SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 6. June, 1966.

Introduction

The Governing Body of SSSERC have decided that the services which we provide, and in particular the Bulletins, will be available to direct grant and independent schools on the same basis as L.E.A. schools, and have accordingly fixed an annual subscription fee of five guineas. This will become applicable with the issue of our No. 7 Bulletin which we expect to get out in early September. While the Governors of the schools concerned will be advised of this decision independently by letter, teachers may well be asked to take the decision and should be informed of the position. For those who have not yet sampled the full benefits of SSSERC, a visit to the Centre during the summer might be considered.

Opinion

I am disturbed at the proliferation of power units which are now making their appearance in science apparatus. The Nuffield Physics Project have prepared specifications for five basic power supplies, an EHT unit, Item 14 giving 5Kv at 3mA, an HT unit Item 15 for valve work, a low voltage unit for bench supply Item 59, a special low voltage unit for the Westminster electro-magnetic kit, Item 104, and a low voltage heavy current transformer, Item 27.

One might be excused for thinking that these, or their combinations, or even their use with additional accessories where necessary would have been adequate to meet the needs of any manufacturer. Yet what do we find? Nuffield power units, all of which have been made by the larger manufacturers, are being ignored in preference for the 'special job', and need I say it, higher price. Thus Millikan's apparatus must have its own power unit, when a fine voltage control and reversing switch would seem to be all that was required.

For reasons which we give in the Trade News section, I have been unable to examine the power supply of W.B. Nicolson's mass spectrograph, but from descriptions all it seems to consist of is a variable D.C. with 50c/s A.C. superimposed. Yet it too is sold with power supply. We have a Ferranti laser in the display laboratory which requires its own power supply, but for which the only non-standard item appears to be a current meter. I feel that in all these instances, with some little consideration, one of the Nuffield specifications could have been used together with a suitable conversion box.

It would appear that I was rather naive in suggesting in Bulletin 2 that the criterion for classifying pupils under the comprehensive umbrella should be ability in the subject concerned, so that all could be educated according to their capabilities. Faute de mieux, we hear of a school where the next intake is to be streamed in strict alphabetical order of surname. While I hope that this will persist only until the children have proven their abilities in their various subjects, this solution of the randomisation problem immediately suggests a number of interesting alternatives. Quite apart from those schools in the Highlands where two-thirds of the pupils are McLeods or Macphersons and for which an alphabetical listing might have to be supported by a numerical index, other schools with disciplinary problems might like to consider sorting the pupils in terms of their height and weight product. With teachers similarly classified,/

classified, the heftiest pupils could be matched with the heftiest teacher. In girls' schools there might be a psychological advantage to be got from grading children in terms of their birth date, so that we could have a class of Scorpios and one of Pisces etc. Now that we have broken free of ability as the criterion for learning, the possibilities are endless.

Trade News

When it first began its immense publicity campaign, we asked for a model of the G and G 201 balance to be placed in the Centre. The campaign has had its success in promoting large numbers of requests from teachers to see and handle the balance. Since before Christmas we have told these teachers that one had been promised us and would soon be on view. On April 1st - there may be some significance in the date - we were promised one within a fortnight. At the time of writing - May 26th - it has not yet arrived. To all those teachers who have been disappointed in asking to see the balance I can only say the fault is not ours, and offer instead a look at the Stanton Unimatic SN1. This we asked to see at the A.S.E. exhibition in Edinburgh on April 7th, and one arrived in the display laboratory within the month. It has the same range as the G and G 201, viz 200g x 1mg, and in addition offers a taring facility up to 100g. Cost is £90.

In a similar fashion, we have been unable so far to persuade W.B. Nicolson to allow us to inspect their mass spectrograph. We have had many enquiries from chemistry teachers for information on this item, and can only repeat that we have repeatedly asked the firm concerned to allow us to put one on display.

If some manufacturers are somewhat tardy in putting their equipment on display, others are only too ready to meet the demands of teachers. After several teachers had written to Teltron for information on their electron diffraction tube, the firm have written us to say that one is on its way to us. By the time this Bulletin is in print, it will be in the Centre.

Oxoid Ltd. have brought out a microbiology kit for schools. It contains everything, except the oven, necessary to carry out at least 12 experiments on bacteria covering an extremely wide range. Details for constructing a suitable oven from a biscuit tin are included with their instruction booklet on the experiments. Examples of experiments are micro-organisms in the air, bacteria on the body surface, the action of anti-biotics and disinfectants. The kit, which can be seen in the Centre, costs £4.19.6d.

The 250ml size Aerocup, used in calorimetry work is obtainable from Dobbies Paper Supplies, at a price excluding postage of 9/- per 100, or 88/- per 1,000. Identification number of the cup is 1011/041.

Teachers who bought Radiospares transistors and now find that, having thrown out their old catalogues, they have no information on their working characteristics, can apply to SSSERC. We have a number of leaflets giving details of all transistors sold by the firm.

Display Laboratory

The following have been added since Bulletin 5.

Item	Manufacturer
L.V. Power Units	S.S.S.E.R.C.
Unimatic SN1 Balance	Stanton
Mettler H3 Balance	Gallenkamp
Helium Neon Laser	Ferranti
Chromatography Unikit	Shandon
Chem-Test Kit	Griffin and George
Exelo Gas Syringe Kit	Philip Harris
27X and 27BU Semi Micro Sets	Quickfit and Quartz
Microbiology Kit	Oxoid
Model Eye Kit	Griffin and George
Worcester Circuit Board	Griffin and George
5Kv EHT Unit	Griffin and George
300A Smoothing Unit	Griffin and George
300 Power Pack	Griffin and George
Xenon Stroboscope	Griffin and George
Millikan's Apparatus	Griffin and George
M1 Transistor Voltmeter	Linstead
Heathkit 10-12U Oscilloscope	Daystrom

Physics Equipment; Year IV

We give below the first half of an equipment list which has been prepared in consultation with our Development Committee. The remainder of the list will be given in Bulletin 7.

This list is intended to bring up-to-date that issued by the Advisory Committee on Physics in 1963.

Notes. P denotes that the equipment should be available in pupil quantity for pupil experimentation, normally one per 2 or 3 pupils.

D denotes teacher demonstration apparatus, normally on a scale of one per laboratory.

NF after a particular manufacturer's equipment denotes that the apparatus has been approved by the Nuffield Foundation Physics Teaching Project. If an apparatus does not have NF it does not mean that it is not approved; it may not be in the Nuffield list, or it may have been approved since December, 1965 when their first list was issued.

Similarly the prices quoted are subject to change, usually in an upward direction and are only the latest we have available.

1. Electrostatics Kits. (P). Those used in Year I can still be employed but it will be necessary to calibrate the electroscopes, requiring a graduated scale

Supplier.	Catalogue No.	Cost.
P.H. (NF)	P.7851	£3.15/-
M.L.I. (NF)	95/51	£3.3/-
W.B.N.	N7/1122	£4.2.8d.
G. and G.	L81/100	£4.6/-

2./

2. Graduated Electroscopes. (D).

Supplier.	Catalogue No.	Cost.
P.H. (NF)	P 798S	£3.2.6d.
W.B.N.	N7/1070	£6.19.3d.
G. and G.	L81/828	£4.1.6d.

3. Pulse Electroscopes. (D). These are projection electroscopes and incorporate a range of accessories such as telescopic ionisation chamber etc. Check with individual catalogues. They are normally supplied without the necessary power supplies which are an E.H.T. unit for the electroscope and low voltage A.C. for the projection lamp.

W.B.N.	N7/1051	£22.1/-
G. and G. (a)	L91/008	£8.18.6d.
P.H.	P7990	£20.17.6d.
S.T.A. (b)	546.00	£29.19.3d.

Notes. (a) and (b) do not include accessories or projection facilities; they can be fitted, with the necessary adapters, to film strip projectors.

4. Extra High Voltage Power Unit. (D). These give a minimum of 5kV and are overload protected to a maximum current of 3mA.

P.H. (NF)	P7998/11	£35.10/-
W.B.N. (NF)	N7/1532	£42
G. and G.	L96/100	£50
Unilab (NF)	U1-0020-5K	£33
S.T.A. (NF)	522.37	£70.18/-
Teltron (NF)(a)	TEL 600 and 603	£47.10/-
Radford (NF)	N.14R	£37.10/-

Notes. (a) Module TEL 600 is a low tension power supply required to drive the E.H.T. unit TEL 603; both are required.

5. Van de Graaff generator. (D).

G. and G. (NF)	L81-275	£15.10/-
P.H. (NF)	P.7891	£27.10/-
S.T.A. (NF)	541.70	£40.17/-
M.L.I.	95-60/1	£24.10/-
W.B.N.	N7/1095	£41.9.6d.

6. Electrostatic Field Apparatus. (D). These are the grass seeds and castor oil, or similar, apparatus used for illustrating electrostatic fields.

P.H. (NF)	P.100/149	£2.5/-
M.L.I. (NF)	95-149	£2

7. Macro-Millikan Apparatus. (D). Condenser plates with a conducting sphere suspended between them.

P.H. (NF)	P.100/142	£7.17.6d.
M.L.I. (NF)	95-142	£7.10/-
G. and G.	GN 142	£7.10/-

8. Millikan's Apparatus. (D). It is considered that this is too difficult for 'O' and 'H' level and that the principles demonstrated by Item 7 are sufficient for all but post-Higher pupils.

P.H. (b)	P7988	£95
P.H. (a)	P7988C	£19.10/-
W.B.N.	N7/2463	£42.16.6d.
G. and G.	L89/960	£36.15/-

Notes. (a) This is the Millikan cell only, and does not include necessary accessories such as microscope,
(b) This is the complete apparatus except for the power unit.

9./

9. Current Balance. (P). This really illustrates the force on a conductor in a magnetic field.

Supplier	Catalogue No.	Cost.
P.H. (NF)	P.100/53	£2.8.6d.
G. and G.	GN. 53/05	£2.17.6d.
M.L.I. (NF)	95.53	£2.2.6d.

Prices for all the above are for ¼ standard kit, i.e. the material is sufficient for 4 sets.

10. Meters. (P). The ranges of meter used in Sections 6 and 10 depend on how the teacher has designed his course, what power supplies and resistors he is using etc. We believe that 0 - 1mA, 0 - 10mA and 0 - 500mA should be sufficient to cover most of the current requirements of the syllabus, with 0 - 1, 0 - 5 and possibly 0 - 20 volts. This differs from Nuffield, who recommend 0 - 1 and 0 - 5 amp, and 0 - 5, 0 - 15 volts. Two types of meter are listed: A are single range instruments; B types are universal meters using the one movement with a range of shunts or multipliers.

A. Single Range.

Derritron	various ranges A and V	£10.10/-
White	Type RM moving coil	£7
Weir (NF)	Type DH moving coil (Nuffield ranges only)	£3.15/-
W.B.N.	N7/1760,2, ammeter	£5.13.3d.
W.B.N.	N7/1835 voltmeter	£5.16.3d.
G. and G.	L93-412 milliammeter	£3.1.9d.
G.W. Smith	Type MR65	£1.9.6d.

B. Universal

Unilab (NF)(a,b)	NR 180	£4 (17/6d.)
Unilab	1mA meter unit	£4.10/- (17/6d.)
W.B.N.	N7/1710 with N7/1720	£8.11.6d. (£2.0.6d.)
Crompton Parkinson (NF)(b)	5" Pivotless	£10.4.9d. (£1.18.6d.)
White (NF)(b)	Type RM A	£7.5.6d. (£1.16.9d.)
Weir (NF)(b)	2½" Universal	£6.17.3d. (£1.11.6d.)
G. and G.	L95-150 with L95-155/25	£8.11/- (£2.0.6d.)

Notes. (a) The prices in brackets give the approximate cost of a shunt or multiplier used in conjunction with the meter. Actual cost varies with the range required.
(b) Full Scale deflection is 0 - 10mA, off-set zero.

11. Centre-Zero Galvanometers. (P). For use in electromagnetic induction. The current value quoted gives the half scale deflection. If off-set zero meters are purchased under Item 10, these may not be necessary.

Weir (NF)	2½", ½, 1 or 2mA	£6.1.6d.
White	Type RMA, 1 or 2mA	£7.5.6d.
G. and G.	L93-500, ½, 1 or 2mA	£8
G.W. Smith	Type MR65, 1mA	£1.9.6d.
P.H. (NF)	P7207, 3½ mA	£4.7.6d.

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12. Demonstration Meters. (D).

Supplier.	Catalogue No.	Cost.
White (NF)(a)	I.N.D.C.	£17.6.6d. (£3.13.6d.)
White	D (Multirange D.C.)	£49.17.6d.
White (NF)	AD (Multirange A.C. and D.C.)	£59.17.6d.
Weir (NF)(b)	6" Universal	£12 (£1.11.6d.)
S.T.A. (NF)	531.86	£70.15.6d.
Crompton Parkinson (NF)(c)	8" DCRA	£20.2.6d. (£1.18.6d.)
Andrew H. Baird (NF)(d)	Russian S 36A	£10.10/-
	S 36V	£10.10/-

Notes. (a) Centre or left-hand zero adjustment. Plug in interchangeable scales.
(b) Scaled 2 - 0 - 10mA. Uses same shunts etc. as 2½" universal meter.
(c) Scaled 1 - 0 - 10mA.
(d) Ammeter gives 500μA D.C., and 3 and 10A A.C. and D.C. Voltmeter gives 5 and 15V D.C., 15 and 250V A.C., and 75mV D.C. Both instruments are centre and left-hand zero, and shunts, multipliers are included in the basic price.

13. Resistors. (P). Unknown values for use in Sections 6 and 10.

Radiospares	1 Watt, 10% tolerance	4½d.
	1 Watt, 5% tolerance	6d.

14. Capacitors. (P). These are best bought by ordering through the pages of Wireless World. Values between ½ and 10μF are suitable. Stantelum reversible electrolytic condensers are a suitable alternative to paper dielectric types.

Lind-Air	.25μF, 12V	4/-
	1μF, 50V	10/-
	2.5μF, 100V	5/-
	6.8μF, 6V	6/-
	10μF, 20V	5/-

15. Electron Tubes. (D). Demonstration tubes for introducing electron physics, with accessories. E.H.T. Power Supply is required.

Diode.		
Teltron (NF)	TEL 520	£6.1/-
Rank (NF)	3030344	£6.10/-
Triode.		
Teltron (NF)	TEL 521	£7.6/-
Maltese Cross Tube.		
Teltron (NF)	TEL 523	£8.10/-
Rank (NF)	3030313	£11.11/-
Perrin Tube (a).		
Teltron (NF)	TEL 524	£8.15/-
Rank (NF)	3030324	£13.
e/m Deflection Tube (b).		
Teltron (NF)	TEL 525	£14.14/-
Rank (NF)	3030340	£18.5/-
Discharge Tube (c).		
Teltron	TEL 530	£16
Rank	3030308	£5.15/-

Spectrum/

Spectrum Discharge Tube (d).

Teltron	TEL 531	£2.2/-
Rank	3030411-16	£1.8.6d.

Stand and Supports.

Teltron (NF)	TEL 501	£6.14/-
Rank (NF)	3030337 and 8	£4.1.6d.

Deflecting Coils.

Teltron (NF)	TEL 502	£8.8/-
Rank (NF)	3030330	£4.17/-

Notes. (a) Perrin tube has a side collector electrode allowing the beam current to be deflected by the deflecting coils and registered on a galvanometer.

(b) e/m Tube carries an internal 'graph' to show Thomson parabola on electrostatic deflection, and by restoring the beam with deflecting coils, e/m may be estimated.

(c) Discharge tube is intended for evacuation from atmospheric pressure to show various phenomena associated with low pressure gas discharge. Teltron version is demountable and has provision for leaking in small amounts of any desired gas.

(d) Spectrum Discharge Tube. This provides a capillary tube discharge for spectroscopic work. Teltron version fits the assembly for TEL 530 the gas being leaked in as described in note (c). Rank have various gases in sealed tubes.

16. Vacuum Pump. (D). A rotary pump is essential; for post 0 level work an oil diffusion stage is also desirable.

Teltron (NF)	TEL 505	£60.9/-
Edwards	EQ2A	£94

Oil Diffusion Stage.

Teltron (a)	TEL 506	£37.4/-
Edwards (b)	EQ4B	£120

Notes. (a) TEL 506 connects to TEL 505 by hose union, supplied with TEL 505.

(b) EQ4B comprises rotary and oil diffusion stages. To convert an already held EQ2A to an equivalent EQ4B, conversion kit costing £33.10/- can be obtained.

17. High Voltage Power Unit. (D). For valve work. Provides 250 - 300V D.C., a - 25V biassing supply, and 6.3V A.C. for heaters.

P.H. (NF)	P7996	£30
G. and G. (NF)	GN-15	£28.15/-
Unilab (NF)	U1-0022-45M	£32
Radford	N15R	£18
Teltron (NF)	TEL 601	£27.10/-
Leybold (NF)	522-35	£43.13.9d.

18. Valves.

Diode (P) EA50 requires no valve base, as wires can be soldered direct to the pins. See Mullard Useful Ideas No. 1, or SSSERC Bulletin No. 3.

Bentley (a)	EA 50	1/6d.
Bentley (b)	OA 81	3/-

Triode (D) or (P) ECC81 (12 AT7) can be used in pupil quantities with low voltage power supply, eliminating the need to purchase item (17) in pupil quantity. See SSSERC Bulletin No. 4. Requires a B9A valve base.

Bentley/

Supplier.	Catalogue No.	Cost.
Bentley (a)	ECC 81	3/6d.

Notes. (a) Price excludes postage.
(b) Germanium diode.

19. Transistors. (P).

Bentley	OC 71	3/6d.

20. Mechanical Oscillations. (D). Very little is available here, except Wilberforce Pendulum.

G. Cussons	6200/109	£5.10/-

21. V.L.F. Generator. (P) or (D). For generating very low frequency A.C.

Unilab (a)	063.631	£4
White (b)	Type RT	£3.19.9d.

Notes. (a) Transistorised 0.1 c/s oscillator.
(b) Wire wound resistor fed with D.C. from battery, with two rotating contacts.

22. Signal Generators. (P) or (D). These must have a low impedance output so that loudspeakers etc. may be connected direct.

Advance	SG 65	£20
Linstead	G1	£20
Grayshaw	A050/T	£15

23. Oscilloscopes. (P). 2¾" screen.

Telequipment (NF)	Serviscope Minor	£23
Heathkit (a)	OS1	£22.18/-

Note. (a) In kit form; assembled cost is £30.8/-

24. Oscilloscopes. (D). 5" screen or larger.

Telequipment (a)	S51E	£55
Advance (a)	OS15	£49.10/-
Heathkit (b)	10-12U	£35.17.6d.

Notes. (a) Available with normal or long-persistence tube, same price.
(b) In kit form; assembled cost is £45.15/-

25. Electrical Oscillations. (D). For demonstrating electromagnetic oscillations.

Unilab (a)	El. Osc. App.	£40
Andrew H. Baird (b)	U.H.F. Set	£12.10/-
W.B.N. (c)	N4/1880	£82.10/-
Unilab (d)	see below	£59.2.6d.

Notes. (a) Demonstrates electrical oscillation at all frequencies from very low to ultra-high.
(b) Fixed U.H.F. transmitter and detector. Needs 300V, 200mA power supply.
(c) 3cm wave kit and accessories.
(d) 3cm wave kit roughly comparable to (c) and comprises 044.571 transmitter; 042.871 power supply, 045.672 receiver without meter, 053.842 amplifier and loudspeaker, 045.673 probe detector, 041.172 metal reflector, 041.173 hardboard plate, 041.174 metal grille, 041.971 and 041.972 hollow prisms, 041.973 lens.

In The Workshop

This tidal aquarium once set up will keep small marine animals healthy for considerable periods, 2 years and probably much longer with little attention. In such an aquarium it would be possible to base a course on rock pool ecology, always with the knowledge that although it is an artificial rock pool, real animals and plants survive and grow, including the appearance of a plankton, be it representative or not. One tank can simulate a 'beach' and the other a rock pool - Nereid worms survive miraculously for years - and small crustaceans, sea anemonies, molluscs, tube worms, and a host of other animals thrive in the rock pool.

Apparatus.

Required:- 2 all glass tanks, 14" x 9" x 9" or larger if possible.
3mm polythene tubing (inside bore) - glass tubing, 3 - 4mm bore.
A dependable air pump.
Siphon bottle G - a (plastic) specimen tube with polythene stopper.
Siphon bottle D - a small bottle - 5-10ml capacity, (height 1" or less) which will float when empty.
Some means of supporting one tank above the other with the lower one 12" above bench level - old television cabinets are ideal.
Means of drilling through glass.

Construction.

1) Drill a hole on the centre line of the end wall of the upper tank A slightly larger than the glass tubing to be used, about 2" from the top of the tank. An old triangular file with a broken edge will cut a hole quicker than a masonry drill - keep moistening the cutting edge with turpentine.

2) Support the tanks, with as little vertical distance between them as is convenient - a refinement is a lamp above each aquarium.

3) Bend glass tubing so that lower end dips into siphon bottle D in upper tank and seal into drilled hole with a short piece of polythene or other tubing - connect siphon C to a glass tube leading into lower tank B.

4) Drill 3 holes in the polythene stopper of a specimen tube using a No. 1 cork borer or size smaller than tubing used. Connect 3 polythene tubes simply by pushing them through holes; one tube should reach bottom of the specimen tube and this is connected to a glass siphon F leading to lower tank. The other two tubes lead to top tank A, and to the air pump respectively. Bend glass tubing as required - long pieces of glass tubing tend to get broken - use polythene tubing for long pieces but preferably glass for inside the tanks. Fill the lower tank with water to test the operation. MAKE SURE THAT SIPHON BOTTLE G IS AT LEAST 10" below B, lower if possible.

Operation.

Close the tube leading to tank A and suck through the air pump tube until water from B fills the siphon bottle G. Release A, reconnect the air pump and switch on. Water and air bubbles should rise up to tank A but the system may 'blow back' initially into tank B. In this event repeat the operation but constrict the siphon from B until the column of water in the long tube E is pushed into the upper tank and then release. A continual flow of water and air should move upwards into tank A and this water is siphoning slowly out of B.

When/

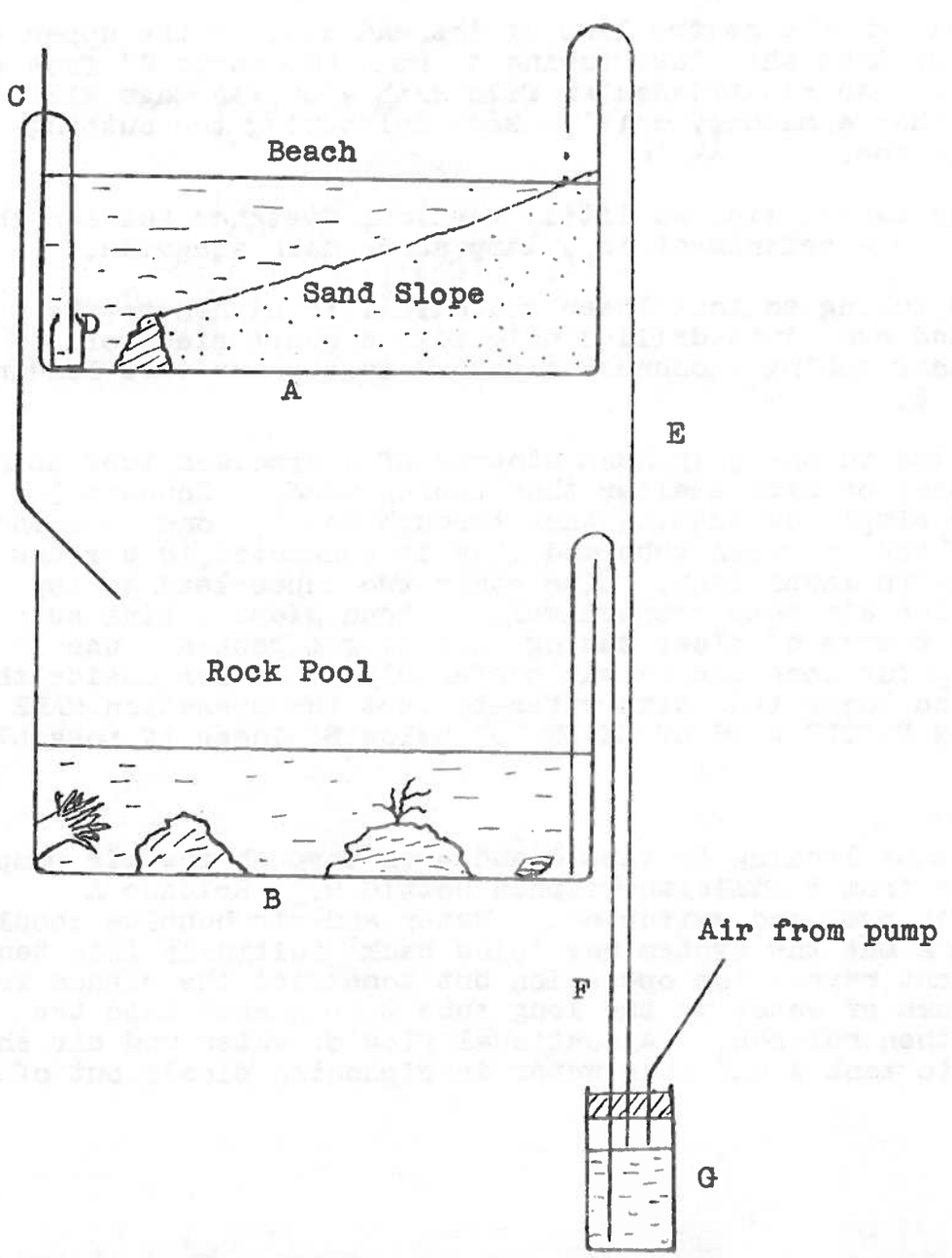
When A fills to the level of the drilled hole, the water will flow out, then siphon out until it empties completely. The function of bottle D is very important as it prevents a balance occurring of "air bubbles and water leaving = air bubbles + water entering" with of course consequent stagnation. If the tides work successfully, - empty the tanks and stock with sea water, sand, rocks etc. as desired - do not put too many or too large animals in to begin with - 3 sea Anemonies, 2 Crabs halfpenny size, and 4 or 5 each of winkles and mussels is quite sufficient - overstocking leads to death and pollution.

Feed <u>very sparingly</u> to begin with. About <u>1gm</u> of raw fish or other food per <u>fortnight</u> is ample. Stereo microscopes can be used to great advantage with these aquaria.

Cycle.

We do not think that the length of cycle is of great importance; what is important for the survival of the aquarium as a habitat is (a) movement of water, and (b) adequate aeration. With the dimensions given it will be found that the complete cycle of tides is about 3 - 4 hours but if required clips may be used to restrict flow, and lengthen the cycle.

Any comments on experiments which may be of value will be welcomed by us, and if any difficulties arise do not hesitate to contact the Centre.



SSSERC, 103 Broughton Street, Edinburgh, 1. Tel WAV 2184.

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

Andrew H. Baird Ltd., 33-39 Lothian Street, Edinburgh, 1.

Bentley Acoustic Corporation, 38 Chalcot Road, Chalk Farm, London, N.W.1.

Crompton Parkinson Ltd., Crompton House, Aldwych, London, W.C.2.

Daystrom Ltd., (Heathkit), Gloucester, England.

Derritron Instruments Ltd., Parklands, Cainscross, Stroud, Gloucestershire.

Dobbies Paper Supplies, Elgin Street, Dunfermline, Fife.

Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex.

Ferranti Ltd., King's Cross Road, Dundee.

A. Gallenkamp and Co. Ltd., Technico House, Christopher Street, London, E.C.2.

Grayshaw Instruments, 126 Sandgate High Street, Folkestone, Kent.

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

Philip Harris Ltd., Ludgate Hill, Birmingham, 3.

Lind-Air Electronics Ltd., 53 Tottenham Court Road, London, W.1.

Linstead Electronics Ltd., 35c Newtington Green, London, N.16.

Morris Laboratory Instruments Ltd., 96-8 High Street, Putney, London, S.W.15.

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

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

Quickfit and Quartz Ltd., Stone, Staffordshire.

Radford Electronics Ltd., Ashton Vale Estate, Bristol, 3.

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

Rank Audio Visual, Woodger Road, Shepherd's Bush, London, W.12.

Scientific Teaching Apparatus (Leybold), Colquhoun House, 27-37 Broadwick Street, London, W.1.

Shandon Scientific Co. Ltd., 65 Pound Lane, Willesden, London, N.W.10.

G.W. Smith and Co. Ltd., 3-34 Lisle Street, London, W.C.2.

Stanton Instruments Ltd., 119 Oxford Street, London, W.1.

Telequipment Ltd., 313 Chase Road, Southgate, London, N.14.

Teltron Ltd., 239 Acton Lane, Chiswick, London, W.4.

Unilab Division, Rainbow Radio Ltd., Mincing Lane, Blackburn, Lancs.

Weir Electrical Instrument Co. Ltd., Bradford-on-Avon, Wiltshire.

White Electrical Instrument Co. Ltd., 10 Amwell Street, Rosebery Avenue, London, E.C.1.