SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 127 April 1981

Bulletin 127. Random Access Memory

We regret that the diagram on page 7 is incomplete. As it stands there are no connections between the 7493 counter and the 7475 latch. To make it work the following additional connections must be made:

counter		latch
pin 12	to	pin 2
" 9		" 3
" 8		" 6
" 11		" 7

Contents

Introduction

Perhaps because of the tight financial situation, we have had no more than a trickle of orders for the conversion of a cassette recorder to make it operate with language laboratory tapes, which we mentioned in Bulletin 124. Nonetheless it has been sufficient to make us realise the nature of the difficult bits of the job, and to decide that, such is the limitation of our draughtsman's expertise, it would be as quick to do the job ourselves as to explain for every different make of recorder how the existing tape head is to be changed for a double track one. The physical shape of the two heads and the positions of their fixing screws are often different, and likewise the adjustments are usually different for each type of recorder. Amongst those we have converted so far we have not found two the same. At present it costs a school £20 to have this done, and on average the instrument will be returned within 2-3 weeks. As we have no direct means of making this information available to modern languages departments, perhaps schools with language labs. could be advised of this service through the staff noticeboard, or a note to a colleague.

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This bulletin will be the last to come to you personally, in an addressed envelope, unless you are a "non-regional" reader, for whom the existing arrangements will continue. The Governing Body have had another look at our bulletin distribution, and decided that each parcel of bulletins to a region (or division in Strathclyde) will have loose copies, and that we shall attach a sheet saying 'Inversnecky Academy - 3 copies' etc. They have further decided that the maximum number of copies per school will be three, something which will hit hardest at those schools where the principal teacher of technical studies, and the principal teachers of biology, chemistry and physics at present all get their own copy.

Future bulletins will therefore arrive unaddressed in the secretary's office, and we hope to be able to attach on the cover a notice advising that bulletins be circulated to teachers and technicians in science and technical studies. Thereafter every school is on its own, and we can only hope that some system of circulation satisfactory for all concerned can be devised.

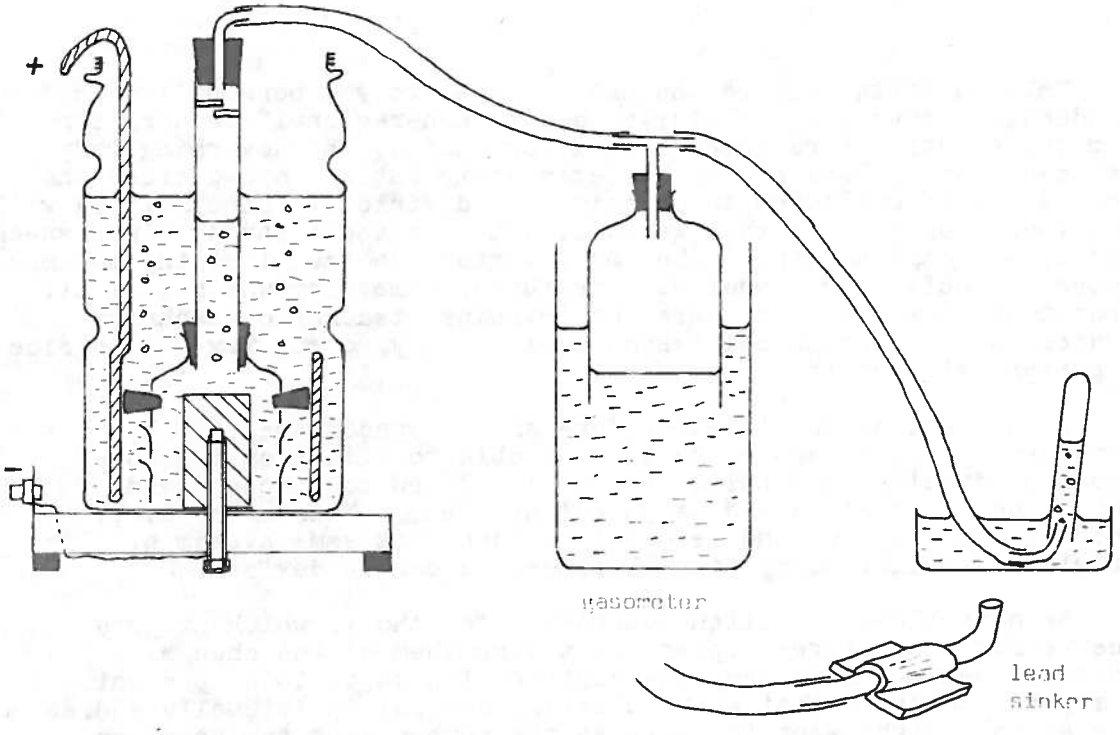
We have already written separately to schools which at present receive more than three copies, to advise them of the change. Otherwise we intend to keep the distribution as it is at present. It may be, however, that when bulletins are not individually addressed, some schools might want to increase the number sent to the school from one to two or three. In this case they must tell us.

Apart from the three copy maximum, none of the foregoing applies to Orkney and Highland regions, who will continue to have bulletins personally addressed to the school.

This bulletin also introduces our logo, and a reduction in paper size, the latter being agreed by the Governing Body after we had tested various diagrams with the printers to see that there would be no loss of clarity as a result.

Chemistry Notes

The design for this hydrogen generator is based on a model sent to us from Auchinharvie Academy, where the generator has been in use for some time. It has also been featured in a Science Newsletter in Ayr Division. One unfortunate practical aspect of making hydrogen from zinc and acid is that as the reactants are consumed, the initial high rate decreases and this can lead to a queue of pupils. In addition large quantities of acid and zinc will be consumed. A neater way is to generate the hydrogen electrolytically with 4M sulphuric acid as electrolyte and lead electrodes. The cost of producing a mole of hydrogen from technical grade zinc and sulphuric acid is 31p at today's prices; the same amount produced electrolytically consumes about 0.3kWh and costs 2p.



The electrolytic cell was constructed from a BDH plastic container, originally for hazardous chemicals. That used by us was 12cm diameter and 25cm high, but the dimensions are not critical. The centrally located lead cathode is covered by a plastic gas collecting hood to carry away the hydrogen. A ring of sheet lead used as the anode surrounds the hood, but is held some 2cm from it by three bungs used as spacers in order to prevent oxygen bubbles from mixing with the hydrogen. The hood is also attached to this anode so that the weight prevents the hood from rising when it fills with hydrogen.

There is a tendency for fine spray and a froth of acid to rise

up the vertical part of the delivery tube. An anti-splash trap will stop this, but an alternative used by us was to have a length of fairly wide perspex tube (12mm i.d.) as the vertical part of the delivery tube. The bubbles have room to burst without carrying the liquid over and the placing of two overlapping discs near the top catches most of the spray. A further advantage is that any sudden movement of a collecting syringe or reservoir only draws the acid level fairly slowly up a wide tube and the chance of accidentally pulling some acid 'over' into the reservoir is greatly reduced. In the size used by us approximately 1.7 litres of 4M sulphuric acid was adequate.

In the design, 6V from a low voltage power unit produces a current of 4A which in turn produces hydrogen at a rate of 30ml/min. Provided one does not go beyond the continuous load specification for the power unit it is possible to go beyond this, and with a current of 8A the temperature of the electrolyte did not rise above 36°C after 3½ hours in use.

The rate of supply is less than would be needed for dispensing to pupils and an initial supply of several hundred cm^3 can be collected in the reservoir by having the generator switched on some 10-15 minutes before the start of the lesson. The gasometer type of reservoir rises as it fills, the three-way tap being closed to the pneumatic trough. A tube can be filled in the pneumatic trough by momentarily isolating the generator and depressing the reservoir to expel the hydrogen. It was found however that if the three depths of liquid were adjusted the three way tap could be replaced by a T or Y tube connection; the generated gas will fill the rising reservoir without any of it being lost through the delivery tube in the pneumatic trough, and yet pushing the 'gasometer' down causes gas to be expelled only through the delivery tube. This arrangement without the tap is much simpler for pupils, and depths found to be suitable were 19cm in the generator, 15cm in the reservoir and 4cm in the trough. These figures are not critical and some trial and error may be needed. The delivery tubing used was very light (3mm bore and 0.75mm wall in latex rubber) so that movement of the gasometer was not impeded.

To reduce the dead space and hence the problem of displacing all the air (i) light weight narrow bore tubing should be used; (ii) the well of the 'gasometer' should be taller than the inner lid so that initially it can be completely submerged and (iii) the delivery tubing should be connected to the highest point of the reservoir so that the air can easily be displaced by water. The use of wide perspex tube does have the disadvantage in that it provides a fairly large dead space, but this can be overcome by pinching the delivery tube to the trough and then raising the 'gasometer', in order to pull the electrolyte up the tube, and holding it until that level is depressed by the gas being generated.

It will be wise to use this apparatus in the sink as any spillages take care of themselves and also the electrolyte is kept below the level of the power supply. A cover constructed from the original lid or from a piece of hardboard or polythene is needed to catch the fine aerosol spray containing acid.

Physics Notes

A random access memory - RAM for short - is one of the essential parts of a computer. The RAM has a number of locations or cells in which information is kept, each cell containing one bit in the form of a logical 1 or 0. A system is required whereby the information is routed to particular cells. The cells are essentially bistables, capable of keeping a logical 1 or 0 indefinitely, once the information has been written in. Another system is needed for getting out the information in the cells. It is a feature of RAMs that getting the information out can be done without destroying that information in the cell, so that the 'reading' process can be done over and over again if necessary.

The RAM to be described is the SN7489, currently costing £2.10 from Technomatic. Its memory is organised as 16 x 4 bits. This means it has sixteen locations, or addresses, each one consisting of 4 cells. All four cells in an address will have the information written in or read out at once. Because an address contains 4 cells, each address is capable of storing a single digit in binary form, e.g. 1001 represents 9. The addresses themselves can also be accommodated in 4 bit binary, as the highest is fifteen = 1111 in binary. In the same way, the 7489 has four data inputs corresponding to the four cells in an address at which the information can be read in, and another four sense outputs for getting the information out. These four connections correspond, so that the 1 or 0 held in cell 2 will be written in on data input 2, and will be read out on sense output 2. It is a minor complication that inputs and outputs are active low, so that in order to get intelligent information from the RAM the inputs have to be inverted.

The process of putting information into the four cells of an address consists of holding the address inputs steady, ensuring that the required information is present at the data inputs, e.g. 0111 would represent figure 7, and momentarily closing a 'write enable' switch which then puts the information into the cells, where it can be got out from the sense outputs. This has to be repeated for the other addresses so that when the memory is full, it will contain 16 bits of information, each of four bits. To make the RAM into a working design, we need some method of changing addresses, an indicator to show which location we are addressing, and a method of holding the address steady until the input information is present on the data inputs. We also need an indicator to show what information is present at the inputs, and the outputs, and the same indicator, a seven segment display, can be used for both. The schematic diagram for the memory is as below.

Thick lines in the diagram represent a 4 bit connection, with A,B,C,D points corresponding on all the chips. Thus there are four inverters, and 4 leds corresponding to the values 8,4,2,1. The clock produces pulses at a slow rate of about 1Hz, and the 7493 counts them on a continuous cycle of 0 through 15. With the read/write switch, which is a 4-pole double throw type, in the 'read' position as shown, the information from the counter goes direct to the driver and display. On a 0-15 cycle the display when it goes beyond 9 will show a meaningless collection of symbols like ⊏ or ⌐, although one of these, on location 15 is useful as it gives a blank which can act as

a spacer between different numbers. The same information is put to the data inputs of the RAM, so that these have a slowly varying cycle of numbers 0 through 9 and beyond.

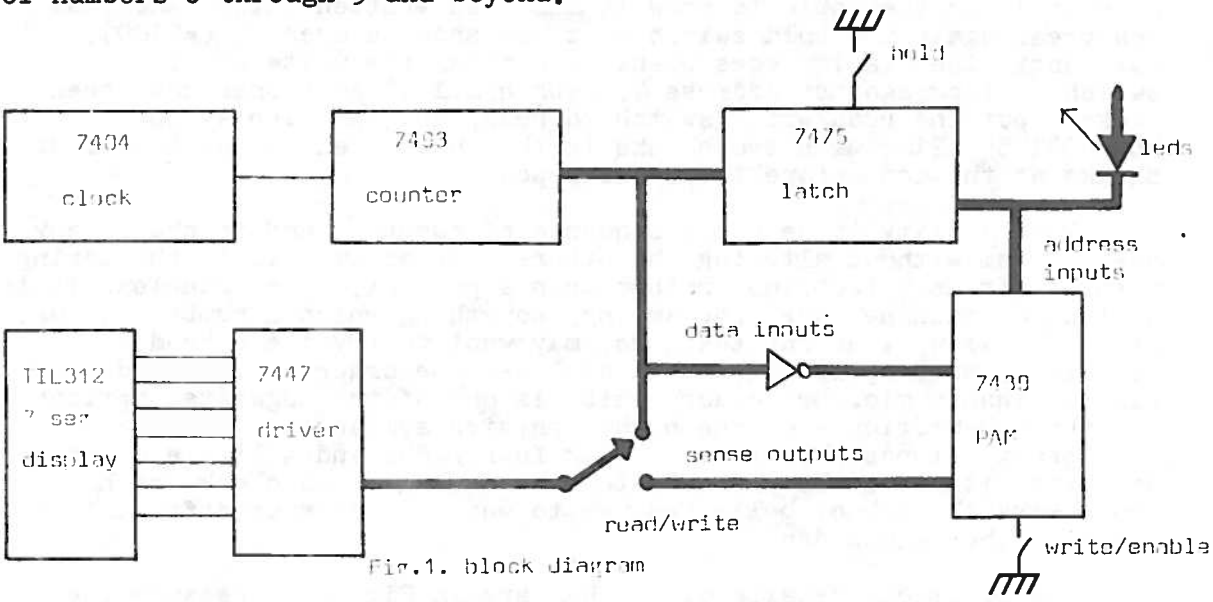


Fig.1. block diagram

The 0-15 cycle goes to the 7475 latch and through it to the address inputs of the RAM. By pressing the 'hold' switch the address is held at one value, which is shown on the four light emitting diodes. The data inputs continue to cycle so that when the data shows the required number on the 7 segment display, the 'write enable' switch is pressed momentarily and the information is written into the address we have chosen. The hold switch is then released to select another address and the process repeated. For success, both the address input and the data input have to be steady before, during and after pressing the write enable switch momentarily, which is why the clock functions at a slow rate.

Getting the information out is simpler; the read/write switch is set to the 'down' position of the diagram, and the display will show the sequence of numbers through the 0-15 cycle of the counter. As was said earlier, the addresses can be written into in any order. To find what information is already in any address, keep the read/write switch in the down position and watch the leds until the required address shows, and press the hold switch. If it is wrong, keep the hold switch pressed but change over the read/write switch, and when the correct information shows on the 7 segment display, press the write enable switch momentarily.

When writing in a sequence of numbers, particularly if it is done in any order, it is sensible if not essential to form a table to show what has been done and what is still to do.

Address No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data in	*	0	3	1	*	5	5	6	*	2	1	8	4	*	*	*

This will give us our own telephone number with blank spaces between the parts, and a longer blank space at beginning and end. The asterisk (*) is used here to show a blank space, corresponding to address 15 on the display. An addressing procedure might go as follows. Press the hold switch - the address shown is 12 (1100 on

the leds). Wait until the display shows a 4, and when it does, press the 'write enable' switch momentarily. Put a tick against address 12 on the table to show it has been written into. Release and press again the hold switch - it now shows address 4 (=0100). Wait until the display goes blank, and press the write enable switch. Tick against address 4. When all 16 addresses have been ticked, put the read/write switch to read, and the display should show 031 556 2184 with two blanks in the number, and a space of four blanks at the end before the cycle repeats.

The facility to select a sequence of numbers, and to change any one of them without altering the others, is hardly a world shattering event. It is a technique rather than a project. Nevertheless it is a piece of machine code programming, something which a number of our students, as well as our teachers, may want to try their hand at. If this seems complicated, it is at least one order of magnitude simpler than a microprocessor, which is one of the suggested options for the new Section R of the higher physics syllabus. There are also practical possibilities. With four 7489s and a little external circuitry it should be possible to make a programmed clock which would work the school bells, enough to work 16 bells at different times of the school day.

The practical details of the RAM are in Fig. 2. Because the 4 bit latch, SN7475 has both Q and $\bar{Q}$ outputs, the Q outputs go to the address inputs, and the $\bar{Q}$ outputs work the leds. These should be located in the same order of the pins as they are on the diagram, with pin 8, the D output, on the left. The display is then that of a 4 bit binary number, with the most significant digit on the left. A four pole, double throw switch for the read/write switch, is available from RS Components. The write enable is a press button, normally open switch, and the hold switch is a SPST type.

The cost of the main components in March was:

SN7404	clock	Technomatic	£0.14
SN7404	inverters	"	0.14
SN7493	counter	"	0.36
SN7475	latch	"	0.38
SN7489	RAM	"	2.10
SN7447	driver	"	0.75
4 x TIL209	leds	"	0.52
TIL312	7 segment display	"	1.10
305-888	voltage regulator	RS Components	0.92
316-995	4 pole DT switch	"	2.08
337-914	enable switch	"	0.64
316-563	hold switch	"	0.58
262-141	bridge rectifier	"	0.26
			£9.97

The current used by the circuit varies from 200-400mA, depending on what indicators are on, so that we thought it worth while to use a voltage regulator. The power supply is Fig. 3.

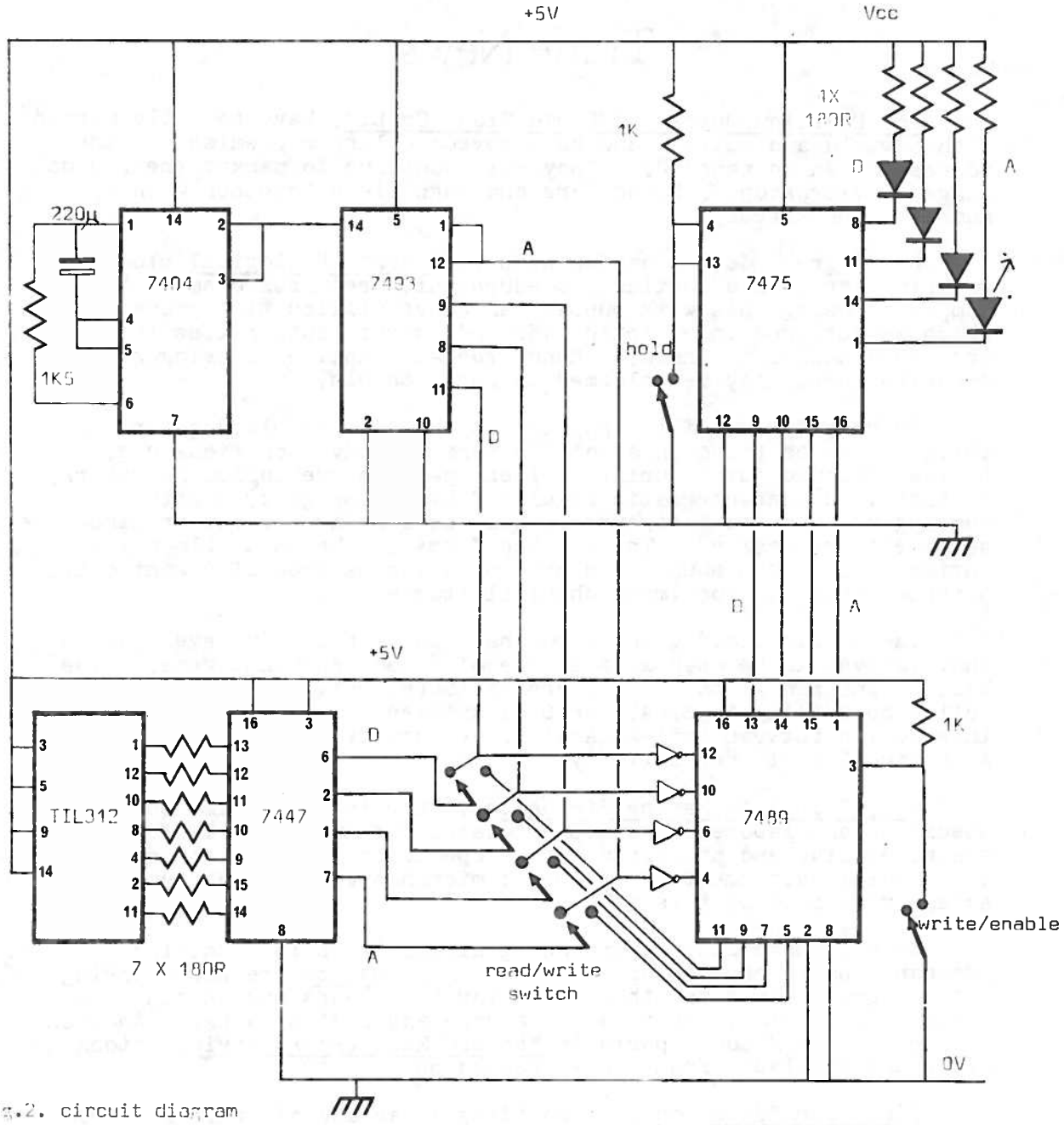


Fig.2. circuit diagram

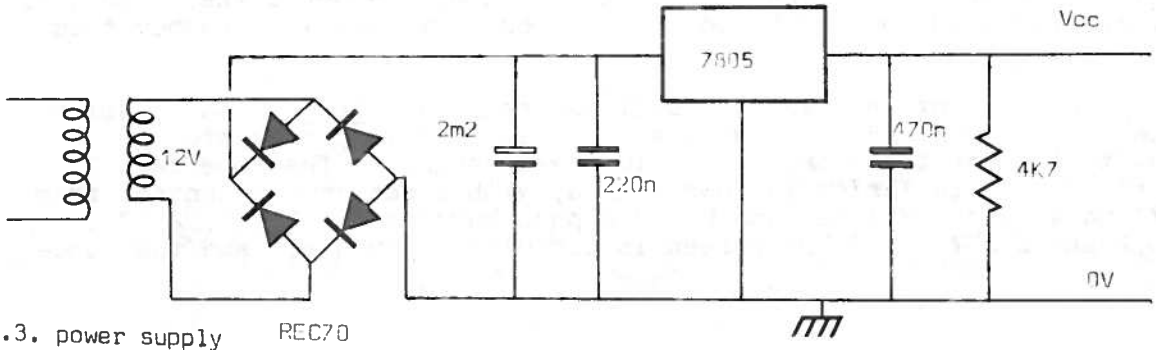


Fig.3. power supply REC70

Trade News

The Parisian Opera and Field Glass Co Ltd. have recently merged with Newbold and Bulford and have moved to larger premises at the address given on page 12. They will continue to market their usual range of microscopes, binoculars and magnifiers together with a number of new items.

Blood group determination with the Harris Biological blood grouping cards is a routine procedure which requires a small blood sample. Using this with pupils can cause difficulties, some of which we outlined in Bulletin 115, and in some authorities the procedure has been banned. Hence the alternative of using saliva, described here, may be welcomed in some schools.

In roughly 78% of the population the ABO (H) blood group antigens can be found in a soluble form in body secretions e.g. saliva, gastric juice, urine. These persons are called secretors, an inherited characteristic regulated by the Se gene. Both homozygous SeSe and heterozygous Sese persons are secretors since the se gene is recessive. The soluble forms of the major blood group antigens have been a useful source of antigens free of unwanted cell membrane material for immunochemical studies.

The Harris blood group cards have been specially developed so that saliva can be used as a source of blood group antigens. The basic principle is that secretors of ABO(H) antigens will produce saliva containing A, B, AB, or O(H) antigens which will block the interaction between Anti-A, Anti-B, or Anti-O(H) preparations and A, B, and O cells respectively.

J.S. Galbraith Marine Biological, have issued their 1981 marine specimens and laboratory equipment catalogue and price list. This describes live and preserved marine specimens; dissection equipment; electronic environmental equipment; microscopes and aquarium accessories sold by this firm.

Schools have been experiencing difficulties in obtaining 'Meccano' parts particularly gears. Economatics are now stocking kits of gears and some other parts for the 'Gears and gearing' section of the 'Science at Work' course and similar work. Another source of some Mecanno parts is Watford Mail Order Service: stock lists are available from the addresses on page 12.

Ideas for Education are providing a variety of items for 'Open Science', one of the many new courses being trialled. Examples include a domestic electricity meter, model electric fire, models of ring mains and earthing board, cat's eyes, various parts of cars such as distributors, H.T. coils, starter motors, flasher units. Many of these items can be purchased locally, but some may wish to buy them ready mounted.

At present we have two oscilloscopes from Albol in the display lab. One, the SB3M, is unusual in that it uses push button switching for the Y input and time base ranges. The time base is from 5ms/cm to 1μs/cm in four ranges, with a continuous control from X1 to X10; the Y input has 6 fixed push buttons for 20, 5, 2, 0.5, 0.2 and 0.05V/cm. The screen is circular, 70mm dia., and the band-

width d.c. to 5MHz. The Y input is a BNC coaxial connector, and a probe ending in 4mm plugs is provided. A necessary but unpleasant feature of push button controls is the verbiage required on the screen to show whether a push button is on a.c. or d.c. + or - trigger etc. The SB3M costs £99.

The SB15M from the same firm costs £142, and has the same screen as the SB3M. The bandwidth is 0-15MHz. Time base is a 20 position switch giving a range of 0.5s/cm - 0.5µs/cm and there is a X5 switch which increases this to 0.1µs/cm. The Y input switch has 11 positions, from 20V/cm to 10mV/cm. Like the SB3M the oscilloscope has a BNC input, but trigger and stability controls etc. are in the form of toggle type switches. One unusual feature of the SM15M is that it can be powered from a 12V battery. The power on battery connection is 25W.

Also in the lab. at present we have the Philip Harris class oscilloscope, cat. no. P63850/5, costing £99. The instrument has a 75mm dia. round screen display, and bandwidth d.c. - 5MHz. Time base frequencies range from 10Hz - 100kHz. An EXT position on the time base, and a horizontal gain control, mean that the oscilloscope can be operated in the X-Y mode for Lissajou figures. Brilliance and focus controls are pre-set potentiometers at the back of the oscilloscope.

We have a note from Philip Harris that their Azlon emergency post for burns (cat. no. C67280/7) does not comply with its description. It is a pain relieving skin spray associated with muscle pain, and is not a burn spray. Obviously education authorities will have purchased these units from Azlon directly or from educational supply companies and will require notification of this breach of product licence. The item was withdrawn from the market as soon as it came under suspicion. In particular, the manufacturer stresses that the spray must not be used on broken skin.

Until the end of June, any school buying a balance from Oertling can obtain a high value book voucher for school text books from Edward Arnold. Any school buying one of the TP, TD, TDS or TS ranges of top pan balance will obtain £120 worth of such vouchers; anyone buying one of the HPα series of dual range electronic balance will get £100, and the Trojan series of single range electronic balance will qualify for £40 worth of vouchers.

We have received the following apparatus reports from Cleapse, which can be borrowed by writing to the Director of SSSERC:

GLU81	Glues and Adhesives
LEV81	Repairs to Philip Harris Lever Balance
L164b	Laboratory Gas Burners
L148a	Chemical Storage
L148b	Chemical Categories and Stocklist
L148c	Chemical Stores
L45	Vacuum pumps

The Japanese single range moving coil ammeter is becoming harder to find, and although they once were a very cheap offer, the price has gradually risen. The only regular supplier whom we know is I.T.T. which has the MR38P (42 x 42mm) in a wide range of values at £5.99, and the MR65P (78 x 86mm) at £7.99. Also, in 1mA value only, the MR38P, renamed MR2P is obtainable from Eagle International at £4.50.

From A Christison we have a note to say that they have resurrected their Gripsafe beaker tongs, and that they are available at £2.95 per pair, or £25 for 10.

Mains electric motors with a very low output speed can be useful for chart recorders etc. From Schuco Scientific one can get peristaltic pump motors for 2, 6 and 10 rev/min output at £6.90, and for 60 rev/min output at £8.90.

In The Workshop

The dimensions of the electrolytic generator are not critical but those given below were the ones used by us which produced hydrogen at the rates given on page 3.

The cathode which is 60mm high and 25mm diameter was made by casting lead in a brass tube which has a brass plate brazed onto the end. A nickel crucible can also be used as a mould and has the advantage that it is easy to reheat the surface in order to get rid of any depressions. The lead block was then drilled and tapped centrally for half its height to take a piece of OBA screwed rod. An alternative is to put a nut at the top end of the rod and embed this in the lead block while it is still molten.

Two thick rubber washers, e.g. from an old car or lorry tyre go on either side of the plastic container to make a seal, followed by a disc of aluminium sheet as a further washer. This is then tightened by a nut recessed into a depression in the wooden base. An exploded view of the mode of attachment is shown in Fig. 2.

The anode is a sheet of lead 2mm thick and 60mm high, being of such a diameter that it was a fairly snug fit in the plastic container. The strap to the top of the container was a piece of the same sheet 25mm wide; the join of the ring and the strap was soldered.

The gas collecting hood was made from a 500cm^3 plastic bottle with the base removed. Around it near the base slits were cut opening upwards to allow a conducting path and yet make the passage of oxygen bubbles into the hood difficult. Three No. 11 rubber bungs were inserted into three holes at approx. 120^0 and pressed into the anode to locate the hood centrally. In addition, two holes were placed near the top of the lead ring to allow a plastic tie to be placed round the neck of the collecting hood. This prevents the hood floating up.

The perspex tube was 90mm long, and 12mm inside diameter. Near the top, two discs from perspex were made to fit inside the tube, a right angle V to the centre was cut in each and these were placed about 2mm apart using perspex cement, so that the cut-away sectors did not overlap. This catches most of the spray. If two holes are made for the anode connection and the perspex tube, the original lid of the plastic container can be loosely fitted on top.

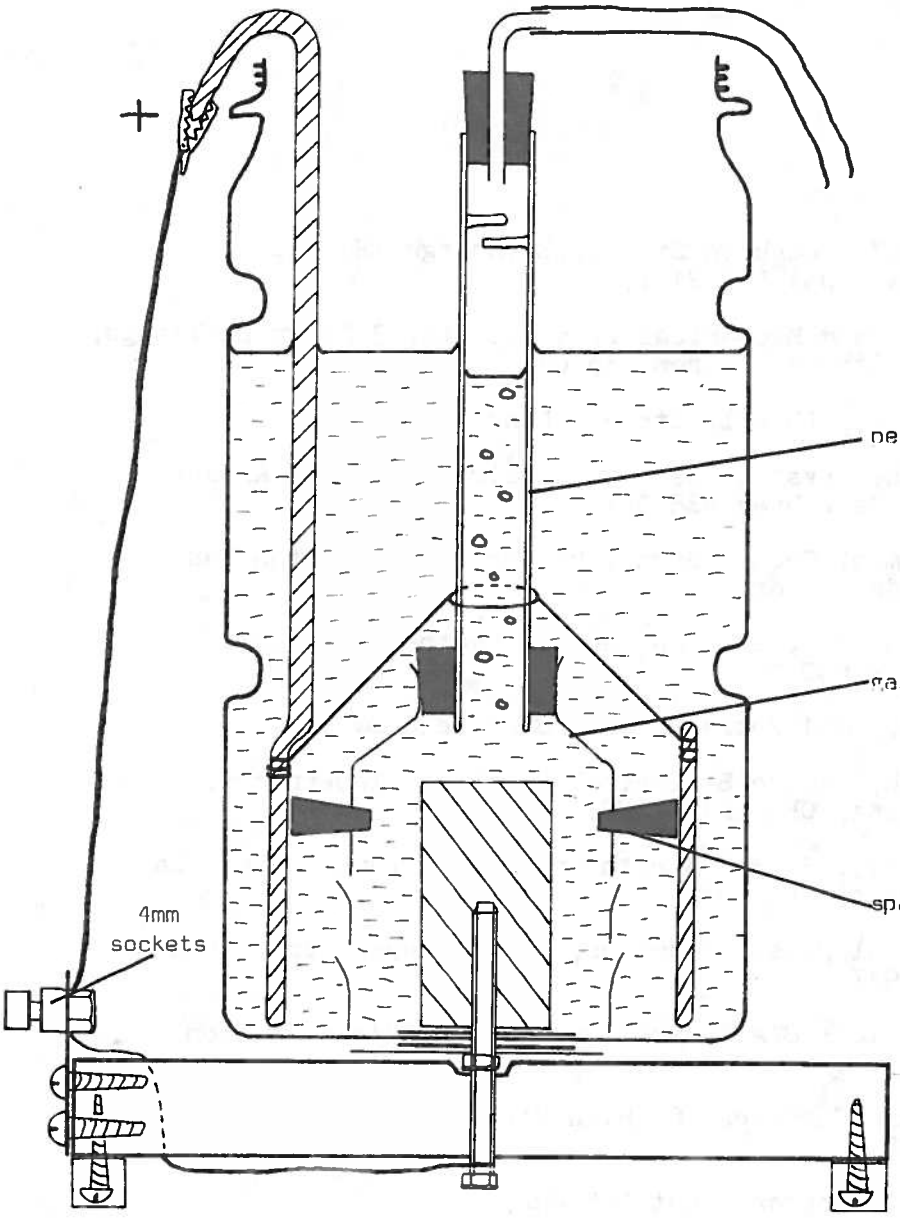


Fig.1. generator

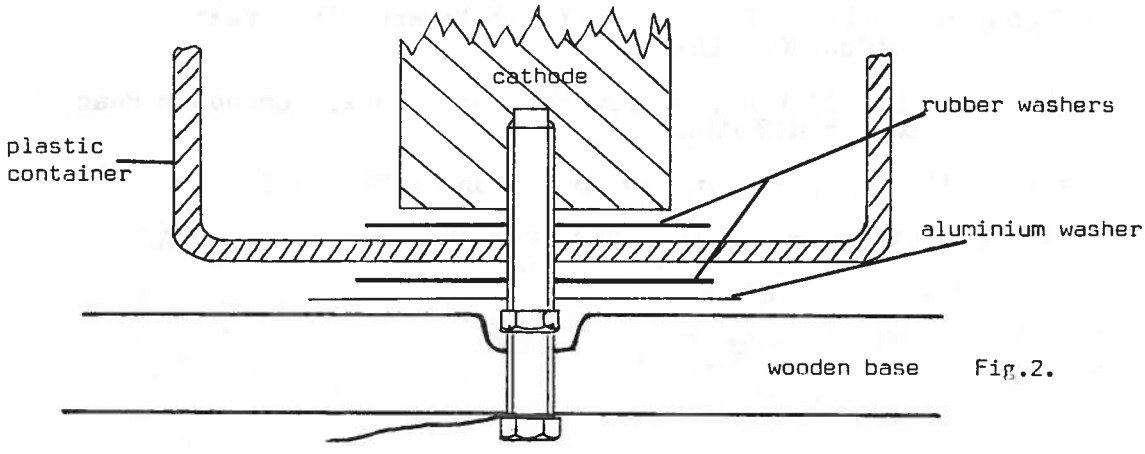


Fig.2.

S.S.S.E.R.C., 103 Broughton Street, Edinburgh EH1 3RZ
Tel. No. 031 556 2184.

Albol Electronic and Mechanical Products Ltd, 3 Crown Buildings, Crown Street, London SE5 0JR.

Edward Arnold Ltd., 25 Hill Street, London W1.

A Christison Ltd., East Gateshead Industrial Estate, Albany Road, Gateshead NE8 3AT.

Cleapse Development Group, Brunel University, Kingston Lane Uxbridge, Mddx.

Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU.

Economatics Ltd., 411 Petre Street, Sheffield S4 8LL.

John S Galbraith, Marine Biological Supplies, Tobernochy, Isle of Luing, Oban PA34 4UE.

Philip Harris Ltd., 34-36 Strathmore House, Town Centre, East Kilbride.

Philip Harris Biological, Oldmixon, Weston-super-Mare, Avon BS24 9AX.

Ideas for Education, 87A Trowbridge Road, Bradford-on-Avon BA15 1EE.

I.T.T. Electronic Services, 62 High Street, Johnstone, Renfrew PA5 8SG.

Oertling Ltd., Orpington, Kent BR5 2HA.

Parisian Opera and Field Glass Co Ltd., Carlton Park, Saxmundham, Suffolk, IP17 2NL.

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

Schuco Scientific Ltd., Halliwick Court Place, Woodhouse Road, London N12 0NE.

Technomatic Ltd., 17 Burnley Road, London NW10 1ED.

Watford Mail Order Service, P.O. Box 168, Watford WD1 5AZ.