

SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

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Introduction

The start of a new school session is perhaps a good time to remind teachers of the service which SSSERC offers, particularly since, one hopes, there may be a number of newly appointed assistant teachers reading this Bulletin for the first time. This Bulletin should arrive approximately every six weeks in the school, there being 7 - 8 issues per school session. In early summer we sent to all addresses on our mailing list copies of equipment lists for the Integrated Science Course, and for the revised Physics Syllabus based on Circular 490. Equipment lists for the revised Chemistry Syllabus, Circular 512, and for the Certificate of Sixth Year Studies in Chemistry will come before our Development Committee in September for their approval, and will thereafter be issued separately, or printed in a Bulletin issue. A general equipment list of such items as clamps, burners etc. which we consider basic to any science laboratory whatever its function, and which we hope will be of assistance to teachers and local authorities faced with equipping a new school, is also in course of preparation.

The equipment lists for the Certificate of Sixth Year Studies in Physics, published in Bulletin 19, and for the new Biology Syllabus, published in Bulletin 23, are still valid, but are being re-examined with a view to bringing them up to date. Lists for the "Brunton" science topics of Astronomy, Dyes, Earth Science, Electric Circuits, Electronics, Fuels, Flow, Metal Corrosion, Nutrition and Weather have been prepared but not generally issued. They are obtainable upon request. Other titles in the Brunton science series are in course of preparation.

Back numbers of all issues of the Bulletin may be purchased at a cost of 1s. per copy plus postage; an order form for this purpose was sent with Bulletin 26, but it is of course not necessary to use this when ordering copies. It is also hoped that we shall be able to publish in booklet form the collected practical hints and designs, mainly from our "In The Workshop" section of the first 30 issues, but this must depend on the response of the educational publishing firms.

The display laboratory at the Centre has a wide selection of apparatus for teaching biology, chemistry and physics (with some interesting sidelines in mathematics and engineering) and may be visited at any time when the Centre is open without prior appointment. Our open hours are 9 a.m. - 5 p.m. weekdays, and 9 a.m. - 1 p.m. on Saturdays throughout the year. It is part of our policy to keep the display laboratory open during school vacations, and qualified advice and assistance is available at all times to explain or operate the equipment. A street map showing the location of the Centre, which is within 10 minutes walk from the General Post Office, was published in Bulletin 5.

As an extension of the display laboratory service we hold exhibitions, by invitation from the S.E.D., Colleges of Education or groups of teachers in schools and colleges outside Edinburgh. Thus in the past session we held 16 exhibitions in places as far apart as Lerwick and Kirkcudbright, and on topics covering the complete range of biology, chemistry and physics teaching. In the current 1969/70 session we have one provisional arrangement to exhibit in Kirkwall in June; otherwise our engagement book is blank, and we invite any who are/

are planning in-service courses, one-day conferences or informal gatherings of teachers to consider whether a SSSERC exhibition would add interest to their programme.

One of the reasons why this Centre was set up was to test and report on apparatus already being manufactured and supplied to schools. When a report has been prepared it is sent to the manufacturer for his comments and is then available to teachers. Legal requirements demand that reports be treated as confidential documents, so that they may be borrowed only by teachers working in Scotland. However, we do have a reciprocal arrangement with the CLEAPSE Development Group, a science centre in the South of England with functions similar to our own whereby schools which are members of CLEAPSE may have access to our reports, and our own Scottish members may obtain CLEAPSE reports from us. A list of CLEAPSE and our own reports to May, 1968, was published in Bulletin 22, although both these have been added to since then. Summaries of test reports are published from time to time in the Bulletin, but once again this is confidential information and is sent to our Scottish readers only. The most advantageous way in which a teacher can use these reports is for him to borrow all reports on the particular instrument he is interested in and by a comparative study to select that best suited to his needs.

We are in close touch with a number of industrial and research organisations which periodically dispose of their obsolete or redundant equipment very cheaply. Also we are active in the government surplus market, buying at auctions such lots as we think may find an application in schools. There are two ways in which the teacher can obtain these items; firstly by direct purchase, and a note on the main selling lines was given in Bulletin 31, and is added to in this Bulletin on page 5. Since Bulletin 31 was published we have had many enquiries for the material being offered, and some teachers may have been disappointed by the delay involved in getting their standard requisition form through the bureaucratic channels to us. In such cases, a phone call or letter will reserve the equipment for the teacher until the paper work reaches us. Likewise we will hold any material purchased until such time as it may be convenient for the teacher to collect it personally, as freight and postal charges add unnecessarily to the cost. We have also on occasions arranged to deliver surplus equipment in conjunction with an exhibition which was being held in a convenient place. Thus recently, an oscilloscope found its way from Edinburgh to Tobermory via Aberdeen!

The second method whereby the teacher may have the use of second-hand equipment is by borrowing on free loan for a period of time which can be adjusted to individual requirements. At this level, most of the equipment is highly specialised and sophisticated, and most is electronic by nature. Details of our loan scheme were given in Bulletin 18.

In addition to the above we are constantly answering by phone or letter a stream of enquiries from individual teachers on difficulties with apparatus. We think we are on good terms with all the firms which deal in school science apparatus, and we hope that they listen with an attentive ear when we take up a teacher's case with them. We like to think that most will listen because they want to; some may feel they have to.

Opinion

It has been a harmless amusement of mine to collect the scientific gaffes which appear from time to time in published literature, sometimes by people who really ought to know better. A happy hunting ground for these are the woman's weekly magazines, or the woman's page in the daily newspapers. Thus from these sources I have learned that carbon tetrachloride is a good grease-spot remover, but that I should not use it near an open fire, as it is highly inflammable, and that gold sequins on some dress material were initially attached by a magnetic process. But my first introduction to the species was in the psychology textbook I used at University, where the writer referred to "current of 110 volts" being used in electro-convulsive therapy.

In the film "Lord of the Flies", as was pointed out in Physics Education, Vol. 1, No. 4, the spectacles used by Piggy to correct his short sight would hardly serve as a burning glass to provide fire. The Wise Old Owl in my son's comic of a few weeks ago informed him that the varying shape of the moon was due to the earth interrupting the sun's light; I hope the Owl was well reprimanded for his mistake by his regular readers, many of whom will have the true facts at their fingertips.

The examples I have given so far may provide amusement and perhaps some irritation to the general reader who becomes aware of them; none could be said to be harmful, but it was brought to my notice that in No. 18, p.361 of the serial encyclopedia, "Pictorial Knowledge" wrong advice on the new international colour coding of mains electric cable was given, to the extent that the recommendation for neutral and live lead colours had been reversed. While it may nearly always be the case that neutral is as well insulated as live inside the apparatus, it is better to be safe than sorry, and I repeat now what we stated in Bulletin 28, that the live lead should be brown, and the neutral light blue, while earth is striped green and yellow. These regulations will come into force, as far as the electrical industry is concerned on July 1st, 1970.

Trade News

The Walden Precision Apparatus K series of galvanometers have increased in price to £24.16s for any one model.

The firm of Modelcraft, which we gave in Bulletin 20 as a source of Japanese made Mabuchi motors has informed us that they can no longer supply these and that at the time of writing only the 35R type remains in stock. Further, the firm has been unable to find an alternative importer for these motors, and it may be that this supply has dried up. Teachers would therefore be well advised to buy up this very useful item if any opportunity for local purchase, e.g. in model shops occurs.

Telegquipment are now manufacturing a double beam oscilloscope. the D51, which will sell to schools at £93 less 15% educational discount, which brings the nett price just a shade over £80. The Y₁ and Y₂ amplifiers and the time base have/

have the same ranges as on the single beam S51E. Switching allows the time base to be triggered from either beam, or externally and from either +ve or -ve going signals. Terminals at the rear allow X or Z (beam brilliance) modulation to be fed into the oscilloscope, and the time base generator waveform is available on another terminal.

Recent useful items being offered by Proops Brothers include their transmission diffraction grating, used in our grating spectroscope, Bulletin 8, where a sheet 12" x 6½" costs 15s; Fresnel lenses with 13½ or 14½in focal length, 12" x 12" and 1 or 2mm thick, at £1.5s. for any type, and polarising film at 1s. per in². (The out-of-date units are the firm's, not ours, but it may be expedient to conform in the interests of having the order executed promptly.)

An item from K.R. Whiston's current catalogue, No. 64. may be of interest to physics teachers. Catalogue No. 3068 lists 1½" long crocodile clips at £1.1s. per 100.

The Scottish representative of Advance Electronics, Mr. J. Wilson, asks that teachers should note that his new address is Greenwalls Farm, Fenwick, Ayrshire.

Morris Laboratory Instruments are now marking their Bourdon gauges, and the pressure gauges on their Boyle's Law and Gas Laws apparatus, in S.I. Units.

A series of miniature centrifugal pumps for operation of low voltage D.C. are available from Boro' Laboratories. Their type Z has a maximum flow rate of 4 litres per minute, and a maximum lift of 2½m. It can be bought with motor for 3, 6 or 12V D.C. working, for £2.19s.6d. The makers claim that the motor can be run continuously at 100% overload without damage, which would double the performance figures given above.

So many items of equipment made up by school technicians or teachers require levelling screws that the bases of discarded beam balances must long since have been stripped of their adjustable feet. At any rate we have had one or two enquiries from teachers for a source of these. Philip Harris will supply adjustable screw feet at 3s.6d. each, or £2 per dozen. A much more substantial foot for trolley runways is obtainable from Griffin and George at £1.17s.6d. per pair.

Morris Laboratory Instruments have made a major review of their price structure. The firm have had an enviable record of keeping prices stable since 1964, and many customers must be surprised that the change did not come sooner. It is a record which the firm were justly proud of, so much so that they took us to task for certain loose statements regarding rising prices which we made in Bulletin 12, and to which we printed their reply in Bulletin 13. Perhaps the only part of that reply in which they could now be faulted is their assurance that when they changed their prices, their customers would be informed of this. This is now being remedied by the publication of a comprehensive price list which shows that as a result of the review, 64.0% of prices have risen, 30% have remained the same and the remainder have in fact dropped. This list is available to teachers on request.

Biology Notes

A cold frame measuring about 60 x 90cm which can be built in a few minutes to surround seed boxes can be made from polystyrene tiles. They are pinned together with cocktail sticks and once fitted round the seed boxes, can be held together by elastic string round the periphery, made by tying rubber bands together. The top cover for the frame is clear polythene sheeting, again held down by the elastic string. The idea comes from Woodburn House Horticultural Centre, Glasgow, who exhibited it recently at the Teachers' Centre, Glasgow.

* * * * *

The following two ideas come from Broughton Secondary School, Edinburgh. To extract living material from a soil sample for examination, it is best to encourage the organisms to move out under their own power. The sample is put in a syrup tin, which is then covered with a coarse wire or string mesh. The tin is inverted in a suitable clamp over a funnel leading to a specimen tube. A 60W electric light bulb is placed at the top in contact with the base of the tin and switched on. The heat transmitted to the soil from above is sufficient to expel the living matter through the mesh, whence it drops into the funnel and specimen tube.

* * * * *

A labour-saving method of catching small ground-living organisms when studying a habitat is pitfall trapping. A syrup tin is sunk into the soil until the rim is level with the surrounding earth. A roofing tile propped over the open tin with a pebble will prevent it becoming rain-filled. The bottom of the tin is covered to 2cm depth with a mixture of glycerin and 5% formalin. If it is desired to have the specimens live for observation, a leaf or two can be put in the bottom of the tin instead of the mixture described.

Physics Notes

There has been a considerable demand for the items of government surplus which we published in Bulletin 31, with the result that many of the lines mentioned are now sold out. This means that only the following are now available:

Item 1: Large Scale Ammeter. These can be supplied with centre zero only, but by removing the front face of the meter it can be set manually for left-hand zero. One must then either remove the set zero control provided, or modify it.

Item 2: Aneroid Barometers.

Item 3: Mercury Barometers.

Item 4: Psychrometer (only one left).

Item 14: Power Rheostats.

Item/

- Item 15: Relays.
- Item 16: Switches.
- Item 17: Potentiometers.
- Item 18: Block Paper Capacitors.

In addition we can offer the following new lines:

- 20. Cathode Ray Tubes. These are designed for electromagnetic deflection and are fitted with deflector coils. Operating data can be supplied with the tube. Price 1s.
- 21. Sets of drawing instruments, Temple BS2460. This is a set of 11 pieces in velvet lined case, Price £2.
- 22. High value wire-wound resistors. A bank of 5 100k Ω resistors, rating probably 20W or over. They are supplied with paxolin mounting bracket which connects all five in series through Terry clip supports, and also carries a spark gap. Price 5s.
- 23. Fahrenheit thermometers. These have scales reading 20 - 180 $^{\circ}$ F x 50 $^{\circ}$ divisions, and are suitable for demonstration in that the scale has 40mm radius and large figures. The sensing element is a bimetallic strip in a sealed brass tube, 80 x 9mm dia. Two types can be supplied; in type A the tube is normal and central to the meter face, projecting behind it. In type B the element is horizontal on the left hand side of the instrument as one views the scale. Please state which type is required when ordering; both types, 5s.
- 24. Transformers and chokes. Mains and audio transformers, and chokes for use in smoothing circuits. All the mains transformers have standard 230 - 250V single phase, 50Hz primary. Secondary outputs are too varied to detail here, and secondary requirements should be specified when ordering. All at one price, 1s. each.
- 25. Electronic Valves, ex equipment. Again, the types are too varied to detail here, and we have both commercial and CV types. Send us a list of your requirements. Price 6d. each valve.

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In Bulletin 29 in the report on the testing of low voltage transformers we mentioned the unsatisfactory fusing arrangement which was to be found on most models. This was usually a straightforward fuse of 1A rating or greater in the primary circuit, and we pointed out that this can be expected to protect the transformer only against a short on the secondary, and not an overload. With a 1A fuse, a mains current of 1.5A could flow for upwards of an hour before melting the fuse, and long before this time the transformer would have suffered damage. At the time of writing the report, the tests on different fuses had not been completed, and we give these results now.

We elected to use Radiospares fuses, as being readily available to schools. These were a "straight" 5/8" glass cartridge fuse, and a 20mm anti-surge fuse, also glass cartridge/

cartridge type, and both of 500mA rating. We firstly arranged to place the straight fuse on the mains at a 500mA continuous load; this gave over 1800 hours working before the test was stopped. We then arranged an inductive load for the fuse as follows;

The secondary of a Philip Harris low voltage transformer was connected to a number of 6 and 12V electric lamp bulbs, adjusted so that the continuous current in the primary was 500mA. (We found early in our tests that the life time of a car lamp bulb was considerably less than that of the fuse we were testing, and so repeated the tests with a heating mat element as the transformer load.) A switching current was set up to switch on the transformer every five minutes, keeping it on for about 30s, and then having it switched off for the remaining $4\frac{1}{2}$ min. In this condition the heating mat element is cold every time it is switched on, so that the measured load current is being drawn. An electro-mechanical counter was included in the circuit so that the number of switching operations could be measured.

Neither of two 'straight' 500mA fuses survived more than 4 such switching operations; one of these was the fuse which had previously done 1800 hours continuous running, but a fresh fuse performed no better, and we therefore turned to the anti-surge type. Fuse No. 1 withstood over 2000 switch-on operations at 500mA steady current, after which the primary current was increased by 50mA by further loading the secondary of the transformer, and the switching process repeated. After 2000 operations at 550mA, the current was raised by another 50mA and so on, testing at least 2000 switchings at the one setting of load current. The fuse failed after 1870 switchings at 800mA. A second similar fuse, using the same procedure, failed after six switchings at 840mA. A third fuse was put on 800mA load to start with, and failed after 500 switchings.

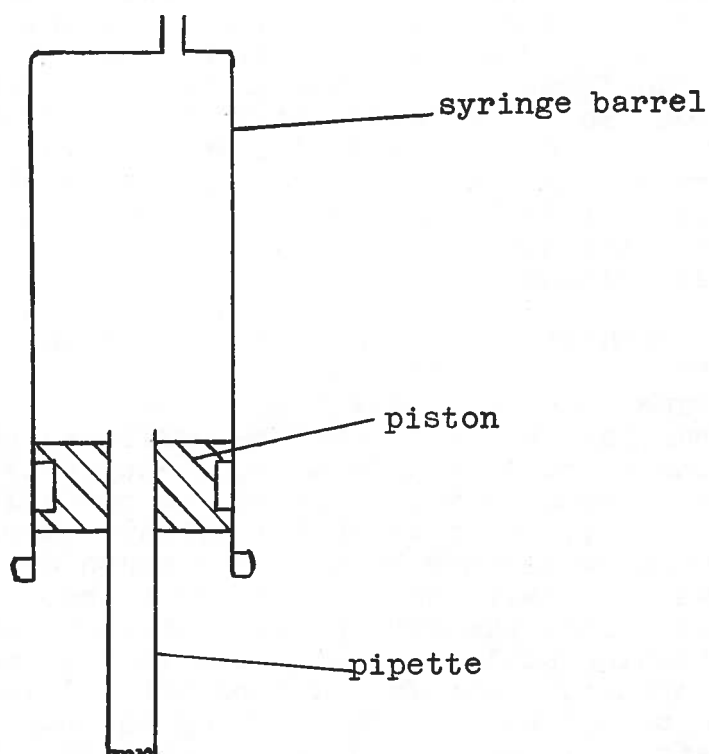
Reference to the test summaries on transformers given in Bulletins 29 and 30 will show that with the exception of the Douglas MT51AT, none of the transformers reach a current of 500mA on full load, and we therefore conclude that any of these will be adequately protected by an anti-surge fuse of a rating the same as the full load primary current of the transformer. If a choice has to be made between two fuse ratings, the one which is less than the full load current is the better since if our results are to be considered representative, these fuses will withstand many switching operations at 50% overload. It is worth noting that Radiospares currently supply 20mm anti-surge fuses in 100, 300, 400, 500, 600mA and 1A ratings.

In The Workshop

Our sketch shows a simple and inexpensive pipette filler which can be a necessity when corrosive liquids have to be pipetted out. A plastic syringe of the same capacity as the pipette is obtained and the flexible piston ring is removed from the plunger, which is discarded. Using a suitable cork-borer, a hole is driven through the centre of the piston of a size to make a snug fit over the end of the pipette. The syringe barrel is then/

then placed upside down over the ring and pushed home.

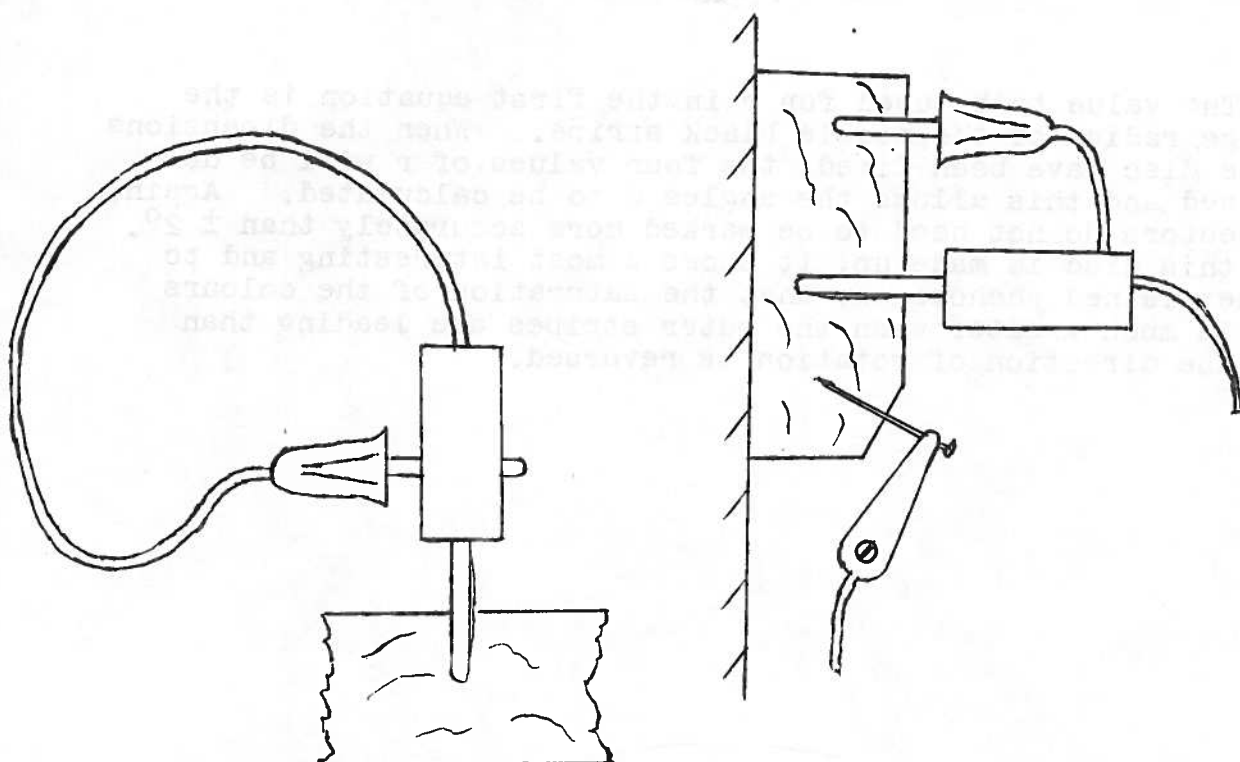
To draw liquid into the pipette, place the forefinger over the syringe nozzle and, holding the pipette in the other hand, withdraw the syringe barrel slowly until the marker level has been passed. The excess liquid can then be allowed to run out under the control of the forefinger in the same manner as for a normal pipette.



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From George Watson's College comes this suggestion for a 4mm lead kit for the individual pupil, which can be checked for contents at a glance and is readily stackable for storage. At least one 4mm termination must be a stackable plug. A wooden block of cross-section 4 x 2cm or thereby is cut $(2n + 2)$ cm long, where n is the number of leads which the block will accommodate, say 6 or 8. Holes to take 4mm plugs are drilled in the block at 2cm spacing between centres, and each lead is stored by connecting one end into the other, which in turn is plugged into the block.

A variation of this technique is to use a much longer block of similar cross-section with two or three rows of holes, staggered vertically, drilled in it at 2cm spacing, screwing the block to the wall of the laboratory at a convenient height. Here it is better to allow one end of the lead to hang freely, as one can then gauge the length of the lead at a glance. Croc-plug leads can also be stored on the block, and for double croc. terminations a row of panel pins hammered into the lower edge of the block will allow one end of a lead to be clipped on to a pin.



One of the few items in the Integrated Science Course which does not feature in the new Circular 490 Physics or perhaps it should be the New Biology Syllabus, is the study of colour. This reduces the scope of the colour wheel which we describe below, but we hope that many teachers may be prompted nevertheless to make it up, if only because a satisfactory explanation of the phenomenon (and if there is one we have yet to hear of it) seems to be somewhere on the boundaries of physics, physiology and psychology. It is also a crowd-puller for open or parents' days.

For those who have not heard of the phenomenon a brief description will suffice. A disc is painted in a pattern of black and white lines. When rotated at speeds between 1 and 15 revolutions per second, colours are seen. It is almost essential that a reversing mechanism be used with the driving motor, since the first question which almost everyone asks on being shown the phenomenon is: "What happens if the disc is turned the other way?"

A hardboard disc, 20cm in radius is cut and painted half matt black, half matt white. On the white portion a pattern of black stripes is painted, each stripe being $\frac{1}{4}$ in. (it was made a long time ago, before the days of metrication) wide and separated from neighbouring stripes by $\frac{1}{2}$ in. Similarly there is $\frac{1}{2}$ in. separation between the outer stripe in one sector and the inner stripe in the next. The actual dimensions are not critical, and 5mm wide stripes will serve equally well.

When the disc is rotated with the inner set of stripes leading, most people see reddish tints on the inside of the disc and deep blue on the periphery. As we have sketched the disc each set of stripes occupies a 45° sector and consequently the outer black arcs are much longer than the inner. At the suggestion of a teacher we made a second disc on which all the arcs were of approximately the same length. The sector angles required for this are calculated from the conditions that:

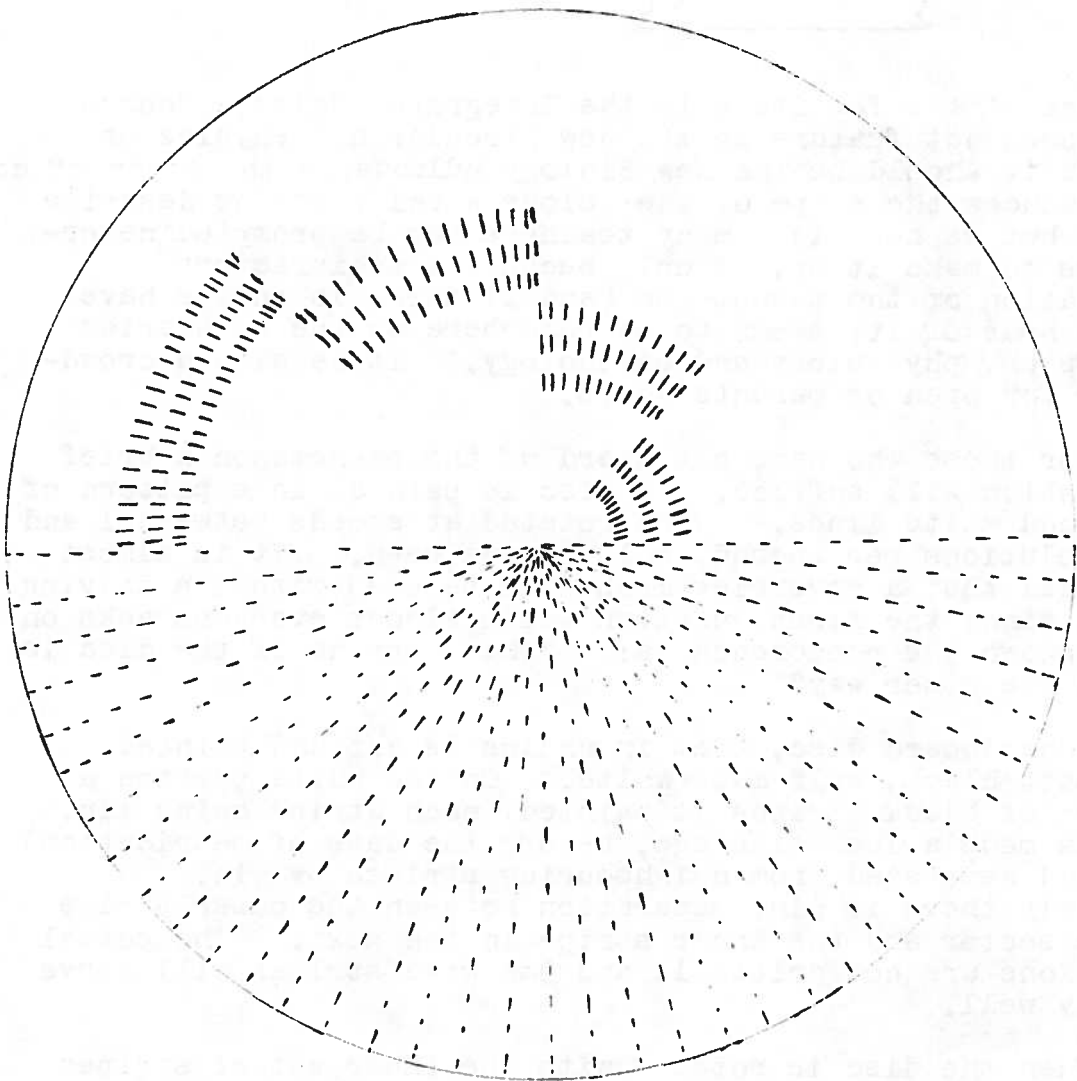
$$r \theta = \text{constant}$$

and

$$\theta_1 + \theta_2 + \theta_3 + \theta_4 = 180^\circ$$

The/

The value to be used for r in the first equation is the average radius of the middle black stripe. When the dimensions of the disc have been fixed, the four values of r will be determined and this allows the angles θ to be calculated. Again, the sectors do not need to be marked more accurately than $\pm 2^\circ$. When this disc is made up, it shows a most interesting and to us unexplained phenomenon, that the saturation of the colours seen is much greater when the outer stripes are leading than when the direction of rotation is reversed.



Bulletin Supplement

Below is a summary of tests carried out on a further selection of power supplies. Reports on these models may be borrowed by writing to the Director. The classifications used are; A - most suitable for school use; B - satisfactory for school use; C - unsatisfactory.

E.H.T. Power Unit K95/1065 from W.B. Nicolson, £42.

Coarse Output Control	Variable Transformer
Fine Control	None
Open Circuit Output	6.1kV
Short Circuit Current	4mA
Low Voltage AC Outputs	6 and 12V at 2A
Output Meter	0-5kV x 100V
Meter Scale	5½cm radius
Meter Error	7%
R.M.S. Ripple	64V
Current for 1% Ripple	1.5mA
Insulation Test	9µA, transformer to E
Decay Time Constant	Less than 1s
Assessment	B

L.T. Power Unit S4A from Linstead Electronics, £17.

Voltage Control	Switched 1V steps
Maximum Output at Zero Current	27.0V AC; 22.6V DC
Maximum Current	8A AC or DC
Outputs at Maximum Current	23.8V AC; 18.5V DC
Overload Protection	Magneto-thermal cutout
Behaviour on continuous load	Satisfactory
Smoothing	None
Stacking Ability	Bad
Assessment	B

E.L.T. Power Unit, S5 from Linstead Electronics, £7.

Outputs at Zero Current	2.11 and 1.18V AC; 1.55V DC
Outputs at 5A load	1.08 and 0.54V AC; 0.7V DC
Outer Case	Metal
Stacking Ability	Bad
Assessment	B

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

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

Boro' Laboratories Ltd., 1 Station Buildings, Catford,
London, S.E.6.

CLEAPSE Development Group, Brunel University, Kingston Lane,
Uxbridge, Middlesex.

Douglas Electronics Ltd., Eastfield Road, Louth, Lincolnshire.

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

Philip Harris Ltd., St. Colme Drive, Dalgety Bay, Fife.

Linstead Electronics, 35 Newington Green, London, N.16.

Modelcraft Ltd., 82 South Clerk Street, Edinburgh, EH8 9PT.

Morris Laboratory Instruments Ltd., 96-98 High Street,
Putney, London, S.W.15.

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

Proops Brothers Ltd., 52 Tottenham Court Road, London, W.1.

Radiospares Ltd., P.O. Box 427, Epworth Street, London, E.C.2.

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

Walden Precision Apparatus Ltd., Shire Hill, Saffron
Walden, Essex.

K.R. Whiston, New Mills, Stockport, SK12 4HL.