lb. or £2.16 per lb. for 7lb. The above information was found in the C.L.E.A.P.S.E. bulletin of April 1972.

R.S. Components Ltd. (formerly 'Radiospares') supply a Freezer Aerosol which is suitable for freezing of biological specimens for sectioning.

Amal Ltd. supply standard bunsen burners which are available with jets suitable for town gas, natural gas and liquified petroleum gas (propane, butane). We have tested these and found them to have satisfactory performance and construction. Prices are 0-39 at 58p each; 40-99 at 49p each; 100 and over at 47p each. The model is Amal "Graduate" Bunsen Burner 502/2/42 and when ordering the jet required should be stated.

S.S.S.E.R.C., 103 Broughton Street, Edinburgh EH1 3RZ.
Tele. 031-556 2184

Amal Ltd., Holdford Road, Witton, Birmingham 6.

H. F. Applegate (Scientific Instruments), 36 High Road, South Woodford, Essex.

Belgrave (Mercury) Ltd., 5 Belgrave Gardens, London N.W.8 OQY.

Fortronic (Fife) Ltd., 13 Knowehead Road, Crossford, Fife.

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

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

R.S. Components Ltd., P.O. Box 427, 13-17 Epworth Street, London EC2P 2HA.

Scientific Instruments Ltd., Radnor Street, Glasgow.