SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 7. August, 1966.

SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Introduction

Like painting the Forth Bridge, the testing of microscopes is a never ending task. New models are continually being placed on the market. In this Bulletin we give the procedure which we adopted in making these tests, together with a key or guide to the various terms which will be used in reporting on individual microscopes. Although the tests so far carried out cover only the cheaper microscopes - under £20 - the procedure will remain unaltered in most respects when testing has been extended to the full range.

A summary of the results of these tests is included in the Testing Supplement, which is not being made available to manufacturers, nor to individuals outside Scotland. In addition, we have on file several copies of the test report on each individual microscope. A teacher wishing to see one of these should write in to the Centre when one will be sent to his school on free loan.

In the introduction to Bulletin 5 we gave what we considered an amusing exchange of letters between a school and a manufacturer concerning the ingestion of a balloon by a vacuum pump. The sequel is perhaps less funny in the shape of a bill for £11, over £7 of which was for travelling expenses. For a "surgeon" who was "working in the area" - we quote the manufacturer's letter - these must surely be Harley Street rates.

Occasionally we get letters from teachers pointing out that, as for example in Bulletin 6, their page 11 has nothing printed on it, that it must have missed the duplicator and please could we send on the omitted material. We would like to reassure all such enquirers that nothing has been omitted if their pages follow in the correct numerical order. We cannot tell in advance how many sheets the material for a Bulletin will cover, and we make a point of printing the address list on the outside back cover of each issue which we believe is most convenient for teachers. It will therefore sometimes happen that the inside back cover is empty of material.

Opinion

Having just received the Nuffield Foundation Guide to Chemistry Apparatus, I am surprised to learn that they have nothing revolutionary to say on the subject of compressed gases. What they do say is that while a 40 cubic foot capacity cylinder is too heavy, one of half this capacity is suitable for school use, but it "should be supported vertically on a stand mounted on castors".

It may be the case that all Nuffield pilot schools had their chemistry laboratories on the same floor, and/or were equipped with brawny technicians capable of carrying these cylinders from one site to another. But many schools are not so fortunately placed, and the picture of a cylinder bouncing on its control valve down a flight of steps must have entered the mind of more than one teacher. I should have thought there was some place for the smaller portable lecture bottle or cylinder providing 5 - 10 cubic feet of gas, small enough for a laboratory technician to carry it in one hand, and cheap enough to allow six or more of each gas to be kept in the department, with an adequate refill service to ensure a continuous supply.

For/

For this we have to look to the U.S.A. which exports such cylinders and bottles to this country. The agents operating this service are Cambrian Chemicals Ltd., and their prices (see Bulletin 5, Trade News) reflect more than the import duty surcharge.

I have been taken to task, with some justification, for using British Units in Bulletin 5 at a time when more than the school science syllabuses are trying to go metric. While pleading guilty to the charge, and hoping that in future bulletins the repetitions will get fewer as time goes on, I would claim two extenuating circumstances.

Although it would be exaggeration to claim that for some of us to go metric in the hope of persuading others to do so would be as disastrous as changing the rule of the road by the same gradual process, the two situations do carry the same element of conformity. In these Bulletins I must consider the balance of convenience to the teachers. "8 inch loudspeaker", which was one of the phrases objected to, is a label, not a dimension. No shopkeeper runs his rule over his speakers before picking out the one requested, neither here nor on the Continent.

My second plea is more aesthetic than scientific, which is perhaps all the more reason why it should be considered. It is that the metric system is surely the most barren of ideas when it comes to naming its substandards. No philologist, considering such inventions as statfarads, nanoseconds, gagacycles could escape the conclusion that scientists are barbarians. Gone will be the charm of such words as ells, scruples, perches, firkins. Instead we are to have decametres, millilitres, and, surely the final admission of failure, metric tonnes!

Trade News

Advance Electronics have produced several power supply units to meet the Nuffield specifications. These are:

Nuffield Reference	Advance Catalogue No.	Price
E.H.T. Supply, Item 14	PP 12	£35.
HT Supply, Item 15	PP 13	£29.10/-
LT Supply, Item 59	PP 14	£28.

Stanton Instruments Ltd have moved to their new address given in the appendix to this Bulletin.

The Glasgow branch of George Anson and Co has moved to new premises. The new address is given in the appendix.

Fire Appliance Industries will refill carbon dioxide cylinders of the type used for producing dry ice for a charge of about 7/-, and provide a same day service for Dundee schools. Outside the city, there may be an additional carriage charge.

Both Philip Harris and Griffin and George have produced a special catalogue for the Nuffield Foundation Physics Apparatus.

Andrew/

Andrew H. Baird have increased the prices of the Russian demonstration ammeter and voltmeter to £12.10/- each. They have also introduced two conversion kits, LA36/NUF for ammeter and LV36/NUF for voltmeter, costing £16 and £14 respectively which will extend the range of these instruments to cover the Nuffield Physics course. The cost of meter and complete set of shunts or multipliers for the Nuffield course is £27 for ammeter and £25 for voltmeter.

John Moncrieff (Monax) have introduced a 100ml conductimetric titration conical flask with two diametrically opposed carbon electrodes, costing 7/-. Carbons are available from Ship Carbon Ltd at £3.8/- for 100 1ft. lengths.

Open top hardwood boxes, measuring 60 x 52 x 26mm, inside dimensions, are very convenient for mounting the smallest size Japanese meter MR38P or other electrical components such as switches. They are available under catalogue No. MK3890 from Wootton and Co at 7½d each plus postage. A slightly deeper box on the same catalogue number is available from Wm. Foster (Rainford) at 10d each.

Gestetner are producing a new type of copying machine which will produce stencils to fit any of their duplicators. The original material, which must be in the form of a single sheet of paper, a film transparency, or photograph is placed side by side with the stencil on a revolving drum. The material is scanned photo-electrically and information is imprinted on to the stencil by a high voltage arc applied through a tungsten wire, the movement of which is synchronous with the p-e cell. High quality reproduction is possible, although a foolscap stencil takes 5 minutes to reproduce. Called the ES390 electronic scanner, the instrument costs £332.10/- nett to schools, but can be leased from the firm for £8.1.6d. per month, which drops to £8.1.6d per annum after five years. Short run carbon stencils cost 1/4d each; long run plastic stencils 4/4½d. The firm will be pleased to arrange a demonstration with any school on request.

Display Laboratory

The following have been added since Bulletin 6.

Item	Manufacturer
Air Pistol Pellet Speed	S.S.S.E.R.C.
g by Free-Fall Apparatus	S.S.S.E.R.C.
Mini-Stirrer	S.S.S.E.R.C.
Piezo-Electric Effect	S.S.S.E.R.C.
Ionic Models	S.S.S.E.R.C.
Solar Motor	S.S.S.E.R.C.
Semi-Circular Canals Model	S.S.S.E.R.C.
Decade Resistance Box	Derritron
Multi range Meter	Derritron
Micro-galvanometer	Derritron
Macro-Millikan Apparatus	Philip Harris
Colour Mixing Apparatus	W.B. Nicolson
Gade Microscope	W.B. Nicolson
Butchart Balance	W.B. Nicolson
Universal Meter and shunts	Crompton Parkinson
Electron Diffraction Tube	Teltron
Microscope Slides	Flatters and Garnett
Microscope Slides	Northern Biological Supplies
Conductimetric Titration Flask	John Moncrieff

Physics Notes

The crystal microphones, type MC1 referred to in the Trade News section of Bulletin 5 can be dismantled and used to show the piezo-electric effect. If the front is removed a thin aluminium diaphragm is revealed; this can be stripped off. The thin rectangular crystal wafer will then be visible and it can be prised off its supports. Connect the leads to a Pye Scalamp galvanometer and squeeze the wafer gently between finger and thumb. The experiment is referred to in Jardine, Physics is Fun, Book 2, Experiment 9.3.

Microscope Tests

The object of these tests is to determine which of the microscopes at present available at prices below £20 would be suitable for use in secondary schools work (up to 'O' grade). It is generally agreed that a magnification of x300 is quite sufficient and in general microscopes which sacrifice clarity of resolution for increased magnification are therefore not to be recommended.

We feel that the optical system is the most important consideration but many other factors e.g. mechanical durability, magnification, ease of operation, parfocal nature of lenses, power change, safety stop, working distances of lens from object and clearance for e.g. smoke cells, stability, lighting system, field of view, zoom facilities, case and accessories, and price, are significant in determining what is a suitable microscope.

1. Resolution. The difficulties in testing the resolving power of a microscope are well known to most microscopists and the two standards which were used were as follows:

(a) clear embossed diffraction grating replica with parallel lines 13,400 to the inch or roughly 2μ apart viewed in daylight and also in artificial light. Results are specified as either Yes or No, with a question mark where the resolution was felt to be dependent on the individual eye.

(b) a Flatters and Garnett test plate "Stauroneis phoenocenteron" diatom which afforded the best all round test for the microscopes.

The latter was divided into two tests both in daylight. These have been classified as follows:

(i) E.M.T. 100 taken at a magnification of x100 or as near this as possible. The results of this test are designated:

A.... Resolution of individual spaces in lines of 'canals'.
B.... Recognition that spaces existed.
C.... Resolution of main longitudinal and lateral 'canals' only.
D.... Indication that these canals exist i.e. blurred lines visible
E.... Loss of longitudinal canal.

(ii) E.M.T. 300 taken at a magnification of x300 or as near this as possible. The results of this test are designated:

A/

A.... Resolution of main and lateral canal - side canals - and that the 'canals' are actually discontinuous.
B.... As above without resolving the tiny perforations
C.... As above without resolving the lines of 'canals'
D.... As above without resolving the spaces in lines

2. Magnification. This was tested by observing a Millimetre gauge - marked off in 1/10mm and 1/100mm - through the microscope and comparing this with a metric ruler held in the same focal plane and using the other eye to superimpose one scale on the other.

3. Field of View. For each eyepiece the diameter of field of view is measured against the standard millimetre gauge used previously and since this diameter x magnification is a constant, this product was used as the measure of width of field, and is referred to as the 'FV factor'. This varied from 90 - 200 and the average was 130.

4. Clearances. These are the distances in mm between the objective in use and the object in focus (focussed clearance); and the maximum distance in mm between object lens in position and the stage (maximum clearance). Two values are necessary when the use of objects like smoke cells are involved e.g. Musselburgh Smoke Cell requires a maximum clearance of 15mm and a focussed clearance of 5 - 7mm.

5. Safety Stop. This is a device which limits the proximity of the objective to the stage, to save breakage of slides and possible damage to object lens, (it can be 'adjustable' or 'fixed').

6. Operation. This is an important aspect of the functional value of microscopes insofar as class pupils are concerned but is very difficult to assess. The manipulation of the standard microscope is usually quite difficult for young pupils to master and often some damage can occur to precious slides or the instrument itself. This is by no means applicable solely to the younger classes, as many teachers will affirm.

7. Objective and Eyepiece. Separate objectives are all Standard R.M.S. thread so that additional objectives cannot be purchased for use on a non-standard microscope. Power change of objective is either by 'rotating turret', or 'screw', meaning that one objective must be unscrewed and the other screwed into place. Eyepieces are described as 'push fit' which implies that the friction grip is sufficiently tight to prevent the eyepiece from falling out when the microscope is inverted, unless expressly stated otherwise, or 'fixed', meaning irremoveable under normal circumstances. Eyepieces are also obtainable as separate items if described as 'standard'.

8. Body. This may be either 'metal' or 'plastic', 'fixed upright', 'fixed inclined' or 'tiltable'.

9. Focussing Mechanism. 'Rack and pinion', on either body or stage; body on screwed thread, 'scroll type'; or by means of a cylindrical rod fixed to the body which bears on the V groove of a rotating pulley, 'rod type'. Fine focussing is usually by 'vertical lever', operated by screwing down on one end of the lever.

10. Stage. This may or may not incline with the body. Some have levelling screws.

11. Stand. Microscope stands are normally stable because they tend to slide on a normal bench rather than topple when given a sideways knock. For those which topple we specify a minimum angle of tilt before toppling occurs. Normal working height and weight are also given here.

Illumination./

Illumination. We have considered measuring this quantity by means of photo-electric cells attached to the eyepiece, but felt that this does not necessarily reflect the true situation, where the size and position of the pupil of the eye may have considerable bearing on the final result. We are therefore committed to a subjective assessment of illumination, which can be taken to be satisfactory unless otherwise stated.

12. Mirrors. Unless specified as single, these are assumed to be double-backed, providing two alternative reflecting surfaces. Reflectors are specified as 'white' (paint or paper reflector), 'plane' or 'concave', and may be of metal, glass or plastic. The latter two can be either 'rear' or 'front surface reflecting'; a front surface reflector is liable to tarnishing or scratching. Mirror diameter is also specified.

13. Substage Condenser. These can be fixed or adjustable, in glass or plastic. Type of adjustment where applicable is specified for each microscope.

14. Iris Diaphragm. This is either a true iris, or a rotating disc with various apertures, specified as 'true' or 'rotating'. In the latter case the number of apertures is given. To give some indication of the light control, the ratio of maximum to minimum aperture diameter, called the 'control ratio', is specified.

15. Phase Contrast. Where available this is specified on individual microscopes. Otherwise it is assumed to be absent.

16. Sub-stage Illumination. Specified on individual microscopes.

17. Case and Accessories. Case material is specified, fitted case implies racks for storage of objectives, eyepieces or slides, case may be latched or locked, and may have a locking bolt to secure the instrument in transit. This last is assumed present unless specified; accessories included in the standard price are individually listed.

18. Special features. These are individually listed and cover any points not dealt with in the above.

Physics Equipment

This is the second half of the equipment list, the first of which appeared in Bulletin 6.

26. Demountable Transformer. (D).

Supplier	Catalogue No.	Cost.
P.H. (NF) (a)	P7005	£25
A.H. Baird (b)	S56T	£17
M.L.I. (a)	95-147	£30.3/-

Notes. (a) Transformer with range of coils and two soft iron pole pieces.

(b) Transformer and two tapped coils, accessories are welding and solder melting coils, pole pieces, eddy current pendulum.

27./

27. Variable Transformer. (D).

Supplier.	Catalogue No.	Cost.
Service Trading Co.	2½A size	£5.17.6d.
	4A size	£8.7.6d.
	8A size	£13.10/-
G. and G. (a)	L96-170	£28.7/-
Claude Lyons	V6H-MT, 3 Amp	£12.2/-
Cressall	55Z, 3 Amp	£9.16.6d.
Berco	44 AE, 3 Amp	£9.8/-
Berco (b)	Windavolt, 1 Amp	£8.10/-
Farnell (b)	Primatran, 1 Amp	£8

Notes. (a) Includes output voltmeter.
(b) Primary only; toroidal transformer with wind-it-yourself secondary.

28. Scaler. (D). All scalers now carry a built-in 1,000c/s oscillator to act as clock, with timing contacts. All will operate with their own photo-diodes and light sources, listed in item 30, but we cannot guarantee their interchangeability, nor their operation with home-made photo cell circuits.

Research Electronics (NF) (a)	905	£51 or £57
Panax (NF)	102 ST	£65.10/-
Labgear (NF)	D.4151/B	£58.18/-

Notes. (a) Battery version £51; mains/battery version £57.

29. MX168 Geiger Tube and Holder. (D). All have standard P.E.T. connectors, and will fit any of Item 28.

Research Electronics (NF)	907/910/MX168	£12.10/-
Panax (NF)	MX168/H6	£11.5/-
Labgear (NF)	D4153	£12

30. Photodiode for timing with Item 28. (D).

Panax (NF) (a)	PD1	£2.2/-
Labgear (NF) (b)	D4162	£3.10/-
R.E. (NF) (b)	918/919	£3.10/-

Notes. (a) Photodiode only; light source LS1 costs 16/- extra.
(b) Includes light source.

31. Solid State Detector and Amplifier. (D). Enables alpha particles to be detected when connected to the appropriate scaler Item 28.

Unilab (a)	053,682	£7.10/-
Panax (NF)	AD1	£15.15/-
Labgear	130/4	£15
R.E. (b)	920/921	p.o.a.
Teltron	TEL 541/542	£28.12/-

Notes. (a) Does not include detector.
(b) Price on application.

32. Radioactive Sources. Sealed sources in a metal mount with 4mm diameter stem. Supplied singly in lead castle enclosed in wooden box. These cost the same from any supplier as follows

A 5μC Americium (alpha)	£3.10/-
B 0.1μC Plutonium (alpha)	£8.10/-
C 1μC Strontium (beta)	£2.18/-
D 5μC Strontium (beta)	£2.18/-
E 5μC Cobalt (gamma)	£4.5/-
F 5μC Radium	£2.10/-

Box/

Box of 3 Sources, made up from items A - F above in single box with separate lead castles.

Sources B, C and F

G. and G.	L91-135	£13.10/-
W.B.N.	N7/2452	£12.17.6d
P.H.	P7990S3	£13.10/-

Sources B, C and E

G. and G.	L91-145	£14.15/-
W.B.N.	N7/2456	£15.15/-
P.H.	P7990S4	£14.15/-
Panax (a)	SK 73	£7.5/-

Notes. (a) consists of Am (0.1μc) Sr (0.1μc) and Co 5μc.

3 Sources F

G. and G.	L91-140	£5.15/-
W.B.N.	N7/2451	£6.15/-
P.H.	P7990S2	£5.15/-
Panax	SMS-3R	£7.10/-

33. Radioactivity Demonstration Sets. Intended for use with the appropriate Scaler, these consist of an 'optical bench' for placing sources etc at measurable distances from the detector together with graded absorbers, etc.

Labgear (a)	D4155	£22.15/-
Panax (b)	SK107B	£25

Notes. (a) Includes its own planchette sources, but can be obtained without sources for £13.18/-

(b) Includes the sources SK7-3, Can be got in an economy version, not showing radioactive decay or deflection of beta in magnetic field, under SK106B, for £14.15/-

34. Storage Cupboard for radio-active sources. (D).

P.H.	P7990SC	£5.5/-

35. Hall Effect. (D). Gives evidence for existence of hole conduction in semi-conductors.

Unilab	091.603/4	£3.10/-

36. Microphones. (P). For use with pupil oscilloscopes.

Land, Speight and Co	MC1	3/6d.

37. Amplifier. (D).

Unilab (a)	032.841	£4.5/-
Unilab (b)	053.842	£6.10/-

Notes. (a) For use as an input to oscilloscope, not suitable for loudspeaker.

(b) Loudspeaker output.

38. Inductances. (D) or (P). For work on A.C. theory.

Unilab	(NF)	011.421, 2400 turns	£1.1/-
	(NF)	011.423, 120 turns c.t.	£1.2.6d
		011.424, 5000 + 250 turns	£1.2.6d
		011.425, 500 + 125 turns	£1.2.6d
		011.426, 9500 + 500 turns	£1.2.6d
		011.121, C core and clips	17/6d.
P.H. (NF) (a)		P100/127, 120 turns	£4.7.6d per pair
		P100/128, 2400 turns	£6.17.6d " "
M.L.I. (NF) (a)		95/128	£5.17.6d " "
		95/127	£4. " "
G. and G. (a)		GN127	£4.5/- " "
		GN128	£5.12.6d " "

Note./

Note. (a) These are coils only, and fit the C type cores provided in the Westminster Electro-magnetic Kit.

39. Spark Counter. (D). Requires E.H.T. power supply Item 4.

P.H. (NF)	P7991	£6.15/-
G. and G.	GN17	£6
M.L.I.	95-17	£5.5/-

40. Thoron Generator. (D). Used with the pulse electroscope, Item 3. to measure half-life.

W.B.N.	N7/2457	£2.5/-
P.H.	P7990TH	£3.5/-
G. and G. (a)	L91-017	£5.5/-

Note. (a) Apparatus includes ionisation chamber.

41. Statistics Frame. (D). Illustrates graphically the frequency distribution of a range of experimental results.

P.H. (NF)	P100/48	£3.10/-
G. and G. (NF)	GN48	£2.18.6d
M.L.I. (NF)	95-48	£3.15/-

42. Wave Machine. (D). Demonstrates motion of individual particles in longitudinal and transverse wave motion.

A.H. Baird	S63	£13.15/-

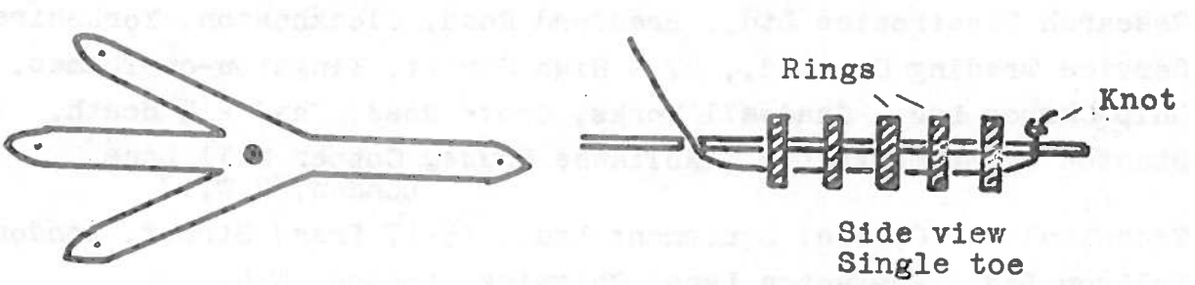
In The Workshop

This is not strictly a workshop project, since with a little preparation pupils can make their own bird claws in class time. The apparatus demonstrates the perching mechanism in birds.

Apparatus:

Empty plastic detergent bottles.
Rubber tubing, 5 - 6mm inside diameter.
Fine twine, e.g. Griffin and George, L21-950.

Cut the rubber tubing into rings 3mm wide; twenty such rings are required for one claw. Cut open the detergent bottle and cut out as many claw shapes as necessary, making the width of a claw 1cm and the total length 20cm, although these dimensions are not critical.



Punch a hole at the central point where all the claws converge, using cork borer. Punch a smaller hole at each claw tip, threading through it a length of thread, secured in the hole by a knot. Push five rubber rings on to each claw, evenly spaced along the claw, so that they secure the thread on the underside of each claw. Push all four threads through the central hole and when evenly tensioned tie together so that pulling the four strand cord operates the perching mechanism.

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

Advance Electronics Ltd., Roebuck Road, Hainault, Ilford, Essex.
George Anson and Co. Ltd., 16 Lynedoch Crescent, Glasgow, C.3.
Andrew H. Baird Ltd., 33-39 Lothian Street, Edinburgh, 1.
Bausch and Lomb Optical Co. Ltd., Aldwych House, London, W.C.2.
British Electrical Resistance Co. (Berco) Ltd., Queensway, Enfield, Middlesex.
Cambrian Chemicals Ltd., Macks Road, Bermondsey, London, S.E.16.
Cressall Manufacturing Co. Ltd., Cheston Road, Aston, Birmingham, 7.
Crompton Parkinson Ltd., Crompton House, Aldwych, London, W.C.2.
Derritron Instruments Ltd., 24 Upper Brook Street, Mayfair, London, W.1.
Farnell Instruments Ltd., Sandbeck Way, Wetherby. Yorkshire.
Fire Appliance Industries Ltd., 4 Commercial Street, Dundee.
Flatters and Garnett Ltd., Mikrops House, Bradnor Road, Manchester, 22.
Wm. Foster (Rainford) Ltd., Rainford, St. Helens, Lancs.
A. Gallenkamp and Co. Ltd., Technico House, Christopher Street, London, E.C.2.
Gestetner Duplicators Ltd., 13/13A Stafford Street, Edinburgh, 1.
Griffin and George Ltd., Braeview Place, Nerston, East Kilbride.
Philip Harris Ltd., Ludgate Hill, Birmingham, 3.
Labgear Ltd., Cromwell Road, Cambridge.
Land, Speight and Co. Ltd., 49 St. Vincent Crescent, Glasgow, C.3.
Leech (Rochester) Ltd., 227 High Street, Rochester, Kent.
Claude Lyons Ltd., 76 Old Hall Street, Liverpool, 3.
(Monax) John Moncrieff Ltd., St. Catherine's Road, Perth.
Morris Laboratory Instruments Ltd., 96-98 High Street, Putney, London, S.W. 15.
W.B. Nicolson Ltd., Thornliebank Industrial Estate, Glasgow.
Northern Biological Supplies, 31 Cheltenham Avenue, Ipswich.
L'Optic Modern Ltd., 71 Great Portland Street, London, W.1.
Optoplast Manufacturing Co. Ltd.,Millmead, Guildford, Surrey.
Panax Equipment Ltd., Holmethorpe Industrial Estate, Redhill, Surrey.
W.R. Prior and Co. Ltd., London Road, Bishop's Stortford, Herts.
Research Electronics Ltd., Bradford Road, Cleckheaton, Yorkshire.
Service Trading Co. Ltd., 47-9 High Street, Kingston-on-Thames.
Ship Carbon Ltd., Chadwell Works, Grove Road, Chadwell Heath.
Stanton Instruments Ltd., Reliance House, Copper Mill Lane, London, S.W.17.
Technical and Optical Equipment Ltd., 15-17 Praed Street, London, W.2.
Teltron Ltd., 239 Acton Lane, Chiswick, London, W.4.
Unilab Division, Rainbow Radio Ltd., Mincing Lane, Blackburn, Lancs.
Wootton and Co. Ltd., Alma Works, Ponders End, Middlesex.