SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 77. February, 1975.

Contents

Introduction

The Centre will be closed on Good Friday, 28th March. During the week following, from 1st to 3rd April we will stage an exhibition of apparatus in the Appleton Tower, Edinburgh, where this year's annual meeting of the Scottish Branch A.S.E. will be held. On the morning of Tuesday, 1st April we will give a lecture demonstration on new apparatus and techniques for science teaching. During the A.S.E. meeting the Centre will remain open.

Opinion

"The greatest danger is not that people don't know about a particular hazard, it is that they don't know they don't know."

This seemingly obtuse, but in fact very sensible remark was made by one of the speakers at a recent conference on safety in biology which one of our staff attended in Manchester. The moral would seem to be that if one is to use an unfamiliar chemical or material one should, as a matter of course, seek information on possible hazards before beginning any experimental procedure. It is one thing to confess ignorance to ourselves and then seek a remedy to plug the gap in our knowledge. It is another thing to ignore the gap, or not even be aware of its existence.

Safety is a very fashionable subject, indeed some teachers may be growing tired of the prominence given to it in these pages. However the attention paid at the moment to safety matters is probably a healthy swing of the pendulum reflecting the comparative neglect of former times. Unfortunately when a subject becomes fashionable another phenomenon arises - not those who don't know they don't know but those who don't know but are jolly well convinced that they do! This is of nuisance value only on most occasions, but it can increase general confusion. False information and non-existent hazards can begin to outnumber or obscure very real sources of danger.

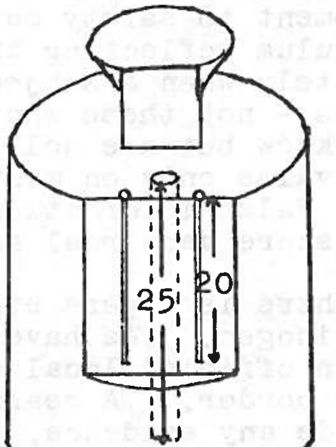
Take the tale of ninhydrin. There is a persistent and widely held belief that ninhydrin is a carcinogen. We have heard of this from a number of sources including an official local education authority circular from south of the border. A search of our fairly extensive references failed to provide any evidence. A discussion with Dr. Dewhurst of the School of Biology, City of Leicester Polytechnic, and author of a number of articles on carcinogens in laboratories revealed two things. Firstly the belief is common amongst teachers in England and Wales. Secondly the lack of evidence for carcinogenic properties is just as striking. As a result of this discussion Dr. Dewhurst approached one of ICI's safety officers who kindly checked a recent literature search. We quote from Dr. Dewhurst's letter to us on the results.

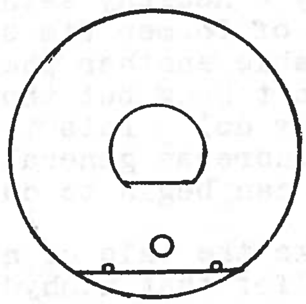
"I followed the ninhydrin point ---- and could find nothing in a survey, carried out in May, 1974 by ICI, to suggest any reason for suspecting ninhydrin was a carcinogen. The fact that ICI's literature survey confirms our own lack of findings strengthens still more my belief that we have here one of the folk myths of modern science. It is nice to know that we have not cut ourselves off from the irrational roots from which our science first sprung."

It would be nice to end at that point, but we, being caught in the same trap as everyone else, feel it necessary to add that although not a carcinogen as far as has been proved ninhydrin is however toxic and a very potent irritant.

Chemistry Notes

In the article in Bulletin 76 on the melting point apparatus we omitted to indicate that the edge of the brass weight nearest to the small holes which take the melting point tubes is filed or ground down until the tube is just visible along its length. In this respect two of our diagrams may also have misled our readers, and we reproduce them more accurately below. The holes for the melting point tubes should initially be drilled as near to the outside edge of the block as possible, in order to reduce the amount of filing to be done. We apologise to anyone who has had doubts or difficulties over the construction of the apparatus.





Dimensions in mm
Not to scale

Physics Notes

The following items of surplus equipment are still available, and from item 498 onwards we give details of items not previously listed. Customers should note that some items which were out of stock, e.g. Teltron tubes items 399 - 402, and NCR adding machines, item 444 are again available. For items previously notified, the number in brackets gives the bulletin in which details will be found.

Item 371.	(67)	Motors, £1 - £2.
Item 375.	(67)	Wire recorder, £5.
Item 379.	(67)	Tuning fork, 50p.
Item 381.	(67)	Heating elements, 5p.
Item 396.	(67)	Fluorescent lamp shades, 10p.
Item 399.	(67)	TEL 521, planar triode, £8.
Item 400.	(67)	TEL 523, Maltese cross tube, £9.
Item 401.	(67)	TEL 524, Perrin tube, £9.
Item 402.	(67)	TEL 525, deflection e/m tube, £13.

Note: for additional Teltron tubes, see items 556-559.

Item 417.	(69)	Fan units, £1 - £5.
Item 418.	(69)	Nasal spray, 30p.
Item 434.	(72)	Pipettes, 1 ml size only, 10p.
Item 436.	(72)	Developer, 10p.
Item 437.	(72)	Fixer, 10p.
Item 438.	(72)	Linagraph paper, 50p.
Item 444.	(72)	Adding machine, £2.
Item 445.	(72)	Tape printing machine, £1.
Item 451.	(72)	Nylon gears, 5p.
Item 475.	(74)	Moving coil meter, 100 µA, £1.50.
Item 476.	(74)	" " " 200 µA, £1.50.
Item 481.	(74)	" " " 1.5 mA, £1.50.
Item 482.	(74)	" " " 50 V a.c. £2.
Item 483.	(74)	Electrostatic voltmeter, £2.
Item 485.	(74)	Steel calipers, 10p.
Item 486.	(74)	Cellacetate sheet, 10p.
Item 487.	(74)	Desk telephones, £1.
Item 490.	(74)	Auto-transformer, £2.
Item 491.	(74)	Capacitor, 10 µF, 10 kV, £1.
Item 493.	(74)	Telephone switchboards, £1.
Item 494.	(74)	Transistors, 1p.

Item 495. (74) Power transistor and heat sink, 10p.

Item 496. (74) Mouse cage top, 20p.

Item 497. (74) Rat cage top, 30p.

In items 498 to 501, the meters will have a derived calibration unless it is stated as 'true'. If the scale divisions are non-linear, this is stated.

Item 498. Moving coil meter, 50 V d.c.; 75 mm scale, true, £1.

Item 499. Moving coil meter, 5 A d.c.; 50 mm scale, true. £1.

Item 500. Moving coil meter, 1 mA; 240° scale 170 mm non-linear, £1.50.

Item 501. As item 500, but f.s.d. 1 A, £1.50.

Item 502. Multi-way connectors, both halves, 10p.

Item 503. Multi-core cable; 1.5 m of 53 separate p.v.c. insulated stranded wires, colour coded, 5p.

Item 504. Silicon diode, 200 p.i.v. 750 mA, 1p.

Item 505. Mixed value potentiometers, mostly carbon track, but some may be wirewound, pack of 20, 30p.

Item 506. Mixed value resistors, 5% tolerance, pack of 40 - 50, 10p.

Item 507. Mixed value resistors, tolerance 2% or better, pack of 25 - 30, 10p.

Item 508. Twin-ganged potentiometer, linear, 10 kΩ or 25 kΩ, 10p.

Item 509. Coaxial shaft potentiometers, 1 MΩ + 5 MΩ, 10p.

Item 510. Wire-wound potentiometer, 25 Ω, with double pole switch, 10p.

Item 511. Large (80 mm dia.) track wirewound potentiometers, 1 kΩ, 10p.

Item 512. Wirewound potentiometer, 590 Ω 0.29 A with pointer knob and 100 division scale, 10p.

Item 513. Ten turn, centre-tapped potentiometer, 1 kΩ, 50p.

Item 514. As item 513, 5 kΩ, 50p.

Item 515. Rheostat tubular, track length 280 mm. No slider but one pre-set contact; 19 Ω, 5 A; 20p.

Item 516. As item 515, track length 210 mm; 3.9 Ω, probably 10 A rating, 20p.

Item 517. Fracmo motors, 115 V, 60 Hz, 1750 r.p.m. worm reduction gear; ratio approx. 100 : 1, 50p.

Item 518. Transformer, 240/115 V, 500 VA, £1.

Note: We have many other items of electrical or electronic nature e.g. switches, relays, ex-equipment panels containing diodes and transistors etc. Specific enquiries are invited or better, call in and see for yourself.

Item 519. Regulated Power supply, variable low voltage, by International Electronics. Consists of two 50 V, 2A supplies which can be supplied separately, in series or in parallel. Separate output ammeters, single voltmeter. One supply operative, the other repairable. With operating instructions and circuit diagram, £3.

Item 520. Digital voltmeter, type LM902 by Solartron. 4 digit read-out, capacity 1 mV to 1000 V in 7 switched ranges. Input impedance 1 MΩ/V. Intermittent fault which may be repairable; with operating instructions and circuit diagram, £3.

Item 521. Digital voltmeter, type BIE2114 by Blackburn Electronics. 4 digit readout, range 1 mV to 1000 V with floating decimal point. Input impedance 50 mΩ. Repairable; probably a faulty relay. With operating instructions and circuit diagram; weight 33 kgf, £3.

Item 522. Transistorised d.c. amplifier by Rank; ranges 10 V/10^{-7}A; 1 V/10^{-8}A; 0.1 V/10^{-9}A; 10^{-10}, 10^{-11}, 10^{-12}, 10^{-13}A; 10^{-8}, 10^{-9}, 10^{-10}C. Operation has been checked on least sensitive ranges only, calibration may be faulty. Requires a 1 mA moving coil meter as detector. £5.

Item 523. Electrometer type 33C, by Electronic Instruments; measures current to 10^{-16}A and resistance to 10^{18} Ω; large scale (100 mm) output meter and output socket for recorder connection. Not in working order; with operating instructions and circuit diagram, £3.

Item 524. Transistor Analyser, Mark 2 by Avo. Not tested, because it requires 14 type T11 dry cells. With operating instructions and circuit diagram, £5.

Item 525. Dry battery, 9V, PP9 size, 3p.

Item 526. " " 9V, PP6 size, 3p.

Item 527. " " 1.5 V, Ever-ready, 1p.

Item 528. " " 1.5 V, No. 14, 1p.

Item 529. " " 1.5 V, No. 5, 1p.

Item 530. " " 4.5 V, Ever-ready, 3p.

Item 531. " " 6 V, No. 6, 1p.

Item 532. " " 18/1.5 V, 1p.

Item 533. " " 150 V, No. 1, 1p.

Item 534. " " 90/7.5 V, No. 1, 3p.

Item 535. " " 90/45/1.5/-3 V, 3p.

Item 536. " " 150/3 V, No. 1, 5p.

Item 537. Fixer, ammonium thiosulphate powder, to make 5 l working solution, 20p.

Item 538. Developer, Johnson's D19 to make 13.5 l working solution, 50p.

Item 539. Developer, Johnson's PQ, to make 4.5 l working solution, 20p.

Item 540. Developer, Johnson's ID type 11, to make 4.5 l working solution, 20p.

Item 541. Developer, M and B Prodox hydroquinone, to make 4.5 l working solution, 20p.

Item 542. Colour film chemicals, Kodak process E4, 1st Developer, to make 13.5 l working solution, 50p.

Item 543. As above, process E4, Unit 1 to make 600 ml working solution, 20p.

Item 544. As above, process E3, Unit 1 to make 2 l working solution, 50p.

Item 545. As above, process E3, Unit 2, to make 2 l working solution, 50p.

Item 546. Bromide paper, Kodak IFL3D hard, 12 x 15 in, pack of 10 sheets, 25p.

Item 547. As above, IFL2D normal, 16 x 20 in, pack of 10 sheets, 50p.

Item 548. As above, WSG1S soft, 12 x 15 in, box of 100 sheets, £2.50.

Item 549. As above WSG2S normal, 12 x 16 cm, box of 100 sheets, 50p.

Item 550. As above WSG4S extra hard, 10 x 10 in, box of 100 sheets, £1.50.

Item 551. Monochrome film, Kodak TXP120, 400 A.S.A., pack of 5 rolls, 25p.

Item 552. Monochrome film, Polaroid type 57, 3000 A.S.A. (recommended in P.I.F. book4, p. 182), pack of 10 exposures, 50p.

Item 553. Eyeshields, cellulose acetate (Anti-Gas W.W.II), proof against acid or alkali splashes, clear or tinted, 1p.

Item 554. Polythene bottles, rectangular, 110 ml capacity, screw cap seal, 1p.

Item 555. Polythene drums, 50 l capacity, with 60 mm dia screw cap and carrying frame, 25p.

Item 556. TEL 520, planar diode, £7.

Item 557. TEL 522, luminescent tube £8.

Item 558. TEL 534, double beam tube, £15.

Item 559. TEL 532, gas filled triode, £10.

Item 560. Book-keeping machine, type 160, by National Cash Register. This can be programmed to add or subtract various entries, which are printed out, along with the final balance along the width of the carriage. We cannot see a use for this in the Science Dept., but perhaps your Business Studies colleagues would like to know. Price £1.

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A mistake crept into our description of an apparatus to demonstrate thermo-electric effect, in Bulletin 76, page 9. The phrase in the sixth line from the top of the page should read "so that the upper plate can be hung ----".

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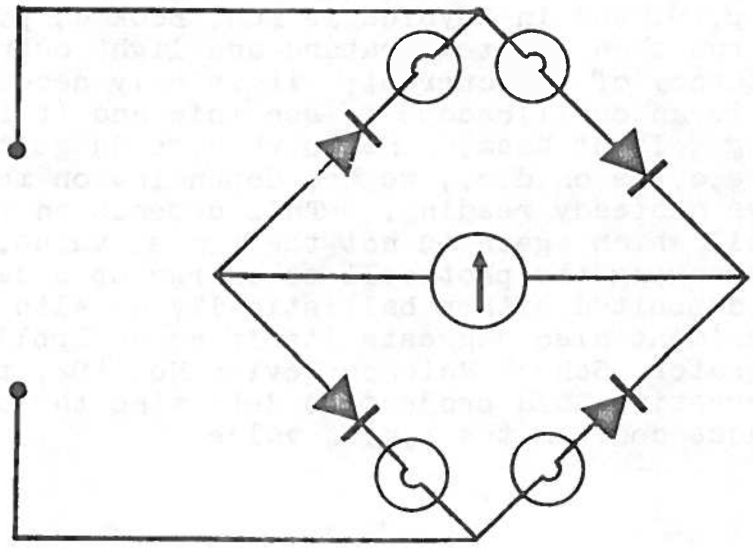
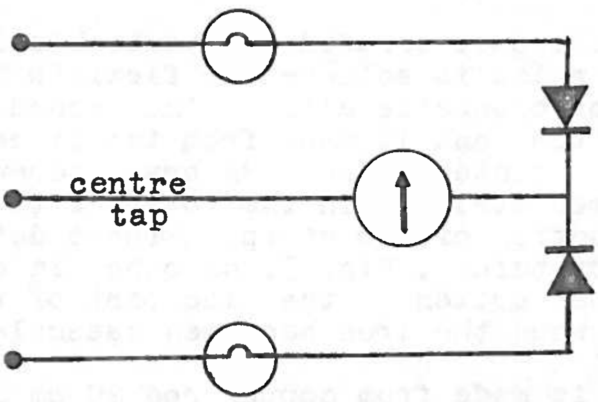
The design for the following apparatus to show the current path at different parts of the cycle in bridge rectification was sent us by a teacher in Ardrossan Academy. The baseboard for the model is a piece of plywood, 30 x 40 cm, painted white. The circuit is drawn on this with black felt pen, the length of side of the square forming the bridge being 18 cm. The symbol for a diode, but not for a lamp, is drawn on the board; this because the diodes may be too small to see, whereas the lamps will be obvious to all. 2.5 V, 0.3 A M.E.S. lamp bulbs were used in their proper holders, and any low power diode capable of passing the necessary current can be used. All components are mounted on the front of the board, in their correct position in the diagram, but all wiring is behind. The meter is a centre-zero 1-0-1 mA, shunted by trial and error method to give a peak deflection which is nearly full scale, and with the lamps giving correct brightness. The input is through a pair of 4 mm sockets.

The input is supplied from the rotary resistor type of very low frequency generator, fed from Nife cells or a similar source. For the lamps specified, we found that 6 cells, i.e. about 7.5 V, was suitable. If a meter of size suitable for demonstration to a class is used, then its pointer will have sufficient inertia to enable the teacher to illustrate the distinction between peak and average current. The rotary resistor can be carefully adjusted to achieve peak current, and stopped at that point so that the current may be noted. Then if the resistor is turned at any reasonable speed, the pointer will hover around a lower value, the average current. The point is worth making because many commercially produced low voltage power units deliver a bridge-rectified output.



A visitor to our display laboratory has suggested that the functions of lamp as indicator and diode as rectifier can be neatly combined in the one component, viz. the light emitting diode. Suitable l.e.d.s are available at 32p from R.S. Components and some may wish to experiment with this version of the apparatus.

Finally the designer suggests that if a centre tap be soldered to the rotary resistor having first scraped off the enamelling on the appropriate part of the wire, it becomes possible to use a similar apparatus to show full-wave rectification. The circuit is shown below.



At one time, full-wave rectification using a double diode valve was by far the most common method of obtaining d.c. from a.c., but since the invention of the high powered silicon diode, this place has almost certainly been taken by bridge rectification. This raises the question of whether it is necessary, or even desirable, to illustrate full-wave rectification. Some pupils, having seen and discussed half-wave rectification may themselves suggest the full-wave circuit, and it is nice to give them the satisfaction of having their thinking confirmed by a working model.

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We have a note from Dr. Dennis Beard of I. for E., questioning the validity of the experiment to establish the equivalence of d.c. and a.c. using a photometer, as described in CSYS Memorandum No. 10, Alternating Current, p.19, and in Physics is Fun, Book 4, p.105. If the lamp is properly run then its temperature and light output fluctuate at the frequency of the current; it is only necessary to couple the photocell to an oscilloscope to see this and it is of course a method of modulating a light beam. Hence when we judge the lamp to be 'as bright' on a.c. as on d.c., we are depending on meter inertia and/or damping to give a steady reading. This depends on the average force on the meter coil which again is not the r.m.s. value. Dr. Beard suggests arranging the photocell to charge up a capacitor, measuring the charge deposited either ballistically or with a d.c. amplifier. The experiment also suggests itself as an application of the op. amp. integrator, School Science Review No. 192, p.556, and it could make an interesting CSYS project to determine the extent to which the apparatus does confirm the r.m.s. value.

In The Workshop

The handle of this soldering iron is a wooden file or tool handle, measuring 130 mm overall length, which must be split down the middle. Fig. 1 shows the cutting required on the two opened-out halves. The connectors referred to, which join the bit to the remainder of the iron were taken from R.S. Components 12-way terminal block, 2 A rating. The assembly drawing of Fig. 5 shows that these protrude half-way out of the handle so that the bit fixing screws are accessible and it is an easy matter to remove and replace a bit.

One of the connectors is screwed to a suitable length of 3 mm brass rod, the other end of which is soldered to flexible 10 A cable terminating in a 4 mm plug or crocodile clip. The second lead must incorporate a simple press switch, and is made from two pieces of 18 SWG copper, 5 mm wide. The switch contacts are 8 BA brass screws, silver soldered into holes in the copper strip. In the lower of these the screw is filed flush with the bottom of the strip. These details are shown in Fig. 2. A piece of tufnol, Fig. 3, or other insulating material is turned to make a push button; the disc part of this rests on the end of the 8 BA screw when the iron has been assembled.

The bit, Fig. 4, is made from copper rod 20 mm long, turned down to 5.5 mm and drilled with a No. 21 drill. The heating element is made from 26 SWG nichrome wire, by making a double turn around a No. 28 drill. This is then squeezed in a vice to elongate it and so allow it to fit into the bit without touching the sides. Two copper extension pieces of 18 SWG wire are silver soldered to the end of the element; the length of nichrome wire to where it joins the copper is 40 mm.

When assembling the element into the bit, a small piece of Rocksil or glass wool is put in the hole first. The element is then dipped into a paste of dental cement, or other similar hard-setting heat-resisting plaster, and inserted into the bit. More of the same cement is packed tightly into the hole. Care should be taken to avoid shorting two parts of the element together e.g. through contact with the side of the hole. Contact at one point of course does not matter as this is a low voltage iron and there is no danger of electric shock.

Twenty four hours should be allowed for the dental cement to harden before using the bit. Various sized bits can be made using the same size of element though it will be obvious that there are limits. The larger the bit the longer it will take to heat up and if one makes a more powerful element to counteract this the greater the drain on batteries. Powered by a battery of 2 Nife cells, giving 2.4 V, the iron takes 3.8 A current and requires 30s to reach working temperature. Obviously therefore it is a light duty iron, suitable only for electronic work on printed circuits and such.

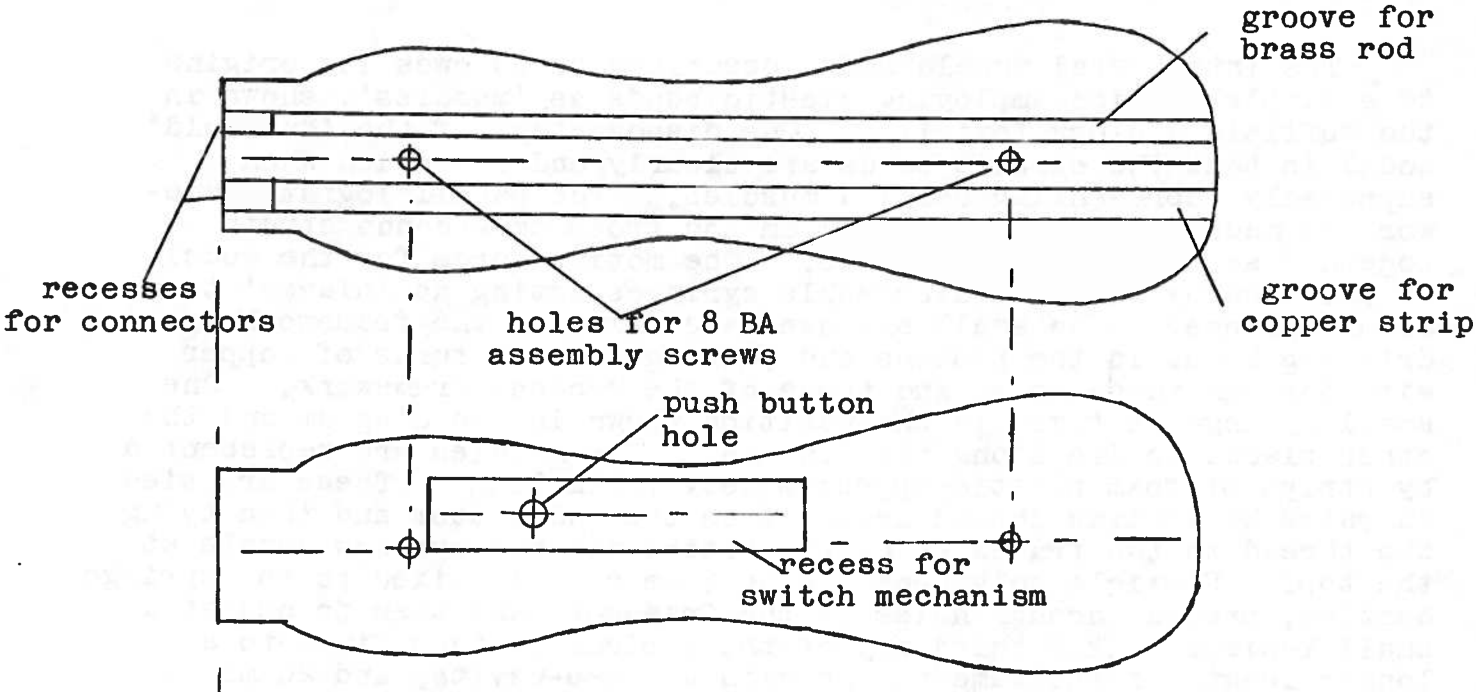


Fig. 1. Plan. Inside view of both halves.

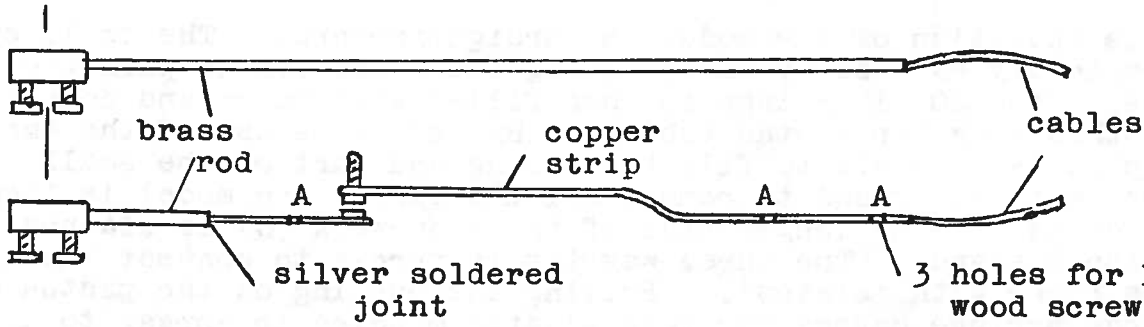


Fig. 2. Elevation. Connectors and switch mechanism.

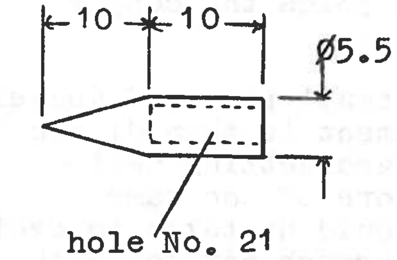
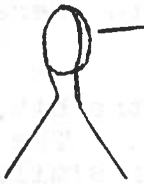


Fig. 4. Bit details



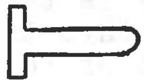


Fig. 3 Push button

Dimensions in mm.

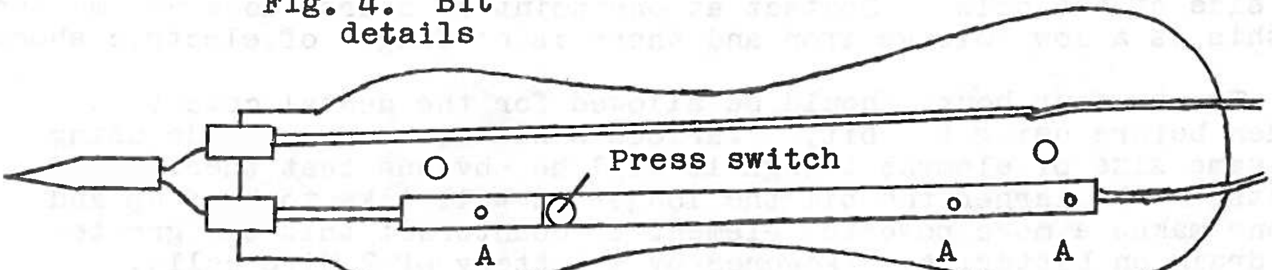


Fig. 5. Assembly

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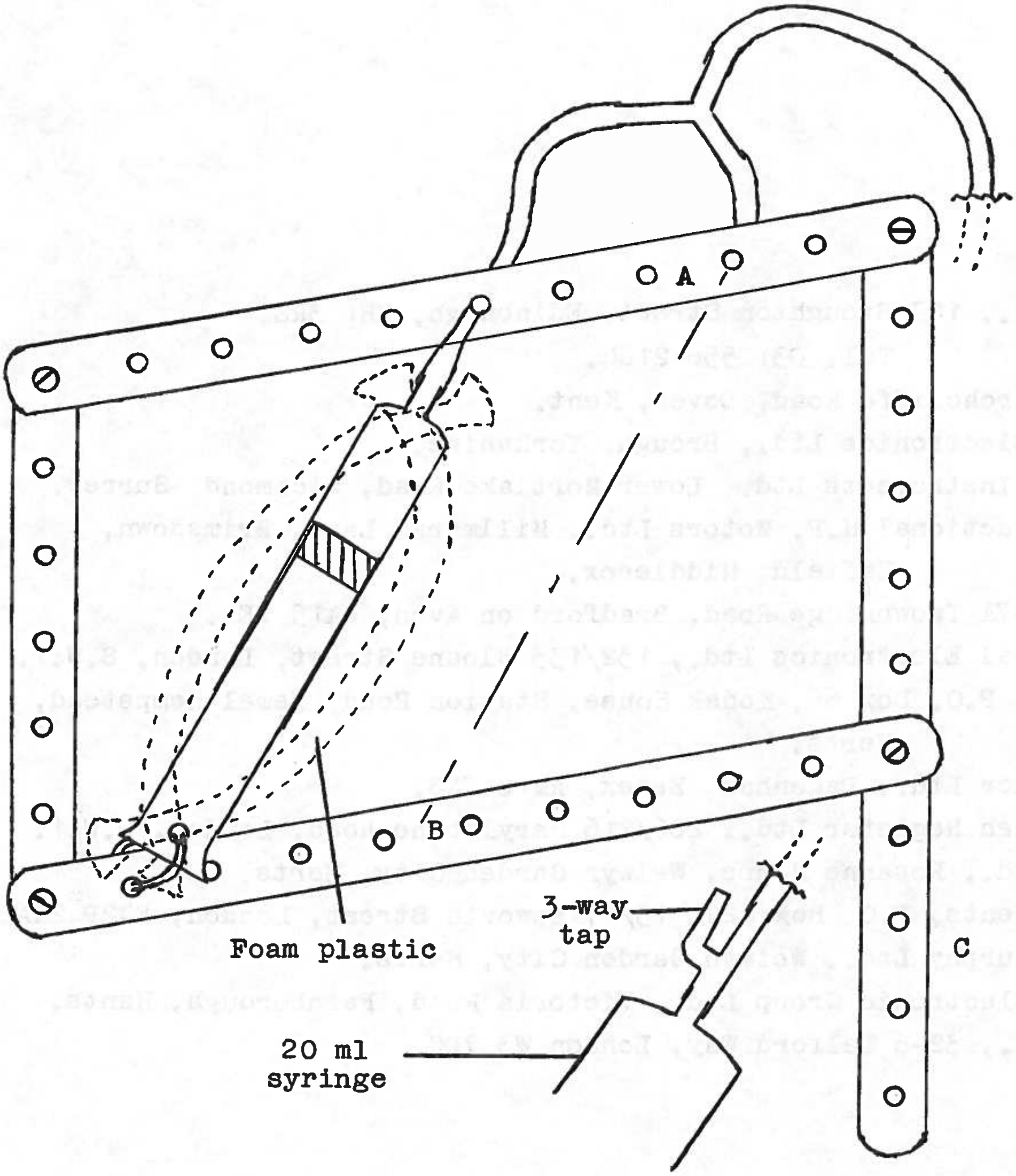
The intercostal muscle model described below owes its origins to a simple version employing elastic bands as 'muscles', shown in the Nuffield Biology Text III. One disadvantage of the 'Nuffield' model is that the elastic bands are clearly under tension when supposedly representing relaxed muscles. The parallelogram framework is made by bolting three 14 cm and two 9 cm Meccano struts together as shown in the diagram. The motive force for the model is provided by two 2 ml disposable syringes acting as 'slaves' to a 20 ml syringe. The small syringes are fixed to the framework by drilling holes in the pistons and passing several turns of copper wire through these holes and those of the Meccano framework. One small syringe is fixed in the position shown in the diagram and the other placed to lie along the line AB. The muscles are represented by strips of foam plastic approximately 12 cm long. These are tied in pairs by winding thread around them top and bottom and then tying the thread to the framework at the bottom and the syringe nozzle at the top. Flexible polythene tubing 5 mm o.d. is fixed to the syringe nozzles, passed through holes in the framework and then joined at a small Y-piece. The third arm of the Y-piece is then fixed to a longer length of the same tubing with a three-way tap and 20 ml syringe fitted as shown. The three-way tap allows the easy removal of air from the apparatus.

The operation of the model is straightforward. The small syringes are completely emptied by manipulating the framework to push the ribs upwards. The 20 ml syringe is then filled with water and connected to the three-way tap on the tubing. By judicious use of the three-way tap it is possible to fill the tubing and part of the small syringes with water and to remove all the air. The model is then ready for use. The longer side of the framework (C) is clamped on a retort stand. The three-way tap is turned to connect the large syringe with 'slaves'. Pulling and pushing on the piston of the large syringe causes the foam plastic muscles to appear to contract and relax and the 'ribs' to be raised and lowered.



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Some teachers and technicians may not be aware that iron wire gauze may be used to abrade glass tubing which has broken unevenly. In this way jagged edges may be removed and the rim evened up so that after flame polishing it will take a stopper. Besides ordinary glass tubing, the writer has used the method on test-tubes, measuring cylinders and burettes. The tube is held at about 45^{o} to the vertical, jagged edge upwards and pointing away from the body. The gauze is held between all four fingers and thumb, palm downwards of the other hand and the edge is struck a glancing blow in the horizontal direction, outwards from the body using that part of the gauze which is under the fingers but beyond thumb reach. Repeated blows will abrade down the edge, each time turning the tube slightly in order to strike a different part of the edge.

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

Avo Ltd., Archcliffe Road, Dover, Kent.

Blackburn Electronics Ltd., Brough, Yorkshire.

Electronic Instruments Ltd., Lower Mortlake Road, Richmond, Surrey.

(Fracmo) Fractional H.P. Motors Ltd., Millmarsh Lane, Brimsdown, Enfield, Middlesex.

I. for E. 87A Trowbridge Road, Bradford on Avon, BA15 1EE.

International Electronics Ltd., 132/135 Sloane Street, London, S.W.1.

Kodak Ltd., P.O. Box 66, Kodak House, Station Road, Hemel Hempstead, Herts.

May and Baker Ltd., Dagenham, Essex, RM10 7XS.

National Cash Register Ltd., 206/216 Marylebone Road, London, N.W.1.

Polaroid Ltd., Rosanne House, Welwyn Garden City, Herts.

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

Rank Bush Murphy Ltd., Welwyn Garden City, Herts.

Solartron Electronic Group Ltd., Victoria Road, Farnborough, Hants.

Teltron Ltd., 32-6 Telford Way, London W3 7DH.