SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 88. April, 1976.

Contents

Introduction

Education cuts have been much in the news lately and we feel it only appropriate that we should do our share, even although this may occasion slight inconvenience to our readers. Where in the past we have sent two or more bulletins to the same science department, in separate envelopes addressed to the principal teachers of the separate disciplines, we will now send them in the one envelope, thus saving on postage. We will keep the same addresses, so that bulletins may arrive addressed to the principal teacher of science, biology, chemistry or physics. In these cases we would be grateful if the recipient would deliver the additional copies to those of his colleagues who were previously in receipt of them. If this change in procedure, which will take effect with the next bulletin, causes any hardship due to late or non-delivery of a bulletin, would the teachers concerned get in touch with us when we may be able to make special arrangements?

While the current economic climate is an appropriate time for making this saving, it is not the only reason for doing so. A number of teachers for years past have made this suggestion but it is only now that we are able to carry it out. Previously the envelopes in which we post our bulletins were addressographed in sets by an outside agency and it was convenient and more economical to have this done in quantity, so that a two-year supply was done at the one time. Now, thanks to the generosity of the Royal Bank of Scotland, we have aquired the necessary machinery to make our own address plates and stamp our envelopes and this we intend to do, one or two sets at a time. We will therefore save money by addressing our own envelopes, and it will be much easier to change the composition of a mailing shot, by removing or replacing individual plates.

This increased flexibility also means that when we send out subject equipment lists - and biology and chemistry lists are in course of preparation - we will send one copy only to the department concerned. Finally, we will achieve a saving by collating and stapling the bulletin ourselves. This not wholly welcome change has been forced upon us by a fall in the standard of printing, itself a result of regionalisation. Readers may have noticed that the print in recent issues, particularly No. 86, was blurred, maybe to the point of being unreadable in places, or that there were blank pages. We apologise for these mistakes, and hope that by doing the collating ourselves they will be avoided in future.

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We have to admit that our attempt last December at a fairer distribution system for our surplus equipment by means of a 'telephone ballot' was not an unqualified success. On the credit side we can point to a much wider distribution, of typewriters for example, than has previously taken place. On debit, we had a number of personal callers, some angry, some dejected, who hoped that after a frustrating morning trying to phone us they could wheedle a machine out of us. They didn't. What persuaded us to abandon the telephone ballot were the facts that lines to Edinburgh might be blocked even although our own line might be free, thus giving an advantage to local teachers, and that it is obviously impractical and wasteful to block all incoming calls to a school while someone dials our number continuously, hoping to get through.

In future we shall adopt a system suggested by a number of teachers, the postal ballot. As in the past, we will try to post any bulletin which offers surplus equipment on a Friday. We will then allow one full week for customers to write in their orders, and on the Monday following letters will be drawn from a dustbin or other convenient receptacle and items will be allocated according to the ballot. If the demand for any item exceeds the supply, we will initially allocate one item per customer, and then use any remainder to make up orders in full, again according to the ballot. Customers can help us operate this procedure in two ways; (i) by keeping correspondence on other subjects separate from an order - obviously this might delay a reply, and (ii) by writing on the back of the envelope the numbers of the items ordered. To avoid unnecessary correspondence, it will be assumed that if a customer does not hear from us following an order, some or all of the items he has ordered are available and awaiting collection. Our normal arrangements for payment and collection of items, last detailed in Bulletin 83, still apply. In connection with the information given in that bulletin, we would point out that the Tayside Schools Technology Centre has ceased to operate so that arrangements for collection through the Centre cannot now be made. By way of recompense, Mr. Pirie hopes to establish a depot for surplus equipment in Seymour Lodge Teachers Centre, Dundee.

The above arrangements will apply to the chemicals we offer on page 4 of this bulletin: for these it will be sufficient if the back of the envelope containing the order is marked "Chemicals".

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The Governing Body has appointed Mr. Allen R.G. Cochrane to succeed Hugh Medine as Assistant Director of Chemistry. Mr. Cochrane will join us on 1st June from Larne Grammar School, N. Ireland, where he is Principal Teacher of Chemistry. He has 15 years experience as a teacher in Northern Ireland schools and was for six years a committee member of the N. I. branch of the A.S.E.

Electronic Calculators

We have embarked for a second time on the task of assessing electronic calculators, one that might well be compared to Hercules cleaning the Augean stables, so great is the flood of models coming on the market. At the A.S.E. meeting at Oxford we learned that in the few weeks prior to last Christmas, a leading chain store was selling 4000 calculators a day, that an estimated 50 M will be sold world-wide this year, of which 4 M will be in the U.K. The effects of this will be visible in the classrooms and laboratories, where more and more pupils already have their own pocket calculator.

Attitudes to children using calculators in schools vary widely, and it is with shame for our national image that we report of a boy in a primary school being belted for using one in an examination, a proceeding which can only be likened to King Canute trying to stem the tide. Fears are expressed that as a nation we will become innumerate,wwhich should of course be more innumerate than we already are. Business in a Princes Street store recently ground to a halt when power to the check-out machine failed, as the girl operators could not tot up the purchases. Yet who could be confident of adducing evidence to show that the decline in the legibility of our writing over the past century has been due to the advent of the typewriter?

The sensible approach would seem to be to accept the fait accompli of the calculator, and teach children how to use it, and the obvious place for this is the arithmetic classroom or lesson. This may lead to economic difficulties, since it could be argued that once the schools acknowledge the existence of calculators the local authorities will have a duty to provide them for the pupils' use. At the same A.S.E. lecture the point was made that we could expect parents to provide calculators for their children in the same way that we now expect them to provide football boots. But this is not an either/or situation, and many parents who might be able to provide one could be hard pressed to provide both.

We are perturbed to see newspaper advertisements proclaiming that a calculator suitable as a present to a school-age child is one having advanced scientific notation with reverse Polish logic and all the complexities which this implies. At the age when most children are given their first calculator which as far as we can ascertain is around 9 - 13 years, the child can hardly be said to be set on a future career, and something a little less specialised would be more suited to the majority of pupils. As a teacher asked to give advice to a pupil buying a calculator we would recommend that he seek one with the following attributes: a display large and clear enough to be easily read; keys with a positive snap action and moreover large enough to be operated separate from each other by fingers which may still have a bit to grow to reach adult size; algebraic logic, i.e. calculations are carried out in the order in which we would normally write them, such as 3 + 4 - 2 = 5; single function keys. Anything added to this list must be a matter for individual preference, but we think the less specialised the better. This brand of calculator is now so cheap that when the pupil leaves school it can be passed on to his or her younger siblings, while he obtains a more specialised instrument more suited to his chosen career.

For the science laboratory, our Development Committee has made the following recommendations. The machine should be desk type, either fully mains powered or with rechargeable battery. The display digits should be 15 mm or larger, it should have single function keys and algebraic logic, and be 'semi-scientific' type, i.e. in addition to four function and memory, there should be keys for square roots and reciprocals. For schools which can afford it, automatic round up, and a print out display are desirable features. We intend to provide a summary of calculators meeting this specification in an early bulletin.

Chemistry Notes

Due to a reorganisation of stock, Griffin and George have given to us for disposal a large number of chemicals, detailed below. These are available free, under the following conditions: (i) the customer must accept the quantity in which the chemical is already bottled; (ii) we will not send chemicals by any form of public transport; (iii) the chemicals are available on the terms detailed on page 2 of this bulletin. We will keep items for any length of time until they can be collected, or we will transport them by prior arrangement to the customer's region as and when our van is in the area, e.g. for an exhibition, provided that the collection arrangements do not involve a third party.

The list below follows the order given in the Griffin 1973 catalogue of laboratory chemicals. Further details of pack size, grade of chemical etc. will be obtained by telephoning us.

Ammonium ceric nitrate, ammonium cupric chloride, ammonium meta-vanadate, ammonium oxalate, iso-amyl alcohol, anthraquinone, barium carbonate, benzaldehyde, benzalkonium chloride, benzoin-d-oxime, benzyl benzoate, sec-butyl acetate, iso-butyl alcohol, tert-butyl alcohol.

Cadmium carbonate, calcium chloride, calcium chromate, calcium sulphate, candles standard sperm, carbon tetrachloride, celluloid cuttings, ceric sulphate, B-chlorotoluene, chromic sulphate, cobaltous chloride, cobaltous orthophosphate, cobaltous oxalate, cobaltous sulphate, cupric orthosphosphate, cupric oxalate, cuprous chloride, decon 75, diamantine, diethanolamine, diethyl phthalate, diethylene glycol, dimethyl glyoxime, dimethyl sulphate, diphenyl carbazone, ducitol.

Ensis fluid, ethanolamine, 2-ethoxy-ethylacetate, ethyl digol, ethyl lactate, fluorenone, furfuryl alcohol, fusion mixture, glycerol triacetate, glycin, hippuric acid, hydrazinium sulphate, 2-iodo-propane, ion exchange resin zeocarb 325, lead shot, lead acetate.

Magnesium fluoride, magnesium trisilicate, methyl cyclohexane, mercurous chloride, mercurous nitrate, molybdenum powder, molybdic acid, mounting compound, nickel powder, nickel wire, nickel chloride, nickel sulphate, niobium oxide, nitrobenzene.

Paraformaldehyde, petroleum spirit, phenyl benzoate, phenyl disodium ortho-phosphate, phenyl thiourea, phloroglucinol, phosphate test powder, phosphorous acid, piperidine, polypropylene glycol adipate, potassium arsenite, potassium chlorate, potassium hydrogem oxalate, potassium hydrogen tartrate, tetra-potassium pyrophosphate, potassium silver cyanide.

Salicin, salicylic acid, sebacic acid, silica gel, sodium pellets, sodium aluminate, sodium bromate, di-sodium hydrogen citrate, sodium formaldehyde sulphoxylate, sodium hydrogen sulphate, sodium hydrogen tartrate, sodium iodate, sodium lactate, sodium metaborate, tetra-sodium pyrophosphate, sodium sulphate, sodium sulphide, stannous sulphide, strontium carbonate, strontium chloride, strontium nitrate, sulphanilamide, sulphanilic acid.

Sym-tetrachloroethane, tetrahydro naphthalene, thallium metal, thorium powder, 1-threonone, titanic chloride, urea, uric acid, cotton wool, zinc sulphate, zirconium dioxide, methyl red, methyl red thymol blue.

Volumetric solutions. Barium chloride, chromic sulphate, chromium potassium sulphate, ethylene diamine tetra-acetic acid, hydrochloric acid, lead acetate, oxalic acid, potassium chromate, potassium sulphide, silver nitrate, sodium hydroxide, sodium oxalate.

Microscopical stains (dry). Acid violet, alkali blue, auramine, azur 1, azur 2, azur 2-eosin, brilliant crocein, chlorazol, azurine G, chloroazol black E, chromotrope 2R, cresyl fast violet, cyanosine, gallocyanine, may-grunwald stain, methylene blue, naphthol green, neutral violet, nigrosine, nile blue, orange G, patent blue A, picro carmine, thionine, victoria blue A.

Microscopical stains (solutions). Aniline blue in cellosolve, aniline orange G acetic, carmine borax, cotton blue magenta, elastin stain, field stain B, fuchsin basic alcoholic, giesma stain, light green in cellosolve, may-grunwald stain, methyl blue eosin, methyl violet 6B, methylene blue polychrome, neutral red-light green, neutral red-fast green, nigrosin alcoholic, orange G alcoholic, orange G aqueous, orange G clove oil, panchrome stain, papanicolaou stain EA25, papanicolaou stain EA36.

Microscopical reagents, oils and mounting media. Asphalt varnish, cellodin wool, dammar xylene, eau de javille, gold size, zinc cement.

Celite 545 ungraded, Green's filter paper No 802, 9 cm, ditto 15 cm, postlip filter paper 10 in.

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Following on a television programme we have had a number of queries from teachers, obviously prompted by parent and pupil concern, on the risks associated with handling asbestos. To state the position as informatively as we can, we quote from a report by the Standing Medical Advisory Committee titled 'Control of the Cancer Hazard to the General Public due to Asbestos'. The report is available free of charge from the Department of Health and Social Security; its reference number is SAC(M)SSC(68)7.

"The danger to the general public lies in the fact that inhalation of asbestos fibres may lead to the production of cancer. Two types are produced, the common bronchial carcinoma and the rare mesothelioma of the pleura or peritoneum. The first is also produced by many other factors and it is difficult to know whether asbestos is producing cases unless the exposure is intense and the risk high. The latter is normally very rare and the assignment of risk due to asbestos is easily recognised even though the number of cases may be small. The risk of developing these cancers varies with the amount and duration of exposure, the size of fibre and the type of asbestos.

The incidence of mesothelioma is particularly associated with exposure to blue asbestos but it is probable that some risk of developing this tumour is also associated with exposure to other types. The risk of bronchial carcinoma cannot be attributed specifically to one type rather than another. No firm statement can be made about the precise quantitative relationships between the risk of developing these diseases and the size of fibre or the amount or duration of exposure. It has been possible to show that mesothelioma can be produced by slight exposures and on present knowledge we must assume that no amount of exposure is completely free from risk. Whether the same is true of bronchial carcinoma is uncertain and it remains possible that a risk of this disease is incurred only when the level of exposure is substantial."

From a later report on the same subject: "There is increasing evidence that exposure to asbestos may be associated with some cases of gastro-intestinal carcinoma and the position should be kept under review, but the Working Party felt that there was no necessity to do anything about the minute amounts of asbestos in food and drink as the evidence was fragmentary that ingested asbestos is harmful".

The first report was published in 1968, the second in 1971. A Factory Inspector from whom we received the information states that evidence which has accrued since publication of the reports provides no justification for modifying the statements in any way. How to translate this information into a code of practice for schools must be left to the local authority or perhaps to the individual teacher. It is evident that he should do all he can to avoid inhalation of asbestos fibre. This would imply that anyone working an asbestos product should wear a face mask. Frayed wire gauze, which might allow asbestos fibre to become detached from its mat and be carried by a bunsen flame into the atmosphere should be rejected. Whole wire gauze and asbestos millboard used to protect benches we would consider reasonably safe. As a teacher, we would be dubious about allowing children to heat materials on asbestos paper or tape; the concurrence of strong heat and convection currents would appear to increase the likelihood of fibres being released to the atmosphere.

The S.E.D. Memorandum No. 6/1968 on the Inhalation of Asbestos Dust, to which we referred in Bulletin 60, was prepared in the full knowledge of the SAC(M)SSC(68)7 report, and although changes in the Factories Act regulations concerning asbestos mean that it is technically out of date, the advice given in that memorandum may be considered still to apply.

Physics Notes

Following the distribution of our experimental guide to CSYS electrostatics, we have received a note from the physics department of Robert Gordon's College of Technology on the experiment to show equipotential surfaces, page 5. One suggestion is to use alternating rather than direct current. The battery is replaced by a signal generator set to 1 kHz or other audio frequency, and the microammeter by a single or pair of earphones. The experiment proceeds as before, the 'balance' point being indicated by no sound or minimum sound in the headphones. For greater sensitivity, an oscilloscope can be used in place of the earphones. In this mode the experiment is safer, as there is a risk of damaging a sensitive microammeter by overloading if the probes are put at too great a p.d.

A second variation is to use blotting paper soaked with electrolytic solution instead of conducting paper. A sheet of drawing paper is first placed on the bench, and covered with carbon paper(s), sensitive side down. Over this is spread the blotting paper, uniformly moistened with copper sulphate solution. The experiment is then carried out as described above. When two equipotential points have been found, marks are made on the drawing paper by pressing the probes down on the surface. We have slight reservations about this modification. The student cannot draw in his equipotential line as he locates it, and hence cannot plan his experiment to get an even spread of lines throughout the area of operation, and at the end of the experiment his drawing paper will have a collection of points where there may sometimes be doubt about which joins to which to form the equipotential line. Attempts to draw lines on the blotting paper with sufficient pressure to mark through to the drawing paper can result in tearing the paper.

Secondly we found it more difficult to illustrate electrostatic shielding, which we tried by placing a well-wetted metal disc on the paper. Even with the disc pressed firmly down on the surface, we found minimum rather than no sound in the earphones for points within the disc, and this minimum was louder than the 'null' point located for equipotential lines outside the disc area. These effects are either due to hand capacitance, or to variations in contact resistance between the disc and the blotting paper around the periphery of the disc.

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Our Higher Grade syllabus requires pupils to know how to measure the e.m.f. of cells or other sources of p.d., and how the null deflection method and the potentiometer enable a 'true' e.m.f. to be measured, because no current is being drawn from the cell. It is perhaps worth pointing out, since most schools now possess a pH meter, that an electronic voltmeter which makes use of a field effect transistor, has an input resistance of the order of 10^8 Ω, and hence draws negligible current. Modern pH meters use the f.e.t. circuit for this reason.

If the purist objects that negligible current is still not zero current as established (in principle) by the potentiometer, and hence the f.e.t. can only be a second-best measurement, his argument is valid only if his null detection system is capable of discriminating between 0 A and 10^{-8} A, for the cells in normal school use. And when he has achieved this sensitivity, he can be asked to consider how accurately he requires to position his potentiometer slider to locate the null point. For a 1 m potentiometer driven by a 2 V supply, and assuming a 'galvanometer' resistance of 1 kΩ, the answer is 0.005 mm. This is not to say that achieving this accuracy could not be done, but to point out that to do it presents immense practical difficulties, which are not present when a f.e.t. voltmeter is available.

In The Workshop

A centrifugal liquid pump in which the rotor is a permanent magnet, driven by a standard magnet stirrer is described below. The stirrer should have a speed of at least 800 rev/min and should be preferably a variable speed type. The flow rate of the pump will depend on the stirrer speed, but as the table below shows, delivery rates for water of 200 - 600 ml/min are possible.

The principle of the pump is simple. It consists of a cylindrical box, in which the magnet rotates synchronously with the stirrer motor, just as it would do if being used as a stirrer. Water enters the top of the box and is impelled by the rotating magnet out through a tubular orifice at the side.

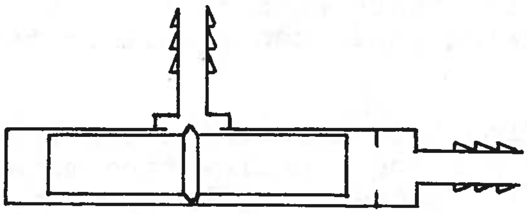

Fig. 1.

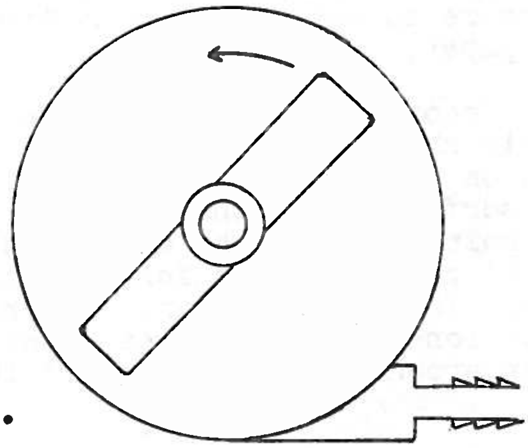

Fig. 2.

Our pump was built round the stirring magnet, which was a commercial version 40 x 8 mm, length x diameter. This particular one was chosen because as well as being plastic coated it has a built up girdle about 2 mm high round its middle which acted as a 'bearing' when the magnet was rotating. This is necessary in a pump to prevent the rotor from moving off centre and jamming on the side of the pump.

It would be possible to start from the other end, i.e. to choose a container such as a pill box and then find a suitable magnet to go in it. When we developed the model we did some work along these lines and got acceptable results from a pump using a 32 x 6 x 6 mm magnet from the Westminster electro-magnetic kit. Any magnet which is used will require to be embedded in plastic to prevent corrosion, and will need a locating ridge built up around its middle.

Figs. 1 and 2 show how our model was built from 2 mm thick perspex sheet and tube. Perspex cement, made by dissolving small chips of perspex in chloroform was used to stick the parts together. Inlet and outlet tubes were cut and drilled from 10 mm dia. perspex rod, although we think that nylon tubing connectors could be shaped to fit. Before cementing the box together a shallow depression is made with a wide drill in the centre of the base, to make a 'bearing' for the magnet. It is also necessary to determine the direction of rotation of the stirrer to be used before fitting the outlet. It will be seen from our model that no attempt has been made to achieve maximum pumping efficiency by close-fitting the magnet, and in fact from this point of view a square section magnet would be better than a round one. What we believe we have produced with a mimimum of expense is a pump which will cope with those situations in the chemistry or biology department where a continuous circulation and moderate water head pressure are required. Because of the loose fitting design, the pump does require to be primed.

Rotor speed, rev/min	800	1200	1500	2000
Maximum head of water obtained, mm	250	410	570	900
Flow rate at half maximum head, ml/min	210	290	330	650

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What we describe here is a wooden stand carrying a back-projection viewing screen which allows the teacher to micro-project a slide to a group of 4 - 5 pupils so that significant features may be pointed out. The system uses, without modification, two standard instruments, the overhead projector and the microscope. The screen image is 12 - 15 cm diameter and can be viewed in daylight. The main functions of our stand is to form a support for the translucent screen, and to exclude as much extraneous light as possible. In the description which follows the dimensions are fitted to the <u>Griffin and George</u> overhead projector and Olympus HSC microscope, and they may require altering to suit other models.

The light from the projector is stopped down by covering the platform with a square of hardboard with a central 50 mm dia. hole. Four strips of softwood are nailed round the edges so that the hardboard sheet is a snug fit over the projector platform. The microscope, which must be of the upright tube, open foot type has any built in illuminator or mirror removed, so that light passes from the o.h.p. directly up the instrument. When one has found the position which gives the best and most even illumination through the microscope, it is a good idea to mark on the hardboard sheet the outline of the microscope foot so that it can be quickly placed in the correct position for a demonstration.

The sides of the stand are two pieces of 12 mm blockboard, 33 x 19 cm, joined at the front by a piece of 18.5 x 13 cm plywood (Fig. 1). For some models of microscope it may be necessary to cut away a part - shown dotted in Fig. 1 - to the rear of one or other of the sides to allow the user to get his hand round the back to operate the condenser and/or focussing controls. The less that is cut away the better for the stability of the stand.

The top of the stand is a rectangular box with slanted sides, the sides being hardboard sheet, with top and bottom of 12 mm blockboard. The base of the box measures 155 x 245 mm; at the rear it has a slot 40 mm wide and 40 mm deep cut in it to take the microscope barrel. 10 mm back from the front edge is fixed the viewing screen. This is a sheet of Cobex 'Clearlite' from the Clearvue Projection Co. glued to a hardboard frame. The frame is cut in one piece from hardboard sheet 150 x 155 mm, using a fretsaw and allowing a 10 mm frame width. Slots 5 mm deep are cut in top and bottom of the box to hold the frame. In place of the 'Clearlite', draughtsman's tracing paper or frosted perspex can be used as material for the screen. Suitable pieces of frosted perspex are used in small 'preview' back projection screens obtainable from Boots. The box top projects 80 mm in front of the screen; this and the sloping sides cut down the room lighting on the screen face to allow acceptable images in daylight, but also restrict the viewing angle. All inside surfaces of the box are painted matt black. The rear of the box is also sloped. In use, this is covered by a rectangular flap of rexine or similar light-proof material tacked to the box top and not shown on the drawings. This flap can be lifted off to allow access to the o.h.p. mirror or lens for adjustment purposes. The box is nailed to the rest of the stand so that it rests horizontally on the front crosspiece and their rear edges are flush.

Few adjustments are needed to use the screen. Access to the microscope slide can be had from the front, and to the microscope controls from the back of the stand. The system usually gives acceptable images with medium and high power objectives, but with low power we found that there was not enough light to fill the field of view. We cured this by laying on the o.h.p. platform aperture a biconvex lens, 50 mm dia., focal length 15 cm. Such lenses should be available in the physics department of the school, and trial and error will establish which focal length is most suitable. Obviously, such a simple projection system improves in proportion as the normal room lighting is reduced.

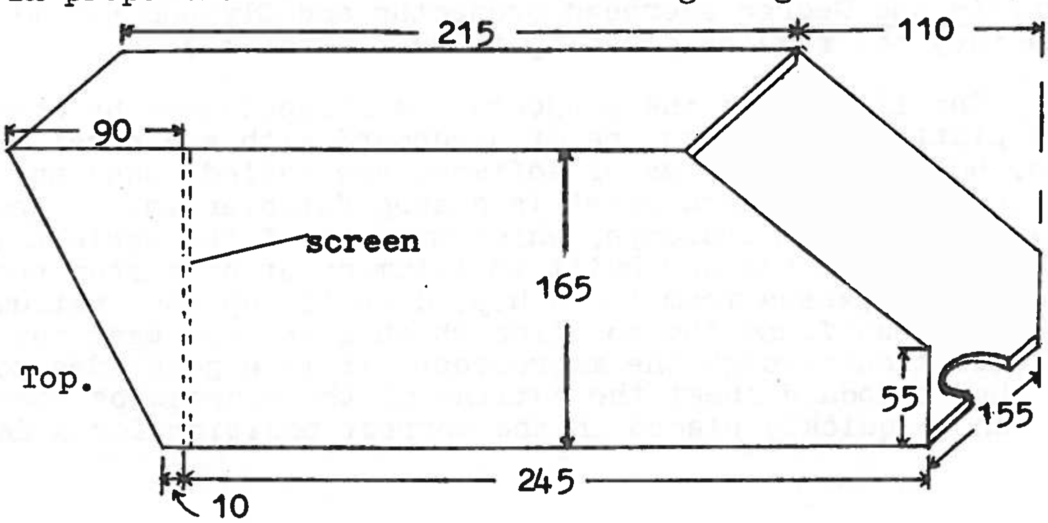
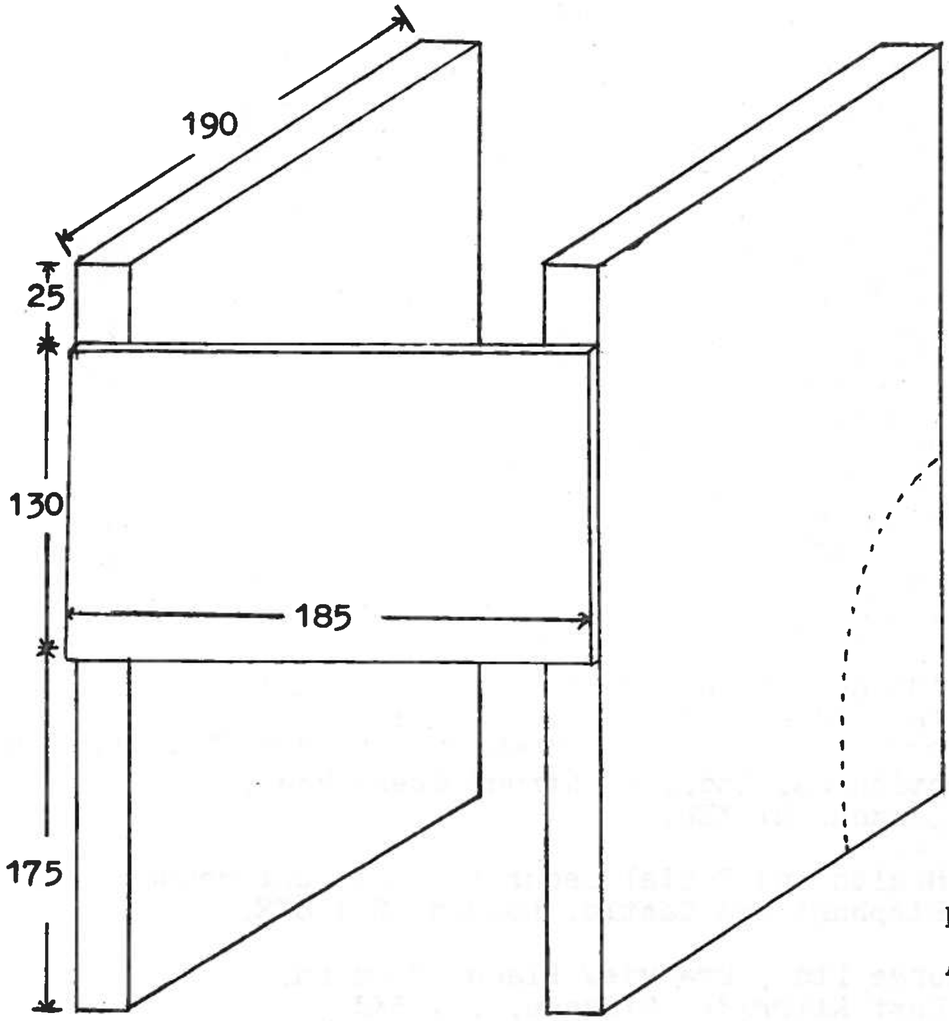


Fig. 2. Top.



Not to scale.
All dimensions in mm.

Fig. 1. Stand.

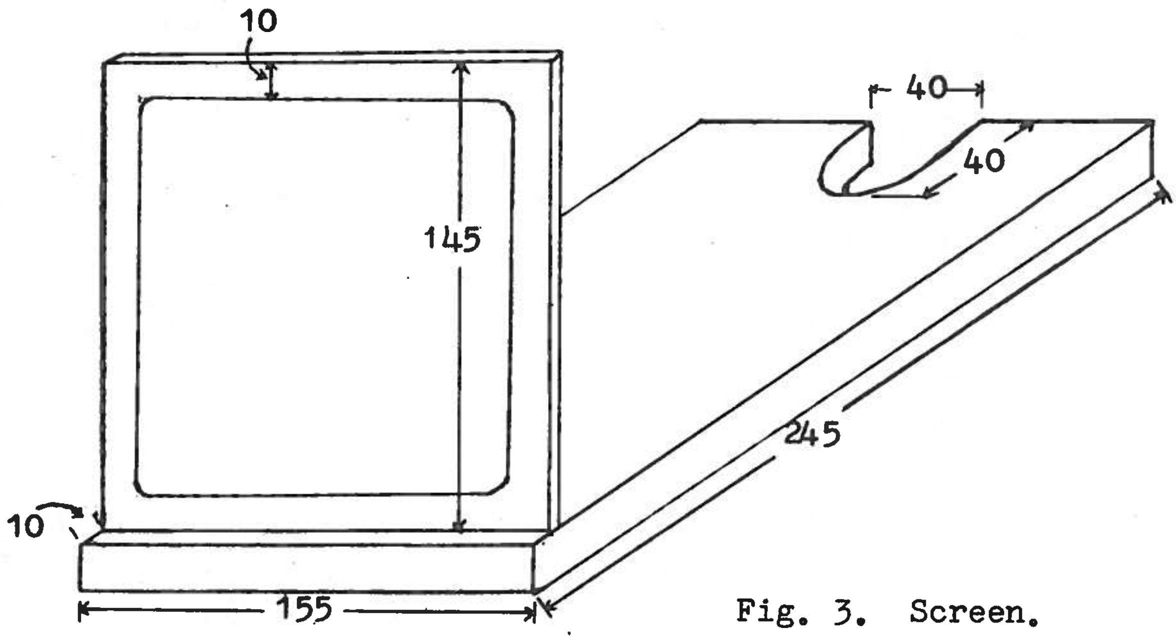


Fig. 3. Screen.

SSERC 24 BERNARD TERRACE EDINBURGH EH8 9NX TEL 031-668 4421

Clearvue Projection Co. Ltd., 92 Stroud Green Road,
London, N4 3EN.

Department of Health and Social Security, Hannibal House,
Elephant and Castle, London, SE1 6TE.

Griffin and George Ltd., Braeview Place, Nerston,
East Kilbride, Glasgow, G74 3XJ.