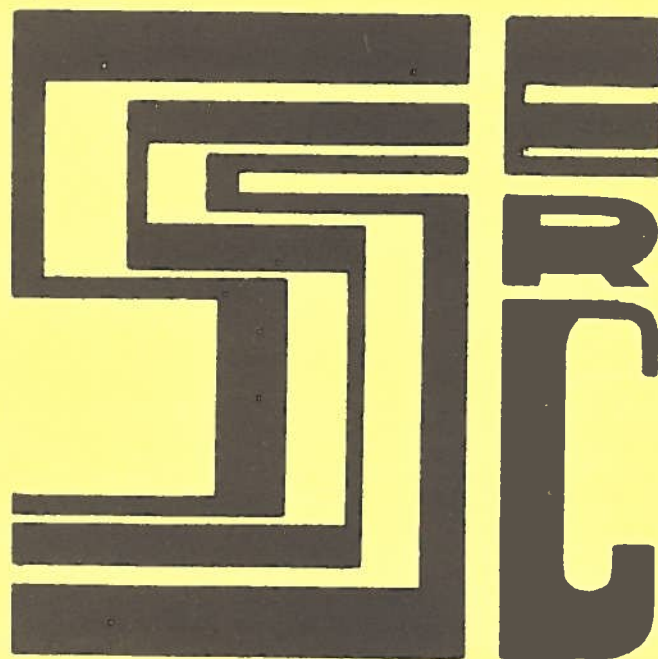


**SCOTTISH SCHOOLS SCIENCE  
EQUIPMENT RESEARCH CENTRE**



Bulletin No 136

June 1983

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- McQuilkin and Co. Ltd., 21 Polmadie Avenue, Thornliebank, Glasgow. Tel. 041-429-7777.
- Metragram Instruments Limited, Radlett House, West Hill, Aspley Guise, Bucks. Tel. (0908) 582262.
- Executive Secretary, The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG.
- Saffron Specialised Plastics, Goldstone Lane, Hove, Sussex BN3 7BB. Tel. (0273) 722286.
- The Salters' Institute of Industrial Chemistry - applications to The Clerk, The Salters' Company, Salters' Hall, Fore Street, London EC2Y 5DE. Tel. 01-588-5216.
- Spiring Enterprises Ltd., Westbrook Lodge, Bognor Road, Warnham, nr. Horsham, West Sussex. Tel. (0403) 790140.
- STC Components, Edinburgh Way, Harlow, Essex CM20 2DE. Tel. (0279) 26811, and:
- STC Electronics Services, 52A High Street, Paisley, Renfrewshire. Tel. 041-889-1711.

## Introduction

### Development Officer

The prospect of an additional SSSERC staff member was touched on in Bulletin 135. A 'Development Officer' post was advertised at about that time. This post has now been filled. We are pleased to welcome Mr. Ian J. Birrel B.Sc., to the staff of the Centre. A definite 'Dunfermliner' and a firm 'Fifer', Ian was educated at Woodmill High. He then crossed the water to attend Heriot Watt and Moray House. After qualifying he returned to his native airt to teach at St. Columba's High in Dunfermline. Ian has taught chemistry, physics and general sciences at all levels for over seven years. His breadth and depth of experience will help us overtake a number of objectives we have been pursuing for several years without notable success. His appointment, the first additional post at SSSERC for more than ten years, will help us offer an improved service and report publishing programme. Ian will be in post by the early part of next session.

### Saturday morning opening

Readers are reminded that, following the practice of recent years, Saturday morning openings will be suspended during the summer break. We will open on the **first two** Saturdays in June. Thereafter the Centre will be open 9-5 p.m. on weekdays only until we restart Saturday opening on the first two Saturdays in September.

### Cost Index

Our cost index for consumables is sampled twice yearly, in May and again in November. The '100' baseline was set in May 1974. In May 1983 it stood at 316.4. Calculation of the percentage increase since May 1983 gives an annual figure of ca.3%. The six monthly figure for November 1982 to May 1983 is approximately 2% (annual rate of 4%).

### Support for research in schools

In Bulletin 132 we indicated the availability of funds from the **Salter's Institute of Industrial Chemistry**. Dr. Alistair Wham and Mr. Hamish Storrie whose 'Electron Direction Indicator' circuit was described in Bulletin 134, were recipients of such an award last year. A total of £2,000 will be available during 1984 for supporting the development of innovations which are designed to improve any aspect of chemistry teaching of pupils in the age-range 11-18.

Those to whom awards are made will be expected to make the results of their work available to other chemistry teachers by, for example, publication in **School Science Review** or **Education in Chemistry**.

Applications from individuals or groups for sur.s of up to £750 should be made on an application form obtainable from the Clerk and which should be returned

to the Clerk not later than 14th October 1983. Applicants will be notified of the result early in December, 1983.

Grants are also still available for scientific research in schools under the scheme funded by the **Royal Society**. Further information can be obtained from the Executive Secretary at the address given on the inside front cover.

## CLEAPSE Guides

We have recently received the following new or revised publications from our sister organisation. (Recently rechristened, for greater ease of recognition, as the "CLEAPSE School Science Service"). Copies of these publications may be borrowed for up to one month by application to the Director of SSSERC.

- L19 "Automatic Graphs - Kymographs Chart Recorders and Electronic methods of recording Time - Dependent Data"
- L130 "Clamps and Stands"
- L161 "Magnets for Primary Schools"
- L59b "LV Power Supplies - Smoothing Units"
- LVU 83 "Repair and maintenance series - "The Maintenance and Repair of Low Voltage Supply Units".

**Review** - "The Gass Book - Gas Applications for School Science"

Jointly published by the British Gas Education Service and ASE this is a large collection of resource material for teachers. We recently purchased a copy and can heartily recommend it as a source of ideas, old and new, for practical investigations and projects on scientific and technical ideas related to the gas industry. "The Gass Book" costs £2.95 from the publications department of the ASE.

## Safety Notes

**"A suspected danger in the preparation of chlorine"**

The attention of readers is drawn to this report, from the Laboratory Safeguards Sub-committee of the ASE. Discussed is a hitherto unsuspected hazard, the formation of dichlorine oxide ( $Cl_2O$ ), during the preparation of chlorine by the action of hydrochloric

acid on sodium chlorate(I) solution. See "Education in Science" April 1983.

### Pipette fillers

There are instances when the very device employed specifically to increase the level of safety brings danger of its own. One good example is the use of pipette fillers designed to prevent accidental ingestion of liquids which has led to several badly cut fingers during the fitting of the pipette onto the filler. This type of accident is akin to that found during the fitting of glass tubing to rubber stoppers or tubing.

We have always felt that the best way round this problem is to use pipette fillers of the types described in Bulletins 32 and 64 and to leave them permanently fastened to the pipettes. The extremely low cost of such devices permits every pipette to be permanently fitted and the only difficulty which may arise is one of storage if the drawers available are not long enough to accept a pipette with filler attached.

Some of the commercially available bulb type pipette fillers have simple devices which greatly reduce the likelihood of this type of accident. One type has a spring loaded clip to open the inlet neck and thus does away with the need to push the glass into the rubber neck. The second type has a long neck with a tapered internal bore so that pipette tops are guided in without excessive force being required. Two fillers of this type are described in 'Trade News'.

### Handling silicon tetrachloride

An accident involving silicon tetrachloride has again been reported to us. Just as a teacher was about to open a bottle of the chemical it exploded, sending the contents over the room. Luckily no one was hurt.

It is the reaction of silicon tetrachloride with the moisture of the air which leads to this type of situation. Some moisture will inevitably enter a bottle each time the stopper is removed and this can be quite large on humid days. The products of the reaction conspire together, the hydrogen chloride giving rise to pressure. The silica tends to mostly form between the stopper and the neck of the bottle and cement the stopper in place. Thus the pressure of the hydrogen chloride generated cannot be relieved resulting in the fracture of the bottle.

Needed for comparisons of the properties of chlorides across the periodic table and in group IV, silicon tetrachloride is used to demonstrate its volatility and non-conducting character which is has in common with carbon tetrachloride, and its reactivity with water. The latter can be explained in terms of difference in atomic sizes and in the availability of d orbitals.

Since it is used infrequently and the smallest quantity currently available is 100cm<sup>3</sup>, it will often take a few years to consume all of it. One of three courses should be followed:

It should not be kept more than two years at the outside and care should be taken to minimise the ingress of moisture into the bottle. Unused liquid should never be returned to the bottle and as far as is possible the opening of the bottle should be avoided on damp days. The excess or the contents of the bottle can be disposed of by adding them slowly to a large volume of water in a container, allowing several hours for completion of the reaction, neutralising and running to waste. Since there have been cases of the bottle suddenly exploding it should preferably be double contained in a large plastic beaker or 'Safe-pak' to minimise the scattering of glass. Furthermore bottles should be handled cautiously before opening, gloves, faceshield and explosion screen being used. If most of the 100 cm<sup>3</sup> is unlikely to be consumed during the course of a year then consideration should be given to either course 2 or 3 below.

2. Purchase it in 4x25cm<sup>3</sup> glass ampoules as supplied by Harris (£8.28). This may seem an expensive mode of purchase compared with £2.48 for 100cm<sup>3</sup>, but clearly no reaction with water can occur in a sealed ampoule. Purchase of the larger quantity will only be an apparent saving if much of it has to be disposed of, and in addition some time is required for the disposal operation. The ampoule should be cooled in a refrigerator for several hours prior to opening. Gloves and faceshield should be used when opening the ampoules.
3. The silicon tetrachloride may be prepared by chlorine over heated silica.

It is often all too easy to take the path of least resistance and relegate this part of the work to 'book and talk'. We feel that the cost of one or two ampoules per year is a small price to pay for basing this part of school chemistry on some real experience.

## Biology Notes

### 'Turbid cube' substitute

The use of turbid blocks of casting resin to teach certain aspects of microscope illumination was described in Bulletin 129. At the request of physics teachers, who had the 'H' grade "Optics" option in mind, we subsequently made a number of attempts to scale-up the idea. This was to allow substitution for the 'smoke-box' in optics demonstrations. Very large turbid blocks from plastics were ruled out as impractical. Instead we suggested a tank of water with the addition of a little milk. This worked quite well. To our eternal shame we never made the simple transfer back to the smaller scale.

Hence our admiration for Dr. Peter Evennett, one time Hon. Secretary (Education) of the Royal Microscopical Society and at present editor of RMS

"Proceedings". Dr. Evennett recently described (1) a simple turbid block substitute based on the lid of a cover-slip box. The turbid medium was - a very dilute suspension of milk in water! A suitable proportion is one drop of milk in 10cm<sup>3</sup> of water.

The photographs here (reproduced by kind permission of Dr. Evennett and the RMS) show the change in included angle of the rays passing through the specimen plane, as the condenser aperture diaphragm is opened (Fig.1) and closed (Fig.2). Also the area of the specimen illuminated (the diameter of the truncated apex of the cone of light) can be shown to change with adjustment of a field diaphragm (eg. the lamp iris).

Angle and area of illumination can be seen to be independently controllable.

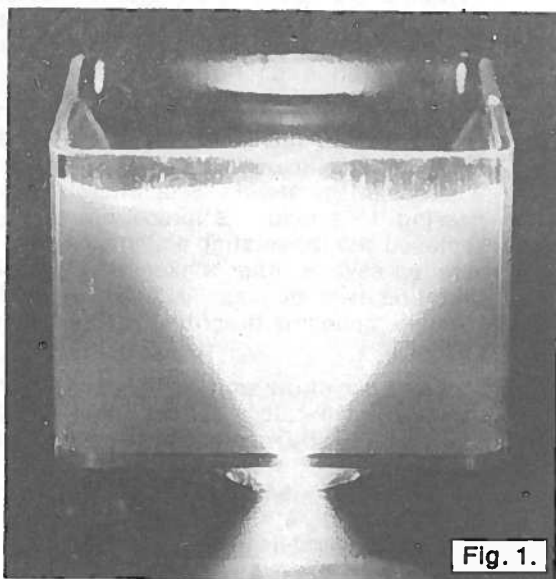


Fig. 1.



Fig. 2.

These photographs were taken with the microscope set up for Kohler illumination. However our own trials have shown the idea to be equally useful with an ordinary bench lamp and source-focussed illumination. This is a further advantage over the plastics blocks we had used previously. These required a relatively high intensity light source. With the milk/water/cover-slip box combination we were able to use a 100W bulb in a bench lamp housing. Watch your fingers though, such a lamp can get hot!

**Reference**

1. Evennett, P.J., 1983 'Turbid Block Substitute', Proc. Roy, micr. Soc., 18/2, 98 (March 1983).

**Skin sensitivity**

A simple but deservedly popular practical activity, when teaching about the human nervous system, is an investigation into the distribution of sensitive nerve endings in human skin. 'Tradition' has it that the sensors for touch are mapped messily on the back of the hand using bristles and ink or explored, dangerously, with dividers.

However, that inexhaustible source of simple, but elegant, practical ideas, Dennis Belford P.T. Biology, Liberton High, has done it again! Below (Fig. 3) is given a template for his 'patent' skin, touch-sensitivity testers.

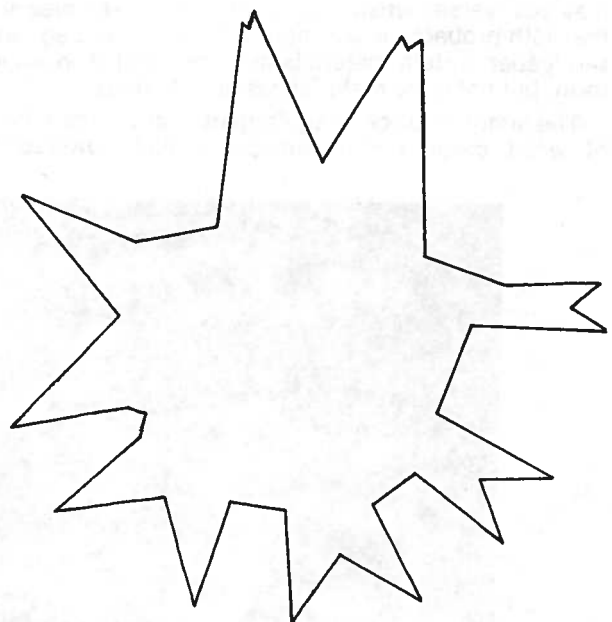


Fig. 3. Scale 1:1

The idea should be obvious from the illustration. The shapes are cut from plastic squeeze bottles or (if you

trust your pupils that much) flattened drinks cans. The shapes provide a large combination of point spacings. Using these, the spacing of touch sensors in various parts of the anatomy can be determined. Certain areas of the anatomy may have to be excluded from investigation - but then you each know your pupils best!

\* \* \* \*

## Foundation Science Notes

### Fabric Wear Testers

One of the several tasks set for us as part of the Foundation Science development programme was to produce a design for a relatively cheap, robust and easily constructed fabric wear tester. There is a requirement for such apparatus in the National Exemplar Option "Clothing". Two versions have now been constructed and exhibited at a number of venues. These are described in these notes with constructional details in the "Workshop" Section.

In wear tests carried out in industrial laboratories and textile research centres, the 'abrasive' surfaces applied to the cloth are in reality quite smooth. The tests are run for long periods of time - days if not weeks. Given the confines of the Pavlovian bells it is necessary to increase the rate of wear by using the rougher surfaces of sandpaper. This difference should be recognised. So also should the fact that the rank order of rate of wearing of a number of pieces of fabric may be reversed when sandpaper is used. The weave of the cloth probably is an important factor here eg. with sandpaper certain materials may fare well in woven form, but not if the material has been knitted.

The simplest piece of equipment is of course a block of wood covered with sandpaper and powered by

human hand. Our first model below mimics this reciprocating action but the even pressure applied and the constant speed of the motor, allow a more valid test to be made.

Both the versions are powered by a 12V car wiperscreen wiper motor. These have the advantages of being

- (i) readily available and relatively cheap at scrapyards. (We purchased ours for four pounds a motor, but hope that a large rush on these by schools does not push up the market prices!)
- (ii) very robust - designed for long running periods.
- (iii) the speed of the motor is easily controlled by varying the d.c. voltage supplied. We found the motors could be run at 20 volts for reasonably long periods. In addition most motors are 'two speed' and it is a simple matter to discover the terminals required for a suitable speed.
- (iv) adaptable - The Lucas models we used had a reciprocating action built into them. Use was made of this in our first 'washboard' model whereas in the second 'wearwheel' model the gearing to provide reciprocating action was removed and the rotating action used. For pure rotation several other makes of wiper motors might be used more easily. The construction of the two models is described in the Workshop section.

Another novel use of the wonderful wiper motor is to make a wave generator. Those who may be investigating either the generation of electricity or simply waves may find some interest here. This application will be described in Bulletin 137.

### "Scrubbing board" model



Fig. 1.

Two strips of cloth are fastened to the removable base board and this located below the rubbing block. The block, covered by sandpaper grade 00, is pressed against the cloth by the 1000g weight. Usually one minute is sufficient to cause quite visible signs of wear and the fluff scuffed off a piece of fabric collects at the ends providing another indication of the extent of wear.

It is best to test only two strips of fabric at a time since a length of thin fabric placed between two thicker ones would not receive an equal abrasive action. After a test run the removable base boards, with strips attached, may be hung up for comparison. The worn strips on double sided sellotape can easily be transferred to a notebook as a record. We tested samples of cotton, rayon, acrylic, nylon, wool, polyester and viscose and found 00 grade to give sufficiently rapid wear without too much tendency to 'snatch'.

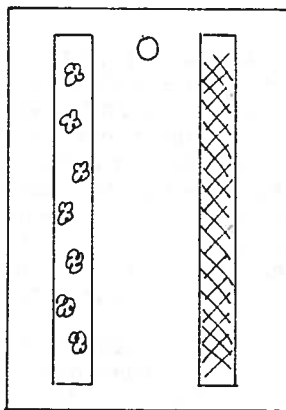


Fig. 2.

### Wear Wheel (Fig. 3.)

The drum consists of a plastic container bolted by its screw lid onto the hub of the rotating disc on the Lucas motor. (Other motors give direct rotating action and a simple wooden boss fitted on the spindle of the motor will suffice). The jar can thus be easily removed from its lid (or hub) for fitting strips of cloth. The reason for using a plastic container as a drum was two-fold. First not every school science department would have access to a lathe nor is it easy to find a block of wood of suitable dimensions. Admittedly one could be made by glueing and screwing together two or more thicknesses of blockboard. Secondly having access to the inside of a hollow drum gives a means of attaching the ends of the fabric strips.

Up to five strips of cloth were attached to the drum by pushing the two ends through slits cut in the plastic sides. If found necessary these can be taped inside to secure them more firmly.

The jar is then rescrewed onto the lid which now becomes an enlarged hub. The abrasive sandpaper is made to bear on the top of the drum, being fastened onto a metal strip loaded with a small weight. Dimensions are not critical, but we found an old hacksaw blade (blunted with a file) 31cms long, bearing

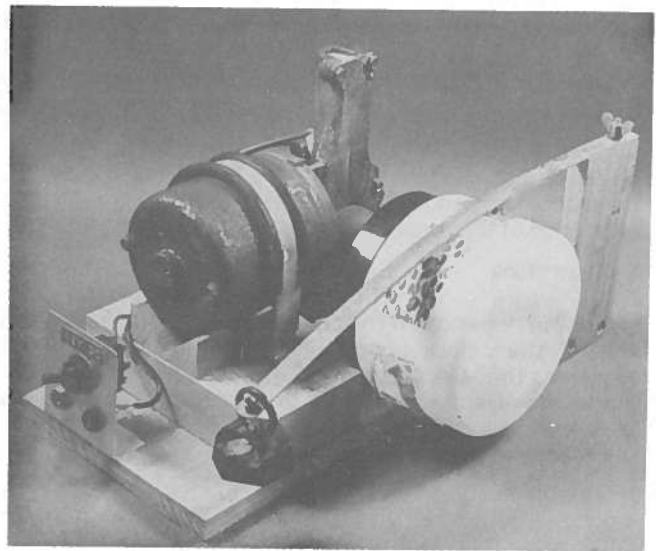


Fig. 3.

on the wheel at the mid point and loaded with a 100g mass at the free end, produced sufficient wear in four or five minutes.

This wearwheel model has the advantage over the 'scrubbing board' version of being able to test five strips at a time instead of two, but suffers from the disadvantages of

- (i) being more difficult to construct
- (ii) being more difficult to fit the strips.

The fluff worn off the fabric is spread right round the drum and cannot be used as an indicator of amount of wear. However the abrasion of the fabric shows up well.

\* \* \* \*

## Interfacing Notes

### Interfacing with the BBC Model B cont.

#### User port - BBC model B

#### Part 2 - VIA timers

#### Scope of article

The principal points which we shall cover in this article are

1. using the VIA timers, and
2. writing assembly language programs on the BBC computer.

The VIA timers have a resolution of one microsecond and in order to time with this order of magnitude it is necessary to program in assembly language. This is particularly easy to do with the BBC computer since no

coding up is involved. Assembly programs are keyed-in in assembly language just as Basic programs are keyed-in in Basic. A good feature in a computer.

“counter registers” and “latch registers”.

The article will make use of the technical information and terminology in “6502 Interfacing”, Section 4.1, pp 52-57(1). For readers south of the Border who may not have access to a copy, the source of supply is given as a reference at the end of the article.

### System clock

Timing depends on the computer's system clock. The BBC system clock operates at a frequency of 2MHz. However the VIA operates at 1MHz, - half the system clock rate. Data written into the timer registers in the VIA will decrement at the rate of one count per microsecond till time-out.

The disparity between the system clock and the VIA clock merits further discussion. When programming in 6502 assembly language each instruction takes an integral number of cycles at the system clock rate of 2MHz.

e.g.

instruction	no. of cycles to carry out instruction	time taken to carry out instruction ( $\mu$ s)
DEY	2	1.0
BEQ to same page	3	1.5
LDA absolute	4	2.0
RTI	6	3.0

However when an instruction is operated on the VIA registers, such as reading Timer 1 or writing to the user port, part of the instruction is executed at the VIA clock rate and the other part at the system clock rate. This would, for example, stretch out an LDA instruction on a VIA register to 2.5 or 3.0 microseconds.

This would suggest that methods of timing based on counting instructions is tricky with the BBC. The methods described below use the VIA timers and are unaffected by this snag.

The system clock frequency is only a nominal 2MHz, though our own 'Beeb' at 1.9987MHz is not far off.

### Two VIA timers

The functions the timers were designed to perform are outlined in Table 1. We swithered over showing you this table because the timers can also be used for functions they were not designed for. There is a danger that a list of correct behaviour becomes a cramp on inventiveness and you should not feel constrained by rule-books.

### VIA timer registers

There are two sorts of timer registers, called

Timer 1	Timer 2
one-shot timer	one-shot timer
free-running timer	counts pulses entering
output(s) pulse(s)	PB6
on PB7 (one-shot or	clocks the Shift
free-running)	Register

Table 1. Functions of VIA Timers

It is only the counter registers which decrement. Data placed in the latch registers is left unchanged and does not count down. The latch registers act as a temporary dump for data before transference to the dynamic counter registers. The need for the latch registers arises because the timer has 16-bit registers and it takes two instructions to write to them. By writing first to the latch registers in two stages we can have our data being transferred simultaneously to the high and low byte counter registers afterwards.

The procedure to place data in the counter registers of Timer 1 (Timer 2 has the same procedure except that it does not have a high byte latch) is

1. write to low byte latch
2. write to both the high byte latch and the high byte counter (one action). This action transfers the contents of the low byte latch into the low byte counter.

The count down of data in the counter registers follows immediately after this procedure. After each time-out the counter registers are reloaded from the latch registers.

Note that Timer 2 does not have a high byte latch whereas Timer 1 does. This explains why we only use Timer 2 low byte when using Timer 2 as a free-running timer to clock the Shift Register, (“6502 Interfacing”, pp 31-35).

An interesting feature is the ability to continually reprogram Timer 1 to produce variable mark-space pulses by changing the data in Timer 1 latch while Timer 1 counter is counting down. With this feature we can transmit data in serial form where the data is coded in pulse length, e.g. to control a servo-mechanism.

The operation of Timer 1 as a free-running timer is outlined in Table 2. The rest of the article is taken up with particular examples.



Basic	Instruction	Action	Effect	duration
?T1CL = N MOD 256	LDA #N MOD 256 STA T1CL	write to Timer 1 Counter Low address (T1C-L)	although you write to the address of T1C-L data doesn't get written to the T1C-L register yet, but is written into the T1L-L register instead.	
?T1CH = N DIV 256	LDA #N DIV 256 STA T1CH	write to Timer 1 Counter High address (T1C-H)	this action writes data into both T1L-H and T1C-H registers; data in T1L-L is transferred to T1C-L; Timer 1 interrupt flag is cleared;  Timer 1 counts down at a rate of one count per micro-second	1.5 $\mu$ s
REPEAT X =?(FLAG)AND#40 UNTILX = #40	.wait1 LDA flag AND #40 BEQ wait1	optional action - wait for time-out by polling the Interrupt Flag Register	time-out occurs when T1C is 0000 0000 0000 0000; Timer 1 interrupt flag is set; data in T1L-H is transferred into T1C-H; data in T1L-L is transferred into T1C-L	N $\mu$ s
X = ?T1CL	LDA T1CL	optional action* - clear T1 interrupt flag by reading T1C-L	Timer 1 counts down at rate of one count per micro-second	2.0 $\mu$ s
REPEAT X =?(FLAG)AND#40 UNTILX = #40	.wait2 LDA flag AND #40 BEQ wait2	optional action - wait for time-out by polling the Interrupt Flag Register	time-out occurs when T1C is 0000 0000 0000 0000; Timer 1 interrupt flag is set*	N $\mu$ s

Table 1 Operating Timer in the free-running mode

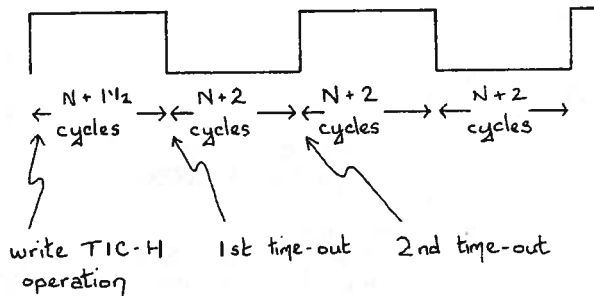
## Pulse generator

We can generate square wave pulses on PB7 on the user port operating Timer 1 in the free-running mode. This mode of operation is achieved by setting bits 6 and 7 of the Auxiliary Control Register (ACR). Setting bit 6 selects the free-running mode. Setting bit 7 enables PB7. The instruction is

?ACR = &CO

bit pattern of ACR							
7	6	5	4	3	2	1	0
1	1	0	0	0	0	0	0

The logic state of PB7 changes at every time-out.



The data written into Timer 1 is related to the required signal frequency by the following equation

$$2x(N\% + 2) = 1000000/\text{freq}$$

$$\Rightarrow N\% = 500000/\text{freq} - 2$$

N% can have any integer value between 0 and 65535. The corresponding frequencies run in the series

N% = 0	freq = 250000 Hz
1	166666
2	125000
3	100000
.	.
.	.
65535	8

In Program 1 the pulses are controlled by selecting the frequency. In Program 2, by writing data directly into Timer 1.

```

10 BASE=&FE60
20 T1CL=BASE+4
30 T1CH=BASE+5
40 ACR=BASE+11
50 ?ACR=&CO
60 REPEAT
70 INPUT freq
80 N%=500000/freq-2
90 ?T1CL=N% MOD 256
100 ?T1CH=N% DIV 256
110 UNTIL FALSE

```

Program 1.

```

10 BASE=&FE60
20 T1CL=BASE+4
30 T1CH=BASE+5
40 ACR=BASE+11
50 ?ACR=&CO
60 REPEAT
70 INPUT data%
80 ?T1CL=data% MOD 256
90 ?T1CH=data% DIV 256
100 UNTIL FALSE

```

Program 2.

Note that both Programs 1 and 2 can be stopped by pressing ESCAPE. However the pulses on PB7 will continue until you clear the ACR, a handy feature in that you can analyse the effect the pulses are having with another part of your program.

An application of this technique is making an automatic sweep signal generator.

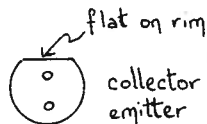
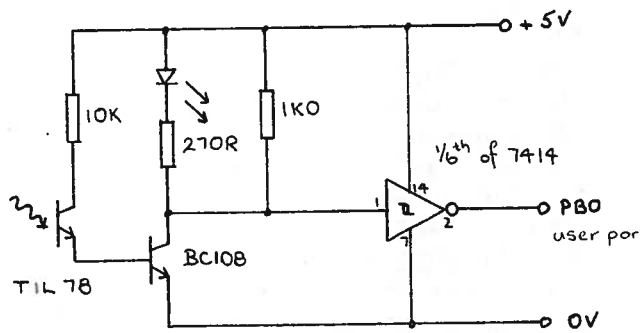
## Timing

Program 3 is the BBC version of "6522 Timer" in "6502 Interfacing", pp58-61.

Timing is started by taking pin PBO low and stopped by taking PBO high. This can be achieved with a light gate (Fig.1). The LED in the circuit indicates whether the gate is working.

When test running the program just link PBO directly to ground. Breaking the link causes PBO to float high. You will, of course, have switch bounce to endure with this short-cut, perhaps one out of every two attempts will be foiled.

The assembly language program is stored at the top of RAM from address &7000 upwards, well above



TIL 78 pin configuration

logic

light output = 1  
dark output = 0

Fig 1. Light gate

```

10 REM ***SSSERC***
20 REM Timer
30 REM connect light switch
40 REM to user port PBO;
50 REM program times to a resolution
60 REM of 256 microseconds;
70 PROClabels
80 PROCassembly
90 CLS:PRINT "Break light beam"
100 CALL start
110 X=?store
120 Y=?cyclecounter
130 interval=(256-X+256*Y)*.256/1000
140 interval=INT(interval*10000+.5)
150 CLS:PRINT interval/10000;"s"
160 END
170
180 DEFPROClabels
190 BASE=&FE60
200 IORB=BASE
210 DDRB=BASE+2
220 T1CL=BASE+4
230 T1CH=BASE+5
240 ACR=BASE+11
250 FLAG=BASE+13
260 cyclecounter=&700

```

```

270 store=&7001
280 ENDPROC
290
300 DEFPROCassembly
310 FORZ=1TO3STEP2
320 P%=&7002
330 [OPTZ
340 .start SEI
350 LDA #&00
360 LDY #&FF
370 STA cyclecounter
380 STA store
390 STA DDRB
400 LDA #&40
410 STA ACR
420 .portread1 LDA IORB
430 AND #&01
440 BNE portread1
450 STY T1CL
460 STY T1CH
470 .time LDA FLAG
480 AND #&40
490 BEQ portread2
500 INC cyclecounter
510 LDA T1CL
520 .portread2 LDA IORB
530 AND #&01
540 BEQ time
550 LDA T1CH
560 STA store
570 CLI
580 RTS
590 ]
600 NEXTZ
610 ENDPROC

```

Programme 3.

LOMEM at the top of the Basic program, and below HIMEM. This is OK when operating in MODE 7 as we are. If however you change MODE you will have to locate your assembly program somewhere else in memory. For example HIMEM in MODE 0 is &3000 so the assembly program could fit into page &2F starting at address &2F00.

The notes that follow refer to those instructions which embed the assembly language program within the Basic program (Program 3).

line 320, address of first instruction in assembly language program is &7002. P% specifically stands for start address.

line 270, "store" is the label given to address &7001 where the data in Timer 1 Counter high byte is dumped at the end of timing (lines 550 and 560).

line 260, "cyclecounter" is the label given to address &7000 which is incremented by one (line 500) if ever the timer times-out.

lines 310, 330,600, the assembly program is loaded twice into memory. On the first occasion, in OPT 1, assembler errors are suppressed and on the second, in OPT 3, assembler errors are reported. The sort of error that OPT 1 suppresses occurs at line 490. The branch instruction, BEQ, refers to a label, portread2, that the computer hasn't heard of yet. The assembly language loading would stop and an error message be displayed if we were not in OPT 1. Next time through, in OPT 3, psuedo errors of this sort are not noticed.

You may prefer to use OPT 0 and 2 instead of 1 and 3. Thereby the screen display isn't fouled up with listings.

lines 330, 590, the symbols [and] start and finish the assembler. Note that in MODE 7 these symbols appear as horizontal arrows on the screen.

lines 340, 570, the SEI instruction disables the IRQ interrupts which the 6502 microprocessor would otherwise get from the keyboard while the program is running. This means that the microprocessor will devote itself singlemindedly to what you want it to do, measure time. This achieved, the CLI instruction enables the IRQ interrupt system.

lines 400, 410, bit 6 of the ACR is set so that Timer 1 is being operated as a free-running timer with PB7 disabled. Time-outs are indicated by the setting of the Timer 1 flag in the Interrupt Flag Register.

lines 470, 480, 490, 510, polling the Interrupt Flag Register to wait for a time-out is explained in "6502 Interfacing", pp56-57.

### Measuring acceleration

Program 4 is the BBC version of "6522 Accelerometer" in "6502 Interfacing", pp 62-67.

```
10 REM ***SSSERC***
20 REM Accelerometer
30 REM connect light switch
40 REM to user port PB0
50 PROClabels
60 PROCassembly
70 PROCintroduction
80 REPEAT
90 PRINT
100 PRINT"Let mask break light beam"
110 CALL start
120 PROCcalculation
130 PROCdisplay
140 UNTIL decision$<>" "
150 CLS
```

```
160 END
170
180 DEFPROClabels
190 BASE=&FE60
200 IORB=BASE
210 DDRB=BASE+2
220 T1CL=BASE+4
230 T1CH=BASE+5
240 ACR=BASE+11
250 FLAG=BASE+13
260 cycle1=&7000
270 store1=&7001
280 cycle2=&7002
290 store2=&7003
300 cycle3=&7004
310 store3=&7005
320 ENDPROC
330
340 DEFPROCassembly
350 FORZ=1TO3STEP2
360 P%=&7006.
370 [OPTZ
380 .start SEI
390 LDX#&00
400 LDA#&00
410 LDY#&FF
420 .clearmemory
430 STA cycle1,X
440 INX
450 CPX #&06
460 BNE clearmemory
470 TAX
480 STA DDRB
490 LDA #&40
500 STA ACR
510 .portread1
520 LDA IORB
530 AND #&01
540 BNE portread1
550 STY T1CL
560 STY T1CH
570 .time1
580 LDA FLAG
590 AND #&40
600 BEQ portread2
610 INC cycle1,X
620 LDA T1CL
630 .portread2
640 LDA IORB
650 AND #&01
660 BEQ time1
670 LDA T1CH
680 STY T1CL
```

```

690 STY T1CH
700 INX
710 STA cycle1,X
720 INX
730 CPX #&06
740 BNE time2
750 CLI
760 RTS
770 .time2
780 LDA FLAG
790 AND #&40
800 BEQ portread3
810 INC cycle1,X
820 LDA T1CL
830 .portread3
840 LDA IORB
850 AND #&01
860 BNE time2
870 LDA T1CH
880 INX
890 STY T1CL
900 STY T1CH
910 STA cycle1,X
920 INX
930 JMP time1
940 ]
950 NEXTZ
960 ENDPROC
970
980 DEFPROCintroduction
990 CLS
1000 row=8
1010 REPEAT PRINT
1020 UNTIL VPOS=row
1030 PRINT"Width of interrupt mask"
1040 PRINT"in millimetres"
1050 INPUT width
1060 width=width/1000
1070 ENDPROC
1080
1090 DEFPROCcalculation
1100 timescale=.256/1000
1110 T1=256-?store1+256*(?cycle1)
1120 T2=256-?store2+256*(?cycle2)
1130 T3=256-?store3+256*(?cycle3)
1140 interval=(T1/2+T2+T3/2)*timescale
1150 initialspeak=width/(T1*timescale)
1160 finalspeak=width/(T3*timescale)
1170 speedchange=finalspeak-initialspeak
1180 accel=speedchange/interval
1190 accel=INT(accel*1000+.5)/1000
1200 ENDPROC
1210

```

```

1220 DEFPROCdisplay
1230 CLS
1240 row=8
1250 REPEAT PRINT
1260 UNTIL VPOS=row
1270 column=10
1280 REPEAT PRINT " ";
1290 UNTIL POS=column
1300 PRINT"Acceleration = ";accel;"ms-2"
1310 row=12
1320 REPEAT PRINT
1330 UNTIL VPOS=row
1340 PRINT"Another reading?"
1350 PRINT" Press SPACE BAR"
1360 decision%=INKEY$(1000)
1370 ENDPROC

```

#### Program 4.

#### Counting pulses

Timer 2 can be used to count pulses which are input through PB6 in the user port. This mode of operation is controlled by bit 5 in the Auxiliary Control Register. If bit 5 is cleared Timer 2 operates in the one-shot mode. However if bit 5 is set its counter register counts down with every pulse into PB6.

One way of operating the counting mode involves waiting for a predetermined number of pulses to arrive on PB6. Suppose you wanted to wait for 1000 pulses, write 1000 into the Timer 2 registers and poll the Interrupt Flag Register until Timer 2's flag (bit 5) is set.

Another way of operating the counting mode involves reading the registers of Timer 2 after a predetermined time interval. This method is shown in Program 5.

```

10 BASE=&FE60
20 T2CL=BASE+8
30 T2CH=BASE+9
40 ACR=BASE+11
50 ?ACR=&20
60 REPEAT
70 INPUT"Gate period (s)",period%
80 ?T2CL=&FF
90 ?T2CH=&FF
100 pause%=TIME+100*period%
110 REPEAT
120 UNTIL TIME=pause%
130 Timer2=(?T2CH)*256+(?T2CL)
140 count=65535-Timer2
150 PRINT count
160 UNTIL FALSE

```

#### Program 5.

The gate period is determined by the Basic centisecond clock function, TIME. Its simple to use but introduces errors of a few milliseconds into the gating. For greater accuracy you should program in assembly language using Timer 1 to set the gate period.

Perhaps the simplest way to obtain TTL pulses to test out Program 5 is from PB7 using Timer 1. Program 6 shows how. You might think it incestuous, but it is simple. You just connect PB7 into PB6.

```

10 BASE=&FE60
20 T1CH=BASE+5
30 T1CL=BASE+4
40 T2CL=BASE+8
50 T2CH=BASE+9
60 ACR=BASE+11
70 ?ACR=&E0
80 REPEAT
90 INPUT "Frequency", freq
100 N%=500000/freq-2
110 ?T1CL=N% MOD 256
120 ?T1CH=N% DIV 256
130 INPUT "Gate period (s)", period%
140 ?T2CL=&FF
150 ?T2CH=&FF
160 pause%=TIME+100*period%
170 REPEAT
180 UNTIL TIME=pause%
190 Timer2=(?T2CH)*256+(?T2CL)
200 count=65535-Timer2
210 PRINT count
220 UNTIL FALSE

```

#### Program 6.

Note that in line 70, bits, 5, 6 and 7 of the ACR are set. You should understand why it is like that. Setting bit 5 operates Timer 2 as a pulse counter. Setting bit 6 lets Timer 1 free-run. Setting bit 7 enables PB7. But this is repetition!

Another quick way of getting TTL pulses uses a Schmitt trigger inverter gate, 7414, along with a capacitor and feedback resistor (Fig.2). This is the easiest of oscillators to make up. The resistor must be about 390R. Frequency is determined by the capacitor value and is approximately  $2000/C$  Hz where C is in microfarads.

If you are working with TTL circuitry it is worthwhile inserting a Schmitt trigger as a last stage before the user port (Fig.3). The Schmitt trigger sharpens up the TTL pulses, the faster the transition the better.

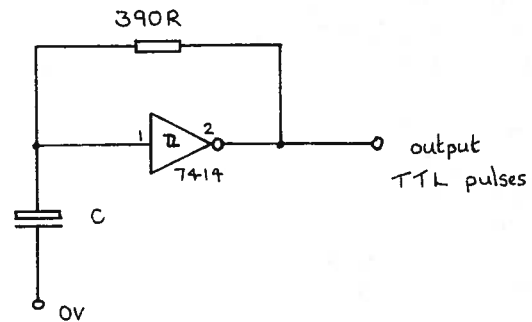


Fig 2. TTL pulse generator

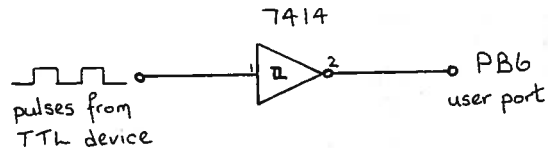


Fig 3. TTL pulse shaping with a Schmitt trigger

For other signals, from a microphone, geiger tube, induction coil, etc., the signal has to be converted into a series of TTL compatible pulses. Doing this will involve some or all of the following

- attenuation or amplification
- power boosting
- pulse shaping.

This can be achieved with an operational amplifier and Schmitt trigger (Fig.4). The op amp is powered by a  $\pm 5V$  dual rail supply so that its output is TTL compatible

The op amp amplifies the input signal. R determines the gain which at low frequencies is  $(R + 10K)/R$ . The gain drops off as frequency rises and some experimentation with resistor values may be necessary if you are working at high frequencies. The table in Figure 4 indicates suitable values. It is OK if the amplifier saturates. For example if the input peak voltage is 1000mV and R is 1K $\Omega$  giving a gain of 11 we obviously go hard into saturation because the supply rail is  $\pm 5V$ .

The op amp is wired as a non-inverting amplifier so that it has a high input impedance. It is a way of power boosting.

The diode across the output prevents the output

going negative (it drops to -0.6V because it is a silicon diode). Something in the 1N4001 family will do. Two Schmitt triggers are required to smarten up the output properly.

A drawback of this circuit is the dual rail  $\pm 5V$  supply which many schools won't have. The usefulness of such a supply is borne out by this circuit, an interface between op amps and TTL.

There is, fortunately, a useful chip, the 392 (thank you Ian Downie for reminding us), which has on board an operational amplifier that operates off a single rail 5V supply. For a modest outlay of 84 pence you could use the 392 in place of the 741.

A source and price of components used in the circuits in the article is given in Table 3.

component	RS no.	RS price	Technomatic price
7414	306 358	58p	18p
741	305 311	£1.76 for 5	18p
392	308 859	84p	60p
1N4002	261 154	46p for 10	5p
BC108	293 533	95p for 5	13p
TIL78	-	-	55p

Table 3. Components, suppliers and prices.

### Discussion

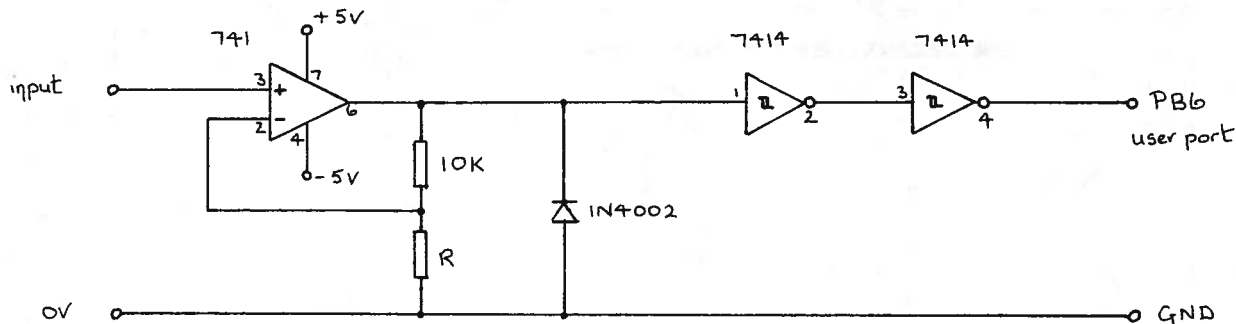
We hope the ideas we have given here will open up a lot of project work. Some personal views on where this leads us will be given.

There is little merit in aping conventional experiments with the computer. Why use a computer to measure acceleration? Why use a computer as a signal generator? Why use a computer as a scaler/timer? There are people who say the computer should be used as a multi-purpose laboratory instrument and we can forget about conventional instruments. Signal generators, ticker timers, voltmeters, ammeters, oscilloscopes. Do you remember them? We don't share this limited view. It is much too exciting a device to use only for things as drab as these. It should also have an emancipative role freeing you from the narrowness of a small country curriculum. Use it in an extra curricular fashion. Create your own curriculum to do so.

We gave you an example (2) of this in Bulletin 133, sorting out multiple measurements of 'g'. Modify the acceleration program to do this. Paul Beverley and Alastair Allen have written a fine series of articles in "Electronics and Computing" (3). It is worth getting back numbers of these. Of special merit is the article (4) on detecting resonances in an air column. One wonders why project work in sixth year studies Physics has been reduced at a time like this.

And engineering, that Cinderella subject, we have at last a versatile medium with which to practise it in schools.

Did you notice? The fairy godmother's been.



Power supplies :-

1. for 741, dual rail  $\pm 5V$  supply
2. 7414, single rail 5V supply

Fig 4. General purpose pulse shaping circuit.

value of R		
max freq (kHz)	input peak (mV)	R
3	10	22R
20	100	220R
>65	1000	1K0

## References

1. "6502 Interfacing"  
- available at a cost of £2.20° from  
The Secretary, Project Steering Committee - MCC  
Project, SCDS - Dundee Centre College of  
Education, Gardyne Road, Broughty Ferry,  
Dundee DD5 1NY.
2. "Interfacing Notes", SSSERC Bulletin no. 133 pp.  
10-15.
3. BBC Micro Series, articles on interfacing by P.  
Beverley and A. Allen, "Electronics and  
Computing", May 1982 to June 1983 inclusive.
4. P. Beverley, "Automatic measurement of  
resonance in an air column", BBC Micro Series,  
"Electronics and Computing", January 1983.

### \*Please Note:

Orders amounting to less than £10 in total must be accompanied by a cheque or postal order for the appropriate amount. Orders amounting to £10 or more and not accompanied by the appropriate payment will be accepted only on the official order forms of recognised institutions.

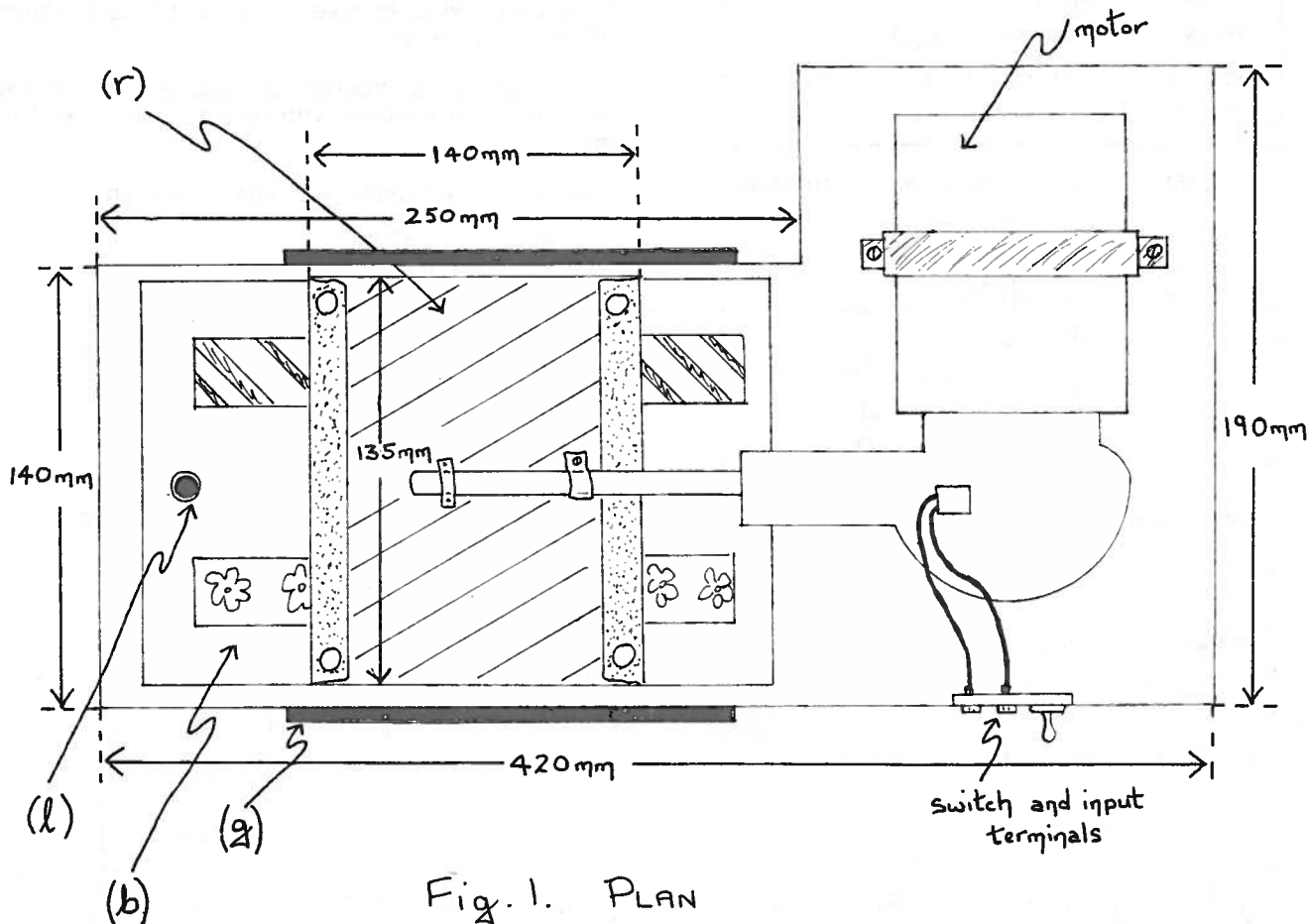
Cheques and postal orders should be crossed and made payable to Dundee College of Education.

## In the Workshop

### Fabric Wear Testers

The wiper motor used was a Lucas type - widely found on many, but not all British makes of car. British Leyland seem commonly to use those types which have a built-in reciprocating acting. This action is transmitted to the spindles of the two wiper blades by means of a cable inside a metal conduit sleeve. The saddle clamps securing the motor to the car body should also be kept. Once the motor is detached and the coupling between it and the outer conduit sleeve undone, the motor plus more than a metre of transmission cable can be withdrawn. Less than 20cms of this cable will be required and the rest can be cut off.

The construction of the "washboard model" is reasonably self explanatory and may be followed from the diagrams (Figs. 1-5). There may be slight variations





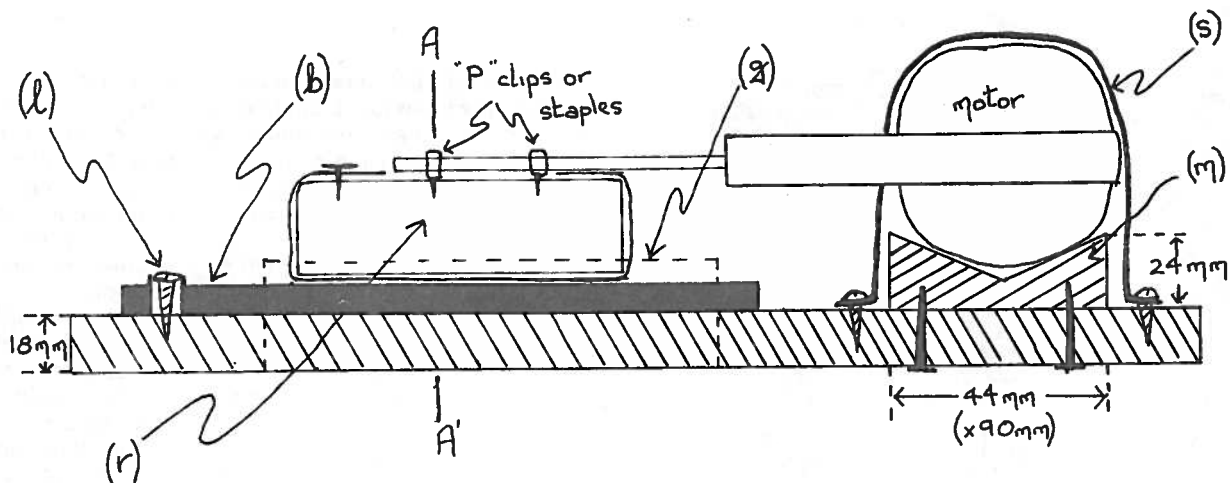


Fig. 2. ELEVATION

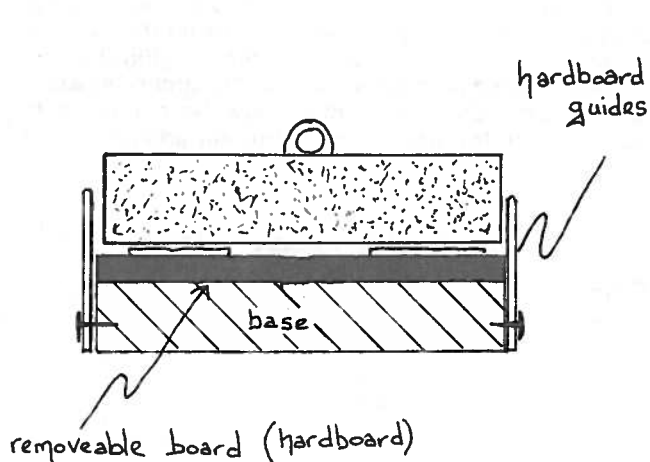


Fig. 3. SECTION A-A'

in the dimensions and shape of different motor casings and the mounting blocks (m) will require modification. A few points are given below.

- (i) After cutting out the base it is best to fit the rubbing block(r), guides(g) and removable baseboard(b) before fitting the motor in position. The transmission cable should be horizontal and should act in the middle of the rubbing block. Adjustment of the motor's final lateral position can be made if the saddle clamp is slightly loosened.
- (ii) The transmission cable is slightly flexible and is best kept as short as possible. We found a length of 130-140mm extending beyond the motor gearbox to be adequate.
- (iii) A simple lug(l) to locate the removable board for holding the samples is made from a half inch no. 8 domed screw with a length of plastic tubing to cover the threads.(Fig.4.)

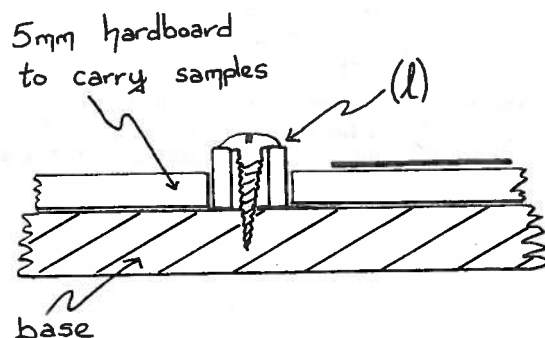


Fig. 4.

- (iv) The leading and trailing edges of the rubbing block are rounded off like the fronts of sledge runners to reduce the amount of 'snatching'. Grade 00 sandpaper was attached by four drawing pins.
- (v) The rate of wear can be increased by fastening a load on the top. A piece of iron or lead would do. However it is convenient to borrow a 1kg slotted weight from the physics Department. The slot can accommodate the transmission cable where it is fastened on the top of the rubbing block. If required a length of plastic tubing can be screwed to the top of the block to provide a fender to secure the weight.
- (vi) Grade 00 sandpaper was used.
- (vii) A switch and 4mm terminals for taking the d.c. supply from a power pack can be mounted on a strip of aluminium mounted beside the motor.

#### Wearwheel version

This version is also mostly self explanatory from the diagrams, (Figs. 6-10) but some detail is given of the

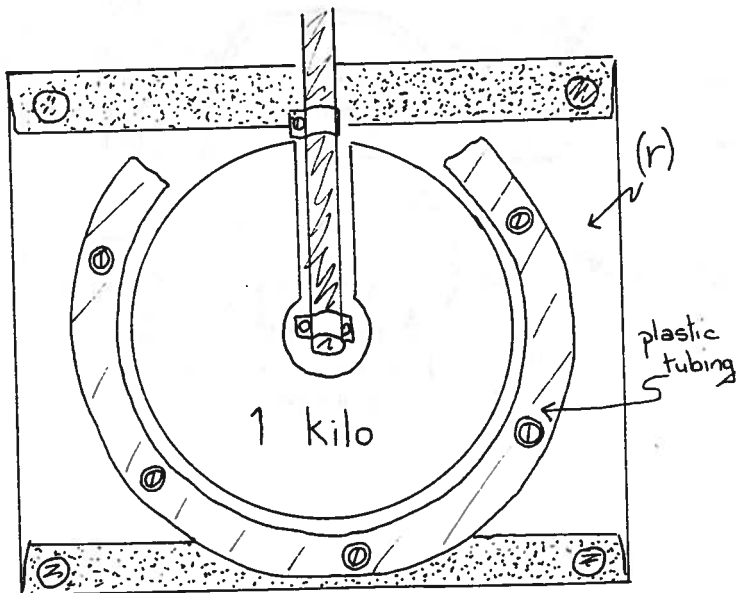


Fig. 5.

modification of the motor drive. For those with the necessary skill and facilities a wooden drum could be turned in a lathe, but this version uses a circular plastic

container of diameter 110mm. Our container was a plastic specimen jar. Dimensions of this are not critical and those given are ones we found to perform satisfactorily. The same type of Lucas wiper motor was used but with the reciprocating mechanism removed. To reach this undo the five small self tapping screws on the gear casing. Remaining now is the worm drive on the motor spindle and a nylon grubwheel backed by mild steel on one side and on its own spindle.

To remove this undo the circlip on the other side of gearbox. The two holes already in the steel backing of the grubwheel should be continued through the nylon and countersunk on the nylon side. This enables two no.8 1½" screws to be driven into the wide end of a no.53 rubber bung. This bung is used since its diameter proved a perfect fit for the casing. The lid of the container is stiffened with a plate (p) of 1cm thick plywood and attached to the other end of the rubber bung by five no.8 1" screws. This calls for some skill in finding the centre of the lid by the method of chords, but trial and error with a pair of dividers proves as good. Once the plastic box is screwed onto its lid the result is a drum attached to its extended spindle. (Fig.9.) This can be relocated in the gearing and the circlip refastened. The old gear casing must now be cut away to accommodate the protruding bung. An additional self

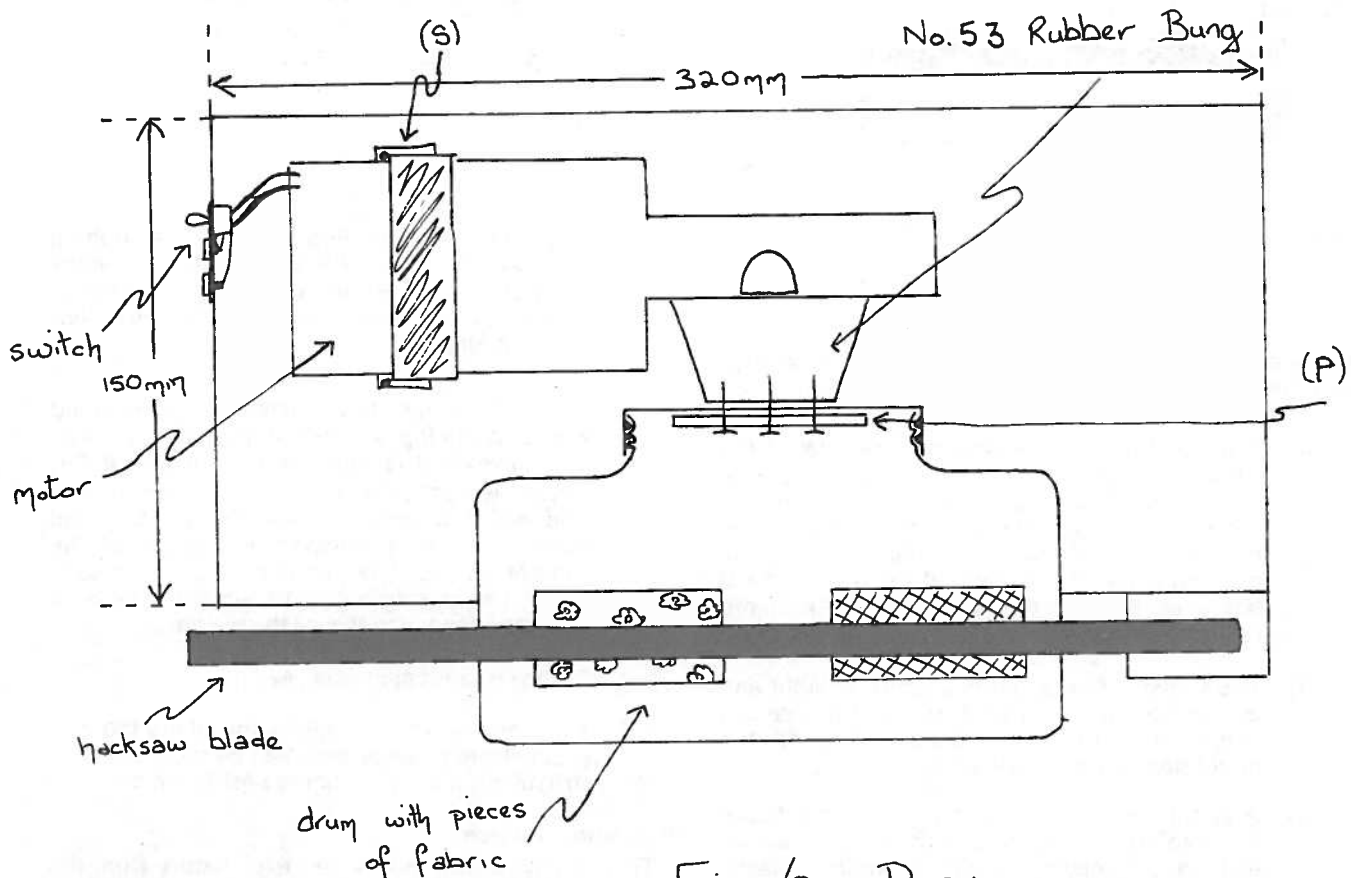


Fig. 6. PLAN

tapper can be used to hold the reduced size cover in place. Finally a small piece of shaped hardboard can be fitted as a block in the aperture in the original cable and conduit outlet. It is important to make the gear cover a close fit to protect fingers or the gears!

The plastic box we used had a diameter of 110mm. In the sides of this five pairs of slits were made with a Stanley knife as shown and the ends of the fabric strips tucked in. In many cases these were held by the grip of the plastic, but in others the ends had to be taped inside. (Fig.10.)

An old hacksaw blade with its teeth filed off was covered on one side by 00 grade sandpaper using double-sided sellotape. The hole in one end is used to secure it on a pillar whose top was approximately level with the top of the drum. A stud inserted into this pillar and a butterfly nut permitted easy change of abrasive surfaces. A small bolt is 'lock-nutted' into the opposite end and the projecting bolt used to carry a small weight.

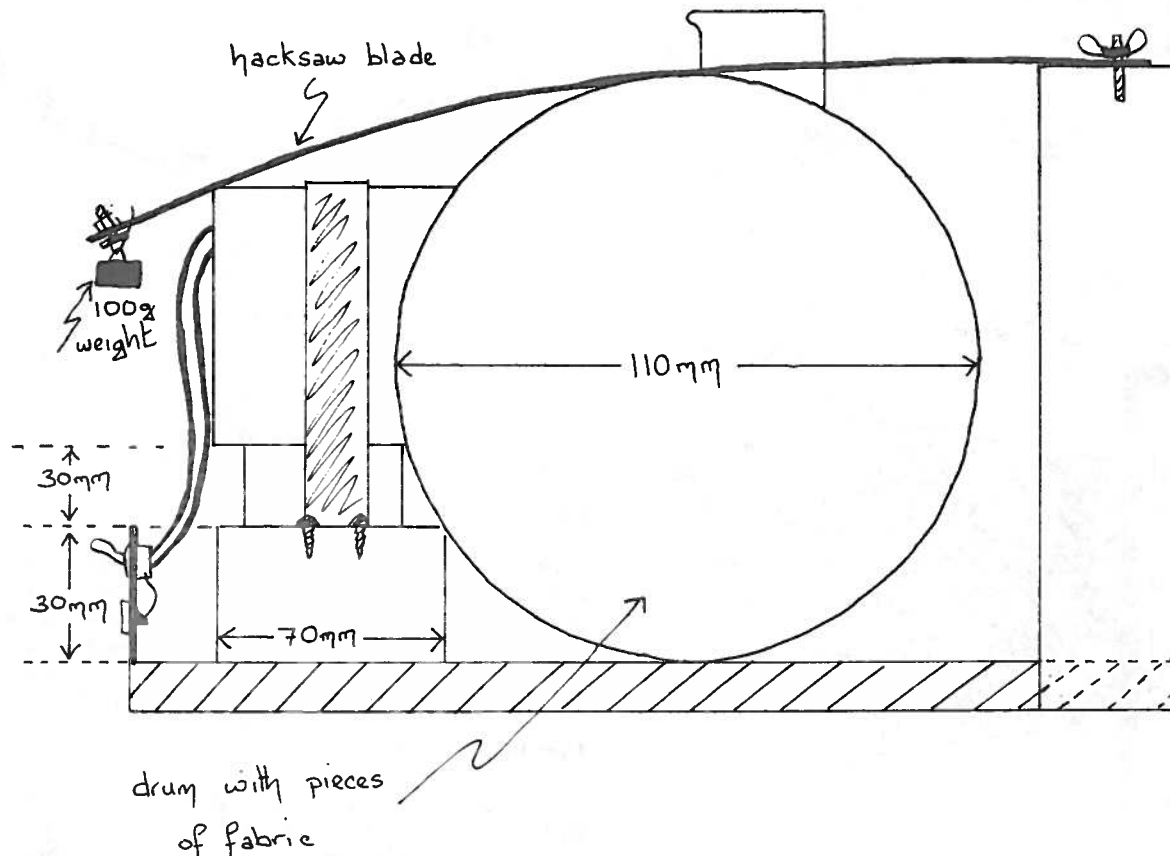


Fig. 7. ELEVATION

Figures not to scale

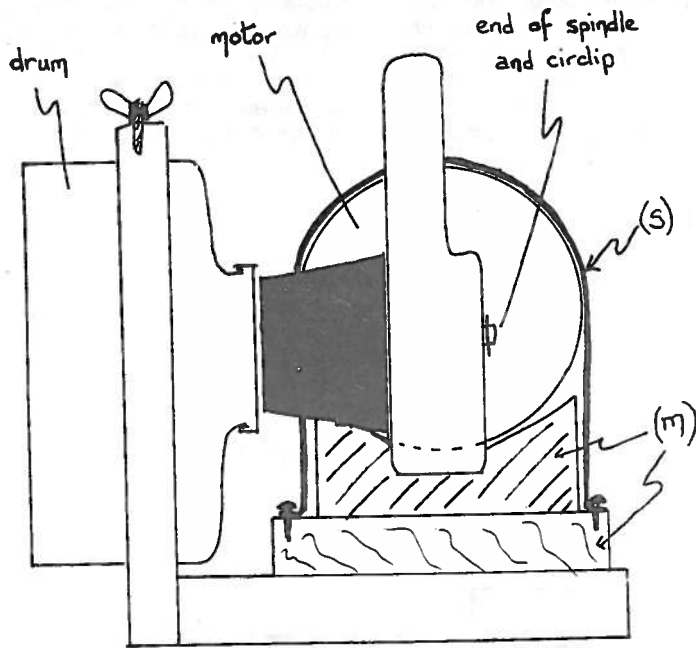


Fig. 8. END VIEW

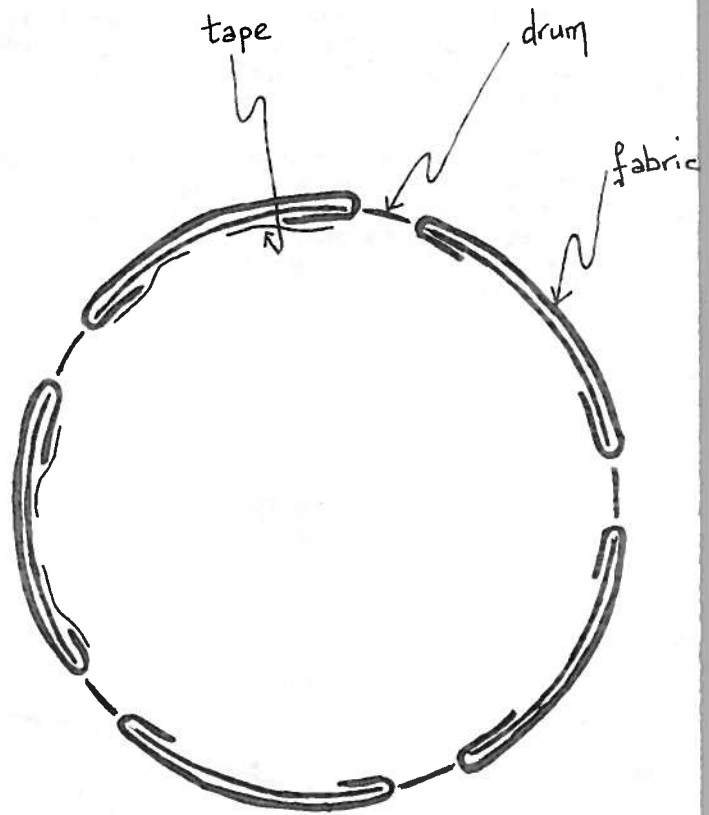


Fig. 10.

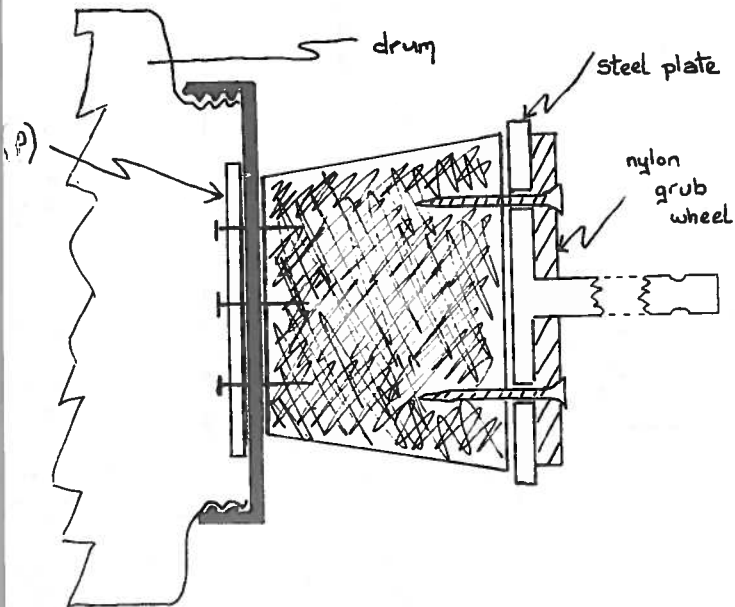


Fig. 9.

## Trade News

### Dental health (Jaws iii?)

Due out any time is the 1983/84 **Gibbs Oral Hygiene Service** catalogue. This gives details of teaching models and other resources available from Gibbs. Of particular interest are large fibreglass models of upper and lower jaws at £25 together with a giant toothbrush (£4) for demonstrating effective brushing techniques.

### New to us

- at least relatively so are **A and L Scientific and Optical Equipment** of Blackpool. A range of equipment for all three sciences is listed and described with minimal fuss in an inexpensively produced catalogue. Worth looking at for some of your basic requirements.

### Capacitance meter

Also worth examination is the 'Metertech' digital

capacitance meter at £69 from **Industrial and Biological Electronics**. This is battery operated and has liquid crystal display (ca. 12mm), 0.1pF to 2000µF test range a claimed ±5% accuracy and low power consumption.

#### 'De-ioniser'

This is a portable deioniser from **Camlab** based on a polythene bottle with a built-in deionising cartridge. A squeeze of the bottle "produces pure water anywhere". When the resin is exhausted the cartridge is unscrewed, refilled with a replacement pack, water added to the 'fill' line and the cartridge replaced. Each cartridge is claimed to give approximately 15l of deionised water. A colour change (blue to yellow) indicates exhaustion of the deionising crystals. A pack of 2 bottles complete with cartridge, resin and dispensing jet (Ref. CDM 100) costs £15 with discounts for six and twelve packs. A pack of 6 refill packets (Ref. CDM 150) costs £12, again with discounts for larger quantities.

#### Chart recorders and accessories

We have recently received literature from **JJ Instruments** on their new, or redesigned, series of chart recorder and XY plotters. There must indeed be some benefits from Mrs. Thatcher's increased productivity, improved technologies and/or competition. Prices for the CR500 models, fairly well known in schools, seem if anything to have actually fallen

A wide range of chart rolls, spare pens etc. for an equally wide range of makes and models is available from a single supplier - **Graphic Contrtols**. This range is described in the "Laboratory Edition" of their catalogue available from the address given on the inside front cover of this issue.

#### Changes of name or address

ITT Components are now **STC Components**, following a reduction in ITT's shareholding. Addresses and trading terms remain unaltered.

**Demco** have moved as have **Spiring Enterprises Educational Electronics** and **Gordon Keeble**.

Most folk will have realised by now that Corning's laboratory glassware division has been taken over by **J. Bibby**. For technical commercial reasons you will now have the same trademark 'Pyrex', coming at you from two different firms, but with one trading only in the domestic glassware market

#### - and speaking of 'Pyrex'

The use of 'Pyrex' test-tubes for heating those solids which either fuse with the glass eg. lead oxides or are difficult to remove (sulphur) is costly. One alternative to ceramic paper (see Bulletin 107) is the use of disposable borosilicate culture tubes which we mentioned several years ago. Unfortunately they

disappeared from the European market but the good news is that they are now available again selling at prices approximately one fifth of the standard tubes. We retested samples of a new batch of sizes 16x125mm (Cat. No. 99445.16X) and 16x150mm (Cat. No. 99445.16XX) which sell at £32.20 and £33.35 per 1000. These we found to stand up to strong heating for several minutes in a bunsen before sagging slightly. They also showed their robustness in that they did not break when dropped onto a wooden bench unless that drop was more than two feet. Seven other sizes are available eg. 10x75mm selling at £16.50 per 1000. One and a half pence a tube cannot be bad! These are available from Bibby agents **Mackay and Lynn** and from **McQuilkins** at the prices quoted above. Breaking down from a 1000 to 250 pack sizes adds on 10%. Neither supplier has a minimum order charge or handling charge. Package and carriage is nil for orders from Mackay and Lynn and costs a whole 25p for orders from McQuilkins!

#### Pipette fillers (see 'Safety Notes')

The **Clandon Scientific** 'Pumpett' Cat. No. ARO-2570 has spring loaded jaws to grip the pipette. In order to accept the pipette top these jaws can easily be opened by a small lever. These fillers may seem expensive at £7.00, but spare parts are available.

**Saffron Limited** produce a bulb type filler at £31.45 for 10 with a 10% surcharge for orders under £75, but carriage is free. The inlet neck for accepting the pipette has a fairly wide hole at the outside and along the lengthy neck gradually tapers down. Thus the attachment and removal of pipettes should be easy. We have been testing a sample of this type and find it much easier to fit than many of the other bulb filler types whose necks have little or no taper. For those not wishing to buy as many as ten, the same filler is available from **Harris** (Cat. No. C61840/0) at £5.32 each.

#### Plastics

Plastic containers can find many applications in science laboratories and those normally supplied in local ironmongers are often expensive.

Plastic containers suitable for containing sets of reagent bottles used in "Choice Chemistry" and other courses can be cheaply provided by the catering suppliers to be found in the Yellow Pages. **Brodie Hamilton and Melrose** supply reasonably stout plastic containers in two sizes which may be of interest. The 2 litre size with square base of side 15½cm and height 9cm will comfortably hold seven glass 125cm<sup>3</sup> reagent bottles. The 4 litre size has the same dimensions for the base, but is 17cm tall. Both have sturdy snap on lids.

The prices vary with quantity, the two litre selling at 30p each (1-199), 26½p(200-999) and 25p (over 1000). The corresponding prices for the 4 litre box are 38p, 34p and 32½p. The delivery is free for orders in excess of

£25 with 3 cases involved and for smaller quantities a delivery charge of £1.50 is made.

**Alex. Gibson** will also supply ice cream tubs of similar dimensions at more competitive prices, but the snag is that the minimum order is 1000. Their prices, in case someone can see many applications, are £150.75 per 1000 and £205 per 1000 of 2 litre and 4 litre size respectively.

#### **Kartell products**

At a recent trade exhibition were a range of such products marketed by Mackay and Lynn. An adjustable pipette filler (Kartell Cat. No. 198) can have the volume to be delivered rapidly altered by adjusting the plunger stroke. A compression rubber chuck can grip several sizes of pipette but the device can be used as a direct liquid dispenser if a length of plain tubing of sufficient volume is attached. It can be used to rapidly dispense many portions of the same volume using a one handed action. We found the device to be somewhat inaccurate. However for many purposes many will find the convenience of use attractive and a worthwhile buy at £8.13.

Measuring cylinders in plastic at competitive prices from Kartell eg. 250cm<sup>3</sup> size in polypropylene £1.25 or in clear TPX which will withstand temperatures up to 170°C sell at £2.12 each. (Cat. no. 1574).

#### **Other useful plastics products:**

Are to be found in the latest **Bel-Art Products** catalogue (No.283) with its very wide range of useful laboratory plasticware.

#### **Its all in the balance**

Two items of good news for those few out there with money and in the market for electronic balances:

Seen at the Scottish ASE meeting at Jordanhill was a special offer on a useful all purpose balance. The Precisa 1500 CE is market by **Metragram Instruments Ltd.** at the special offer price of £675. It has a high capacity combined with reasonable sensitivity which does away with the need for dual range balances - the trend mentioned in Bulletin 134. The 1500CE has a capacity of 1,500g and a sensitivity of 0.01g. Other features include (i) an RS232 output, enabling it to be interfaced to many of the popular computers, as well as an analogue output (ii) an automatic calibration facility (iii) a floating display. Finally the balance is backed by a two year warranty.

Another special offer was being made at the time of going to press by **European Instruments**. From time to time EI have for sale, at greatly reduced prices, balance models from discontinued ranges. For example, by the time this Bulletin reaches the schools, they are likely to have acquired fifty of the A series Ohaus A300 (300 x 0.01g) electronic top pans which were recently replaced by the B series. These will sell new at £435 each as against £680 for the B series equivalent.

On other occasions those with limited funds should consider consulting E.I. directly to discover if they are holding stocks of these or other discontinued models.

This firm will accept older mechanical top pan balances as trade-ins. Also several makes redundant to your use could be purchased directly by them. Generally EI find a market in industry for second hand Oertlings, Mettler and Sartorius top pans which read to 1 or 10mg, eg. Mettler P1200 or Sartorius 23 series or the Oertling R20 four place balance. Prices will vary with condition and age but figures of £60 to £70 were mentioned to us.

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