Wireless World

RADIO, TELEVISION AND ELECTRONICS

43rd YEAR OF PUBLICATION

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DECEMBER 1953

In This Issue

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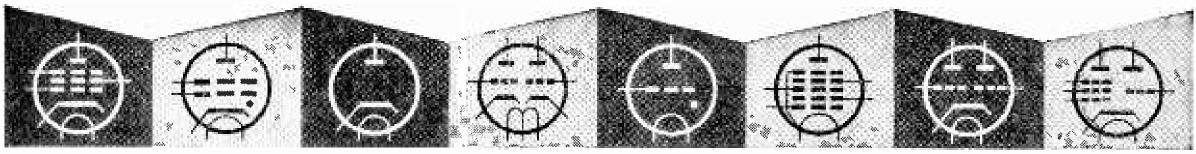

VALVES, TUBES & CIRCUITS

12. APPLICATIONS OF DOUBLE TRIODES IN AUDIO AMPLIFIERS.

There are three double triodes, types ECC81, ECC82 and ECC83 in the Mullard range of noval-based valves which can be used in audio amplifiers. These three types provide designers with a range of characteristics which enables the most suitable valve to be chosen for any particular application.

Each valve type is single-ended and of all-glass construction, being in the miniature bulb with a B9A (noval) base. The pin connections and dimensions of the three types are identical. The two independent triode sections and the high heater-cathode voltage rating considerably widen the field of application. Either triode section can be used to drive the other when used in a cascade circuit, the choice depending on the most convenient wiring arrangement.

One end of each of the two heaters is joined to a common pin so that the heaters may be operated in series at 12.6V, 0.15A or in parallel at 6.3V, 0.3A. With this type of heater, operation in series chains of 0.3A or 0.15A, or in mobile equipment is possible. With 6.3-volt A.C. operation the heater supply should be centre-tapped to earth, in order to reduce hum. Under these conditions the equivalent hum level on the grid of each section when used in a typical amplifier circuit is less than 25μV with a grid circuit resistance of 500kΩ.

CHOICE OF VALVE

For general purpose amplifier use, the high-μ type ECC83 is the most suitable, a stage gain of 50 to 60 times being obtained under the recommended operating conditions. This, together with its low microphony ensures satisfactory performance at the low signal levels which occur, for example, in pre-amplifier circuits. For such applications the ECC81 is less favourable due to its greater microphony. Although in later stages the ECC81 can be an alternative to the ECC83, the latter is generally to be preferred because of its better linearity.

The audio applications of the low-μ ECC82 are more limited because of its low voltage gain, but it may be found useful in penultimate stages where a low impedance is desirable.

VALVE DATA

HEATER Suitable for series or parallel operation, a.c. or d.c. The heater is centre-tapped and the two sections may be operated in series or in parallel with one another.

Series V_h applied between pins 4 and 5

Parallel V_h applied between pin 9 and pins 4 and 5 connected together

	Series	*Parallel*	
V_h	12.6	6.3	V
I_h	0.15	0.3	A

CHARACTERISTICS (Each Section)

	ECC81	ECC82	ECC83	
V_a	250	250	250	V
I_a	10	10.5	1.2	mA
V_g	-2.0	-8.5	-2.0	V
g_m	5.0	2.2	1.6	mA/V
μ	60	17	100	
r_a	12	7.7	62.5	kΩ

LIMITING VALUES (Each Section)

		ECC81	ECC82	ECC83	
V_a	max.	300	300	300	V
p_a	max.	2.5	2.75	1.0	W
I_k	max.	15	20	8.0	mA
V_{h-k}	max.	150	180	180	V

BASE B9A

DIMENSIONS *Max. overall length 56 mm. Max. seated height 49 mm. Max. bulb diameter 22.2 mm.*

TYPICAL PERFORMANCE AS R.C. COUPLED AUDIO AMPLIFIER.
(Each Section). At $V_b = 300V$.

	R_a (kΩ)	R_k (kΩ)	R_{gl} * (kΩ)	I_a (mA)	$\frac{V_{out}}{V_{in}}$	V_{out} ** (V)
ECC81	100	1.0	330	1.7	42.5	30
	220	2.2	680	0.9	42	34
ECC82	100	4.7	330	1.5	12.3	43
	220	6.8	680	0.9	13	48
ECC83	100	1.5	330	1.0	53	40
	220	2.2	680	0.6	66	45

*Grid resistor of following valve. ** $D_{tot} = 5\%$*

Reprints of this advertisement, together with additional data, may be obtained free of charge, from the address below

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Home Recording and the Law

UNTIL the domestic tape recorder became commonplace, the legality or otherwise of making recordings from broadcast transmissions was largely an academic question. The number of people capable of cutting a good disc was never significant, but now, with the help of a modern tape machine, almost anyone living in an area served with a good signal can, by choosing the best of the B.B.C. transmissions, make a recording that compares well with the average long-playing disc. The small amount of skill needed is easily acquired by many ordinary listeners, and the gear needed is neither highly complex nor unduly costly. Is there any legal barrier in the way of making recordings "off the air" in this way?

The question of copyright as it affects home recording has already been discussed in this journal. But there are other considerations, and the whole matter has been revived by a B.B.C. statement published in *Radio Times* of October 23. The statement reads :—

> "We have been asked to remind listeners to B.B.C. programmes that in view of the provisions of the Dramatic and Musical Performers' Protection Act, 1925, it is, in certain circumstances, an offence to make recordings by means of tape equipment or otherwise of any dramatic or musical work broadcast by the Corporation without the consent in writing of the performers. Moreover, the making of unauthorized recordings of any copyright material included in B.B.C. programmes may also constitute an infringement of the provisions of the Copyright Act, 1911.
>
> "The Corporation cannot undertake to secure the consent of performers and owners of copyright material on behalf of parties wishing to record programmes broadcast by the Corporation."

That statement, though strictly accurate so far as it goes, tells only a part of the story, and is liable to confuse the great body of listeners and potential home recordists.

Let us first consider the effect of the Dramatic and Musical Performers' Protection Act. True, that Act makes it an offence to record directly or "indirectly" (e.g., through broadcasting) or to sell, hire or use for public performance any recording made without authority. What the B.B.C. statement does not mention is the highly relevant proviso that the home recordist has a valid defence if he can prove that the recording was not made for "purposes of trade." Thus it is quite clear that the private individual who makes a recording for his private use—and not for gain—does not commit any offence under the Act.

The ordinary home recordist's position under the Copyright Act is almost equally clear. The essence of the matter is that, for an infringement to be committed, the recording must be played back in circumstances that introduce some element of "public performance." In defining the word "public" the law takes quite a narrow view; for instance, performance in a club to which members only were admitted would almost certainly be ruled to be in public. Also it is not necessary for an admission charge to be made in order to bring the performance into the "public" category. What seems quite certain is that playback of a recording made "off the air" is not an infringement if done in the recorder's own home, with an audience limited to his family or intimate circle of friends.

All this seems to be in accordance with commonsense, and we believe that neither performers or copyright holders are likely to suffer in the long run through the growth of home recording. Indeed, it may stimulate public interest in what they have to offer, just as broadcasting stimulated the sale of gramophone records.

There remains the possibility that the law of copyright may soon be altered, but that seems unlikely to affect the position. The present Act is overdue for revision, but the Report of the Copyright Committee 1952, on whose recommendations the revision will presumably be based, did not touch on the subject of recording "off the air."

Finally, it should be emphasized that those who use the B.B.C. transmissions without authority to make recordings for sale or public performance do most certainly infringe the law, and no doubt the B.B.C. warning was directed against those who are "pirating" the Corporation's transmissions in this reprehensible way.

Pocket Reactance and Resonance Calculator

By
V. J. TYLER,
B.Sc., A.M.I.E.E.

Covering Twelve Decades Without Ambiguity

LIFE is too short to calculate every minor value in an electronic circuit design; such things as bypass capacitances and stray inductances are often assessed by experience or intuition. But where a quick and reliable aid to calculation is available it is possible to be more meticulous in design and leave less to be determined by trial and error. I say "reliable" rather than "accurate," because normal tolerances do not permit of accurate design where valves are concerned; but it is of vital importance that one should, for instance, be sure of the position of the decimal point in a calculated value.

The calculator (Fig. 1) is intended as such an aid and deals comprehensively with the quantities capacitance (C), inductance (L), frequency (f), capacitive reactance (X_C) and inductive reactance (X_L), under conditions of resonance or otherwise.

Where two of the quantities C, f and X_C are known, the third can be found directly; similarly the quantities L, f and X_L can be dealt with. Where a resonant circuit is involved (i.e., where $X_C = X_L = X$) the fixing of any two of the quantities C, L, f and X automatically fixes the other two, and both can be found directly.

The calculator consists (Fig. 2) of three Perspex discs, calibrated with logarithmic scales, interleaved with three cursor discs. The outer "C" disc and middle ("f") disc form a circular slide rule connecting C, f via the fixed cursor lines. X_C is read on the middle scale against an index mark on the outer one. The middle and inner discs form a similar slide rule connecting L, f and X_L.

Since a common "f" scale is used for both rules, the X_C and X_L scales increase in opposite directions and cannot be replaced by a common scale. Where resonance is considered, X_L and X_C are made to have equal values by balancing the "resonance diagram" in the centre of the calculator. The diagram is a combination of lines engraved on the various transparent discs. The design on the "C" disc consists of a ring of diagonal lines one of which terminates in an approximately "equi-angular" spiral. The "L" disc diagram is the exact mirror-image of the "C"

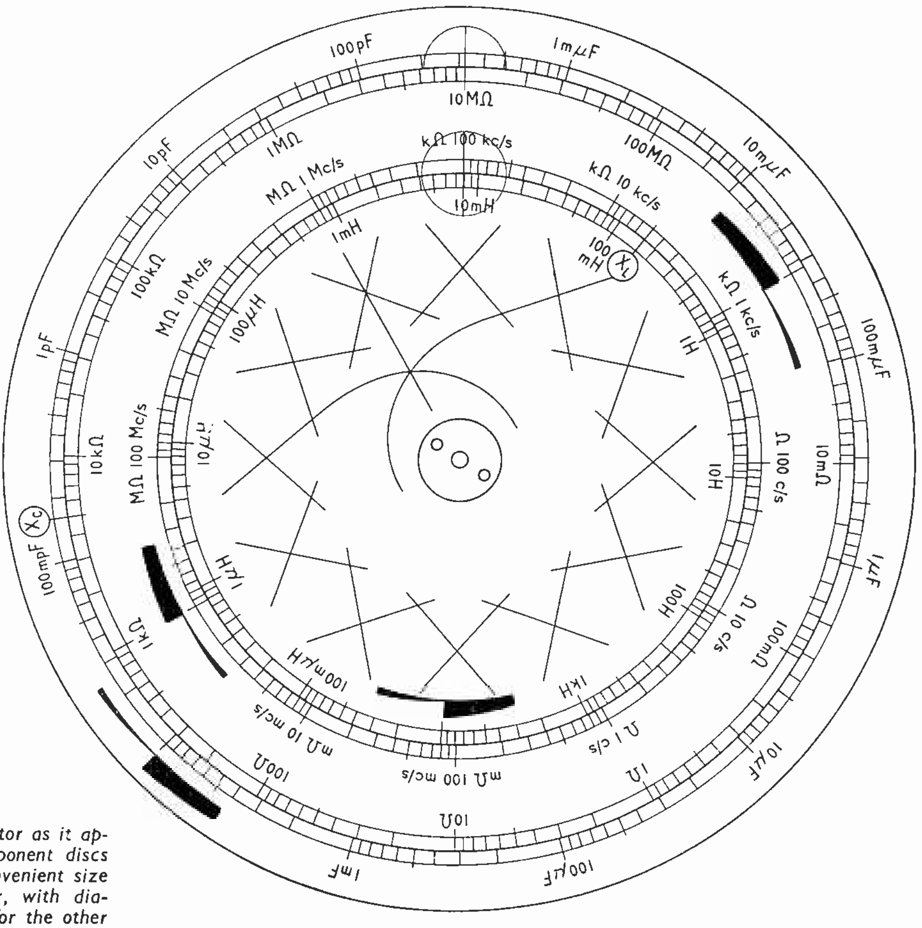


Fig. 1. Complete calculator as it appears when the six component discs are superimposed. A convenient size is 4¾in outside diameter, with diameters of 4⅛in and 3in for the other discs.

disc diagram. The radial line on the "f" disc is engraved on both sides of the Perspex to minimize parallax error. "Balancing" the diagram consists of making the radial line pass through the intersection of the two spiral lines. This can be done by moving any one of the three discs, e.g., by moving the "L" disc to position (*a*), the "f" disc to position (*b*) or the "C" disc to position (*c*) (see Fig. 3). Since the spirals cut at a shallow angle, the initial accuracy of balancing is not high, but is sufficient to indicate with certainty which of the many intersections of the diagonal lines should be used to refine the balance and to achieve an accurate "cut" as shown at (*d*).

In actual use this process is quick and straightforward. The illustration of the "complete calculator" shows a worked example. Assuming, for instance, that the values given are f = 100 kc/s and L = 7.9 mH, the inner and middle discs are set to bring these values over the cursor line. The outer disc is then rotated until its spiral line passes through the intersection of the radial line and the other spiral line, and the "cut" refined on the outer diagonal lines. The capacitance can then be read off as 320 pF, and the reactance (either X_C or X_L) as 5 kΩ.

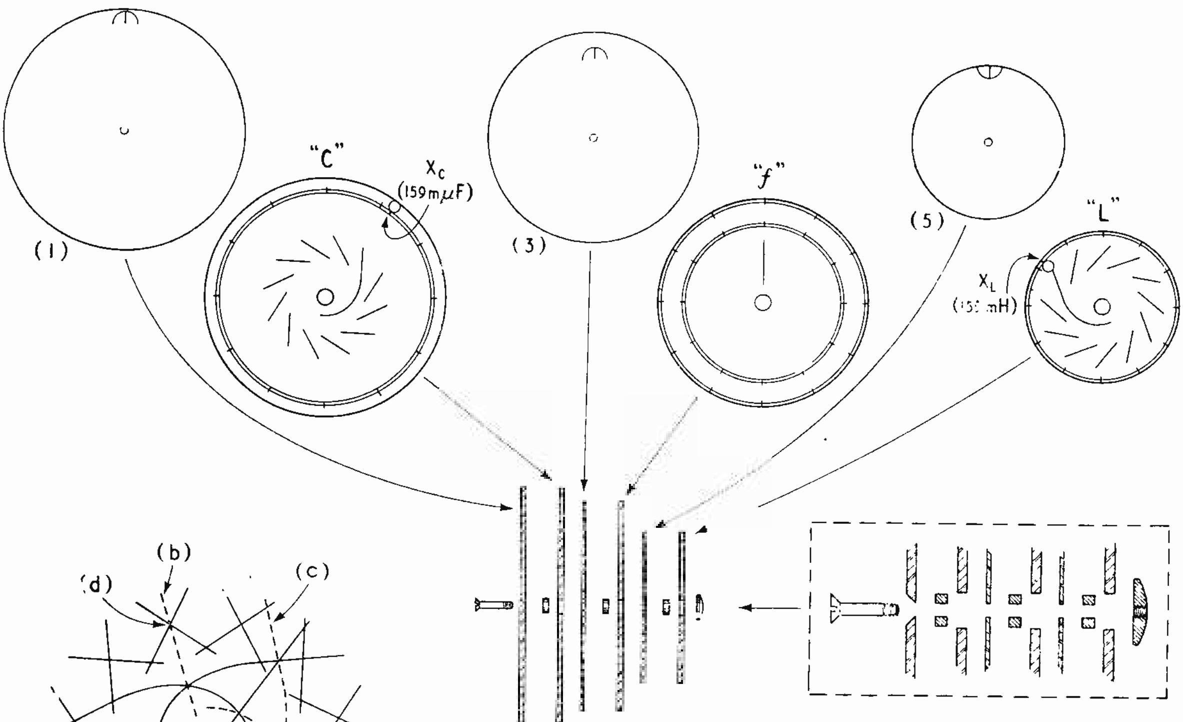
If greater accuracy is required the answer can be checked by calculation, using the appropriate simplified formula given in the table.

The positions of decimal points can be ignored when using the formulae to check results obtained by the calculator,* since the decimal position given by the calculator is quite unambiguous and cannot be in error by less than a million to one, which would be immediately obvious. Applying these formulae to the worked example above, we obtain 32009 and 49638 as more exact evaluations of C and X, giving final answers of 320.09 pF and 4963.8 ohms. In most cases, however, electronic circuit design does not justify such accuracy.

The core of the calculator is an assembly of metal

Resonant-Circuit Relationships

Unknown Quantity	Equivalent in Terms of Known Quantities. Units either c/s, μF, H, ohms or Mc/s, pF, μH, ohms.		
X	$\frac{159020}{f \cdot C}$	$6.283 \cdot f \cdot L$	$10^3 \cdot \sqrt{\frac{L}{C}}$
f	$\frac{159020}{X \cdot C}$	$\frac{0.15902 \cdot X}{L}$	$\frac{159.02}{\sqrt{LC}}$
C	$\frac{159020}{X \cdot f}$	$10^6 \cdot \frac{L}{X^2}$	$\frac{25287}{f^2 \cdot L}$
L	$\frac{0.15902 \cdot X}{f}$	$10^{-6} \cdot X^2 \cdot C$	$\frac{25287}{f^2 \cdot C}$



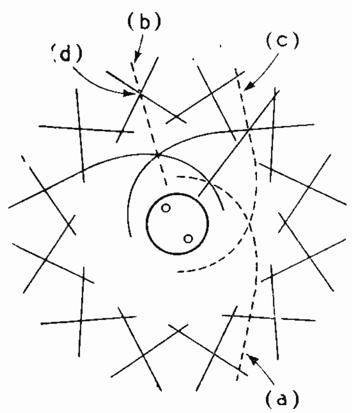


Fig. 2. Component discs of the calculator in order of assembly. The inset shows how the washers are arranged as clamps for the cursor discs and bearings for the "C," "f" and "L" discs. In the sectioned side elevations the disc thicknesses have been exaggerated relative to the diameters.

Fig. 3. Illustrating the manipulation of the resonance diagram pattern.

* Except in square roots, but even here any convenient *even* number of decimal shifts may be made before calculation.

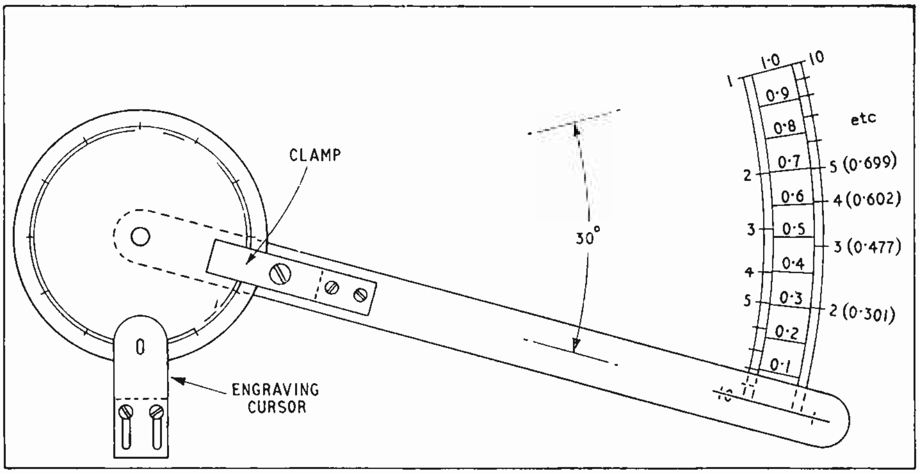


Fig. 4. Suggested method of dividing the scales. A radius of 19cm will give 10 mm per division (3 deg. of arc) on the centre scale.

spacers bolted solidly together with the cursor discs (1), (3) and (5). Disc (1) may be of aluminium, or, like the calibrated discs, of $\frac{1}{16}$in thick Perspex. Most transparent materials other than Perspex warp to a saucer-shape in use. Discs (3) and (5) are of any transparent material, but are as thin as possible. Each of these discs has on it a cursor design consisting of a semicircle and radial line, the lines being accurately registered with each other when the assembly is bolted together. The spacers are dimensioned so that the calibrated discs turn freely upon them. When one calibrated disc is turned, the fixed cursor discs prevent it from disturbing the settings of the others. A calibrated disc is easily adjusted, using one or both thumbs on the scale surface, the fingers resting on the back of cursor disc (1) .

Engraving the Scale

Although neater scales result from machine engraving, the scales can easily be made by hand using the arrangement shown in Fig. 4. The scale to be engraved is first divided into twelve equal parts by ordinary geometrical means, but using more than ordinary care. It is then set up on a board on a well-fitting pivot together with a Perspex arm which can be clamped to it by a simple friction device. An engraving cursor is also fitted to the board, having a slot in it which exactly fits either an engraving stylus or a set of punches (for various line lengths).

In use the engraved line on the Perspex arm is set to the appropriate end of the enlarged scale shown, and simultaneously the corresponding decade mark on the calculator scale is set up directly under the cursor slot. The clamp is then tightened up and the arm moved to the "2" position on the enlarged scale. A corresponding mark is made on the calculator scale by scratching through the slot with a stylus, or lightly tapping through with a punch. The arm is then moved to "3" and so on. All decades are marked in this way.

The enlarged scale is made by constructing geometrically a thirty-degree arc and dividing it up into ten equal divisions (which are themselves sub-divided where necessary). On either side of this linear scale two logarithmic scales are drawn increasing in opposite senses. The value for each unit on the log scale is taken directly from a table of common logarithms in the manner indicated. The log scale can be usefully subdivided, further than is shown, by making dots (not lines) on the calculator scale corresponding to 1.2, 1.4, 1.6, 1.8 and 2.5, but further subdivision is not recommended in a twelve-decade, pocket size calculator.

The spiral lines are engraved by marking out a thin template with a spiral more or less as shown (the exact shape not being important), cutting it along the marked line and smoothing it with a file. It is then used, after the fashion of a French curve, to engrave one scale, and is turned over to engrave the other.

The diagonal lines are made by marking out two rings of twelve dots each. The diameters of the rings are not important, but the dots must be exactly equally spaced, and one dot in each ring must lie exactly on the radius passing through the X_L or X_C mark. The appropriate dots are then joined by straight lines as illustrated. Unlike the spiral lines, the diagonal lines must be engraved as accurately as possible.

To minimize parallax, the engraving should be as follows :

"C" disc	(rear) :	"C" scale.
"	(front) :	Resonance diagram and X_C index mark.
"f" disc	(rear) :	X_C scale and radial line.
"	(front) :	f and X_L scale and radial line.
"L" disc	(rear) :	L scale, resonance diagram and X_L index mark.

The front of cursor disc (1) is sprayed white as a background for the scales and diagrams. The reactance scales and index marks are filled in red as a reminder that they are not read against the cursors. All other engraving is filled in black.

In practice the calculator has proved quicker, more certain and more convenient than either a reactance chart or an abac. A reactance chart demands a high degree of concentration if one is not to lose one's way among four mutually intersecting logarithmic scales. An abac gives sensible answers only to sensible questions, and is apt to exclude from the latter category queries concerning, for instance, the reactance of a microfarad at a megacycle, although such values are common in the design of decoupling networks. Moreover, neither kind of chart may safely be left to bang about a bench among soldering irons and flux pots, nor can either be carried in a pocket ready for immediate use.

Tape Recorder For Home Construction

Parts for Assembling Tape Mechanism and Amplifier

IT has been suggested, and is accepted in many quarters, that whereas the electrical side of a tape recorder is within the capabilities of the home constructor, the mechanical side is not. The sponsors of the "Sound Master" tape recorder have challenged this view with a kit of parts which includes the components for building the tape mechanism as well as the associated amplifier. True, the role of the constructor is limited to the assembly of parts which have been accurately machined for him by the Brenell Engineering Company, but is this very different from accepting ready-made valves as components for the amplifier?

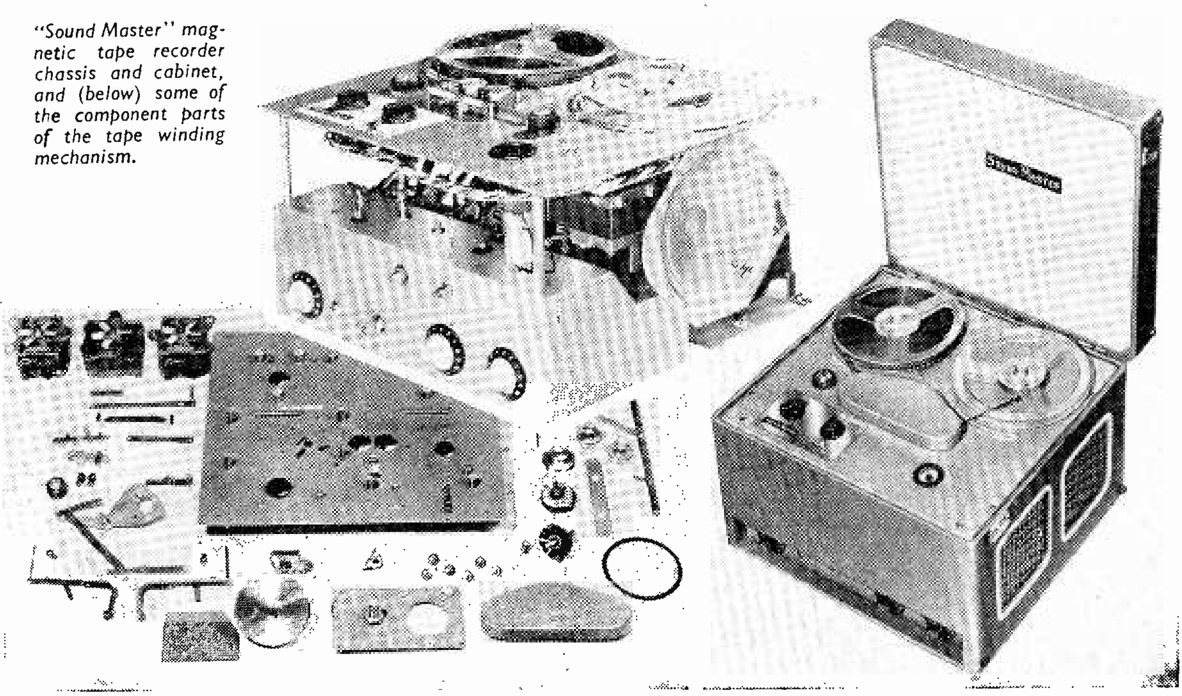
Designed by W. I. Slack, who was also responsible for the "View Master" television kit, the "Sound Master" follows the best practice both in mechanical and electrical design. Three motors (by Collaro) are used in the tape drive, and the magnetic heads are made by Wright and Weaire; other firms collaborating in the supply of components are Bulgin, Mullard, N.S.F., Radio Resistor Company, T.C.C., and Whiteley Electrical Radio.

Three tape speeds are provided, $3\frac{3}{4}$, $7\frac{1}{2}$ and 15 in/sec. Speeds are changed by altering the position of the capstan flywheel driving belt under the top plate, or by fitting or removing a sleeve which increases the diameter of the driving capstan. Either method is arranged to give a 2: 1 change in tape speed.

Switching has been reduced to the practicable minimum, and a mechanical interlock is provided to prevent accidental erasure of recorded tape. In addition, a three-colour indicator lamp shows when the equipment is set for recording (red), rewinding (amber) or playback (green).

The performance of the complete equipment is very good, even when set up without the aid of special test instruments. The speed constancy of the tape is excellent and passes critical listening tests, both on recorded music and with constant-frequency inputs. Quality of reproduction depends upon the skill with which the bias and volume indicator circuits have been adjusted, but there is no reason why professional standards should not be reached with a little practice and a critical ear, or, better still, by the aid of a cathode-ray oscilloscope and an audio oscillator, as described in the instruction manual.

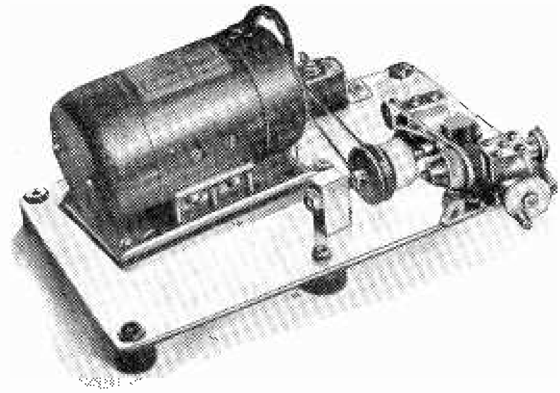
A kit of parts, excluding cabinet and microphone, costs £56 5s 10d. The W.B. cabinet costs £6 6s and the recommended Lustraphone microphone £5 15s 6d for the table model or £6 6s for the hand model. The instruction manual can be purchased separately for 6s 6d.



"Sound Master" magnetic tape recorder chassis and cabinet, and (below) some of the component parts of the tape winding mechanism.

Sharpening

Simple Machine Giving Well-shaped and Burnished Points

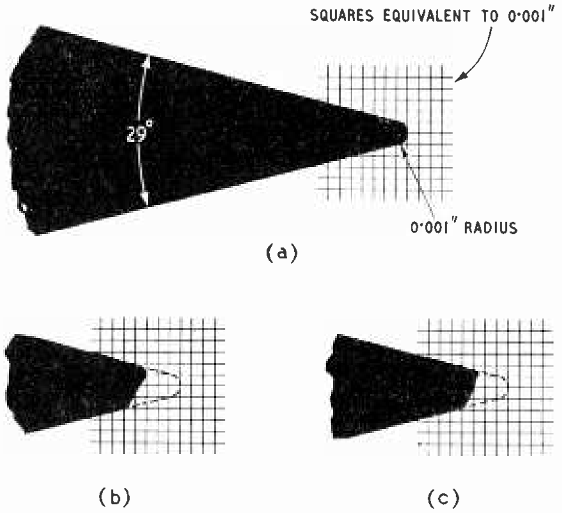


General view of sharpener with needle chuck locked in the grinding position.

IN the course of giving gramophone recitals in the North for over 20 years, the writer has met many owners of valuable record collections who have tried, with varying results, to use thorn or fibre needles, but who have given them up in favour of steel or sapphire, since they were unable to make a thorn last more than one side or less. Often these people had not the patience or the time, sometimes not even the inclination, to look for the cause.

So the general condemnation of thorn needles goes on. In reality the "object" used can hardly be termed a needle, and when highly magnified looks more like a poker than anything else. One would have thought that with a smooth groove surface finish, the thorn point also would be made smooth and without flats, yet some sharpeners depend on the use of glass paper with practically no surface speed. No wonder the point soon goes, and also the user's patience.

Many discussions, in print and otherwise, have taken place regarding the use of thorn needles, but little indication is given as to their shape or smoothness, or as to how they are sharpened. The articles by A. M. Pollock[1] and S. Kelly[2], also the excellent photomicrographs of C. E. Watts, are perhaps the only instances in print of serious study given to the subject; and only in Mr. Pollock's article is any sharpening process mentioned.



Shadowgraph tracings of Davey miniature thorn needle profile, (a) as sharpened, with a 0.001-in point radius, (b) after playing two sides of H.M.V. DB6965 ("Faust"), and (c) after playing six sides of Decca K1574-8 ("Firebird") 78 r.p.m. records.

The Machine.—In 1933 the writer made a needle sharpener for B.C.N. fibre needles, driven by a Meccano spring motor, which gave fairly good results, and was exhibited at the Liverpool Gramophone Society's "Coming of Age" meeting in January, 1934. Breakage of springs and low peripheral wheel speed caused it to be redesigned in 1948, and the writer has since used it regularly both at home and at recitals elsewhere. Since that date it has had no replacements, nor has the wheel become glazed or needed retruing.

A series-wound, 15-watt universal motor runs at 7,000 r.p.m. and is mounted on a brass baseplate 6in $\times$ 9in $\times \frac{1}{8}$in, with rubber feet. The white grinding wheel, 1in diameter, $\frac{1}{2}$in wide, $\frac{1}{4}$in hole, Grade A 46R, is made by the Carborundum Company. This is mounted on a hardened silver-steel spindle, with adjustable silver-steel needle point bearings, almost frictionless. Silver steel, which is stocked by most large tool shops, is a carbon tool steel containing nickel. Water-hardened at 780 deg C, it gives a Brinell hardness of 700, which is ideal for the purpose. Lubricant for the points should be graphite grease, sold by cycle dealers. The point angle of thorn needles, usually 29 degrees, can be varied by a small screw at the bottom of the "headstock," which acts as a stop for the pivoted slide plate carrying the needle chuck. A quick-acting clamp keeps the slide against the stop while the needle is being ground.

The wheel speed of 7,000 r.p.m. is, of course, much lower than the specified wheel speed of 22,000 r.p.m. for a 1-in diameter wheel, but it gives a very smooth finish and does not glaze. Some may question the apparently coarse wheel used, but a wide experience of micro-finishes has shown the writer that a finer wheel does not necessarily produce a smooth surface, whereas a suitable grit, grade and bond, though somewhat coarse, with a high surface speed will give the best result.

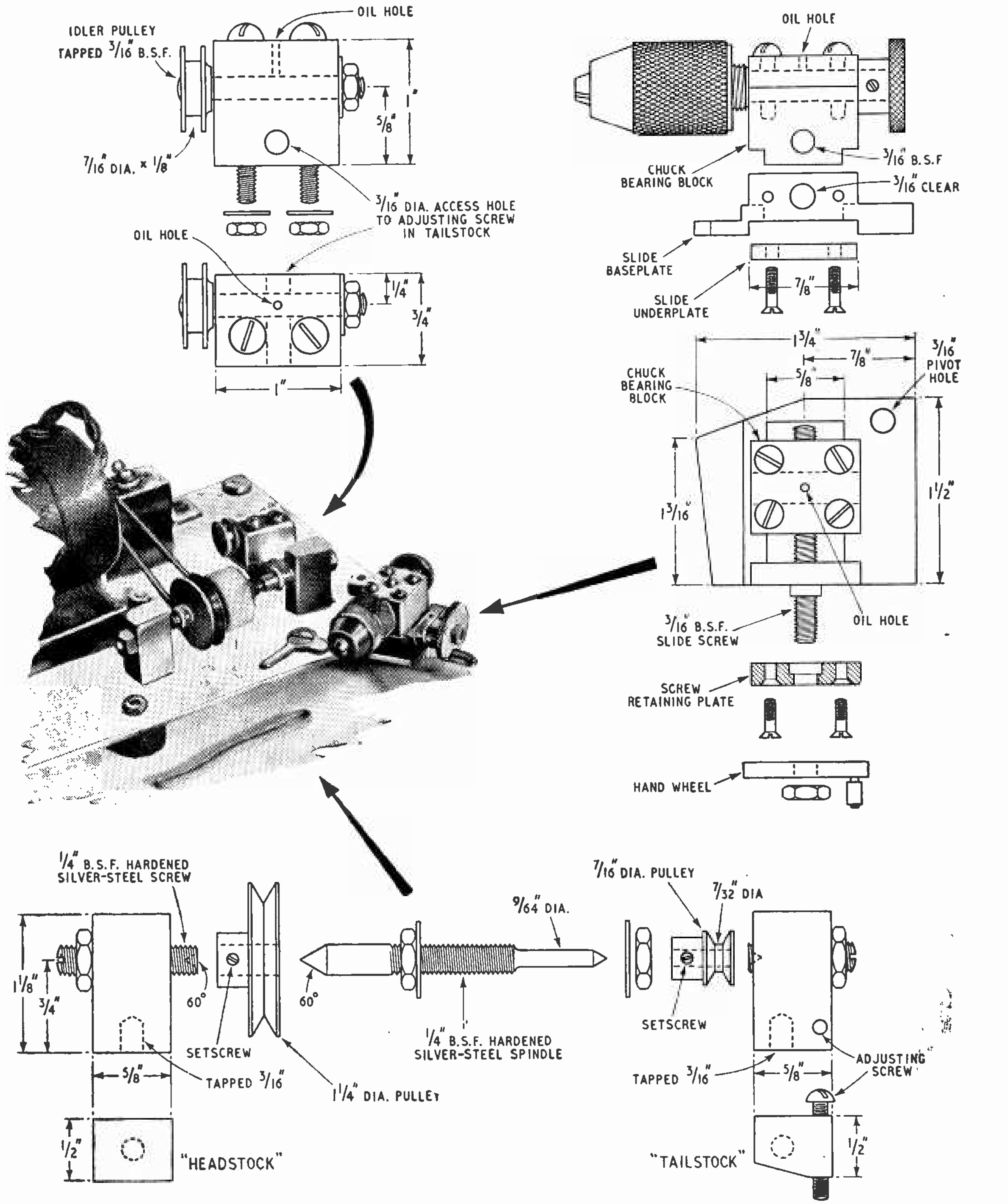
The thorn needle, of any diameter, is held by a small, three-jaw drill chuck. One elastic belt drives the wheel, while another elastic belt drives the chuck and needle by vee pulley on the spindle, and by the knurled portion of the chuck. An idler pulley at the back maintains the belt tension. Three needles per minute, ground and burnished, is the normal production rate.

Thorn Points.—The operating surface of a needle

[1] *Wireless World*, December, 1950.
[2] *Wireless World*, June, 1952.

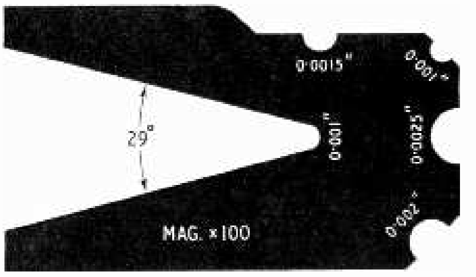
Thorn Needles

By E. F. FOSTER



These constructional details of the machine used by the author may suggest the lines along which readers can construct their own needle sharpening and burnishing equipment should have a surface finish equal to that of the record groove, in order to minimize the risk of retaining abrasive dust particles.

The needle points shown have been checked by shadowgraph on an optical projector, with a glass screen 15in×12in, having ruled squares of 0.1in which, with a magnification of 100, correspond to spaces of 0.001in. This projection by light is accurate to 0.0005in all over the screen. By using the scaled-up radius gauge shown, the shape and radius of any needle can be compared, and wear quickly discerned, by turning the needle round, in a small fixture, during examination. It is remarkable how large dust appears under these conditions.



Scaled-up template used to check the profiles of gramophone needles on the screen of a projection microscope.

Performance.—The pickup used in the tests with high-quality equipment was the Connoisseur Fibre Pickup with balance weight giving 14 grams playing weight. It will be noticed from the profiles shown that the wear is almost equal after playing either two sides of "Faust" (H.M.V. DB6965), or six sides of "Firebird" (Decca K1574-8). Another splendid record is Toccata and Fugue, Germani (organ) (H.M.V. C3781). Here is tremendous volume, clarity and sense of space and vastness. A miniature thorn needle plays this six times without loss of quality even on the high notes.

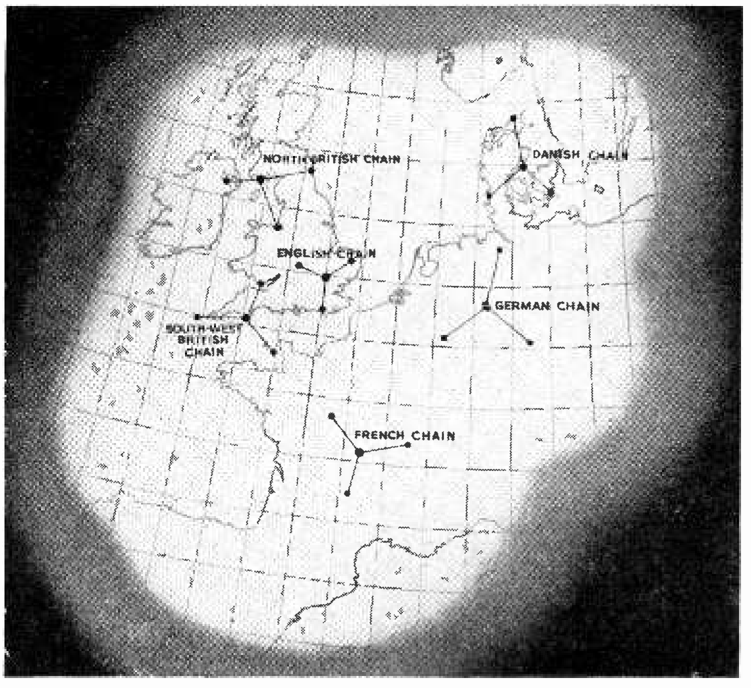
All these records have been played only with thorns, as one should not expect a thorn to function correctly on surfaces previously operated with steel or sapphire, or on bad pressings, of which there are many. I have heard many record recitals utterly spoiled by playing, with thorns, discs which have been used, and well worn, with sapphire styli.

Conclusion.—The purpose of this article is not to reopen the thorn or semi-permanent needle controversy, but instead to underline the fact that thorns seldom get a fair chance, are rarely correctly sharpened, and are used under conditions which are not good for needle, record or sound. The extra trouble taken in forming a good point will be well repaid by reduced record wear, and an extended frequency response can be achieved with suitable reproducing equipment. Quite recently the writer heard Mr. Pollock demonstrate in public, on his own instrument, the relative merits of sapphire and miniature thorn by playing a fine orchestral record with both types of needle, and none of the critical audience could detect any serious difference. He also played most successfully an L.P. disc with a thorn.

The main difference between the sharpening described and simpler types of machine is that it not only grinds, but burnishes a thorn needle and also produces a truly conic surface. These results are not obtained by commercial sharpeners with axial wobble and low peripheral speed.

Thorns, sapphire and diamond needles all have their merits and demerits and although the latter are probably the best, except for cost, there are still a large number of record collections in existence whose value depends on their not having been played with other than fibre needles, and for which improved thorns may be an advantage.

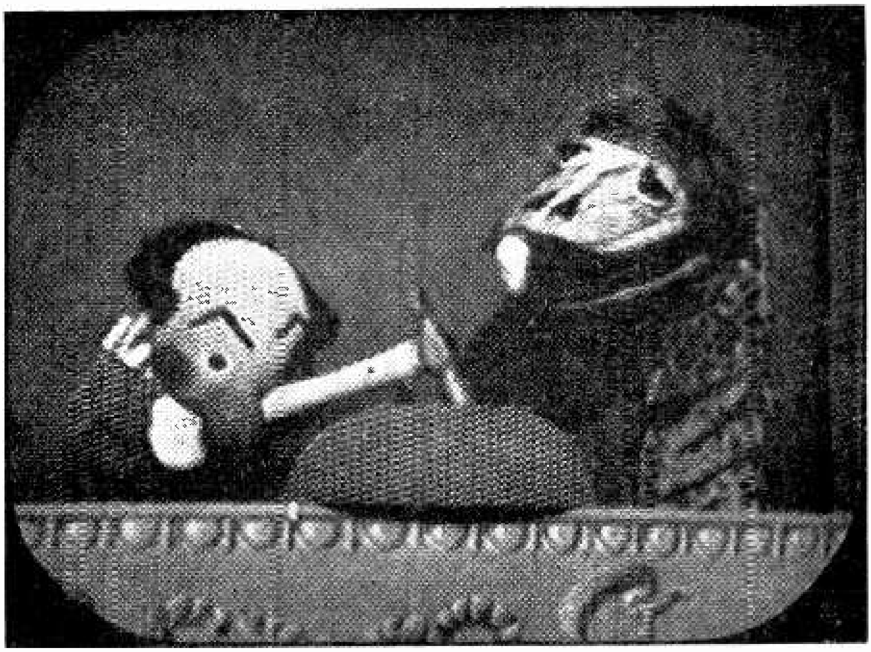
To test the matter finally the author will gladly, without obligation, sharpen any thorns sent to him at 29, Charlestown Road, Manchester, 9.



Decca Navigator

THE French chain of Decca Navigator stations, the sixth to be brought into service since this continuous-wave hyperbolic navigational system was introduced in 1946, was officially opened towards the end of October. With the master transmitter at Montluçon, the siting of the three slave stations follows the usual "star" formation; the red, green and purple slaves being, respectively, near Amboise, Chalon-sur-Saone and Aurillac. The complete service area of the six chains is indicated on this map. Variations in the day and night coverage are shown approximately by the shaded fringe area. Equipment for the French chain was manufactured under licence and installed by the Société Française Radioélectrique of Paris. The number of British and foreign ships equipped with Decca Navigators is now over 2,000.

Picture taken from the screen of a black-and-white television receiver in New York during a demonstration of N.T.S.C. colour television standards to the F.C.C. Parts of the picture appear to carry a rather bad interference pattern, possibly from the colour sub-carrier in the vision signal. This may be unduly emphasized by the camera, which does not have persistence of vision like the eye—a phenomenon on which the system relies for cancelling out the pattern.



N.T.S.C. Colour Pictures

BRITISH observers who have seen recent demonstrations of N.T.S.C. colour television in America all seem to have been greatly impressed by the quality of the pictures. One engineer tells us that the colour pictures at their best were very good indeed, and certainly better than anything he had seen before, irrespective of the bandwidth used. There was a surprising amount of uniformity in colour rendering between receivers of different makes, but this was probably because 10 out of the 13 colour sets he saw together were using the same RCA tri-colour c.r. tube. Another engineer, who saw demonstrations on closed circuits, says that definition, brightness and colour rendering were all excellent. Moreover, there was no colour fringeing (spurious colour at the boundaries of differently coloured areas) and a complete absence of the colour break-up seen on frame-sequential systems with moving subjects.

As for the various methods of displaying the colour pictures, it was generally agreed that the RCA tri-colour tube is the most suitable one for domestic receivers, though considerable skill is needed in adjusting it to obtain correct convergence of the three beams. Rather more faithful colour reproduction is given by another device using three separate c.r. tubes, but this is too cumbersome for the home and is likely to be more useful as a studio monitor.

On the question of compatibility the observers were a little more guarded. One said he thought the black-and-white pictures were perfectly acceptable, and he could not detect any interference pattern (from the colour signal) on them. At the same time he pointed out that at this particular demonstration there were only three monochrome receivers to 13 colour sets, and he was obliged to view them from behind a rope at a distance of about 12-15ft. Those who saw the closed-circuit demonstrations were particularly impressed by the "beautiful quality" of the monochrome pictures. On this occasion, however, the pictures were displayed on control-room monitors and there was no colour sub-carrier present in the vision signal. They later saw the pictures on a typical American receiver, and here the colour-signal interference pattern could be distinguished, but only by very close inspection. On a special receiver with a frequency response well maintained to 4 Mc/s the pattern was visible as a background of crawling white dots.

Apart from these reservations, the general opinion seems to be that the N.T.S.C. have made out a good case for the adoption of their system in America, and that there is no reason why a similar one, compatible with 405-line standards, should not be developed in this country.

Meanwhile, in America the F.C.C. are continuing their examination of the system, and demonstrations have been arranged to cover all possible operating conditions. Tests have been done with various light levels, with close-ups and rapidly moving subjects and with indoor and outdoor scenes.

According to *Electronics*, it is almost certain that the F.C.C. will formally accept the N.T.S.C. standards before the end of the year, and interest is now centred around the availability and prices of receivers. One firm estimates that it can produce up to 75,000 sets next year at 800 dollars each, while another has promised a price for 1955 only 25 per cent above that of monochrome receivers. The Columbia Broadcasting System thinks that the first receivers will be about 1,000 dollars. Of course, the cost of the picture tube is a big item. *Electronics* says that the R.C.A. tri-colour tube has been quoted at various figures between 175 and 250 dollars and the Lawrence at 100 dollars.

TRANSISTORS

By THOMAS RODDAM

11.—*Conclusion : Frequency Response in Transistor Circuits*

SO this is the last of the present series of discursive articles on transistors, unless you hastily sign the petition at your local newsagent—no, not that one, that's for c.p.t.t.v. t . . . v. . . . The object of the series has been to describe what has happened, so that future articles on what is happening will find *Wireless World* readers already well informed.

One topic which must be dealt with before we come to the end of the series is that of frequency response in transistor circuits. This is a question which seems to lead to a certain amount of confusion: since the frequency-response limitations are the controlling features of transistor use in linear circuitry, it is obviously necessary that this confusion should be cleared away. It is not merely that I want a transistorized television receiver : I want to see transistors in such large production for home receivers that I can afford to use them for more serious applications. Those of you who remember doing design work with LS 7 and LS 8 repeater valves, or even earlier with the LS 5's, will appreciate this point.

The confusion, as I have met it, is something like this : A, who makes transistors, says that the current amplification factor is 3db down at, say, 1 Mc/s ; B, who has used this particular type in a video amplifier, says that it starts to cut off at, perhaps, 100 kc/s. C, having talked to both, either damns A as a rogue or condemns transistors as only suitable for low-frequency working. In fact, A and B are telling consistent stories : C's trouble is that he has failed to realize that they are talking about two different things.

The discrepancy is especially marked in the case of the best junction transistors, so that the cleverer A is in this manufacturing process, the less C likes him. Justice, and even Cambridge mathematicians deserve justice, according to Heaviside, demands that we should deal with this matter.

Let us follow D. E. Thomas, in *Proc. I.R.E.* Nov. 1952, and consider the elementary transistor amplifier shown in Fig. 1, with its equivalent circuit. Using the notation given, which I rather dislike, since it seems more logical to make i_2 clockwise, we have the following linear equations, which we have already encountered in an earlier article :

$$R_E i_1 + r_b i_2 = v_g$$

$$(r_m + r_b) i_1 - (r_c + r_b + R_L) i_2 = 0$$

with

$$R_E = R_G + r_e + r_b$$

Solving these equations for i_2, we have

$$i_2 = -\frac{r_m + r_b}{r_c + r_b + R_L} \cdot i_1 = -\frac{r_m + r_b}{r_c + r_b + R_L} \cdot \frac{v_g - r_b i_2}{R_E}$$

$$= -\frac{r_m + r_b}{r_c + r_b + R_L} \cdot \frac{v_g}{R_E} \cdot \frac{1}{1 - \frac{r_b}{R_E} \cdot \frac{r_m + r_b}{r_c + r_b + R_L}}$$

Now provided that R_L is small compared with r_c, which will be the case for an amplifier with extended frequency response, and r_b is small compared with r_m, which is true for any useful transistor, this cumbersome expression reduces to

$$i_2 = -\frac{\alpha}{R_E\left(1 - \frac{\alpha r_b}{R_E}\right)} \cdot v_g = -m v_g$$

where α is the current amplification factor and equals $(r_m + r_b)/(r_c + r_b)$

In the special, and purely theoretical, case where $r_b = 0$ this is simply

$$i_2 = -\alpha\, v_g / R_E$$

The additional term, $1/(1 - \alpha\, r_b/R_E)$, is obviously greater than unity. It is, indeed, the gain enhancement due to positive feedback produced by the base resistance, and in the special case where $R_E = \alpha r_b$ the gain will be infinite and the amplifier unstable.

Now consider a resistive generator working into a capacitive load. The voltage V_2 across the capacitance is given by

$$\frac{V_2}{V_1} = \frac{1}{1 + j\omega CR} \quad \text{or, writing } CR = 1/\omega_o$$

$$\frac{V_2}{V_1} = \frac{1}{1 + j\,(\omega/\omega_o)} = \frac{1}{1 + j\,(f/f_o)}$$

This is the general form for a 6db per octave high-frequency droop, 3db down at f_0. It is the simplest form of physical response we encounter, and corresponds to an elementary minimum-phase-shift network. Let us assume that α, which we know falls off at high frequencies, falls off in just this way. For many transistors, this form has been found to be appropriate. We therefore write

$$\alpha = \alpha_0 / [1 + j\,(f/f_0)]$$

and substitute this in our equation for i_2 above. After quite a deal of manipulation we reach the following equation :

$$i_2 = -\frac{\alpha_0 v_g}{R_E\left(1 - \frac{\alpha_0 r_b}{R_E}\right)\left[1 + j\frac{f}{f_0\left(1 - \frac{\alpha_0 r_b}{R_E}\right)}\right]}$$

$$= -\,m_0 v_g \frac{1}{1 + j[f/f_0(1 - \alpha_0 r_b/R_E)]}$$

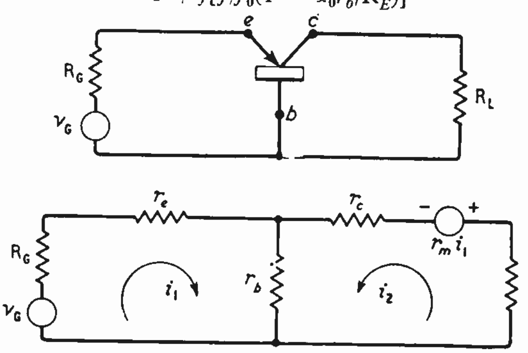


Fig. 1. Elementary earthed-base transmitter amplifier and its equivalent circuit

At very low frequencies the equation is just

$$i_2 = -m_0 v_g$$

with m_0 the value of m introduced earlier, writing α_0 in place of α.

The second term, the frequency response term, is just $1/[1 + j(f/f_0)]$ when $r_b = 0$. When r_b is not equal to 0 the frequency response term can be written as $1/[1 + j(f/f_0')]$ where $f_0' = f_0 \left(1 - \frac{\alpha_0 r_b}{R_E}\right)$. This means that the characteristic frequency, at which the response is 3db below the zero frequency value, has been reduced by a factor $\left(1 - \frac{\alpha_0 r_b}{R_E}\right)$

Looking back we see that this is just the factor by which the low-frequency gain was increased as a result of the positive feedback through the base resistance. This is, indeed, merely another example of the trading balance which we so often encounter in feedback circuits: gain swings, bandwidth roundabouts, "you pays your penny and you takes your choice".

The earthed emitter amplifier, which is a very important form, can be treated in the same way. The circuit and its equivalent are shown in Fig. 2. From Thomas (*loc. cit.*) the equations for this system are

$$R_E i_1 + r_e i_2 = v_g$$

$$(r_e - r_m)\, i_1 + (r_e + r_c + R_L - r_m)\, i_2 = 0$$

with $R_E = R_G + r_e + r_b$

Assuming $R_L \ll r_c$ and $r_b \ll r_m$ we have

$$i_2 = \alpha v_g \Big/ \left[R_E \left(1 - \frac{\alpha\,(r_b + R_G)}{R_E}\right)\right]$$

We can now perform the same analysis as before, to find that the gain increases and the characteristic frequency decreases by a factor $\left(1 - \frac{\alpha\,(r_b + R_G)}{R_E}\right)$.

This will, of course, be a more serious effect than before, because we now have R_G added to the feedback resistance r_b.

For the junction transistor earthed-emitter amplifier, it is easier to consider only the current gain equation

$$i_2 = \frac{\alpha}{1 - \alpha}\, i_1$$

which applies when the load is very small compared with the collector resistance. Remembering the very high collector resistances obtained with the *n-p-n* junction transistors, this is always a reasonable approximation in a wide-band case. Now if we put

$$\alpha = \alpha_0 / [1 + j\,(f/f_0)]$$

we shall get

$$\frac{i_2}{i_1} = \frac{\alpha_0}{1 - \alpha_0} \cdot \frac{1}{\left[1 + j\,\dfrac{f}{(1 - \alpha_0) f_0}\right]}$$

The earthed-emitter amplifier has its current gain pushed up from α_0 to $\alpha_0 \left(\frac{1}{1 - \alpha_0}\right)$: at the same time the characteristic frequency is brought down by the factor $(1 - \alpha_0)$.

Type	α	α cut-off	Earthed-emitter cut-off
1	0.93	1.5 Mc/s	105 kc/s
2	0.98	3.0 Mc/s	60 kc/s
3	0.995	5.0 Mc/s	25 kc/s

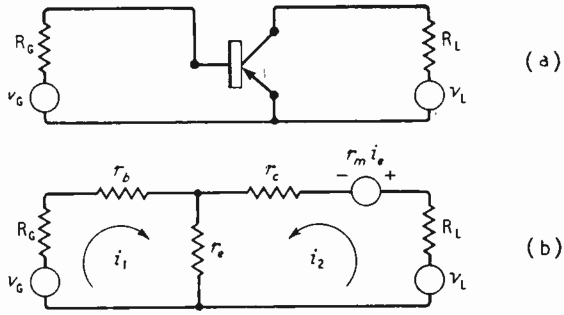
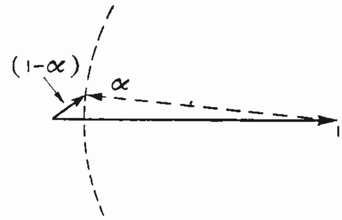


Fig. 2. (a) Earthed-emitter amplifier and its equivalent circuit (b).

Fig. 3. This vector diagram shows that (1-α) is very sensitive to small changes in the phase of α when α is nearly 1.



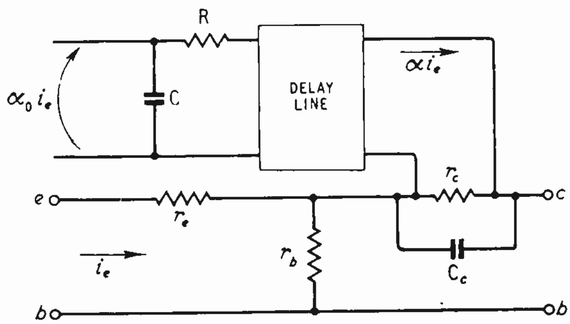


Fig. 4. Delay-line equivalent circuit of a junction transistor.

Let us take a numerical example of what happens in practice. One manufacturer advertises a range of transistors, of different α's and different α cut-off frequencies. I have tabulated these at the foot of the previous column, together with the earthed-emitter cut-off frequency.

The more successful a manufacturer is in his effort to bring α up to 0.999, the worse the frequency response to the earthed-emitter amplifier using a junction transistor.

It is fairly easy to see why the cut-off frequency falls so much if we draw a vector diagram for $(1 - \alpha)$. This is given as Fig. 3, where it can be seen that a very small phase shift in α produces a large change in $(1 - \alpha)$. Long before the falling off of α is apparent, there is enough phase shift to produce the falling of the earthed emitter gain.

The simple expression for α as a function of frequency is rather misleading: it suggests that the cause of the dropping response at high frequencies may be a capacitance somewhere in the circuit. Examination puts this capacitance across r_c, and we hope blithely that it is just a problem in circuitry to get the same gain-bandwidth product, at any convenient centre frequency. As you already know, life contains one order of complication higher than you expected. The falling of α at high frequencies is a transit time effect, as we indicated when describing the junction tetrodes, and there is in consequence a real time delay, not just a phase shift. (I agree that two are interrelated, but I am sure that the meaning of this phrase will be clear). The equivalent circuit of a transistor turns out to be of the approximate form shown in Fig. 4 ; the delay line is the stumbling stone. It is not possible to shift the frequency band sideways by a simple tuning operation, any more than the corresponding transit time effects in a valve can be avoided by purely circuit means. The junction tetrode, and the production of welded-junction triodes with very thin centre layers, are the only immediate solutions to the problem of good frequency response in the junction transistor.

To conclude the series we may look again on the history of the transistor. It is now just about five years since we first heard of it, and only half that time since the junction transistor appeared. Already there are some serious large-scale applications. A new system for setting up telephone calls has been introduced making use of punched cards, photo-transistors, transistor amplifiers, and cold-cathode valves. It would be possible, though not economic, to make this elaborate machine work with conventional valves and an enormous amount of cooling plant to deal with the heat dissipated. Looking back on the history of the valve we see a very much slower time scale, and yet, in less than 50 years, the world production of valves is probably nearing a thousand million a year. In the last 15 years, valves have been moving out of the ordinary wireless and long-distance telephone field into other, more complex, applications. Electronic computers, in the broadest sense, operate on information : they do not just transmit it. From the relatively simple gunnery predictors to the most advanced calculating devices, from photocell door-openers to complex servo-mechanisms, valves are doing the " thinking " for machines. Here, because of the complexity of the systems, the transistor has an immediate application, to which its price is no barrier. Because the signal to be handled at any stage usually originates with another transistor, the relatively low rating is unimportant. Working with microwatts, the saving of the heater power, at least one watt per stage, makes the transistor enormously superior to the valve.

The bread-and-butter of the valve industry is still, however, the home receiver. Receiving valves have been made smaller and better, but their life is relatively short, and even to amplify a few microvolts you will normally need to draw watts from the supply mains. Power means space for cooling: short life means a valveholder for easy replacement. The overall cost of a valve is higher than you think. It looks like 10s, perhaps, but if it lasts 5,000 hours it will have used at least 10 kWH of power, and at 5d. a unit, which is what I pay, that means an additional 4s. Your transistors should last 50,000 hours, or ten times as long as the valve, and use very little power. Even at £7 each, therefore, transistors are competitive.

The detailed cost analysis is more complicated, because with a transistor receiver, broadcast or television, the actual works will be much smaller. Remove the cathode-ray tube and loudspeaker and the remainder of the set becomes a really simple package which imposes few demands on the cabinet designer. As a rash prediction, we can expect to see a really attractive piece of radio furniture, one day.

Looking further into the future of the transistor in the home, the use of time division multiplex seems more likely. Present systems of transmission rely on the approximate linearity of the ordinary valve, and cross-modulation and distortion are the price of the approximation. The transistor provides an extremely simple switching circuit, immediately applicable to the push-button receiver in the v.h.f. band. Frequency modulation may be only a digression, the last flourish of a decaying technique.

Weathering of Polythene

Advantages of Adding Carbon Black

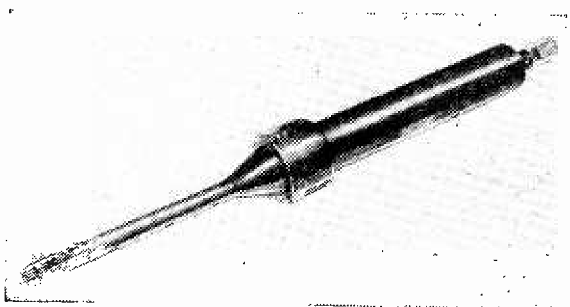
IT is generally known that finely divided carbon black has almost magical properties in increasing the toughness and abrasion resistance of rubber; it is in fact at the very foundation of the pneumatic tyre industry.

One would hesitate to add a substance of potentially high electrical conductivity to a dielectric of such low power factor as polythene in the hope of improving its performance as an insulator, but that in fact is what has been done with success in the rather special conditions of exposure to extreme tropical conditions in the jungle, on the beach and in the desert.

It has been established that under these conditions, and particularly of intense ultra-violet radiation, the power factor (at 10 Mc/s) of polythene without carbon black can deteriorate in 12 months from 0.00022 to 0.0056. The addition of 0.1 per cent of carbon black, widely dispersed, of course, throughout the material, increases the initial power factor to 0.00028, but inhibits the increase after 12 months' exposure to about 0.0022. The deterioration under the worst conditions is thus only one-third of what may be expected without the use of carbon black.

Nevertheless, the deterioration in power factor after six months, even with the addition of carbon black, is regarded as prohibitive under semi-desert and surf-beach conditions and if protection from sunlight cannot be provided, a limited service life must be accepted.

Detailed descriptions of the test sites in Nigeria and figures for the changes in physical as well as electrical properties obtained over a period of 12 months are contained in Ministry of Supply "Reports on Plastics in the Tropics. 2.—Polythene," obtainable from Her Majesty's Stationery Office, price 2s net.



This new electrostatic storage tube made by E.M.I. (type VCRX350) has a storage time of 5-10 minutes and can be used for producing semi-permanent displays of transient images. In one half of the tube a cathode-ray "writing" beam builds up a charge pattern on a central grid corresponding to the incoming signals, while in the other half a "reading" beam scans the stored pattern and converts it back into signals.

2 New MODELS

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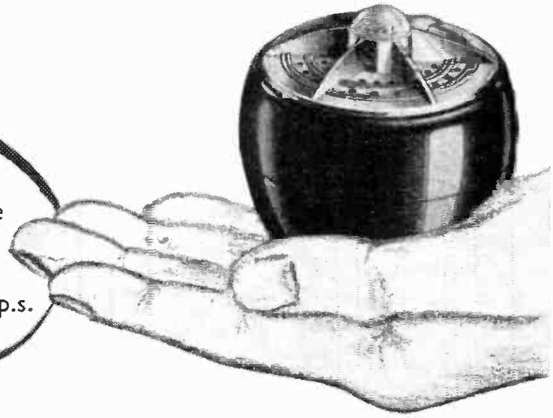

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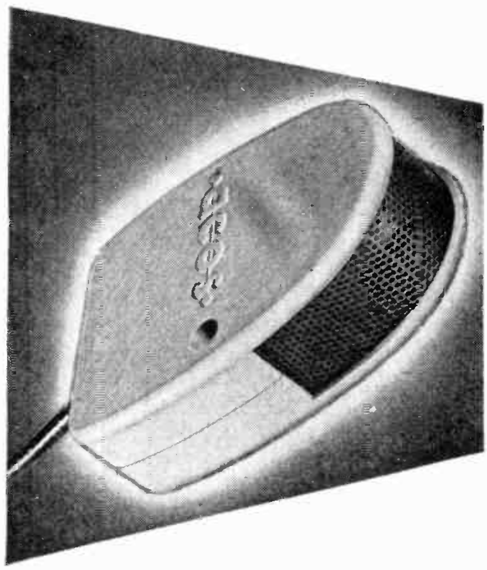

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Some Coaxial Problems

Transformer Effects Between the "Inner" and the "Outer"

By "CATHODE RAY"

AS I believe I mentioned before, anyone can become a "radio engineer," or consultant, or serviceman, at least in the sphere of receivers for sound broadcasting, on a course consisting of one lesson, duration 10 seconds. I give the entire course absolutely free of charge. It is the method I myself have used for many years with consistent success. Even my non-technical wife can confidently deputise, without having to refer the details of each problem to me. All you have to do, on receiving a complaint of bad reception, without even waiting to hear the nature of the trouble (though it generally makes a better impression if you do listen to that first) is to say "Use a decent aerial." Possibly 10 per cent of all cases of bad reception have nothing to do with aerials, but any consultant ought to be able to get by with that margin of error.

When I was at college we had a lecturer in electrical engineering who similarly believed in one master-key to fit (nearly) every problem. No matter what we were working on, when he moved around the class to rescue those who were completely stuck he almost invariably transfixed the victim with a hypnotic glare and hissed—"Magnetomotive force is point four pi times the current enclosed," at the same time suiting the action to the words by scribbling violently round and round a large piece of paper and then stabbing it repeatedly with his pencil inside the coil, presumably to suggest lines of force. (This was in the days when c.g.s. units were universal; nowadays his successor, who is an exponent of m.k.s. units, is no doubt endlessly repeating the liturgy "Magnetomotive force is numerically equal to the current enclosed.") There must have been many students who, floundering in the troublous ocean of a final exam, clutched gratefully at this ineffaceable classroom memory and were saved. More years later than I care to think, even, it comes in useful when thinking up these meditations. As recently as last month, skin effect—often regarded as one of the obscurer phenomena of radio—turned out to be a fairly obvious consequence of the old magnetomotive force principle.

In the meanwhile, by a remarkable coincidence, a reader has submitted a problem that fits on to that story as if it were made to measure. The problem is as shown in Fig. 1, where (to use my correspondent's description) a short piece of coaxial cable is used as a 1:1 transformer. When an e.m.f. is maintained between the ends of the inner conductor, as at (a), an equal e.m.f. will appear between the ends of the outer conductor or sheath. (If you don't understand this, don't give up; just take it as a fact until the principle of the thing is explained in a very few moments.) Next, the generator and infinite-impedance voltmeter are transposed as at (b). Granting that the piece of cable *is* a 1:1 transformer, we are invited to explain how, since the current flowing through the sheath produces no magnetic flux where the inner conductor is, an e.m.f. is nevertheless induced in it. What flux is cutting the "secondary" to induce such an e.m.f.?

My first reaction, on being confronted with this as a suggestion for these pages, was to wonder how many readers would get past the very first statement, that the "short length of coaxial cable" is a 1:1 transformer. Unless the teaching of electrical principles has recently undergone a profound change—and comparing present-day elementary books with those of years ago gives little ground for thinking that it has—I suppose most people still learn about inductance and induction as something to do with coils, in which case any problem which begins by taking for granted that a short piece of coaxial cable is a 1:1 transformer may tend to be dismissed as something too recondite for elementary students. Yet transformers and other devices which at low frequencies are made up of coils will in future increasingly be made up of rods and tubes, especially when the higher-frequency television bands are opened up; so it seemed to me that there was a case for dealing with that aspect in general, before considering the finer points of any trick problems arising. And as it happens, by the aforementioned coincidence, all the spade work has already been done. Anybody who followed last month's explanation of skin effect—and that was basically simple, in spite of the number of words I wove around it—should find this coaxial transformer a piece of cake.

I suppose a transformer could be defined as a device making use of the principle that an e.m.f. can be magnetically induced in one circuit by varying the current in another. The necessary condition is that at least some of the magnetic flux caused by the current in one circuit is linked with the other circuit. To be 100 per cent coupled, *all* the flux would have to be linked with both circuits.

Just in case anyone is not *quite* sure what "linked" means in this connection, the term signifies the same relationship as exists between links in a chain. If a

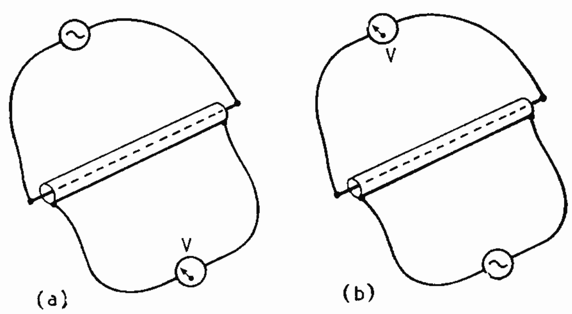


Fig. 1. In (a) the inner wire of a piece of coaxial cable is connected to a v.h.f. generator, and the outer sheath to an infinite-impedance voltmeter; in (b) the generator and voltmeter have changed places. The leads are supposed to be far enough away from the cable for their influence to be negligible.

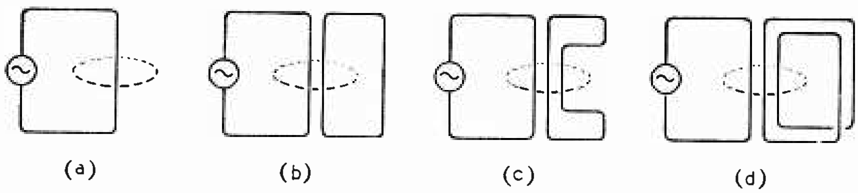


Fig. 2. Showing the meaning of flux linkages. At (a) the flux linkage causes self-inductance in the generator circuit; at (b) there is mutual inductance with a secondary circuit; at (c) there is no linkage with the secondary circuit: and at (d) there are two linkages.

generator is connected up to a closed circuit, as in Fig. 2(a), a current flows, and the current sets up magnetic flux which is linked with the circuit—or rather with the current, for as we saw last June a magnetic field of flux links a current even when it flows through space as a capacitive displacement, without any conducting circuit. However, there is no need to worry about that, for this month all our currents will flow through visible circuits. In Fig. 2(a) the flux is shown as one dotted loop, like a link on a chain, whereas of course it fills the space around the circuit. But (disregarding the flux inside the metal of the wire itself—see last month) it is all linked with all the current. If now any other circuit is linked with this flux, as in Fig. 2(b), the system is potentially a transformer. For it to be so at least some of the flux must pass around both circuits—and not in the sense shown at (c), where the secondary circuit is not linked with that particular flux loop at all; it could be pulled out without cutting the flux. On the other hand, in (d) it is linked twice, giving a voltage step-up as compared with (b). Too elementary? Yes, I thought so; let us move on.

Now this is where our pass-key comes in. So as not to raise any questions about units, let us put it in these words: magnetomotive force is proportional to the current linked. If the same current is linked n times, it counts n times, so the "current linked" (and therefore the m.m.f.) can be reckoned in ampere-turns. For low-frequency purposes, and even for fairly high frequencies, it is nearly always necessary to use quite a number of turns to gain the desired result, hence one becomes accustomed from the start to think of all this in connection with coils and to disregard as a mere stray effect any magnetic field set up by single wires. It is the purpose of the present argument to try to correct this.

Simple Equation

The great merit of the magnetomotive force equation is that it is so simple. It is one of the very few things to do with magnetism that are simple. For directly we start to find out what the field strength and flux density are, we are faced with the problem of reluctance. It is rather like Ohm's law would be if the resistance of a circuit were a very difficult thing to calculate or measure. We were only able to go as far as we did last month with skin effect because the only kind of circuit we went into in detail was the completely unpractical one of an infinitely long, straight cylindrical wire with no return. In that special case it is known that the flux paths are coaxial circles around the wire, and so their lengths are known; dividing the m.m.f. by the length gives the strength of the field (H) around that path; and multiplying H by the permeability of the stuff the path is in gives the flux density (B); and multiplying the average B through any cross-section by the area of that cross-section gives the total flux (Φ) through it. The trouble with most practical circuits is that the flux paths—and

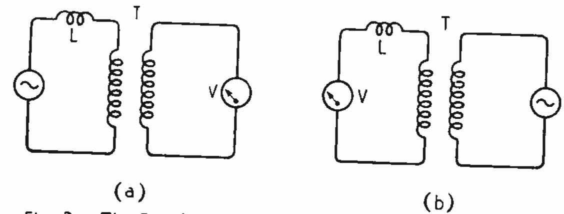


Fig. 3. The Fig. 1 situation shown in conventional symbols.

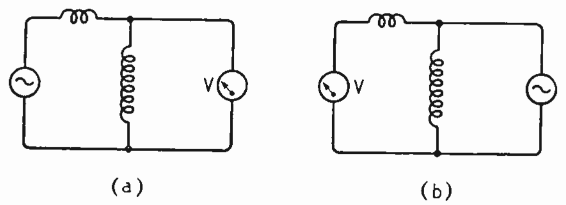


Fig. 4. As T in Fig. 3 is a 1 : 1 transformer with 100% coupling it can be replaced by a single coil.

hence their lengths—are difficult to determine; and if more than one permeability is involved that complicates matters still further.

In Fig. 1 these difficulties do not arise. The only part of the circuit (a) we are considering is a straight wire, and the sheath is presumably copper or some other material whose permeability does not differ appreciably from that of air. So the flux, which makes rings round the wire, is not significantly affected by the presence of the sheath, for there is supposed to be no current in it (the voltmeter being assumed to have an infinite impedance). The m.m.f. everywhere around the wire is the same—proportional to the current flowing, multiplied by one (turn). The field strength and flux are greatest where closest to the wire—because there the path is shortest—and fall off in inverse proportion to the distance from the wire. So the most intense field is inside the sheath and does not link with it at all. But all flux outside the inner surface of the sheath (except what passes outside the voltmeter circuit altogether, and that is supposed to be too far away to matter) links the voltmeter circuit, so produces an e.m.f. whenever the primary current is varying. But because some of the flux does not link the secondary circuit, the secondary voltage, even on open circuit, must be less than the primary voltage.

We have already begun to use familiar transformer terms. Continuing in the same vein, we would say that although this transformer has a nominal 1 : 1 ratio there is a good deal of leakage inductance, corresponding to the flux inside the sheath. It can be reduced by reducing the space between wire and sheath, but can only be eliminated altogether by reducing the space to zero, making wire and sheath one. The separately "wound" transformer then becomes a 1 : 1 autotransformer, and primary current can pass straight through to the secondary circuit—all except the "magnetizing current" that is needed to maintain the voltage across the erstwhile cable.

Now look at Fig. 1(b). All the flux due to current in the primary (the sheath) inevitably links with the secondary, too. (In case experts at wire puzzles are tempted to claim that they could remove a ring linking the sheath without cutting the voltmeter circuit, let me recall at once that the voltmeter leads are assumed to be "infinitely" far away, and solutions that depend on bringing them close in and folding them back along the sheath will not be entertained.) Therefore, far from there being any doubt about whether this arrangement can work as a transformer, it is the only genuine 100 per cent transformer I can think of, and much better than Fig. 1(a).

For the sake of anyone who likes to see it in the familiar circuit symbols, Fig. 3 is specially provided.

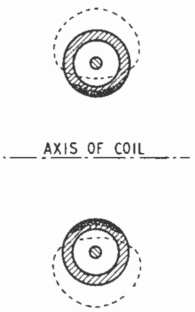


Fig. 5. If the coaxial cable is wound into a coil, "proximity effect" causes the sheath current to crowd to the inner parts, as shown shaded darkly, for these parts escape some of the flux linkages and so have less inductance.

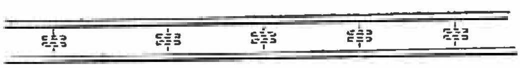


Fig. 6. The capacitance between fully-coupled parallel conductors has no effect at the frequency of the current flowing therein, because both have identical voltages.

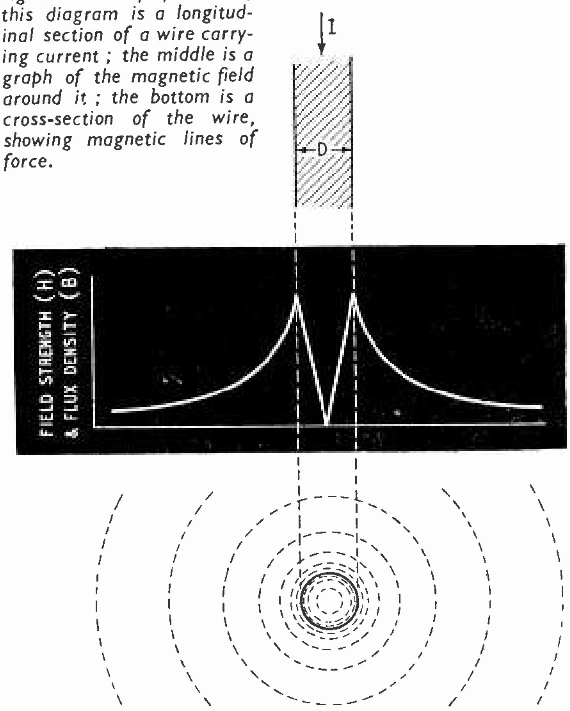


Fig. 7. T:e top portion of this diagram is a longitudinal section of a wire carrying current; the middle is a graph of the magnetic field around it; the bottom is a cross-section of the wire, showing magnetic lines of force.

Here, L stands for the inductance corresponding to flux *inside* the sheath when the wire is carrying current.

In case you have a momentary uncomfortable feeling that a 1:1 transformer ought to give the same voltage either way round, it may be worth pointing out that whereas in Fig. 3(a) the coil L takes some of the generator voltage, because every transformer requires some magnetizing current, even when the secondary is open-circuited, in Fig. 3(b) it takes no voltage, because the voltmeter is assumed to take no current. This is perhaps easier to see when we replace—as we may—the perfect 1:1 transformer T by its equivalent, a single coil, as in Fig. 4.

But to get back to the original problem, Fig. 1; why was it a problem at all? Simply because so many of us were taught electromagnetic induction in terms of "flux-cutting." As I said in the June issue, it is much better to think of variation of flux linkages. When one does—as we have with this problem—there is no problem.

You may remember that I said Fig. 1 (b) was a transformer with 100% coupling. Except at very high frequencies—or with an absurdly large length of cable—its impedance is too low to be practical, so supposing one has a requirement for a coil-wound air-core transformer with as nearly 100% coupling as possible, one might think it could be done to perfection by winding it with coaxial line, using the outer as the primary and the inner as the secondary. Well, certainly the coupling would be very close—probably as close as one could reasonably get it—but it would not be quite 100%. The reason is that the statement that the flux set up by the outer conductor completely encircles that conductor—and therefore the inner as well—only holds good for a straight run, with no other conductors anywhere near. Directly one starts winding the line into a coil this condition is broken and one has to take account of the m.m.f. of adjacent turns. When we did so, last month, we found that the current no longer flowed uniformly all round the circumference but crowded to one side; this being called *proximity effect*. The general principle is that the current tends to flow where it makes the inductance least. So in a coil it flows on the *inside* (because that makes the effective diameter of the turns least), as in Fig. 5. Obviously some of the flux encircling this will fail to link with the wire; our coil is, in effect, wound with parallel-wire line, and the coupling is slightly less than 100%.

Capacitance between Windings

One thing that may tend to worry anyone requiring a very tight-coupled transformer is the thought of the large capacitance between the windings. To obtain the desired closeness of coupling, the windings must be very close together, whether side-by-side or one inside the other. The capacitance between a short length of the twin winding can be shown conventionally as in Fig. 6. But one result of the close coupling is that practically all the flux that links one wire links the other, so the voltages induced are the same in both. Now if the potentials of two points are the same, it doesn't matter how much capacitance there is between them—there can be no capacitive current. The same is true if there is a constant difference of potential (and the purpose of a double-wound 1:1 transformer is usually to enable two circuits to have a constant p.d. between them). It is only when there has to be a signal voltage between the two windings that the capacitance may be a difficulty.

Magnetic Field Distribution

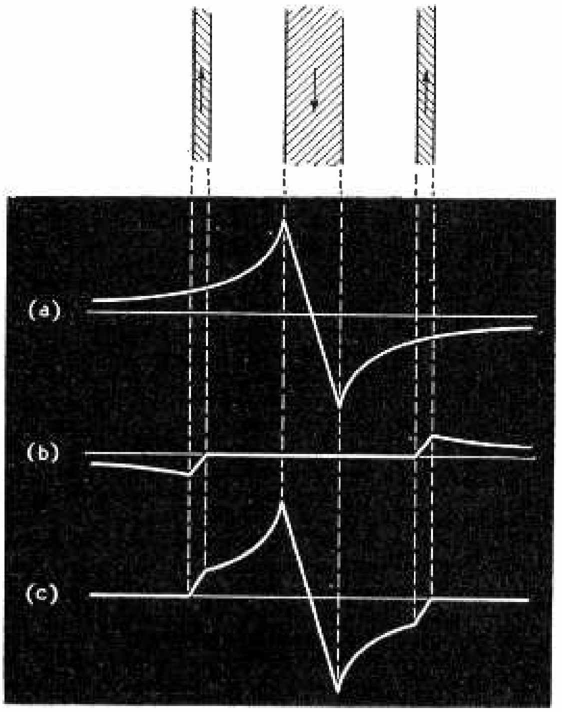
Our study of skin effect last month was based mainly on calculating the field strength around and inside a wire and plotting it as a graph such as the middle part of Fig. 7. The top part is a longitudinal section of the wire, shown on a large scale for clearness, its diameter being D. We know that the magnetomotive force anywhere around the outside of the wire is the same, because the same current is enclosed. The field strength is equal to this divided by the length of the "lines of force," so is greatest where the length is least, i.e., at the surface of the wire, and falls off in proportion to the distance from the wire, as shown by the graph. Inside the wire, decreasing length of field path is more than offset by decreasing m.m.f., the current enclosed being less and less till right at the centre it is zero. Hence the V-shaped portion of the graph. The same graph does for flux density, for B is H multiplied by the constant μ. The total flux is represented by the area between the curve and the zero line. Note that although the flux density at the centre of the wire is zero, current flowing there has *all* the flux outside it; that is to say, linked with it.

Another way of showing the same thing is in cross-section, as in the lowest part of Fig. 7, where, of course, the wire appears as a circle. The relative field strength and flux density is indicated—rather crudely—by the relative density of the dotted rings, the imaginary lines of force. According to the "corkscrew" rule, a clockwise direction of the lines of force would indicate that the direction of current was into the paper. In the upper parts of the diagram the lines of force would have to be represented in cross-section, as points, aimed away from one on the left of the wire axis and towards one on the right. The graph as shown takes no account of direction, both halves of it being "above the line," so conventionally positive. But when finding the total effect of more than one current, it is essential to distinguish the directions of the flux.

I admit that last month, dealing rather briefly with skin effect in a coaxial line, I drew its diagram without going through the process of combining the separate diagrams of the inner and outer conductors. That was because it was such an easy case. But anyone who did not find it obvious is recommended to trace the process through Fig. 8, where (a) is the diagram for the current in the central wire, (b) for the equal return current in the sheath, and (c) is obtained by adding the two together. Except for the distinction between positive and negative it is the same as last month's Fig. 7. The important feature, of course, is that there is no field anywhere outside the cable, so no inductive pick-up from the currents flowing therein. Remembering, too, that the sheath (if earthed, as it usually is) forms an electric screen around the inner wire, one might imagine that this wire was completely protected from external coupling.

But it is not. Fig. 9 shows an aerial, with its down-lead screened by earthing the outer conductor of the coaxial cable of which it is composed. The idea is to

Fig. 8. This diagram shows the distribution of field around a coaxial cable carrying equal go-and-return currents: (a) field due to current down inner wire alone; (b) due to current in outer sheath; and (c) both together. Unlike Fig. 7, it shows sign of field (+ and −) as well as magnitude.



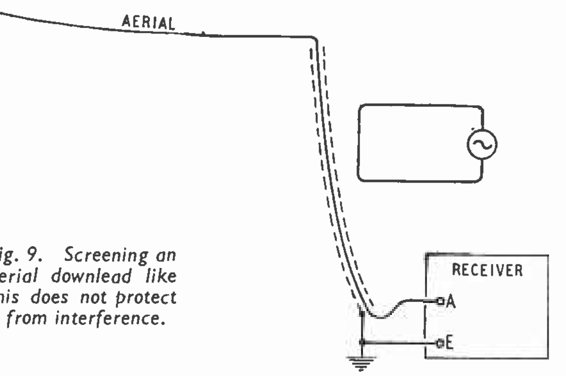


Fig. 9. Screening an aerial downlead like this does not protect it from interference.

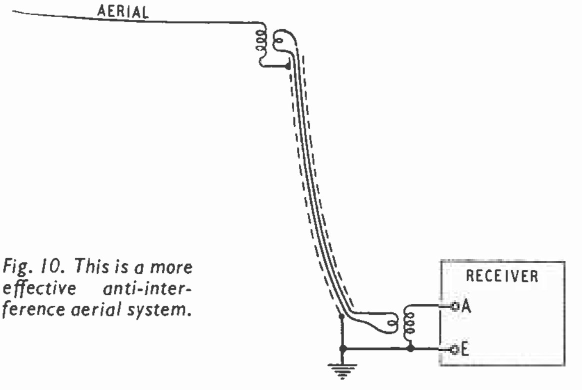


Fig. 10. This is a more effective anti-interference aerial system.

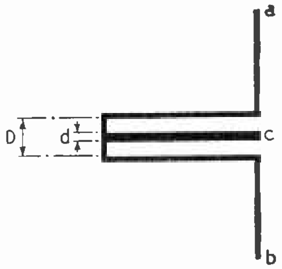


Fig. 11. Section of a coaxial inductor.

screen it from interference, represented by the generator driving current through adjacent wiring. But in so far as this wiring is parallel to the aerial, there is nothing to stop its magnetic flux from linking with the aerial wire and inducing interference in it. The "screening" does not even give complete immunity from electric fields, for if they affect the upper part of the cable they cause currents to flow to earth through its sheath, and their flux links 100% with the aerial wire.

A way out of this disappointing situation is to rearrange things as in Fig. 10. Here the cable is a screened parallel-wire type, connected so that any interference coupling with one wire affects the other practically equally, so does not drive current through the coupling coils. Since any cable of this kind has a comparatively low impedance, the impedance-matching transformers are necessary for satisfactory efficiency.

Reverting to coaxial cable and Fig. 8, the complete absence of external field is strictly on condition that the go and return currents are equal. If there is any surplus in either direction along the cable, it produces an external field.

A useful application of coaxial line is for providing an accurately calculable amount of inductance without external coupling. For this, one end is completely stopped up by a short-circuiting disk, and the terminals are the other ends of inner and outer. Supposing *ab* in Fig. 11 is the screening panel of some apparatus, a convenient form of known inductance between it and *c* is as shown. The go and return currents being equal, there is no external field, and the inductance can be calculated from basic principles. (Actually it is very nearly $0.0046 \log_{10}(D/d)$ microhenries per centimetre length.) There is, of course, the complication of parallel capacitance, if the length of the line is appreciable compared with quarter of a wavelength of the signal used. But this, too, is quite easily calculated and allowed for. When the line is a quarter-wavelength long, the capacitance is enough to tune the inductance to resonance, and one obtains a highly efficient resonator or "rejector circuit." By a happy coincidence, any variation of inductance caused by varying the dimensions *D* and *d* is exactly compensated by the change of capacitance, so all that affects the tuning is length.

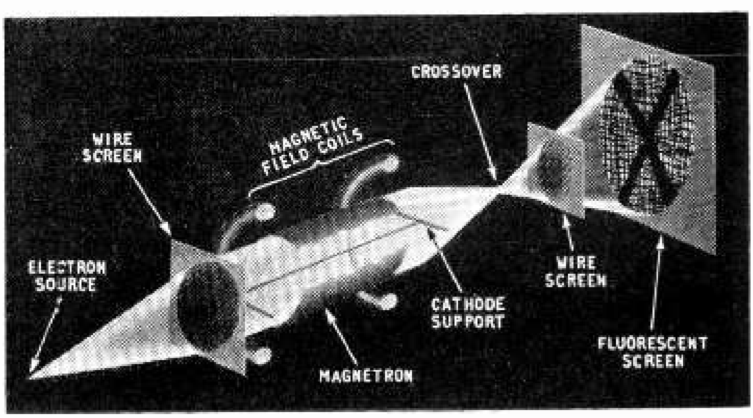
Mapping Magnetron Fields

By MICHAEL LORANT

New Method for Studying Electric-Field and Space-Charge Configurations

AN accurate and sensitive technique for experimentally determining the electric-field distribution and space-charge density within a magnetron has recently been developed by D. L. Reverdin at the U.S. National Bureau of Standards. The new method, which is also well suited to investigations of electron-optical lenses, gas discharge, and other space-charge problems, is a modification of an electron-optical shadow technique recently developed at the Bureau for the quantitative study of minute electric and magnetic fields. A magnetic lens is used to produce shadow images of two fine wire screens placed at either end of the magnetron in the path of an electron beam. Then, from the distortion in the shadow network caused by deflection of the electrons as they pass through the magnetron field, the radial electric field is computed. These results are used to obtain the space-charge distribution.

The high space-charge density within a magnetron is known to have an important bearing on performance. However, very little is actually known about the electric-field distribution and space-charge configuration within the valve. Although the problem has been investigated theoretically by many workers, the formidable mathematics involved have not permitted an exact solution, and the various simplifications of the theory that have been suggested have led to widely divergent results. Attempts at direct measurement have also proved unsuccessful because



the very critical symmetry of the field under study was disturbed.

The Bureau's new method uses an electron beam as a probe but keeps the charge density of the beam small compared with the space charge in the magnetron. Thus, the field under study is undisturbed. An electron gun sends the beam axially through the valve. Coaxial coils surrounding it provide a homogeneous magnetic field for the operation of the magnetron and at the same time act upon the beam as a convergent magnetic lens, bringing it to a focus beyond the valve. Two fine wire screens are placed in the path of the electrons, one just in front of the magnetron, the other just beyond the back focus of the beam. A complex shadow pattern of the two wire screens is then formed on a fluorescent screen. When the d.c. potential across the magnetron is zero, the pattern is undistorted. When an electric field is applied to the magnetron, however, the shadow network on the fluorescent screen becomes quite distorted, and theoretical analysis of this effect has related the distortion of a given part of the pattern to the intensity of the electric and space-charge fields in the corresponding region of the magnetron.

The actual apparatus takes the form of a cathode ray tube with a very long neck, inside which the magnetron and wire screens are mounted. The electron beam comes from the cathode of the tube in the usual way, while the magnetic-field coils are mounted externally on a wooden former. Photographs are taken of the shadow network formed on the screen of the tube, both in the undistorted and distorted form. The changes in the paths of the electrons as they pass through the magnetron are then determined from measurements of the shadow patterns and the geometrical constants of the system, such as the positions of the wire screens, the magnetron, and the electron source and the number of meshes per unit length of the wire screens. From the deflection of an electron entering the magnetron at a given radial distance from the centre the strength of the electric field in the corresponding region of the magnetron is computed.

The Bureau's study of the field within a steady-state magnetron indicates that the actual space-charge distribution differs considerably from that predicted by the theorists. A number of different shapes of space-charge configuration were observed which are closely related to the symmetry of the magnetron. A certain lack of sharpness noted in the patterns gave a visual indication of the noise in the valve. This suggests further extension of the method to learn more about the problem of noise in the oscillating magnetron.

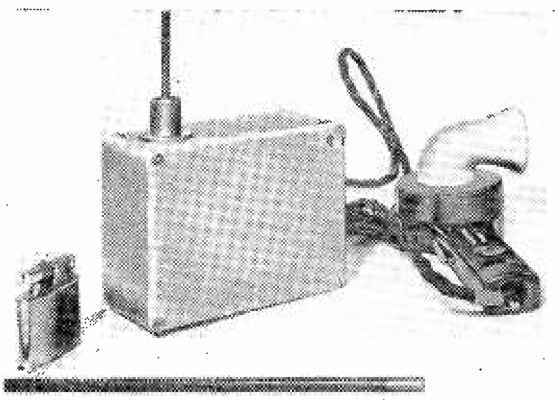
Transistor Radio-Telephone Transmitter

WHILE there is no real difficulty in making a transistor oscillate at the high radio frequencies there does appear to be a great deal of difficulty in finding the right kind of circuit in which they can be used for both the r.f. oscillator and the modulator.

It is claimed that these obstacles have been successfully overcome in a small experimental radio-telephone transmitter evolved by Douglas Walters and which is being operated as a portable station under the call G5CV/P.

As at present designed the transmitter consists of a G.E.C. germanium triode, Type GET1, functioning as a quartz crystal controlled r.f. oscillator on 3,608 kc/s (83 metres approx.) with a similar germanium triode for the modulator. With the few capacitors and resistors needed and a small 22½-volt dry battery the whole is housed in a metal box measuring 6 in × 4 in × 2 in. By substituting a really miniature hearing-aid battery it is claimed that it could be reduced to about one-third this size.

When used as a "personal" transmitter it employs a two-section copper rod aerial about 4 ft long, and under these conditions, which are most unfavourable for this frequency, a confirmed range of about one mile has been obtained so far, but from indirect reports it is suspected that the actual range is much greater, as with a non-resonant long-wire aerial at a fixed station, several miles have been covered. It is for this reason that reports of reception of the portable station would be welcomed by Mr. Walters, at "Greenfield," The Drive, Godalming, Surrey.



The crystal controlled radio-telephone transmitter described in the text. The cigarette lighter gives some idea of the size. Part of one section of the collapsible aerial is included.

CLUB NEWS

Cleckheaton.—At the meeting of the Spen Valley and District Radio and Television Society on December 16th, J. E. Church (G2BMC) will describe a "Poor Man's BC221 (communications receiver)." The club meets on alternate Wednesdays at 7.30 in the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds.

Derby.—December's meetings of the Derby and District Amateur Radio Society include a demonstrated talk on valve characteristics by C. M. Swift on the 2nd. The club meets on Wednesdays at the School of Arts and Crafts, Green Lane, Derby. Sec.: F. C. Ward (G2CVV), 5, Uplands Avenue, Littleover, Derby.

Wellingborough.—A member of the Post Office Engineering Department, Northampton (A. C. Homer), will address the Wellingborough and District Radio and Television Society on December 18th on "Some Problems Affecting Reception of Radio and Television in this Area." Meetings are held each Thursday at 7.30 at the Co-operative Society, Silver Street, Wellingborough. Throughout the session lectures are being given on television theory and practice. Sec.: N. M. Seabrooke, 85, The Drive, Wellingborough.

Seventh Amateur Radio Show

Preview of Commercial Equipment at this Year's Exhibition

THE amateur radio exhibition opening at the Royal Hotel, Woburn Place, London, on Wednesday next, November 25th, is the seventh of its kind held by the Radio Society of Great Britain.

While its primary purpose is to foster interest in amateur radio and provide an opportunity for exchange of ideas and a general get-together in a congenial atmosphere it also provides an opportunity for firms manufacturing parts and equipment especially suited to the occasion to exhibit their latest products.

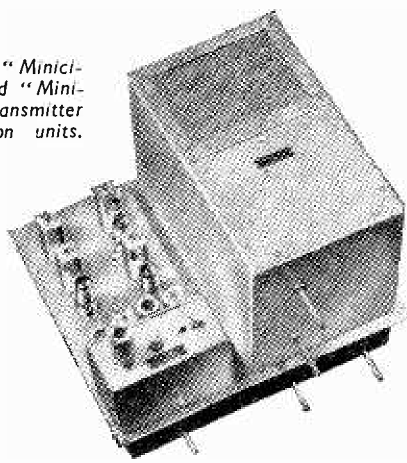
A new development is a limited range of small units described as transmitter foundation units which are intended to provide the basis for a home-built band-switched transmitter covering the 3.5- to 28-Mc/s bands. They can be used in conjunction with most existing modulators and power units if required. The two main items consist of a VFO unit (Miniciter) embodying a buffer amplifier and frequency multipliers and a power amplifier unit (Minipa) with a pair of parallel-connected tetrodes and a band-switched aerial coupling circuit for matching to a wide range of aerials. These will be shown by David Godwin.

The once much-favoured open rack for transmitters and other apparatus is now largely replaced by closed cabinets in most amateur stations. Examples of modern metal cabinet-work of this kind will be shown by Philpotts Metalworks. Brighter colours are finding favour in modern station design and some good examples will be shown together with a new style described as "hammer finish." Supply of cabinets to users' requirements, generally at no greater cost than for stock sizes, is a speciality of this firm.

Tailor-made chassis will be found also on Denco's stand and here visitors interested in components for radio and television sets will find much to hold their attention. Some new Denco products include f.m. discriminator units and an inexpensive modulated test oscillator. Two complete transmitters will be shown this year by Panda Radio: one is the 1954 version of their PR120V 150-watt table-top transmitter which includes a number of refinements, the other is a moderately priced 25-watt model appropriately called the Panda "Cub." It is band-switched for operation on 1.7 to 28 Mc/s with automatic reduction of power on the top band.

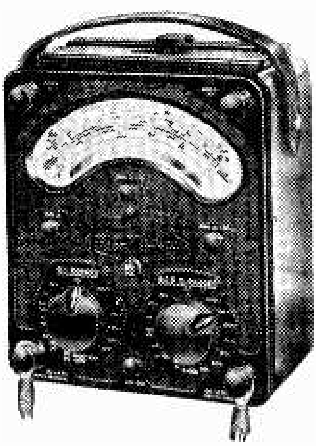
Quartz crystals for fundamental and overtone operation and in a variety of plug-in mounts will be the main feature of the Salford Electrical exhibit. Among other items G.E.C. will have two new ribbon microphone heads, one (costing £10) being particularly suitable for the amateur transmitting station. It is a high-quality microphone, with long-range pick-up characteristics and a very even response over 200 to 1,400 c/s. The impedance is 600 ohms. Other interesting G.E.C. products will be a range of new "Q" valves for industrial purposes where ruggedness is essential such as for mobile equipment of all kinds, metal cone loudspeakers and some audio amplifiers.

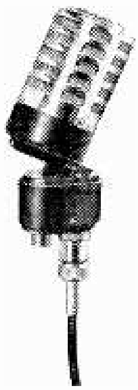
In addition to the existing range of piezo-electric products Cosmocord will have a range of reasonably priced microphones recently introduced for high-

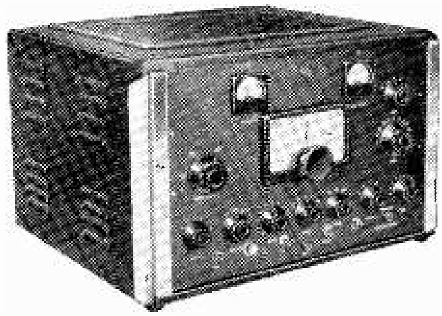


Godwin "Miniciter" and "Minipa" transmitter foundation units.

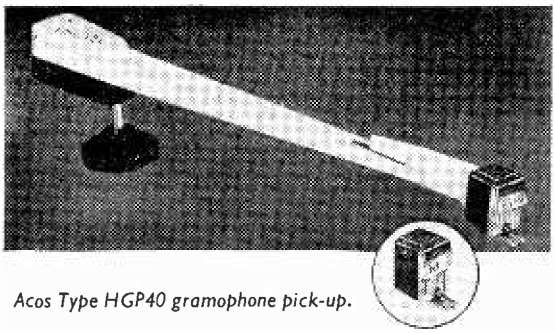
Avo model 8 wide range test meter and (right) G.E.C. Type BS2374/77 ribbon microphone head.







Panda 1954 model of the PR120V transmitter.



Acos Type HGP40 gramophone pick-up.

quality recording; these are equally suitable for transmitting purposes.

One of the latest Acos developments is the HGP40 high-fidelity pickup designed to track easily on standard and long-playing records. It has a compensated tone arm bringing the tracking weight to 8 grammes only.

Visitors interested in tape recording will find something of more than passing interest on the Grundig stand. Apart from the recorders themselves this firm have a "Stethoscope" head-set for private listening to recording and a mixer unit enabling up to four different inputs to be mixed, faded in or out and controlled quite independently.

Measuring apparatus is all-important in the amateur station so the comprehensive display of equipment by Avo and by Taylor should not be missed.

Aerials will be the feature of the Telecraft exhibit where in addition to some television models there will be various industrial v.h.f. aerials and arrays.

Next month we hope to review the amateur and non-commercial exhibits in the show.

FIRMS SHOWING

Automatic Coil Winder and Electrical Equipment Co., Ltd., Douglas Street, London, S.W.1.
Cosmocord, Ltd., Great Cambridge Road, Enfield, Middlesex.
David Godwin, 37, Dollis Hill Avenue, London, N.W.2.
Denco (Clacton), Ltd., 357-9, Old Road, Clacton-on-Sea, Essex.
General Electric Co., Ltd., Kingsway, London, W.C.2.
Grundig (Gt. Britain), Ltd., Kidbrook Pk. Rd., London, S.E.3.
Panda Radio Co., 58, School Lane, Rochdale, Lancs.
Philpotts Metalworks, Ltd., Chapman Street, Loughborough.
Salford Electrical Instruments, Ltd., Silk Street, Salford, 3.
Siemens Electric Lamps and Supplies, Ltd., 38-39, Upper Thames Street, London, E.C.4.
Taylor Electrical Instruments, Ltd., 419-424, Montrose Avenue, Slough, Bucks.
Telecraft, Ltd., 64, Brigstock Road, Thornton Heath, Surrey.

Precision Two-speed Drive

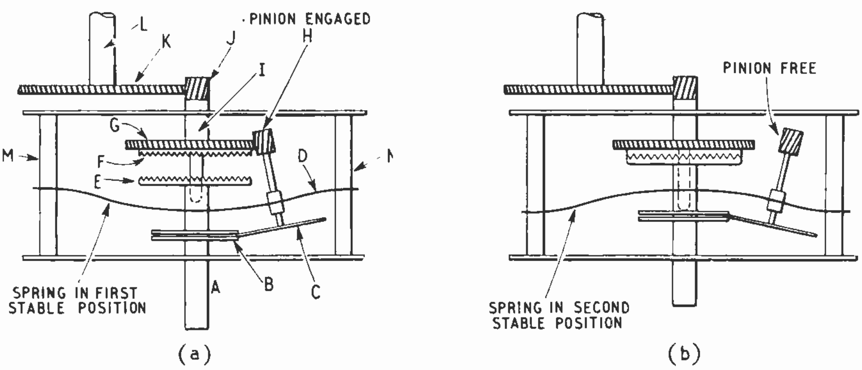
AN ingenious slow-motion tuning control primarily for use in precision equipment has been produced by Transradio Ltd., 138a, Cromwell Road, London, S.W.7, but present production is restricted to manufacturers only.

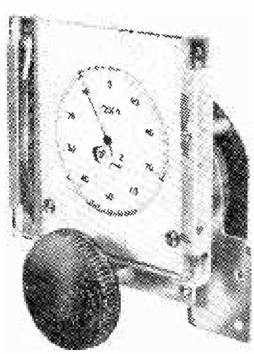
It utilizes a combination of friction drive and spring-tensioned gearing and provides two speeds, one for coarse and the other for fine control. In some models these are 8 and 100 to 1 respectively, while in others they are 15 and 200 to 1. Change from one speed to the other is effected by pulling out or pushing in the control knob spindle.

How this operates the change-over mechanism is best explained by means of the two drawings shown here. In (a), which shows the highest reduction arrangement (knob out), the sequence of drive is from control spindle A via friction discs B and C, thence through gears H, G, J and K, the latter being fixed to the output spindle L.

With the control knob "in" (fast drive), the spring D bows inwards and as it carries the bearing for the lay-shaft, the pinion H disengages from G and at the same time the two crown-wheel type gears E and F lock together and provide a direct drive between spindles A and I. The gears J and K remain operative as before. The drawing (b) shows this change.

There are several models of this Microdual drive as it is called and all utilize the same basic principle. The latest addition is the Type 57/360 giving a 360-deg rotation of the output spindle L for one complete rotation of the coarse tuning scale, whereas 180 deg is normal. This is marked 0-20 with no subdivisions; the larger clock-face dial is engraved 0-100 with half-divisions marked. Its ratios are 15 and 200 to 1 and it is possible on fine control to record accurately 1/4,000th of a revolution of spindle L. Actually the dial can be read to a quarter of a division so that a movement of 1/8,000th of a revolution can be determined. The mechanism of the drive is such that no backlash in the gearing is transmitted to the scales. In point of fact we were unable to detect the slightest backlash in any part of this mechanism.



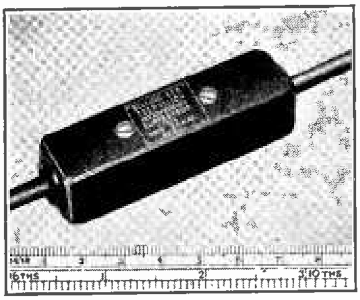


Mechanism of the Transradio Microdual drive, (a) showing gear train for high and (b) for low ratios. (Right) The latest version of the Transradio Microdual drive Type 57/360 giving a full rotation of the output spindle.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

PERTURBATIONS



Our English-French dictionary gives the meaning of this French word as " disturbance." It appears as part of the title C.I.S.P.R. In full, Comité International Special des Perturbations Radioélectriques. This committee has been a guest in this country and has attended sessions of the Institution of Electrical Engineers at Savoy Place.

It is refreshing to be reminded that in working towards the abatement of radio interference, we are in no sense alone, but are a small part of a very large international organisation affecting many industries. We are probably justified in saying that without the efforts of C.I.S.P.R. broadcast, television and navigation communications, etc., could never have reached present standards, nor could any of the airports handle anything like the number of aircraft, in a given time, that they do now.

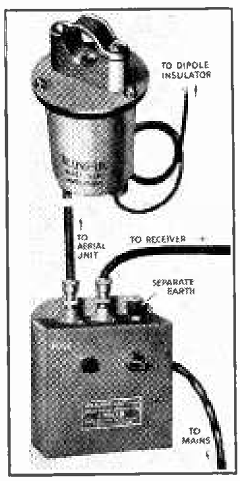
On the last day at Savoy Place, we were privileged to be one of several bodies who staged an exhibition to show delegates what contribution we make towards the art of suppression. The exhibition was to let delegates see what was being done by countries other than their own. The countries supporting this feature with exhibits were Britain, America, Germany and Switzerland.

The most recent addition to our range of suppressors is a very small flex lead suppressor type L1314, illustrated above. This is intended where T.V. suppression only is required, and to be used in a flex lead close-up to the offending component of an appliance. As mentioned in the last edition of WIRELESS WORLD if used in conjunction with a suppressor at the supply point, say type L.1308, all wave suppression can be achieved. You will note we have emphasised the " very small " feature. It is necessary to keep these flex lead suppressors small—they will not be used if large. What is more annoying than a large protuberance dangling from a hairdryer, electrical drill or perhaps worse still, a razor ?

Needless to say, the ideal place for a suppressor is within the casing of the offending piece of apparatus. The suppressor itself is generally a tiny inductor and perhaps a very small capacitor, but it is quite a job to dismantle an appliance and " house " these suppression components. Therefore, they have to be in a bakelite case in the lead, and must have terminals and cord grips, etc., if they are to be serviceable at all and all this adds to the size and price.

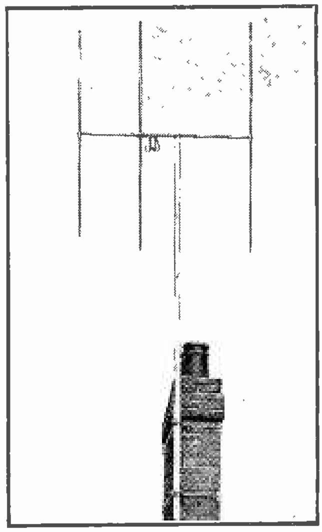
When an appliance is being serviced the necessary little inductor and capacitor units should be fitted inside its housing. In that form they are very small and inexpensive

Concerning the Mast Head Amplifier



We have evidence that some users expect the T.V. Masthead Amplifier to reduce interference. One dealer even underlined the fact that it was known that there was some interference being picked up on the aerial itself and who considered the amplifier unsatisfactory because the interference persisted.

We cannot emphasise too strongly that the amplifier cannot alter the signal-to-noise ratio at the aerial. In cases where there is a long cable run from the aerial and where interference is being picked up on the feeder, there



The " Belling-Lee " mast head pre-amplifier fitted to a " Junior Multirod."

may be some improvement in signal-to-noise ratio, but not otherwise.

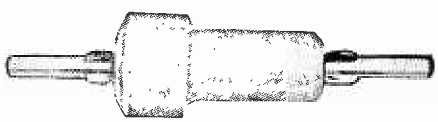
We have investigated a number of cases where indifferent results have been reported. Invariably, the trouble has either been faulty installation, e.g., failure to remove the matching stub in the aerial. The matching stub, illustrated below, is the short $\frac{1}{4}\lambda$ length 50Ω feeder (about $\frac{1}{8}$ dia.) with a plug on one end. The amplifier should be connected directly to the dipole. The other trouble is lack of appreciation of what can be expected of the system. We would like to emphasise that we have made no extravagant claims regarding performance.

Written 27th October 1953

POLYTAGS...lead-through and stand-off insulators

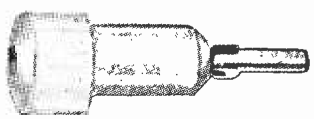
Polytetrafluoroethylene (P.T.F.E.) is an outstanding insulator. It is tough, durable and will not crack or arc. Its dielectric properties are substantially constant over a frequency range of 60 c.p.s. to at least 300 Mc.p.s. and are unaffected by temperature changes between minus 100°C. and plus 288°C. It has zero moisture absorption and is water repellent. It is, therefore, a most suitable material for stand-off and feed-through insulator terminals and has been chosen by Ediswan for this purpose. Ediswan Polytags are available in five types as illustrated below.

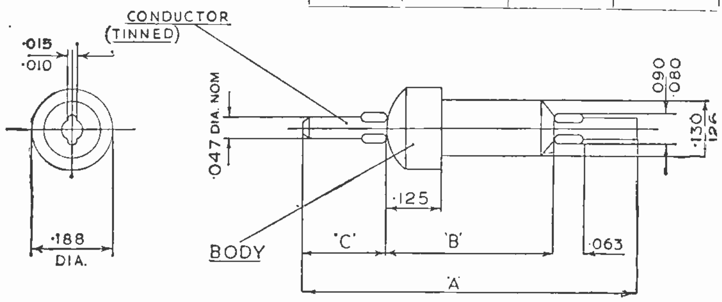
PT 1 & 2. Lead-through



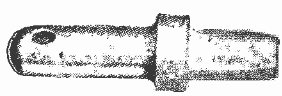
	A	B	C
PT 1	.750	.375	.188
PT 2	.875	.500	.188
PT 3	.563	.375	—
PT 4	.688	.500	—

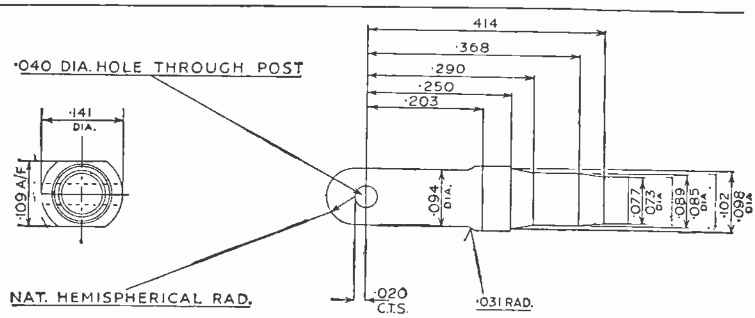
PT 3 & 4. Stand-off





PT 5. Component mounting





Fixing: Polytags are primarily designed for fixing with a 5 B.A. nut—PT 1—4 or an 8 B.A. nut PT 5. They are self-tapping.

We are equipped to produce components fabricated or moulded in P.T.F.E. to individual specifications and enquiries will be welcomed.

EDISWAN

CLIX

THE EDISON SWAN ELECTRIC CO., LTD.,

Sales Department P.T.F.E.6, 21 Bruton Street, London, W.1. *Telephone: Mayfair 5543* ER24

Head Office: 155 Charing Cross Road, London, W.C.2. *Member of the A.E.I. Group of Companies*

"Wow" Measurement

An Oscillographic Method Suitable for Use With Tape Recorders

By D. W. THOMASSON, A.M.Brit.I.R.E.

THE kind of wow that is found in tape recorder apparatus is much more unacceptable to the ear than the kind commonly experienced with disc recording. It has a higher variational frequency, and the waveform of the variation is often much more complex, so that the audible effect of a given error is far more obvious. The effect is so obvious, in fact, that an extremely low degree of wow must be sought if it is intended to record music.

The first essential to such a search is a satisfactory method of measuring wow. Several possible techniques exist, but many are unsuitable because they are quite incapable of detecting the small frequency variations concerned. According to Shower and Biddulph (*J. Acoust. Soc. Amer.*, Vol. 3, p. 275, 1931) the human ear can detect a frequency variation of 0.17 per cent under favourable conditions. This figure applies to a 2,000-c/s tone varied sinusoidally at 2 c/s, the sensation level being 70 db. If the wow meter is to be of any practical value it must be able to detect much smaller variations.

Laboratory Technique.—A technique which has been found of value for laboratory work is based on a "strobe" type of oscilloscope display. A test recording is first made with a suitable signal (e.g. a 1 kc/s sine wave) and the output on replay is observed on an oscilloscope with an accurate frequency standard time base. The trace will waver from side to side as the frequency varies, and the lateral movement gives the deviation of the tape from its proper position in terms of time. The tape speed being known, this can be interpreted in terms of distance along the tape, and the frequency variation can then be calculated.

For very precise work it is necessary to determine both the waveform and frequency of the wow variation, but it is generally sufficient to assume that the waveform is approximately sinusoidal and that the frequency is the rotational frequency of the capstan, as it often is.

If the recording is made at a tape speed S_1 inches per second, with a signal frequency f_1, and the frequency on replay is f_2, then the speed on replay is equal to $S_1 f_2/f_1$. If, further, the capstan is d inches in diameter, the rotational frequency will be $S_1 f_2/\pi d f_1$. The time error can be observed as a fraction K of the cyclic period of the replayed signal, and this will represent a distance of KS_1/f_1 inches along the tape.

This is the peak-to-peak range over which the tape position is varying from the nominal mean, and the variation is assumed to be at the capstan rotational frequency, so the maximum error velocity will be $KS_1^2 f_2/d f_1^2$. This is equal to KS_1/df_1 times the tape velocity on replay.

The percentage error velocity can thus be found without measuring either the tape speed or signal frequency on replay, and is directly proportional to K, so that a calibrated speed error scale can be used.

A Practical Case.—This method has been used to check the wow on many types of tape recorder, but the case of most interest is that which made the greatest demands in respect of accuracy and capability of showing small degrees of wow. The recorder in question was the "Reflectograph," and, as this recorder is fitted with a continuously variable speed control, observation was rather more simple than usual, the control being used to eliminate long term speed variations that must otherwise be checked by using a variable time-base frequency.

At 7½in per second, the value of K was found to be 0.1, and as the capstan diameter is 0.3in the peak speed error is seen to be 0.25 per cent. This is greater than the minimum audible level under favourable conditions, and on this particular machine—which had been in use under domestic conditions for several months—a trace of variation could be heard on a 1 kc/s reproduced note, but there was no sign of wow on normal recordings.

The trace was "clean," showing that higher frequency flutter components were entirely absent.

The reference signal frequency must be chosen to suit the particular recorder in question. If the capstan diameter is small (say of the order of 0.15in) a higher frequency may be needed to keep K in a convenient range, but as such small capstans tend to produce more percentage wow, especially after a short period of use, this tends to balance matters up. With large capstans the use of a lower frequency is advisable, and where the wow performance is very bad a lower frequency is essential. In one very bad case it was found necessary to go down to 200 c/s to bring K below unity. (Wow percentage was about 5.)

Interpretation.—A careful study of the strobe display will provide much useful information on the performance of the tape drive mechanism. A smooth movement across the screen is preferable, and an irregular movement warns that the wow is non-sinusoidal and may have a high peak velocity error. If the trace is "fuzzy" there is some high frequency flutter, and the "distance error" can be estimated by the width of the trace.

One particularly interesting effect observed was due to a faulty tape that had become excessively sticky. The machine had a slight tendency to wow, but the tape exaggerated this violently, as it stretched to a remarkable degree as the capstan tried to accelerate it, suddenly became free-moving, caught up with a jerk, and then slowed down again. This was traced by using a modified strobe display in which the trace moved from top to bottom of the screen for the main scan, and slowly from left to right as well. The position of the tape was indicated by using the replayed signal to brighten the trace at a given point in the cycle, and this produced a graph of the varying positional error (Fig. 1). This technique allows both waveform and frequency of the wow to be observed and measured.

The figures themselves also need careful interpretation. It may not be enough to say that one machine has less percentage wow than another, and is therefore better. Comparisons of test figures with auditory tests indicate that the percentage peak frequency variation may not be as important as the rate of change of frequency in terms of the frequency itself. $\left(\frac{df}{dt}\right.$ compared with f as a percentage.$\left.\right)$ This accords with common experience, for when a note changes in pitch very slowly (e.g., the horn note that ends Britten's setting of Blake's Elegy) it is sometimes difficult to detect the change, whereas a more rapid slur over a much smaller interval is readily apparent.

The relevant information may be obtained from the test described without difficulty. The maximum frequency error is KS_1/d, and the maximum rate of change of frequency is thus $KS_1^2 f_2/d^2 f_1$ cycles per second per second. Numerically, this is $KS_1^2/d^2 f_1$ times the reproduced frequency.

In the case of the "Reflectograph," taking $f_1 = f_2$ the maximum rate of change of frequency is about 6 per cent of the frequency. With the small-diameter capstan recorders the higher capstan speed gives a much higher rate of change for the same wow percentage, and with slow speed capstans the figure is much lower. It may be noted in passing that this "figure of merit" permits a much more reasonable, comparison of the relative audible effects of wow in tape and disc recordings.

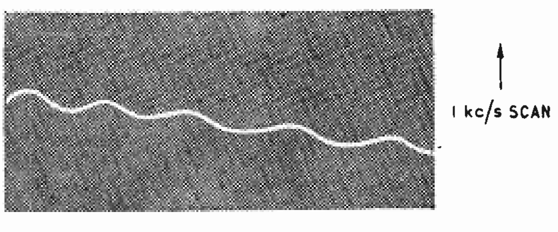


Fig. 1. Waveform of "wow," displayed by the technique indicated in Fig. 2.

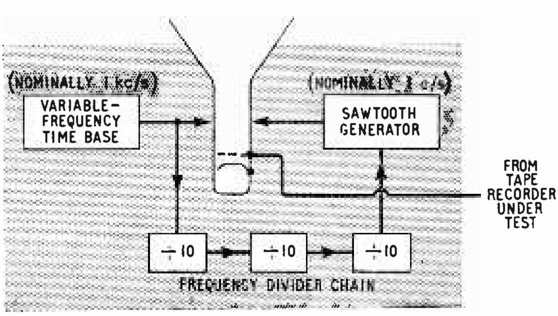


Fig. 2. Block diagram of modified two-dimensional display.

Peak Velocity Display.—It should be noted that the simple strobe technique actually measures the peak time displacement of the wow, and the peak velocity is deduced on the basis of an assumption. In cases where this is not considered a sufficiently reliable technique, the modified two-dimensional display illustrated in Fig. 1 may be used to measure the peak velocity error directly.

For this purpose the arrangement shown in Fig. 2 is used. The vertical scan frequency is adjusted to be equal to the mean frequency of the signal from the tape recorder, and the horizontal scan frequency is derived from the vertical scan by a frequency divider chain having an overall counting ratio of 1000:1. Using the same symbols as before, the vertical scan period will be S_1/S_2f_1 and the horizontal scan period will be $1000\ S_1/S_2f_1$.

The maximum slope of the displayed wow curve may be defined as dV/dH, where dV and dH are expressed as fractions of the vertical and horizontal dimensions of the raster respectively. Then the time error involved is dVS_1/S_2f_1 seconds, during which the tape moves $dV.S_1/f_1$ inches. This error occurs during a period of $1000dHS_1/S_2f_1$ seconds, at a rate of $\frac{dV}{dH}S_2 \times 10^{-3}$ inches per second, which, expressed as a percentage of the replay speed S_2 is a peak velocity error of 0.1 dV/dH per cent. Once again, no separate measurements are required other than the direct determination of the slope in an appropriate manner. If the amplitudes of the horizontal and vertical scans are equal, a 45-degree slope indicates a peak wow of 0.1 per cent.

Values used in practice have been $f_1 = 1000$ c/s, for $S_1 = 7\frac{1}{2}$in/sec. These have been found to be capable, especially with suitable variations in the frequency ratio of the scans, of dealing with extreme cases. Being an "absolute" method of measurement involving neither assumptions nor approximations, this technique might be useful for establishing a standard method of wow specification, which appears to be a rather urgent necessity.

Production Wow Testing.—For many purposes it is enough to use a standard tape in the same test set-up for production testing, but since this may not detect all types of fault in respect of tape transit mechanisms a further kind of wow test may be mentioned. This uses a frequency measuring circuit of the type in which a capacitor is alternately charged and discharged during each signal cycle, the average discharge current being proportional to the signal frequency. The magnitude of the current is first measured by a bridge circuit to determine the actual tape speed in terms of replayed signal frequency, and the a.c. component is then passed to a meter circuit which can measure both the true r.m.s. value and the peak value of the wow signal, so that the form factor can be estimated.

This instrument is somewhat limited in its present form by the difficulty of observing very small variations of frequency with high accuracy, but some apparatus of this sort must inevitably appear on the test benches of all tape recorder manufacturers before long.

"Television Aerials of the Future": A Correction.

The last sentence of para. 2 on p. 508 should read: The characteristic impedance is 300 ohms and the *loss* at 450 Mc/s (when dry) is about 3db *per* 100*ft*.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Ignition Interference in U.S.A.

THE LETTER from Malcolm S. Morse, published in your October issue, rallies me to "Diallist's" support on the subject of ignition interference.

If Mr. Morse has never seen or heard of a case of ignition interference on television in this country I am moved to question where he has been spending his time since television operations commenced here. I live about four miles closer to the four Washington television stations than he does and I have an antenna installation of average performance. However, under certain conditions some automobiles and trucks do cause ignition interference which can be seen as well as heard on my receiver. This is no isolated case and I am certain that most viewers have at one time or another seen the series of black dots followed by trailing whites produced by the adjacent passage of some internal-combustion-propelled device.

Even in the canyons of New York City where the modern cliff-dwellers exist in apartments ten or more storeys above ground level and literally within the shadow of seven television stations (not more than two or three miles distant) I have seen and heard ignition interference. Therefore I would take issue with your correspondent on behalf of the British manufacturers who turn out "poorly designed television sets that are subject to interference from automobile ignition." On the other hand, I will willingly join hands with him in condemning the short-sighted bureaucratic monopoly of the B.B.C. which deliberately selected positive modulation which tends to emphasize interference rather than the negative system which in most cases reduces interfering pulses to black level.

The car radio is as integral a part of the American automobile as a windshield wiper or a horn (and is used as much!). As of January 1, 1953, at least 25,000,000 auto receivers were in use, and 3,500,000 were produced in 1953 in the first seven months. This latter figure works out very closely to one per car produced this year. Most of these car radio installations use either resistor suppressors, resistive ignition leads (which have the same effect as suppressors), or shielded harness.

Possibly this letter is a little long, but I feel that its length is justified in defence of the sweeping indictment of British manufacturers presented by Mr. Morse.

Bethesda, Md., U.S.A. JOHN S. BATTISON.

THERE'S none so blind as those who will not see, they say. Or perhaps Malcolm S. Morse (your October issue) lives in the backwoods and rarely sees a car. I am an Englishman working over here as a TV serviceman, and one of our biggest problems is ignition interference. My workshop is on one of the main roads out of New York, and despite a 1000 μV signal and a directional 5-element aerial with its back to the road we have plenty of reason to wish for the legislation "Diallist" was asking for—suppression of motor vehicle ignition systems.

As to the "penalizing" of British motorists, I suppressed my car in England for 1s 6d, and for 21 cents in U.S.A. That is some penalty, is it not!

There is absolutely no doubt that satisfactory suppression of any interference must be done at the source, and not in the set.

Hillsdale, N.Y., U.S.A. L. JOHN WHEATLEY.

IGNITION interference with television reception has been a dire complaint of your contributor "Diallist" for some time and no doubt you, too, feel strongly on the subject, but I do think that the letter of Malcolm S. Morse in the October number is deserving of more broadminded consideration than you, Sir, appear to have accorded to it.

It appears to have become axiomatic with most of the technical Press and *Wireless World* in particular, that the policy of the B.B.C. is the correct one, regardless of what evidence may appear to show the contrary. Strenuous efforts have been made to convince the non-technical viewer that the nuisance caused to him by ignition interference is due only to the thoughtlessness or, indeed, malice, of the motorist.

Mr. Morse takes the view that ignition interference in the United States is practically negligible, and this view has been expressed previously by both technical and administrative spokesmen of the American TV industry.

Perhaps, then, the B.B.C.'s peak white modulation may be a contributory cause of our sufferings in this country?

No doubt the big guns are already loaded to disprove this, just as no doubt very soon they will "prove" that the American colour (and 3D?) TV is, in fact, inferior to our black-and-white picture with its 405 very noticeable lines.

Malvern, Worcs. P. J. ATKINS.

Identifying Receiver Controls

A RADIO (or television) set is far from the "amateur" stage where function was everything, and both are now accepted as items of domestic furniture. While a regular user has no difficulty in knowing the controls and can operate the set without difficulty, this is not the case with occasional users, as in semi-public rooms, hotels, clubs, canteens and so on with a floating population. It is frequently a matter of some difficulty to determine if a receiver is correctly set when it has been switched on. With a panel light the fact that the set is on is obvious, but an associated volume or tone control may lead to indeterminate reception, particularly owing to the warming-up time. Further, the position of a wave-change switch may not be obvious, leading to possible delay in receiving a wanted programme.

Is there not a case for some degree of standardization of the location and/or appearance of these controls? I hasten to add that I am not proposing an arrangement of prominently labelled control knobs which would spoil the appearance of a set; but where there are three knobs, as is commonly found, these might well be standardized in their sequence, with some addition for ready identification. An on-off switch which is obviously on or off by its appearance would be an advantage, especially where there is a wall switch. Some form of indication such as an up-down motion similar to a lighting switch would be obvious to all, and could be made to match the other control knobs. The wave-change switch needs some marking and this is already provided on many sets. It is frequently on the right, and might well be standardized there. The tuning dial control need only be marked in some way to indicate which it is, since its real indication is on the main dial. It might usefully be located nearest to the dial or scale.

Finally the volume control. For a given case it is often left indefinitely; on the other hand it may be frequently reset by various users to suit themselves, and it may be altered when reception in another room is required. A volume control set at a high level and the set then switched on can result in a startling blare, and on the other hand the control may be left so low that the set is not heard and considered faulty. A simple marking on the knob or fixed near it would overcome this, so that on switching on and leaving the receiver to warm up the volume control could be set at the same time. A very unobtrusive marking is essential, such as lightly embossed or engraved radial lines. A convenient number might be six, needing no figures, or alternatively ten, with the fifth mark longer.

The volume control marking is, of course, a very controversial one: makers may claim that users would tend to compare receivers on the grounds that "my set gives me all the volume I want at 2, but the so-and-so set needs 4." Further, an ageing receiver would need a progressively increasing setting, although this might be turned to advantage by the maker pointing out that a given increase in setting is an indication that certain valves need renewing.

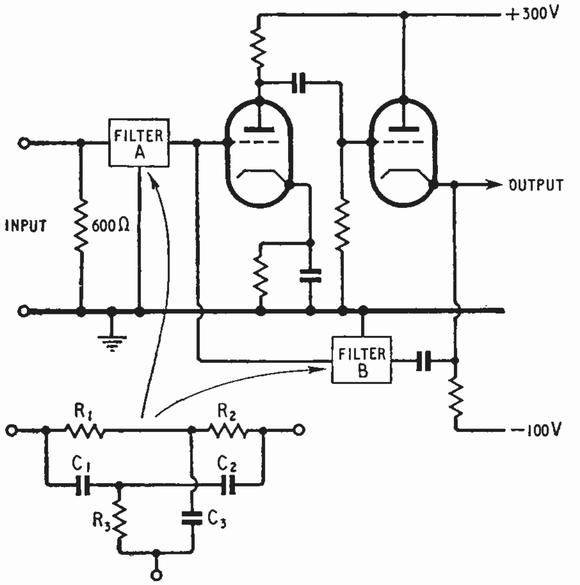
Bexley, Kent. E. H. W. BANNER.

"*Simple Distortion Meter*"

THE advantages of the parallel T network for the removal of the fundamental in distortion measurements are noted by V. J. Tyler in the September issue. The disadvantage of the very low selectivity ($Q=\frac{1}{4}$) may be overcome quite simply by including a similar network in a feedback loop of the following amplifier.

The loss of harmonics in the input filter is greatest for the second, amounting to about 9 db. The loop gain must be substantially the inverse of the input filter response, except near the fundamental. For instance, with a loop gain of 30 at high harmonics, the second harmonic is in error by 0.4 per cent in amplitude and 5 deg in phase; with a loop gain of 10 the errors are 4.4 per cent and 16.5 deg.

The filtering of the fundamental will be offset to the



extent of the loop gain, so that the rejection of the input filter is greater by that much. For instance, suppose it is required to measure a distortion of 1 per cent to an accuracy of 10 per cent; using a loop gain of 10, there will be the response error of 4.4 per cent so a further 5.6 per cent error due to fundamental may be allowed, corresponding to 0.056 per cent of fundamental in the output; thus the input filter must give a rejection of 85 db.

Now the rejection of the filter itself may be made very high with ordinary components. It is not necessary for the components to have any precise relationship, provided there are two variables. The limit to the overall rejection is set by the stability of the test oscillator and by the feedback amplifier noise at fundamental frequency.

Measurements have been made in the range 10 c/s to 40 kc/s of distortions down to 0.1 per cent using loop gains of more than 30 so that 120 db rejection, at least, can be obtained.

The circuit is shown in outline in the figure. Each filter works from a low impedance into the other filter so that their responses are the same. High-stability components are used. In the filter, R_1 and R_2 are 160 kΩ and R_3 is 80 kΩ. The capacitances C_1 and C_2 are equal and C_3 is twice C_1. The filters are similar in values but R_3 of A is made variable—68 kΩ fixed with 20 kΩ and 500 Ω coarse and fine variables.

Adjustment of A for a null is by variation of R_3 and the frequency of the test oscillator. The latter is a better adjustment than that of R_1 and R_2. (In either case the two adjustments are not independent.)

From the two conditions for a null, viz.,

$$R_1R_2=(X_1+X_2)X_3 \qquad X_1X_2=(R_1+R_2)R_3 \qquad \text{where } X=\frac{1}{\omega C}$$

it can be seen that the only independent variables are R_3 and C_3. However, adjustment of R_3 and ω is not difficult in practice.

G. H. ASKEW, R. MATCHELL.

Cinema-Television, Ltd.,
London, S.E.26.

"*Meter Overload Protection*"

I AM obliged to T. H. Francis for pointing out (your November issue) that the circuit resistance was not specified in the "Overload Factor Test." In point of fact the tests reported were carried out with a circuit resistance of more than ten times the instrument resistance.

Perusal of the curve of Fig. 1 shows that the resistance of the rectifier disc shunting the movement under overload conditions approaches 10 ohms (<1 per cent of coil resistance). When used in a multi-range meter this device will give full protection on the low-voltage and high-resistance ranges when the indicator is not shunted at all.

I regret that no reference was made to M. G. Scroggie's work on this subject (*Wireless World*, 11.1.35 and 2.6.38). Although the circuit elements are similar, the linear scale shape and negligible temperature error were not a part of the earlier design.

Rickmansworth, Herts. J. de GRUCHY.

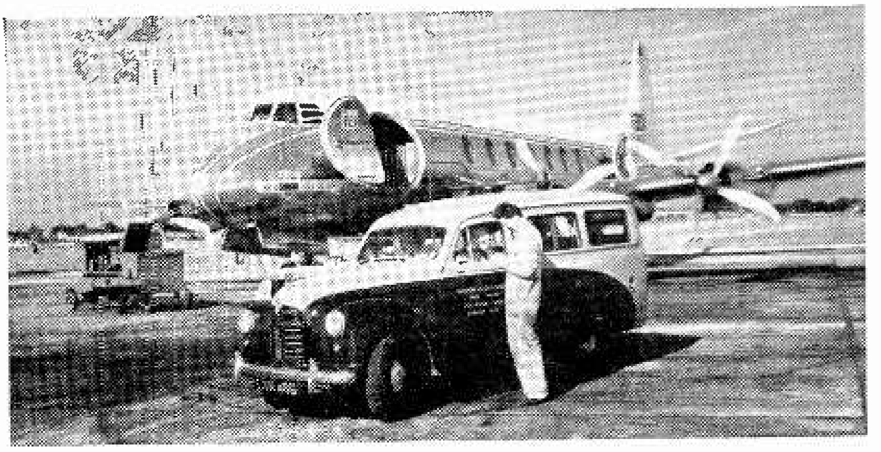
Technical Qualifications

WHILST being in full agreement with Mr. Squires' letter and the last paragraph of Mr. Barton's letter (both October issue), I cannot agree with Mr. Barton's remarks on the mathematical standards of the City and Guilds of London Institute, nor on the question of the syllabus as applied to Post Office engineers.

The City and Guilds technologist is not intended to be a mathematical genius, but a first-class technologist with a good working background of mathematics. If an employer wants a mental giant then he asks for and gets someone with a good degree from a University. The degree man is the theoretician in the main, and the technologist the man who interprets (or tries to interpret) these theories in practical form. In any case I fail to see how any City and Guilds student can pass Grades 4 and 5 Telecommunication Principles without having done the necessary mathematics for these grades.

Naturally the present City and Guilds syllabus places emphasis on telecommunications as understood by Post Office engineers, who are in the very wide field of telecommunication engineering for which this course was designed, as its name implies. So are B.B.C. engineers, cable wireless engineers, relay engineers, etc.

Willenhall, Staffs. "GRADE IV STUDENT."



Experimental V.H.F. Radio Extension to G.P.O. Telephone System at London Airport

AIRPORT GROUND COMMUNICATIONS

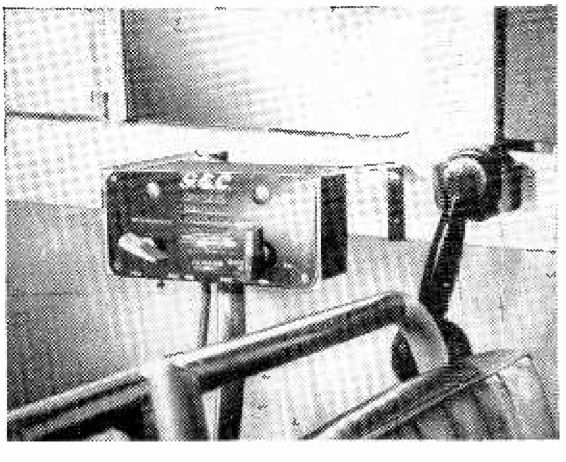
A V.H.F. radio extension to the ordinary telephone system is being tried out at London Airport by the Ministry of Civil Aviation, using the General Electric Company's equipment. The idea is to provide means of direct communication between the offices and depots of the various air transport firms using the airport and their staffs in the more inaccessible parts of the aerodrome. Anyone familiar with London Airport and knowing the amount of ground it covers must know that one can be right out of reach of a telephone for very long periods.

The permanent adoption of this scheme would enable the driver of a vehicle towing an aircraft from its hangar to inform his company's duty officer of any mishap which would be likely to cause considerable delay in its arrival on the loading apron; or permission might be required to cross an intersection or duty runway. Staff loading aircraft may have an urgent message for the company's office or vice versa, or airport officials may wish to notify some last-minute changes in the departure schedule to staff scattered about the airfield.

All this can be, and is, carried through by messengers or someone seeking the nearest fixed telephone, but how much simpler and speedier it could be by radio telephone!

The experimental v.h.f. equipment installed in the various vehicles is of 10 to 12 watts rating, is amplitude modulated and can operate on any spot frequency between 70 and 180 Mc/s. Duplex working is employed, without a change-over switch. The sets are remotely controlled and the main items can be stowed away in any convenient part of the vehicle. They operate entirely from the car's battery.

Above: Radio equipped vehicle passing on a message to mechanics working on the aircraft seen in the background at London Airport. Below: The G.E.C. remote control unit is very compact and easily accommodated in any type of vehicle. Here it is mounted just behind and to the left of the passenger's seat.



TAPE *versus* DISC

DEVELOPMENTS in tape recording, and the possibility of providing good quality at economical tape speeds, has brought the tape machine into the picture as a possible competitor with the disc for domestic sound reproduction. A recent discussion on this topic, staged by the Radio Section of the I.E.E., started with the assumption that both methods were capable of giving better than acceptable quality for domestic use. Relative cost and convenience were thought to be the most important considerations.

Though some disagreement arose as to comparative basic costs of component parts for the two systems, there was no strong suggestion that the price of a simple tape reproducer need be significantly greater than that of a disc machine of comparable performance. On the other hand, it was not contested that the present price of magnetic tape was such as to give an economic advantage to the disc, though the margin could be reduced by using slower speeds and multi-track recording. Existing methods of duplicating tapes by "dubbing" or "printing" might be no more costly than the pressing of discs, but it was stated some difficulty has been experienced in duplication on a really large scale. Inspection, too, is a problem, as tapes cannot be examined visually for flaws.

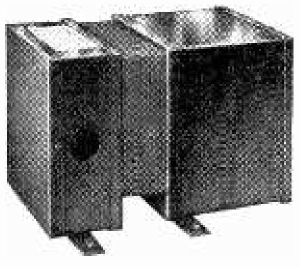
Both tape and disc had their supporters on the score of ease of handling and susceptibility to accidental damage. Tape was said to give a greater number of playings without deterioration, but to suffer from deterioration in storage (which might be prevented by re-spooling).

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Automatic Boost Transformers

SINGLE-STEP voltage booster transformers designed for use with equipment which might fail to operate satisfactorily or even suffer damage from a substantial fall in mains voltage have been introduced by Advance Components, Back Road, Shernhall Street, London, E.17.



Advance "Advolt" Type N2A automatic booster for 230-V a.c. supplies.

Known as the "Advolt," it is completely automatic in operation and when the mains supply falls to a predetermined voltage a 12% boost voltage is immediately added to the output. When the supply reverts to normal boost is removed.

The equipment consists of a boost transformer switched by means of relays operated by a voltage-sensitive circuit. The Type N2A transformer, which measures $8\frac{5}{8} \times 7\frac{1}{2} \times 5\frac{1}{2}$ in, weighs 16 lb, is for a nominal a.c.-supply of 230 V and a load capacity of 2 kVA, costs £16 15s. A 110-V model (N2B) is available and two for 5 kVA loading are in course of development.

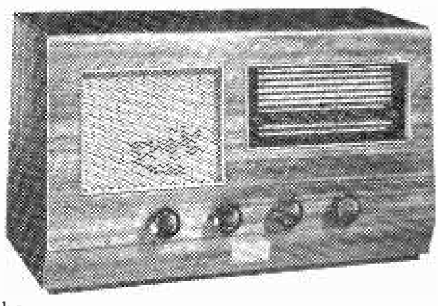
Anti-interference Aerial

IT has been established that a frame aerial is less susceptible than an open aerial to locally generated electrical interference, particularly in the zone where the interfering field has not yet established itself as a self-propagating wave. The directional properties of a frame can also contribute materially to the reduction of interference when the desired signal is coming from a different direction. The superiority of a frame aerial over indoor "picture rail" aerials is most marked on long waves and at the top end of the medium-wave range, but its use has been restricted because conventional frames are thought to be incongruous in the living-room.

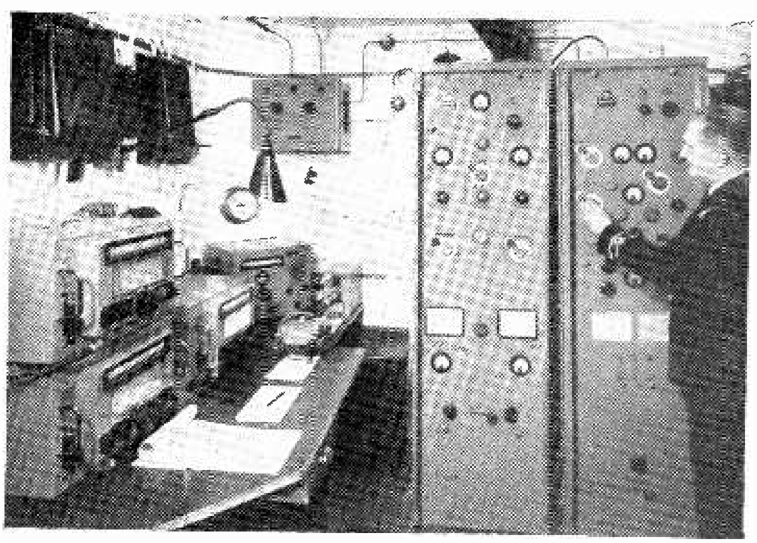
This objection has been overcome in the "Klerecep" aerial, distributed by A.B. Metal Products, 16, Berkeley Street, London, W.1. The windings are enclosed in an attractive picture frame which can be placed anywhere adjacent to the set, and are tuned by a small variable capacitor at the back. Switching is arranged to preserve the symmetry of the windings on both medium and long waves, and tappings are adjusted to match the input impedance of the average receiver. The selectivity conferred by the additional tuned circuit is worth having, and has proved useful in receiving Continental long-wave stations free from a background from Droitwich. The price of the "Klerecep" aerial is 47s 6d.

Cabin Broadcast Set

THE Cameo Senior Model RM1 marine broadcast receiver marketed by Rees Mace Marine, 11 Hinde Street, Manchester Square, London, W.1, which was briefly described in our November 1952 issue, is now available in a wooden cabinet with either a walnut finish or covered in light blue rexine. No circuit changes have been made and both sets have nine wavebands, seven of which are on the short waves. It is a superhet for a.c. or d.c. operation. A point of interest is that fitting instructions, circuit diagram, list of components and a list of service agents throughout the world are packed with each receiver.



Rees Mace marine broadcast receiver fitted in a walnut cabinet.



RADIO ON THE ROYAL TOUR

SPECIAL radio equipment has been installed in the s.s. *Gothic* for the Royal tour of the Commonwealth. Apart from a heavy volume of State, Naval and Press messages, provision has been made for transmitting material for "live" B.B.C. broadcasts, for picture transmission and distribution of radio and recorded programmes throughout the ship.

The main transmitter is a Marconi SWB11X, giving 7 kW output on radio telephony and telegraphy in the band 4 to 22 Mc/s. Its installation gave rise to numerous difficulties from stray r.f. currents in rigging, poorly earthed metalwork and such-like. Thorough bonding cured these troubles. The supporting transmitter is a 600-W "Worldspan" (shown in the photograph) modified for high-speed telegraphy.

Special aerial equipment enables any of the receivers to be operated during transmission, provided a frequency separation of 1 Mc/s is allowed.

The ship carries also Marconi radar, direction finder and echo sounder.

WORLD OF WIRELESS

International, Organizational, Personal and Industrial Notes and News

Interference: International Agreement

DETAILS have now been issued by the British Standards Institution of the recommendations on radio interference to be made to the International Electrotechnical Commission as a result of the recent London conference of the International Special Committee on Radio Interference (C.I.S.P.R.), to which we referred last month.

It was agreed to recommend that all countries should adopt the following limits of noise voltages measured at the terminals of appliances: 150-200kc/s, 1,500μV; 200-285kc/s and 525-1,605kc/s, 1,000μV. It was also recommended that the 1,000μV limit should, as far as practicable, be applied from 1,605kc/s to 25Mc/s.

These limits are applicable to domestic, industrial and commercial appliances rated up to 1kW, and intended for direct connection to a distribution system operating at not higher than 750 volts between conductors, or 375 volts between one conductor and earth.

It was recommended that all countries should consider the adoption of the 50μV/m limit at a distance of ten metres for Band 1 (41—68Mc/s) as now applied in both the U.K. and the U.S.A.

A considerable measure of agreement was also reached on the capacitor currents (at mains frequency) to frame or earth which could be accepted for various classes of domestic appliances without danger of shock to the user.

The countries represented at the meeting were Belgium, Czechoslovakia, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, U.K. and U.S.A.

Transmitting Licences

THE MORSE TEST for prospective amateur licensees will not in future be taken at any Head Post Office as in the past. From January 1st the test will be conducted on request at G.P.O. Headquarters, St. Martins-le-Grand, London, E.C.1; Post Office Coast Stations (Burnham, Cullercoats, Humber, Land's End, Niton, North Foreland, Oban, Port Patrick, Seaforth, Stonehaven and Wick) and Radio Surveyor's Offices in Belfast, Cardiff, Falmouth, Glasgow, Hull, Leith, Liverpool, London (E.C.3), Newcastle-upon-Tyne and Southampton.

In order to meet the need of applicants who cannot conveniently reach the above places, tests will also be held, provided there are sufficient candidates, twice a year (January and September) at the Head Post Offices in Birmingham, Cambridge, Derby, Leeds and Manchester. Applications for the January test must be received by O.T.D., Radio Branch, G.P.O. Headquarters, London, E.C.4, by December 20th.

We understand that the P.M.G. is still considering the question of issuing vision-only licences to those who do not hold the normal amateur licence but wish to experiment in vision transmission. The whole question of amateur licences is under consideration and there will probably be considerable changes when the new regulations are made known.

Audio Shows

THE SIXTH annual exhibition of sound recording and reproducing equipment sponsored by the British Sound Recording Association has been arranged for May 22nd and 23rd at the Waldorf Hotel, Aldwych, London, W.C.2.

The fifth exhibition of audio equipment to be organized by the Association of Public Address Engineers will be held on April 28th and 29th at the Horseshoe Hotel, Tottenham Court Road, London, W.1.

Alternative Television Proposals

NEW GOVERNMENT ideas for an alternative television service were set out in a White Paper (Cmd. 9005; H.M.S.O.; 4d) issued on November 13th. The scheme is for a network owned and operated by a public corporation like the B.B.C., but station time would be leased to private programme companies deriving their revenue solely from advertisements. The programmes would be under the control of the corporation, which in turn would be responsible to the Postmaster General.

The White Paper discusses the problem of finding frequencies for the proposed new stations. After pointing out the difficulties of working on Bands 4 and 5 it goes on to say that there are two, or possibly three, channels in Band 3 which could be used almost at once. This does not mean, though, that only two or three stations could be set up. "The number of stations that there can be on each channel without causing interference with one another depends on the power and range of the stations and their distance apart, and many different combinations of power and distance are technically possible." It would not, however, be possible to run a service of local independent stations, each leased to a different programme company. The programmes could only be produced economically if local stations were linked up into a network for the purpose of putting out the same programme for the bulk of the time, with something approaching national coverage.

For some years, says the White Paper, it will be impossible to set up more than one such network. Using two channels in Band 3, it would begin with stations in London and possibly in two other large centres of population.

Student Exchange

DURING the 1953 summer vacation 3,783 students participated in the international exchange organized by the International Association for the Exchange of Students for Technical Experience; more than double the 1950 figure. Of this number 623 came to this country and 544 went from the United Kingdom to other countries.

The statistics given in the annual report of the Association do not indicate how many students were studying radio and telecommunications—they are included under the general heading of electrical engineering. However, from the list of firms in the U.K. who received students it is apparent that a considerable number of the 117 listed as spending part of their vacation in the electrical industry, went into radio.

Eighteen countries participated in the scheme, particulars of which are obtainable from J. Newby, Imperial College, South Kensington, London, S.W.7.

PERSONALITIES

Dr. S. Whitehead, director of the British Electrical and Allied Industries Research Association, has relinquished the chairmanship of the International Special Committee on Radio Interference (C.I.S.P.R.) as he is no longer concerned so intimately with the problems before the committee. He had been chairman for seven years. Dr. Whitehead is succeeded by O. W. Humphreys, director of the G.E.C. Research Laboratories.

Commander (L) C. V. Robinson, O.B.E., R.N., this year's chairman of the Southern Centre of the I.E.E. has specialized in radio throughout his 40 years in the Royal Navy. He was for many years on the experimental staff of H.M. Signal School and at A.S.R.E. Haslemere. For three years from

1935 he was lent to the R.A.F. and was in charge of the radio gear for the operation of the radio-controlled *Queen Bee* aircraft. Throughout the war Commander Robinson was in charge of a department he formed which was responsible for the testing and adjustment of all W/T and radar equipment fitted in H.M. ships. He is now serving in H.M.S. *Collingwood*, the Navy's main electrical school.

Horace Freeman, exhibition manager of the R.S.G.B. Amateur Radio Show, which opens at the Royal Hotel, Woburn Place, London, W.C.1, on November 25th, has also organized each of the six previous shows. He has in fact been associated with radio publicity since the early 1920s and has been advertisement manager of R.S.G.B. publications since 1925. He was instrumental in the staging of the first All-British Wireless Exhibition at the Royal Horticultural Hall, London, in 1922. Mr. Freeman is now with the National Publicity Co. with which his own agency was merged in 1951. The portrait reproduced here was painted this year by Brigadier A. L. Harris, M.C., Royal Signals (Retd.).

Dr. A. Rosen, who was formerly chief engineer (telecommunications cables) with Siemens Brothers, has been appointed telecommunications consultant in the engineering organization of British Insulated Callender's Cables in succession to the late Dr. Hans Carsten.

S. Erickson, for the past four years officer-in-charge of the Technical Branch Drawing Office of Government Communications Headquarters at Cheltenham, has joined A. T. and E. (Bridgnorth), Ltd., as chief draughtsman. Before going to Cheltenham, Mr. Erickson was with Burndept and previously for many years at the radio and television works of the General Electric Co.

Walter Newman, chief designer of Salford Electrical Instruments, Ltd., has retired after 45 years' service with the company.

OUR AUTHORS

G. P. Anderson, who describes an amateur transmitter-receiver in this issue, joined the Post Office from school in 1934 and for the past 11 years has been in the Radio Branch Laboratory at the Post Office Research Station. He has held an amateur transmitting licence (G2QY) since 1934 and is particularly interested in u.h.f. and low-power low-frequency portable work.

D. W. Thomasson, author of the article on "wow" measurement in tape recorders, was test gear designer at Cossor's until 1947, when he became an independent consultant and operated his own prototype workshop (Earl Services) in Exeter. He joined Cossor's in 1937, but throughout the war was in the R.A.F., latterly on loan to the Armament Division of R.A.E., Farnborough.

OBITUARY

William A. Jackson, O.B.E., M.I.E.E., sales director of the Telephone Manufacturing Company died on October 25th at the age of 68. He had been associated with the company since 1916—a year after its formation. Mr. Jackson had been a director since 1939 and was also a member of the boards of Telephone Rentals, Ltd., T.M.C. Harwell (Sales), Ltd., and Carrington Manufacturing Co., Ltd. He was a past-chairman of the Radio and Electronic Component Manufacturers' Federation.

Lewis Marcus Lyons, chairman of the board of Claude Lyons, Ltd., died on September 1st at the age of 59. He had been with the company for 33 years. Claude Lyons also suffered earlier this year the loss of another director, **Louis Cedric Smith**, who was also chief engineer. He was 65 years old.

IN BRIEF

Thirteen Million broadcast receiving licences were current in the United Kingdom at the end of September. Sound licences totalled 10,278,157, television 2,615,259, and car sets 197,574. The month's increase in television licences was 76,156.

"Gothic" Radio-Telephones.—In addition to the installation described on page 584 the *Gothic* has been equipped for the Royal Tour with Pye v.h.f. radio-telephone gear to provide short-range communication between the ship and ports of call. Terminal equipment has been flown to some ports but at others a portable station will be landed from the *Gothic* for connection into the land telephone system.

Longest direct radio-telephone link in the world—linking New Zealand with the U.K.—was recently opened. The equipment for the New Zealand station at Himatangi, 75 miles north of Wellington, was supplied by Standard Telephones and Cables, and includes a 40-kW and three 4-kW single side-band transmitters. The equipment will be used to relay the Queen's Christmas Day broadcast from New Zealand for recording and retransmission by the B.B.C. The station is also equipped with phototelegraphy apparatus.

New B.B.C. Transmitter.—A permanent 2-kW station at Bexhill was brought into service by the B.B.C. on November 8th to replace the temporary station which has been in use at Hastings. This 206-metre Home Service transmitter will serve the coastal area between Rye and Beachy Head.

Transistor Lectures.—The course of eight lectures on "Crystal Valves and Transistors," which ends at the Borough Polytechnic, London, S.E.1, on December 8th, has created so much interest that it is being repeated. The lectures, which are by members of the G.E.C. Research Laboratories' staff, will be given at 3.0 and repeated at 7.0 on Tuesdays from January 19th until March 9th. The fee for the course is £1 10s, and intending students should apply for an enrolment form from the secretary.

Radar Association.—Originally formed as a social club for ex-wartime members of the R.A.F. who had been associated with radar, the Radar Association is to expand the technical side of its activities by the formation of a Technical Division. Membership is open to those who are or have been engaged in this field of radar in the Forces or in industry. The winter programme includes "The Exploration of Space" by Arthur C. Clark (at 7.30 on December 7th in the Anatomy Theatre, University College, Gower Street, London, W.1), "The Future of Secondary Radar" and "Radar in Meteorology." Particulars of the Association are obtainable from the Secretary, 83, Portland Place, London, W.1.

Canadian Approval.—The British Standards Institution has compiled a list of electrical equipment which has been approved for export to Canada. A number of electronic manufacturers appear in the miscellaneous section of the list, which is obtainable free of charge from the B.S.I., 2, Park Street, London, W.1. They include: Advance (test instruments and signal generators), B.S.R. (record changers and motor units), Cossor (twin-beam c.r.o.), Dawe (industrial electronic test equipment, pulse generator and Q meters), Garrard (record playing equipment and record changers) and Plessey (record changers).

Bibliographies on a variety of subjects are being produced by the Library Association and No. 22 of the series (issued under the general title of "Readers' Guide to Books") covers radio and television. The 240 or more books listed in this 20-page booklet are classified under 30 headings. The booklet is obtainable from the Library Association, County Library, Widemarsh Street, Hereford, price 10d (postage 2d).

French TV.—The third 819-line transmitter was brought into service in France on October 15th. This 20-kW transmitter at Strasbourg radiates on 175.15 Mc/s sound and 164 Mc/s vision. Two other transmitters are in course of construction at Lyons and Marseilles and are scheduled to be brought into service during the latter half of next year.

Belgium.—Experimental bi-lingual two-standard television transmissions began in Belgium at the end of October. The two transmitters, one radiating a Flemish programme on 625 lines and the other a French programme on 819 lines, are in the Brussels area. The equipment for the studios was provided by Pye.

Radio Stamp.—One of the three Swedish postage stamps issued to mark the centenary of the opening of the first public telegraph service in Sweden bears a symbolic radio design enclosed in a frame with *Radio Suédois* in morse.

PUBLICATION DATE

The January issue will be published on January 5th, the delay of a few days being due to the Christmas holidays.

Radio Show 1954.—H.M. The Queen has consented to be patron of next year's National Radio Show which will be held at Earls Court, London, from August 25th to September 4th, with a pre-view for overseas and other special visitors on August 24th.

MSF.—Bona fide users of the standard frequency transmissions from the Rugby station, MSF, can obtain a leaflet from the National Physical Laboratory, Teddington, Middlesex, giving details of the service, which, since May, has been radiated continuously on 2.5, 5 and 10 Mc/s.

Juvenile Lectures.—"The Uses of Radio Waves" is the title of the course of six lectures to be given by J. A. Ratcliffe, F.R.S., Reader in Physics, University of Cambridge, at the Royal Institution, 21, Albemarle Street, London, W.1, on December 29th and 31st, and January 2nd, 5th, 7th and 9th, at 3.0. It is the 124th course of R.I. Christmas Lectures "adapted to a juvenile auditory." The fee for children between 10 and 17 is £1.

Institute of Navigation.—The annual report of the Institute of Navigation records that the membership at the end of June was 1,349; an increase of 95 during the year.

Moroccan TV.—It is expected that the television station now being built at Casablanca will start transmissions next March. It will employ the French 819-line standard.

International Telecommunication Union.—Léon Mulatier, who has been secretary-general of the International Telecommunication Union for some years, is retiring at the end of the year and will be succeeded by Dr. Marco Aurelio Andrada, who is at present secretary-general of the Argentinian Posts and Telecommunications Administration.

Telecommunications Advisor.—The office of Telecommunications Advisor to the United States President, created by ex-President Truman in 1951, has been ended on the resignation of the holder, Haraden Pratt.

Plastics in the field of telecommunication cables is among the specialized uses of plastics covered by the papers included in "Plastics Progress, 1953" recently published by *British Plastics.* The text of the 439-page volume is based on the papers and discussions at the Convention held during the British Plastics Exhibition in June. It costs 50s.

Radio Control of a crane is a feature of the documentary sound film "Mechanical Handling on Show" which covers last year's Mechanical Handling Exhibition. It can be borrowed by societies, clubs, trade organizations, colleges, etc., free of charge from *Mechanical Handling,* Dorset House, Stamford Street, London, S.E.1.

Yachtsmen among our readers may like to know that the "*Yachting World* Diary 1954" includes in its 52-page reference section, details of Consol stations, radio beacons, times of B.B.C. weather forecasts and the Beaufort scale used in these. It costs 8s 9d (blue morocco leather) or 7s (rexine) including purchase tax.

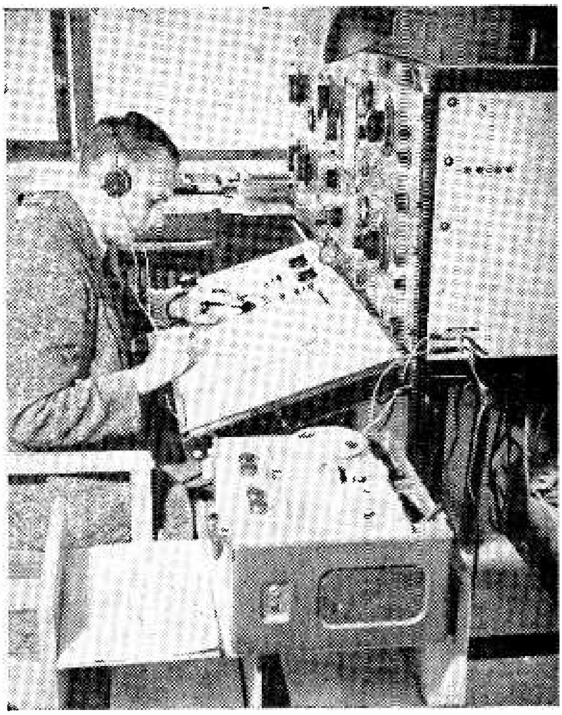
Exporting to Canada.—The 1954 edition of the CABMA Register of British Products and Canadian Distributors, which is sponsored by the Canadian Association of British Manufacturers and Agencies, is in course of preparation. The first edition was issued by our Publishers and Kelly's Directories last June, and included a number of radio and electronic manufacturers and exporters whose products and services are available in Canada. Any British manufacturer exporting to Canada whose name was not included in the 1953 edition should communicate with Kelly's Directories, Ltd., 186, Strand, London, W.C.2.

BUSINESS NOTES

Pye Industrial TV Equipment has been supplied to the recently opened National College of Rubber Technology, Holloway, London, which has been wired to enable large audiences in the lecture theatre to see televised details of processes and machinery in the comparatively small laboratories and workshops. The lecture theatre is equipped with a 27-inch monitor and a talk-back system permits students to ask questions of the lecturer or demonstrator in the laboratory.

Marconi's are to supply, through their Berne agents, Hasler S/A, a v.h.f. omni-directional radio range (VOR) beacon to the Swiss civil aviation authorities. VOR, which is an internationally approved system, enables an aircraft within range of a beacon to take an immediate bearing without having to carry complicated equipment.

Kelvin Hughes, echo-sounders have been installed in the trawler *Sarsia* which will carry out marine biological research in the Western Approaches on behalf of the Marine Biological Association of the United Kingdom. The two sounders, one recording soundings to a depth of 2,250 fathoms, use Teledeltos dry recording paper.



E.B.U. RECEIVING STATION. One of the short-wave receiving positions at the recently opened Jurbise-Masnuy (Belgium) operating station of the European Broadcasting Union (see September issue). The magnetic-tape recorder in the foreground is used as an aid to identifying stations.

Winston Electronics, Ltd., of Hampton Hill, Middlesex, of which F. Winston Reynolds is managing director, have acquired the metal engineering firm of Goswell and Co., of Alpha Road, Teddington, which will in future be known as Winston Metal Fabrications, Ltd.

Rewound TV Transformers.—Direct TV Replacements, of 134-136, Lewisham Way, London, S.E.14, have introduced a "24-hour replacement rewind service" for television timebase and line output transformers. They state that they have a stock of some 700 different rewound transformers.

International Aeradio is to provide further radio stations for use at the Yugoslav aerodromes at Belgrade, Zagreb and Skoplje.

Philco (Great Britain), Ltd., have supplied 150 short-wave universal portable receivers (Type A3214) for British troops in Korea. These tropicalized sets incorporate a 5-ft telescopic aerial.

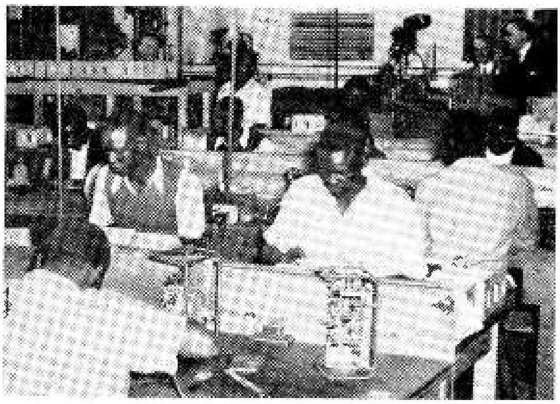
Decca Radar announces that L. J. Dennett, who was previously in charge of the company's service division, has been appointed general manager of its Canadian associated company, Decca Radar (Canada), Ltd.

Ekco Electronics, Ltd., announce the appointment of E. B. Thompson as sales manager and R. Y. Parry as technical manager, nucleonics. Mr. Thompson joined the parent firm, E. K. Cole, Ltd., in 1937 and in recent years has been responsible for the export sales of Ekco communication and electronic equipment. Mr. Parry, who has been with E. K. Cole since 1936, has been associated with the development of Ekco nucleonic equipment.

Sir Robert Renwick, Bart., K.B.E., has been elected chairman of the board of **Reliance-Clifton Cables and Industrial Products, Ltd.**, which reaches its centenary in a few months. The operating company is Reliance Electrical Wire Co., Ltd., Staffa Road, Leyton, London, E.10.

Mervyn W. Shorter, a director and the general sales manager of **Westinghouse Brake and Signal Co., Ltd.**, has been appointed managing director.

Hallicrafters in Great Britain.—The recent announcement in the *London Gazette* that Hallicrafters, Great Britain, Ltd., had gone into liquidation has caused some misunderstanding. H. R. Adams, who was responsible for floating the company in 1946, points out that, because of the dollar restrictions the company never traded and that the liquidation in no way affects McElroy-Adams Manufacturing Group, Ltd., who continue as the sole U.K. distributors of Hallicrafters communication equipment.



RHODESIAN RADIO. J. R. D. Sainsbury, who was with Ultra Electric and is now with Chassay Bros. (Pvt.) Ltd., Bulawayo, sends us this photograph of part of the works of the company, which concentrates on the production of portable and car sets and is the only one manufacturing receivers in Central Africa.

From Canada.—R. H. Tanner, who was in the B.B.C. Research Department before going to Canada to join the Northern Electric Co., of Belleville, Ontario, has notified us of the installation by N.E.C. of the master control equipment in the new C.B.C. studios in Winnipeg, Manitoba.

Rees Mace Marine are to supply Pye v.h.f. radio-telephone equipment for eight cross-channel vessels operated by British Railways from Dover.

Solartron Laboratory Instruments has taken over a factory in Queen's Road, Thames Ditton, Surrey, into which it is also planned to transfer the administrative staff from the offices in High Street, Kingston-upon-Thames.

MEETINGS

Institution of Electrical Engineers

"Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies on 2nd June, 1953" by W. S. Procter, M. J. L. Pulling, M.A., and F. Williams, on December 3rd.

Radio Section.—"Telegraph Codes and Code Converters" by T. Hayton, B.Sc., C. J. Hughes, B.Sc., and R. L. Saunders, B.Sc. (Eng.), and "Code Converters for the Interconnection of Morse and Teleprinter Systems" by R. O. Carter, M.Sc. (Eng.), and L. K. Wheeler, B.Sc. (Eng.), on December 2nd.

Disscussion on "Will Transistors Oust Receiving Valves?" opener E. H. Cooke-Yarborough, on December 14th.

All the above meetings will be held at 5.30 at Savoy Place, London, W.C.2.

Cambridge Radio Group.—"Electronics in Aircraft" by R. W. Chandler, at 8.15 on December 1st at the Cavendish Laboratory, Cambridge.

North Midland Centre.—"Some Applications of Electronics" by T. G. Bridgwood, Ph.D., B.Sc., at 6.0 on December 8th at the University of Leeds.

Discusson on "Some Criticisms of Technical Education," openers G. A. Haigh and G. Auton, at 6.30 on December 15th at the British Electricity Authority, 1, Whitehall Road, Leeds.

East Midland Centre.—Faraday lecture, "Electric Process Heating—an Aid to Productivity" by O. W. Humphreys, B.Sc., at 7.15 on December 3rd at the De Montfort Hall, Leicester.

South-East Scotland Sub-Centre.—"Special Effects for Television Studio Productions" by A. M. Spooner, B.Sc. (Eng.), and T. Worswick, M.Sc., at 7.0 on December 1st at the Heriot-Watt College, Edinburgh.

South-West Scotland Sub-Centre.—"Special Effects for Television Studio Productions" by A. M. Spooner, B.Sc. (Eng.), and T. Worswick, M.Sc., at 7.0 on December 2nd at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

South Midland Radio Group.—"Radio Aids for Airport Control" by E. J. Dickie, at 6.0 on December 7th at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Southern Centre.—"Colour Perception and Colour Television" by J. H. Mole, Ph.D., at 7.30 on December 9th at the R.A.E. Technical College, Farnborough, Hants.

"Receiving Aerials for British Television" by I. A. Davidson, B.Sc., at 6.30 on December 11th at the South Dorset Technical College, Weymouth.

Maidstone District.—"Electronics in Industry" by B. Kellet and E. R. Davies, at 7.30 on December 7th at the "Wig and Gown," Maidstone.

Norwich District.—"The Basic Principles of Electronic Digital Computing Machines and their Uses" by R. L. Grimsdale, M.Sc., at 7.30 on December 7th at the Royal Hotel, Norwich.

British Institution of Radio Engineers

London Section.—A symposium on Vibration Methods of Testing: "Vibration Generators" by H. Moore (Goodmans), "Stroboscopes" by F. M. Savage (Dawe Instruments), "Strain Gauges" by P. Jackson (Saunders-Roe), and "Electronic Aids to Vibration Measurement" by R. K. Vinycomb, B.Sc., (Southern Instruments), at 6.30 on December 9th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section.—"The B.B.C. Television O.B. Unit" by a member of B.B.C. Glasgow staff, at 7.0 on December 3rd, at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

North-Eastern Section.—"The Effects of Aural Disturbances on Audio Production" by Dr. M. Anderson, at 6.0 on December 9th at the Neville Hall, Westgate Road, Newcastle-upon-Tyne.

West Midlands Section.—"Printed Circuits: Some General Principles and Applications of the Foil Technique" by P. Eisler, Dr. Ing., (Technograph Electronic Products), at 7.15 on December 15th at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

Merseyside Section.—Discussion on "Training for the Radio and Electronics Industry" at 7.0 on December 3rd at the Electricity Service Centre, Whitechapel, Liverpool, 1.

North-Western Section.—"The Monitoring of High Speed Waveforms, using a Sampling Technique" by J. G. MacQueen (Metrovick), at 7.0 on December 3rd at the College of Technology, Manchester.

British Sound Recording Association

London.—"Problems of Magnetic Tape Reproduction" by P. E. Axon, O.B.E., at 7.0 on December 18th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Manchester Centre.—"Some Records of 25 years ago," conversazione opened by C. C. Blyton, at 7.30 on December 14th at the Engineers' Club, Albert Square, Manchester.

Television Society

London.—"Information Theory and Television" by Dr. E. C. Cherry (Imperial College), at 7.0 on December 17th at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Radio Society of Great Britain

Annual General Meeting at 6.30 on December 18th at the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Institute of Navigation

Developments in Radio Aids to Surface Navigation: "The Reduction of Sea and Rain Clutter in Marine Radars" by J. Croney, "A Racon Beacon for Reception by Civil Marine Radars" by C. Randall-Cook, and "A Portable Beacon for Identifying Ships on Harbour Radars" by A. L. P. Milwright, at 5.0 on December 18th at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.

Society of Instrument Technology

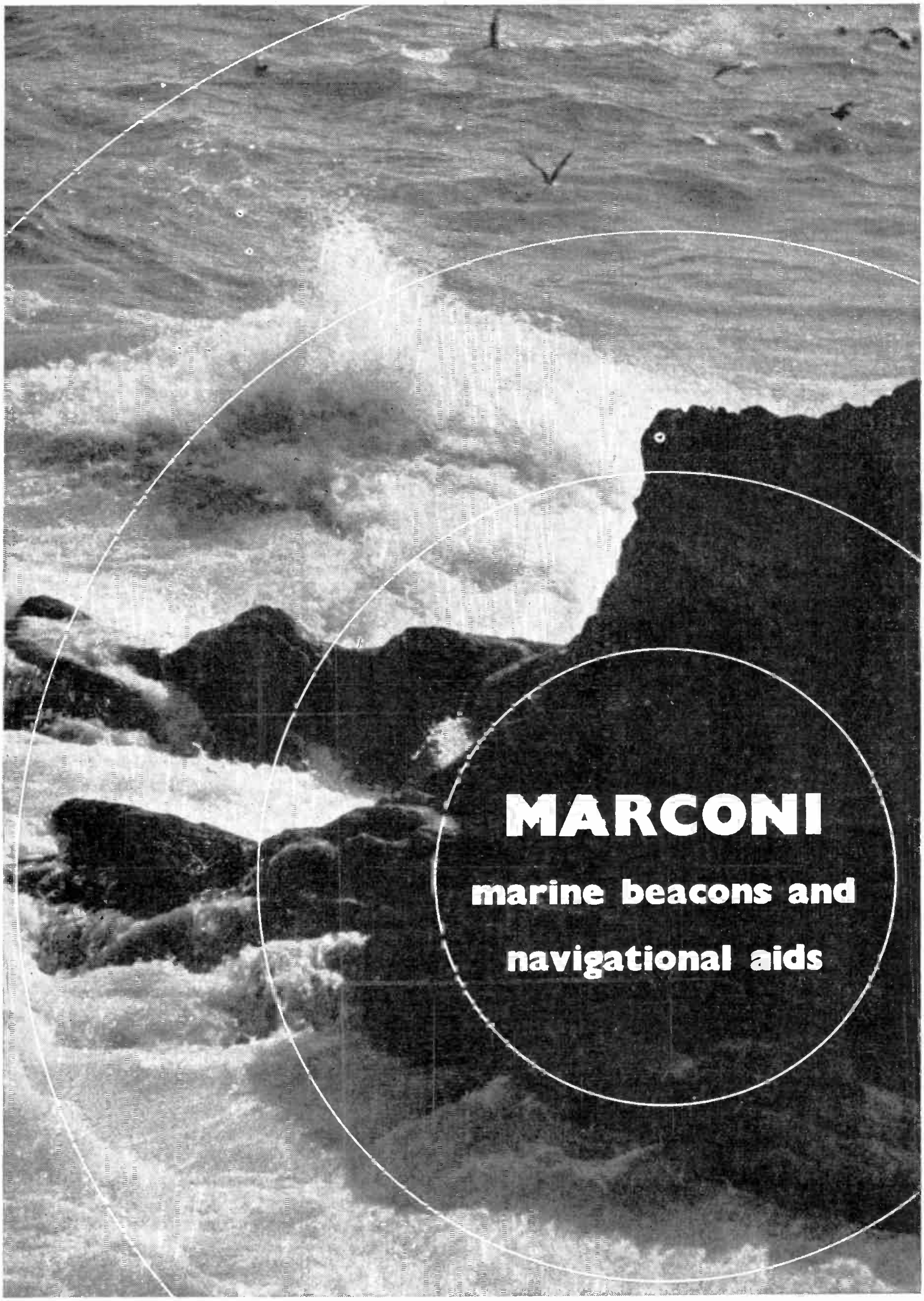
London.—"Sectional Paper Machine Drives with Electronic Control" by T. E. Barany, M.A., at 7.0 on December 15th at Manson House, Portland Place, London, W.1.

Tees-Side Section.—"Some Factors Influencing the Design of New Types of Instrument" by A. J. Philpot, C.B.E., M.A., at 7.30 on December 17th at the Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough.

Cardiff Section.—"Electronic Motor Control" by L. Babad, at 6.45 on December 2nd in the Physics Lecture Theatre, College of Technology, Cardiff.

Institute of Practical Radio Engineers

Midlands Section.—"Modern Industrial Metal Finishing" by F. Wild (Cruickshanks, Ltd.), at 7.30 on December 7th at the Crown Hotel, Broad Street, Birmingham.



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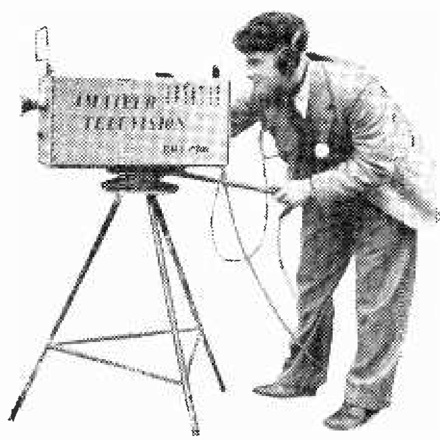
Amateur Television Progress



More Pick-up Tubes Available for Home-Built Cameras

By M. BARLOW,* (G3CVO)

JUST over a year ago a report on progress in the field of amateur television transmission was given in the pages of *Wireless World*. Since then, several interesting developments have taken place; some 250 experimenters are on the lists of the British Amateur Television Club and active clubs have sprung up in ten overseas countries. The total number of active experimenters is probably around the 500 mark, but it will be appreciated that the majority of these are running closed-circuit transmission systems. It is unlikely that more than 25 amateur television stations exist in the world at the moment, owing to the severe difficulties to be overcome, but we may be proud of the fact that some of the leading stations are in the United Kingdom.

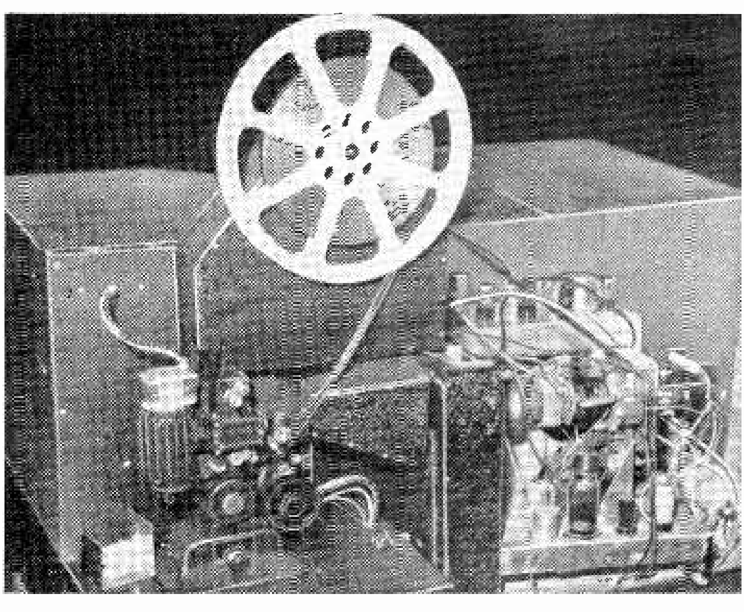
As mentioned before, the flying-spot scanning method of picture generation finds great favour on account of its simplicity and economy in cost and components. There is still a lack of suitable photocells—the ubiquitous RCA type 931A having disappeared from the surplus market—although the scanning c.r. tube position has improved now that some blue-trace tubes are on the commercial market. In the main, however, these have not a flat face, which in turn introduces optical distortions into the picture, but it is becoming more general to use some form of lens system to improve definition and signal-to-noise ratio. The Club has standardized on 2-in × 2-in (35mm double frame) slides for captions, and a series of suitable slides is being turned out for the benefit of members. 16mm has been adopted as the standard for telecine working, either silent, sound-on-film or with the sound on tape. The normal means of scanning is to use two 25-c/s rasters (three at $16\frac{2}{3}$c/s for silent film) scanning the film in the opposite direction to the film motion. The film moves through the gate continuously, not intermittently, so that the mechanical drive requirements are considerably eased, and a tape recorder type of drive is often employed. It may interest readers to learn that a home-made equipment of this nature is used experimentally on board the whaling factory *Balaena* to relay films to its attendant whaling vessels in the Antarctic!

Circuitry for these units has been recently improved by a design due to J. Mason, ZL1QS, of Auckland, New Zealand. Mr. Mason's video amplifier breaks away from the traditional by employing a cathode-coupled input stage after the photocell, followed by a frequency-correcting stage and a feed-back-pair video amplifier. The amplifier is designed to pass 4Mc/s, but, with a 5FP7 scanning tube, it is not possible to exceed 3Mc/s on normal subjects.

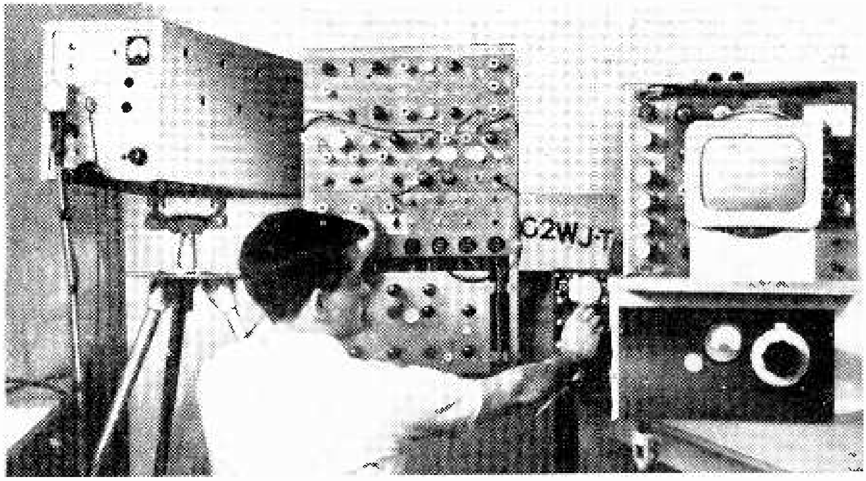
Since the last article was written the supply situa-

* Hon. Secretary, British Amateur Television Club.

The title picture shows an Image iconoscope camera constructed by I. Waters.



Right: Film scanning equipment built by D. Shepperd on board the "Balaena" whaling factory. The 16-mm film (left) is scanned by a flying-spot scanner (right) and the 405-line picture is transmitted to attendant whaling vessels. At the back of the equipment is a control position and monitoring screen.



Transmitting equipment at G2WJ/T, from which pictures have been received by G3GDR some 30 miles away. Constructed by J. Royle, it includes an image iconoscope camera (left), waveform generators (centre) and a monitor and 436-Mc/s converter (right).

tion with camera tubes has improved considerably. At first a few reject studio-type tubes were made available through the kindness of various manufacturers, but, as readers will appreciate, the circuitry and coil-winding involved is rather formidable for an amateur to undertake. Nevertheless, two of the tubes were in action within four months of delivery of the bare tube, and there are now six studio-type tubes giving reasonable pictures. Unfortunately, it is not permitted to give public demonstrations with these cameras, but a good deal of research into economical circuits has been done, for the average amateur is not particularly interested in getting the last ounce out of his camera as long as the picture is satisfactory; this is, after all, the aim of any television system. In view of the relative disadvantages of using the large studio-type tubes, it is good news that a supply of reject Vidicon-type camera tubes has been made available at a reasonable price. Although none is in action yet, no fewer than 22 are on order, and our overseas friends are offering most tempting swaps—including a pair of image orthicons!—for the chance of obtaining one of these tubes. Unfortunately, it is not possible at the moment to supply overseas. The addition of these tubes will bring up the total number of cameras in this country to 39, including eight RCA type 5527s, up to now the standby of amateur and industrial television apparatus. These tubes are now being consistently run at a much higher definition and at much lower light levels than RCA stipulate in the data. Careful attention to shielding and focusing, together with such unlikely tricks as attaching very small magnets near the camera, have improved results out of all belief. Similar unorthodox short-cuts with the studio cameras have produced good results with about half the specified scanning power, although the use of milk-bottle tops instead of an adjustable iris diaphragm may be frowned upon by the purists!

A few monoscopes have also been supplied for experimental purposes, although it is difficult to judge how popular these will be compared with the flying-spot scanner. As a good picture source, of course, they are unsurpassed, and serve to remove one of the largest unknowns in the entire vision system, the output from the camera.

Many experimenters are still using very simple scanning equipment, wiring the scanning and monitor c.r. tubes in parallel so that no synchronizing problem arises. However, more advanced pulse generators are now being more generally used, and the advantages of interlacing—relatively few in amateur work—are being exploited by some of the more advanced workers. Conventional circuits vie for popularity with some highly unconventional ones. These all use a minimum number of valves, perhaps at the expense of long-term reliability, but perform the functions for which they were designed. One such unit, giving a complete B.B.C.-type waveform, uses just nine valves, whilst a conventional circuit employs fourteen. The use of a B.B.C. standard waveform is universal amongst the transmitting members, but some closed-circuit enthusiasts have been using a very short frame synchronizing pulse to eliminate the need for inserted pulses in the frame interval. Current development is to find a count-down circuit using still fewer valves; for amateur purposes it does not matter greatly if the counter has to be reset occasionally, and with this in mind great economies can be made. On the other hand, some readers may have seen the pulse generator exhibited by the R.E.M.E. amateur radio club at the past Radio Show at Earls Court; this used binary counters and a servo correcting system, in all some 26 valves.

Transmission Experiments

The transmitters continue to be handicapped by lack of suitable valves, and by the fact that they are blazing a new trail all the time. The present transmitting licence is shortly to be replaced by a new one, at, it is earnestly hoped, considerably less cost. As an example of what can be done, it may be mentioned that G2WJ/T near Dunmow has repeatedly put a television signal into G3GDR at Kings Langley, some 30 miles distant, with just 2 watts peak white. The transmitter uses a conventional driver to 210Mc/s employing two QVO4/7s and an 832; the power amplifier unit uses a CV53 doubler driving a CV53 power amplifier in a coaxial line circuit. This valve, by the way, is actually a receiving type, but is the only suitable one easily and cheaply available. At G2WJ modulation is on the grid from a cathode follower; the picture source is an image iconoscope camera and the pulse generator gives a standard B.B.C. output. The aerial consists of eight stacked full-wave elements with a wire netting reflector about 30ft off the ground in a reasonably flat location. At G3GDR a trough mixer using a CV102 diode and a cascode head amplifier is used, output being at 45Mc/s to a standard B.B.C. television set. It is found that pictures can be resolved whenever the signal strength is S9 or greater. Contact at this range, although an everyday occurrence with telephony or morse, is the result of months of painstaking tests and adjustments by the station concerned.

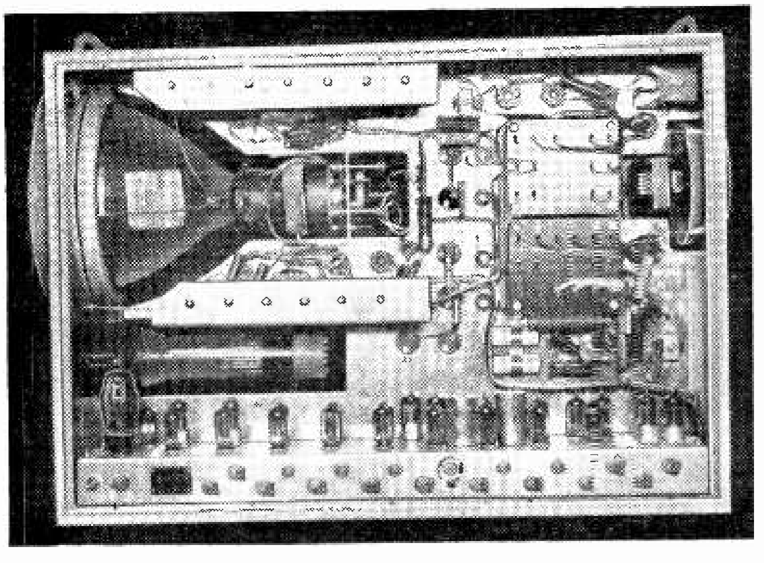
Other power amplifier stages being tried are coaxial units with Det24 disc seal triodes, and trough circuits with QQEO6/40 and QQEO3/20 types. Unfortunately, these valves are extremely scarce and very expensive, and in most cases not too easy to modulate with television signals. Modulation is normally either on the grid, as above, or with a bootstrap modulator feeding both power amplifier and driver stages. It must be remembered that most of these 70-cm transmitters are using earthed-grid techniques, which can make wide-band modulation very difficult. A d.c. restorer is usually used on the modulator chassis in preference to a d.c. clamp so that only composite video need be fed to the transmitter rack. A simple audio amplifier has to be included so that the call-sign can be sent by telephony on the vision channel, in accordance with Post Office regulations!

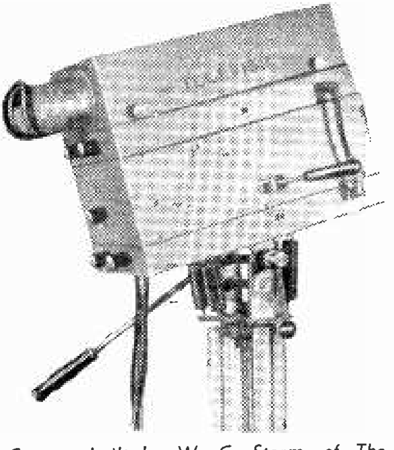
Aerials form a fascinating branch for experiment; stacks, Yagis, helical arrays and fan aerials all have their adherents, but in general highly directive arrays are in use owing to the low transmitter power available. On the 430-Mc/s amateur band, where most of the experimental transmissions take place, bandwidth restriction in the aerials is not a limiting factor. Very little work has been done on the higher frequencies, again because of the shortage of suitable valves.

70-cm receiver design has improved considerably in the last year, several very good designs having appeared in the literature. The sensitivity and noise figures obtained are much superior to any obtained with commercial equipment. Most of these designs are for communications-type equipment, but can be adapted to the needs of amateur television; typical figures are 95 db below 30mV for the sensitivity and 12 db for noise, under wide-band television conditions. Careful attention to the head amplifier of the i.f. chain makes for a low noise figure, and a cascode stage is almost a necessity.

A considerable amount of ingenuity has been expended in the construction of mechanical parts; a camera dolly made out of two bicycles; a camera crane weighing several hundredweight consisting of parts of a mangle and a bedstead; camera-tube racking devices made out of toy railway track. Dexion and Gascoigne fittings plus Woolworths towel rail have

Mobile camera unit built by Dr. de Waard, of Groningen, Netherlands. The 625-line interlaced picture from the iconoscope camera is sent by a 70-cm transmitter to the main transmitter working on 145 Mc/s. Sound is conveyed by f.m. on a 5·5-Mc/s sub-carrier. Power (about 700 watts) is supplied by a petrol generator in a trailer.





Camera built by W. G. Storm, of The Hague, Netherlands, with home-made panning and tilting head, and (left) camera control and monitoring unit designed for a Vidicon-type camera by K. A. J. Russell.

turned up in the most unlikely situations. Post Office-type construction, with valves at the front and circuitry at the rear of the racks, is very popular. To ease matters generally, and to permit any units to be used together, a standard output of 5 volts across 75 ohms has been adopted. This is larger than B.B.C. level, but means that just one video amplifier is all that is required to feed a monitor tube.

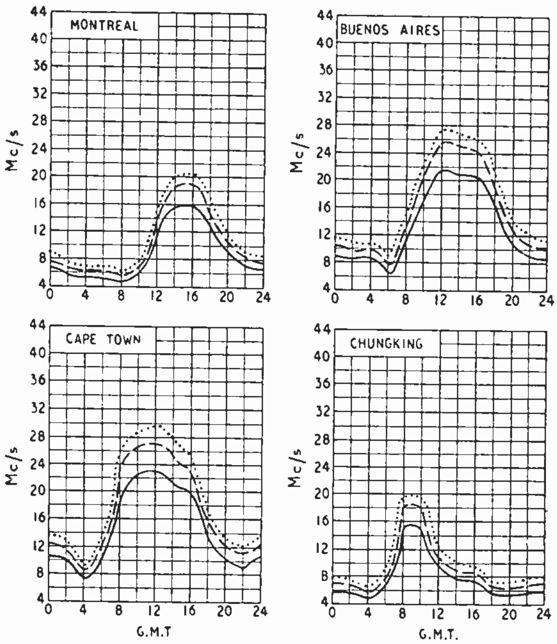
Five people are actively engaged in experiments with colour television. These experiments are confined to the transmitter mainly, since tri-colour tubes and the like are quite out of the question. A complete three-colour rotating-disc camera running 100 frames 150-line sequential has been built and is under test. A colour flying-spot scanner is under construction now that a flat-faced white-trace scanning c.r. tube has been found. Although it is not likely that any great discoveries will be made, the fascination of producing live colour television pictures is likely to draw more adherents as time goes on. In the meantime black and white television offers plenty of opportunity for experiment!

Short-wave Conditions

Predictions for December

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during December.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.



——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

– – – – PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

·········· FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

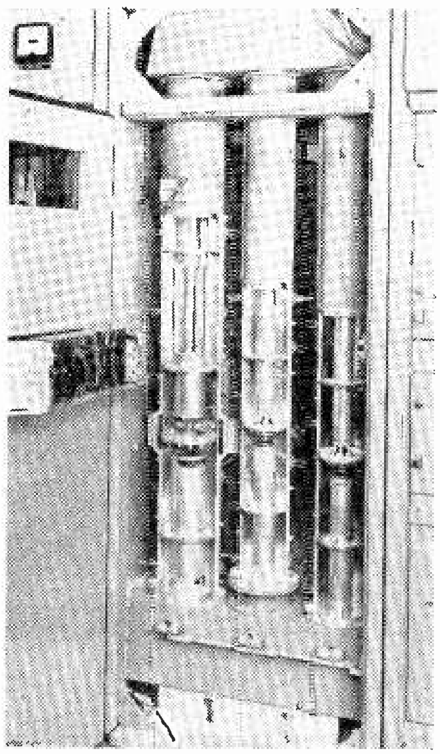
BAND 3 TELEVISION TRANSMITTERS

SOME idea of what television transmitters for Band 3 will look like, if we ever get them here, can be gained from the new Marconi 2½-kW medium-power equipments which have just gone into service at Rome and Pisa. Their design is particularly interesting in that coaxial-line techniques are used throughout the r.f. power stages of both the vision and sound transmitters.

The vision equipment has a crystal-controlled drive oscillator, two Class C r.f. amplifiers using earthed-grid triodes and a final modulated tetrode amplifier with broad-band output circuits. In the two Class C stages, coaxial lines form the anode and cathode circuits of the valves and are tuned by adjusting their lengths with shorting rings. A quarter-wave coaxial line provides the output circuit of the transmitter and this is coupled to the anode circuit of the final stage by capacitance and to the aerial feeder by a quarter-wave matching section. These two circuits, anode and output, together form a double-tuned circuit which is arranged to give a flat response. All three valve stages are neutralized.

The sound transmitters are very similar to the vision ones in the design of their r.f. amplifiers, but they have narrow-band output circuits and make use of the Marconi "FMQ" system in which frequency modulation is applied directly to the crystal-controlled driving oscillator.

One of the vision transmitters showing (from right to left) the first, second and final amplifiers. Sections of the coaxial lines have been removed to give access to the valves inside.



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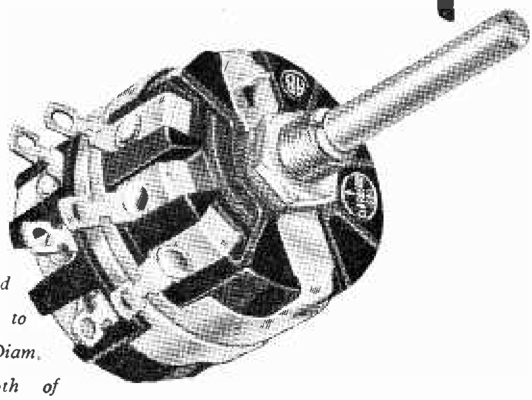
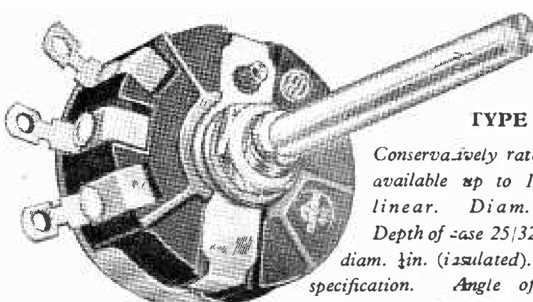


TYPE 58 (Dual)

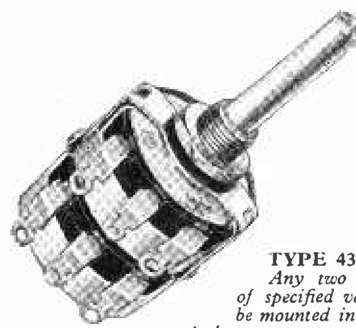
Two controls in tandem operated by a common spindle. Each control wound to any resistance up to 100,000 ohms linear. Diam. 1.21/32in. Total depth of case 1.9/16in.

All **Clarostat** controls are manufactured with high grade Bakelite cases of rugged construction. Solder tags are heavily silver-plated and of special design, removing all danger of turning or loosening under operating conditions. The controls are fitted with metal dust covers which are firmly keyed into the Bakelite casing and connected to the fixing bush, thus providing automatic earthing of cover. Samples available on application.



TYPE 58

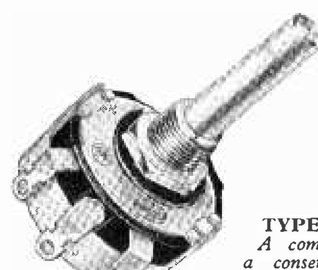
Conservatively rated at 3 watts: available up to 100,000 ohms linear. Diam. 1.21/32in. Depth of case 25/32in. Spindle diam. ¼in. (insulated). Length to specification. Angle of rotation, mechanical 300°. Effective 280°.



TYPE 43 (Dual)

Any two controls of specified value can be mounted in tandem operated by a common spindle. Diam. 1⅜in. Total depth of case 1.3/16in.

All controls can be supplied with special windings and closer tolerances to specification. Can also be supplied fitted with single or double pole mains switch if required.



TYPE 43

A compact control with a conservative rating of 2 watts. Available up to 25,000 ohms linear. Diam. 1⅛in. Depth of case 19/32in. Spindle diam. ¼in. (insulated). Length to specification. Angle of rotation, mechanical 300°. Effective 280°.

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Here are some specimen data.

Unistor Code	D.C. Current Rating in Max. Ambient Temp. 55°C.	71°C.	Maximum Continuous Inverse D.C. Voltage	Maximum Instantaneous Inverse D.C. Voltage	Capacitance at Approx. Zero Volts
	mA	mA	Volts	Volts	pF
Q1/1	0·25	0·25	20	56	20
Q3/1	1·5	1·5	20	56	65
Q6/1	7	3	20	56	500
Q8/1	10	4	20	56	1,000

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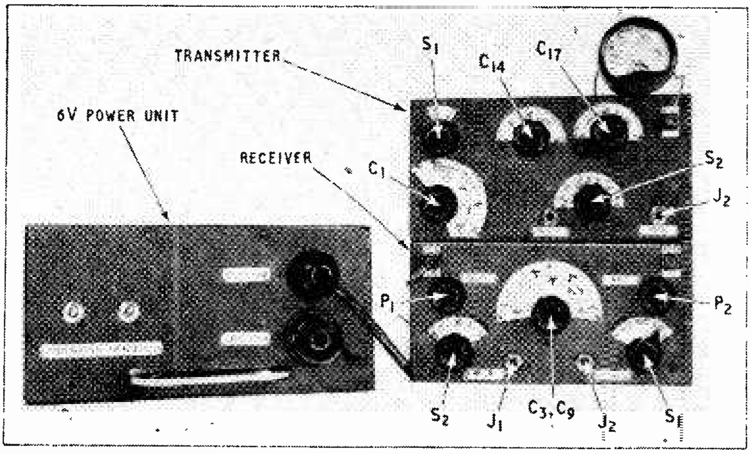


Two-Band Transmitter Receiver

Low Power Equipment for Portable and Fixed Stations

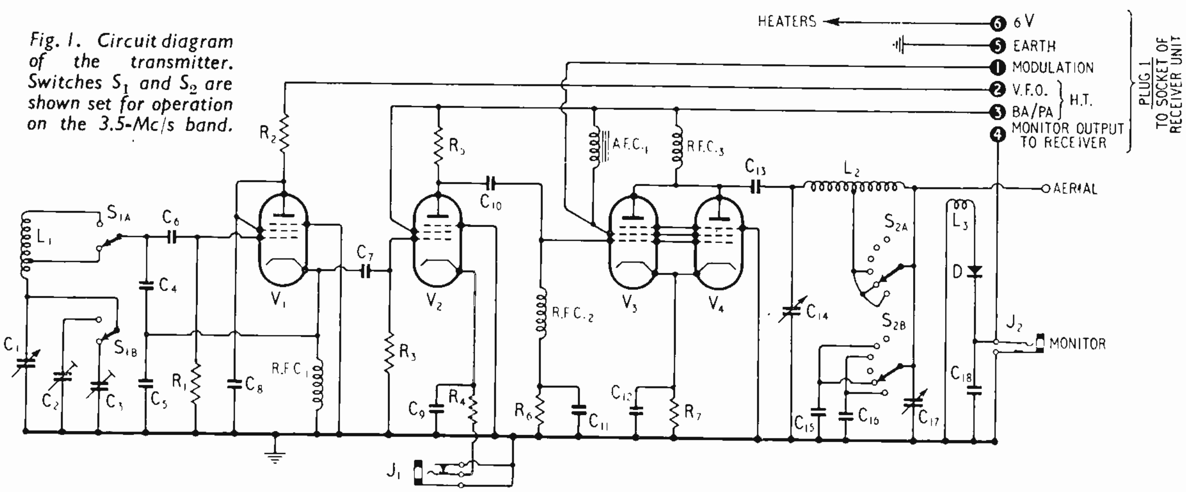
By G. P. ANDERSON*

THE apparatus to be described was built primarily for use as a portable station, but has been used also as the "home station" when the main transmitter was out of action. Physically it has been designed to fit comfortably into the glove compartment of a small family car, and is constructed in three units, including the power supply. It provides telephony and c.w. operation anywhere in the popular 160- and 80-metre bands, with switched band change, and an input of 5 to 7½ watts; at the lower input one type of valve is employed throughout thus simplifying the carriage of spares. But at the higher input a different valve is used in the final stage of the transmitter. Provision is made for operation with almost any length of wire as an aerial, and excellent results have been obtained with random wires of the order of 80 feet long simply thrown into a tree. The units described can be placed in the car and be in operation within a few minutes; in view of recent natural disasters this feature is felt to be important.

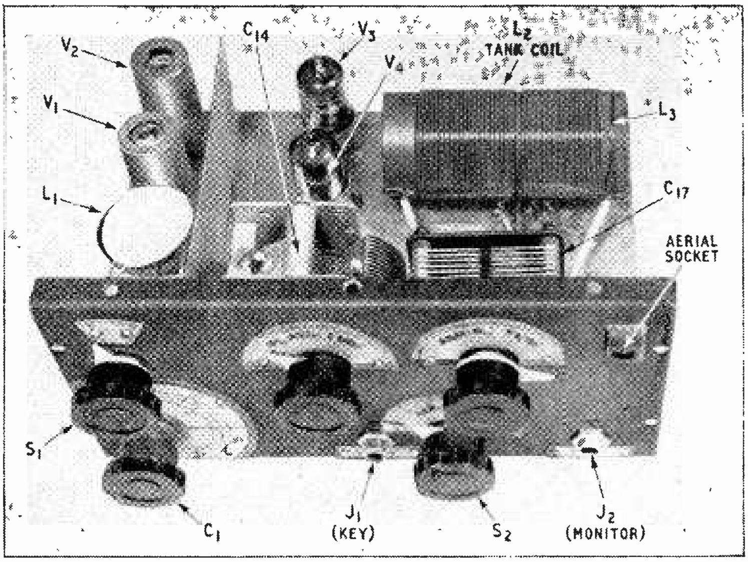
Before proceeding to describe the circuits in detail, a general outline of the apparatus will be given. As mentioned above, the complete apparatus except for the power unit occupies two boxes. These are identical in size, and measure 8in × 4in × 5in deep. The transmitter is assembled in one box, and consists of a variable frequency oscillator, followed by a buffer amplifier and a power amplifier, switched for the 1.8- and 3.5-Mc/s amateur bands, with a "pi"-network tank circuit to facilitate connection to a wide range of aerials. The second box contains a t.r.f. receiver and the audio stages are used for modulating the transmitter when required. Provision

* Amateur radio station G2QY.

Fig. 1. Circuit diagram of the transmitter. Switches S_1 and S_2 are shown set for operation on the 3.5-Mc/s band.



Our title picture shows the complete station with the transmitter (upper right) receiver-modulator-control unit (lower right) and 6-V power supply unit on the left.



Looking down onto the transmitter unit. The buffer amplifier is on the left of the screen and the PA tank coil is in the right-hand corner at the back of the chassis.

is made also for monitoring the signal during transmission, and "netting"—that is, setting the transmitter accurately on a given frequency without radiating a signal, by means of the receiver. All control, except transmitter tuning, is performed from the receiver unit.

Power for the apparatus may be obtained from a vibrator or a rotary generator supply, from batteries or from a small mains unit.

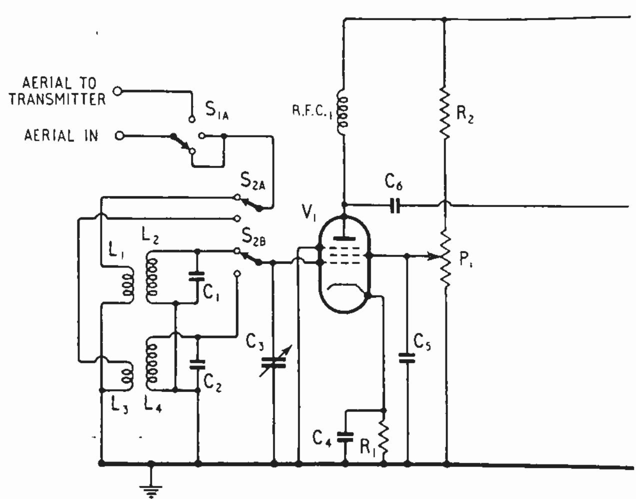
Transmitter Unit :—The transmitter utilizes the popular "Clapp" VFO circuit, working always at half the transmitter output frequency; the circuit constants have been designed so that each band occupies the full 180° of dial spread. Originally the oscillator was designed to work on the fundamental output frequency, but when wires approaching a half wavelength long were used as aerials, pulling of the oscillator frequency occurred, presumably due to the transmitter chassis being at high r.f. potential, despite connection to earth. The oscillator is followed by an untuned buffer amplifier, to further reduce any likelihood of changes in the oscillator frequency when adjustments are made to the last stage; the BA is used also for keying, the key being inserted in the cathode circuit. The following stage is the power amplifier, and consists of two valves connected in parallel. At the frequencies covered by this transmitter the extra capacitance produced by paralleling the valves is not serious and the two valves enable the desired input of five watts to be easily achieved using the same type of valve as is used in the earlier stages, namely the 6AM6 or its equivalent. Alternatively, should a 50-% increase in power be desired, a pair of 6AM5 valves may be substituted in this stage.

A further advantage of the parallel connection in preference to push-pull is that it allows a "pi" network to be used for the tank (or anode) circuit, and enables a wide range of aerial impedances to be catered for and thus simplifying the provision of aerials. For operation on the 3.5-Mc/s band approximately half the anode coil is short-circuited, but this does not appear to seriously reduce the efficiency. As will be seen from the circuit diagram Fig. 1, a 300-pF variable capacitor is used to tune the valve side of the "pi" network and a 500-pF variable with switched additional fixed 500- and 1,000-pF capacitors on the load side. The crystal rectifier shown loosely coupled to the aerial circuit is used to monitor transmissions, either aurally or by means of a meter. The meter if preferred may be inserted in the jack on the front of the transmitter; alternatively, the output of the rectifier is connected to the receiver-control unit, and is automatically connected to the operator's headphones when transmitting.

The a.f. Choke in the screen supply to the PA valves is used for modulation purposes. As will be seen later, when the apparatus is set in the "send" condition, audio output from the a.f. stages in the receiver-modulator unit is connected to the screen end of this choke, and modulation is applied to the screens. The choke is fitted in the transmitter unit so that the transmitter is complete in itself, and the required h.t. voltages are applied to all stages if the unit is used without the companion receiver-modulator.

The PA stage is provided with sufficient cathode bias to protect the valves during keying; the 100-Ω resistor, R_7, maintains a fairly constant load on the power supply with and without r.f. drive to the PA, thus further minimizing the possibility of frequency shift or "chirp." The resistor R_4 and capacitor C_9, in addition to providing bias for V_2, serve also as a filter for reducing key-clicks.

As will be described in more detail later, there are three positions of the main operating control—"Net," "Receive" and "Transmit." In the "Net" position power is applied only to the oscillator valve in the transmitter, while the receiver is also running, enabling the transmitter to be set to zero-beat or work alongside another signal. In the second ("Receive") position, no h.t. power is applied to any stage



of the transmitter, while in the "Send" position full power is applied to all transmitter stages, the r.f. section of the receiver is muted and the monitoring facilities are automatically brought into circuit. Modulation is applied also, but if telephony is not to be transmitted the removal of the microphone plug from its jack will ensure no modulation on the carrier.

The controls provided on the transmitter unit comprise: oscillator band selection and tuning, PA anode-circuit band selection, and tuning for the "pi" network. The two jacks visible on the front panel are for the key and either headphones for monitoring or connection of a d.c. milliammeter to assist in tuning the transmitter. In practice it has been found more convenient to use a 200-milliampere r.f. meter in the aerial lead for tuning purposes, the capacitors in the tank circuit being adjusted for maximum aerial current. Power and audio connections between the transmitter and the receiver-control units are made through multiway plugs and sockets fitted at the backs of the units, while the aerial is connected by a separate lead to the appropriate socket on the receiver. All connections from the transmitter (except the key) are made through the receiver to allow switching to be controlled from that unit.

The transmitter described is complete in itself for c.w. working, and may be so used in conjunction with any receiver covering the appropriate frequencies. The power consumption is of the order of 50 mA at 250 V h.t., while the heaters require 1.2 A at 6 V (1.0 A if 6AM5s are substituted in the last stage for greater power, when the h.t. consumption will be approximately 60 mA.).

A small moving-coil microphone is suitable for use with this apparatus, and an ex-government moving-coil headphone receiver serves the purpose admirably, being very sensitive as well as robust enough for use in the field. The one used by the writer was modified by cutting away the bakelite grill over the moving-coil unit diaphragm, but leaving the heavy rubber earpiece flanges in place, as they protect the microphone if it is dropped.

The dial of the oscillator tuning control may be conveniently calibrated in kilocycles for each band, and a note on a suggested procedure is contained in a later paragraph. The calibration of the other controls may be made to suit the individual constructor.

Receiver-modulator-control Unit:—In designing the receiver the question of superheterodyne or "straight" receiver was thoroughly examined, bearing in mind the need to receive c.w. and telephony signals, and the desire to restrict the design to the use of the 6AM6 type of valve in order to line up with the transmitter. Also in the interests of space it was desirable to limit the number of pre-a.f. stages, since two audio frequency stages were necessary to provide modulation for the transmitter. Unless sufficient signal frequency selectivity is provided the superheterodyne is prone to interference from second-channel signals, and provision has to be made for a beat frequency oscillator (or for the second detector to oscillate) to enable reception of c.w. to be carried out. It was decided therefore to build the receiver on the familiar t.r.f. circuit lines, with one stage of r.f. amplification ahead of the detector, and two stages of a.f. amplification following it. A further optional stage has been provided to operate a small loudspeaker.

As in the transmitter the circuit constants have been selected to spread each band over the entire 180° of capacitor rotation. Detector oscillation is provided by a cathode tap on the grid coil, and is controlled by the screen potentiometer P_2 (see Fig. 2), while the r.f. gain is adjusted by means of P_1. Smooth regeneration control is assured by arranging for the detector to oscillate with a low screen voltage.

At first glance the functions of the several switches shown may not be apparent, so the service performed by each section will now be explained; the references are to Fig. 2.

S_1 is a six-pole three-way switch for net, receive

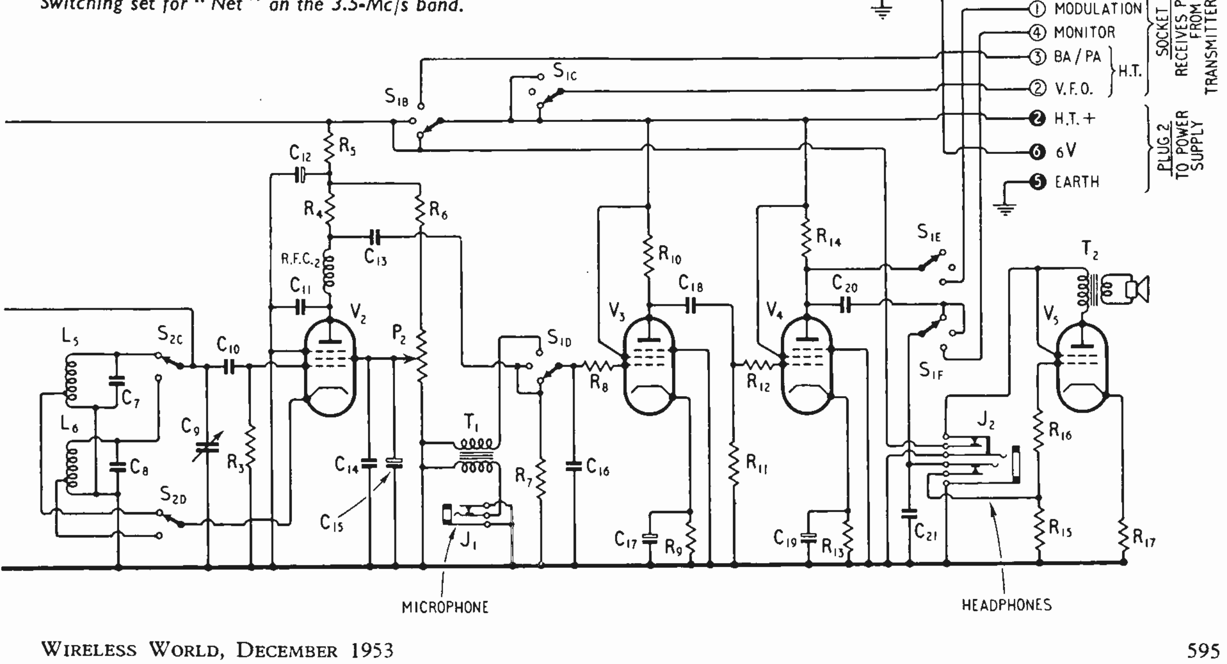


Fig. 2. Circuit diagram of the receiver-modulator unit. Switching set for "Net" on the 3.5-Mc/s band.

and transmit and its principal functions have been explained already, but in addition it changes over the aerial when required from the receiver to the transmitter.

The various parts of the switch performing these functions are as follows :—

S_{1A} ; Aerial change-over, transmitter to receiver.

S_{1B} ; H.T. to receiver or to BA-PA stages of transmitter.

S_{1C} ; H.T. to oscillator in transmitter in " Net " and " Send " positions.

S_{1D} ; Input to audio amplifier, from receiver or microphone.

S_{1E} ; Connects output of a.f. stages to screen of PA in transmitter for modulation purposes.

S_{1F} ; Selects output of receiver or monitor and connects it to the headphones.

S_2 is the waveband selector, switching the coils and padding capacitors in the grid circuits of the r.f. and detector stages by means of S_{2A} to S_{2D}.

In addition to the conditions that are set up at the various positions of the two switches S_1 and S_2 the presence or absence of the headphone plug in the jack provided for it determines the connections to the output valve in the receiver. Thus, with the plug not inserted, the signal from S_{1F} is connected through the jack contacts to the grid of V_5, and at the same time h.t. is applied to the plate and screen of this valve. In order to avoid feedback from the loudspeaker into the microphone during transmission, when headphones are not used, the h.t. supply to V_5 is disconnected by means of S_{1B}, being taken from the line supplying the r.f. and detector stages. Thus there is no monitoring facility during transmission when the loudspeaker is being used for reception.

An examination of the circuit will show that during transmission the a.f. choke in the screen of the PA is shunted by the 33-kΩ resistor R_{14} in the anode circuit of V_4. This resistor is included to enable the receiver to be used independently of the transmitter if desired. The resistor has no measurable effect on modulation.

Care should be exercised in wiring the receiver to prevent instability being caused when the detector is oscillating, due to r.f. finding its way into the a.f. stages. A certain amount of filtering is included, and screened wires should be used for heaters and grid leads of V_3 and V_4.

As in the case of the transmitter, it makes for convenient operation if the tuning scale is calibrated in frequency.

Power Supplies :—The power supplies required for the complete station are 2.4 A at 6 V, and 70 mA at 250 V, and as stated earlier these may be obtained from a small mains unit, or for portable operation from batteries and a vibrator, or from a rotary generator. As an example of the battery-loading that may be expected, the writer uses a surplus rotary transformer Type 47, which is obtainable at small cost. This unit is designed to give 450 V out with an input of 9 V, but when run from a 6-V supply it provides exactly 250 V when fully loaded by the transmitter-receiver for a battery consumption of 4 A. Off load the voltage rises to 350 V only, so that with the components specified there is no danger of breakdown if the generator is switched on before the heaters are connected. Very simple noise suppression has been found to be sufficient, and the complete circuit of this unit is shown in Fig. 3.

Construction :—No details of layout are given, but provided the components are placed in approximately the positions shown in the photographs, no trouble should be encountered. If reasonably miniature components are used there will be ample space for wiring after all the components that are fitted to the chassis have been mounted. All wiring should be carried out in at least 20 s.w.g. wire to ensure rigidity and care should be taken in making soldered joints to avoid faults caused by vibration during transport. The layout of the r.f. and detector stages in the receiver should be arranged so that the wiring of the two stages is of similar length.

In the original model the receiving tuning capacitors C_3C_9 were " manufactured " from one miniature air-spaced 100-pF variable capacitor (Polar Type C18-02) by careful application of a small hacksaw ; the stator plates are supported at both ends, and it was found possible to divide the stator into two sections. A small copper screen was then fitted to the capacitor to provide screening between the two halves. Alternatively a small two-gang capacitor could be used, such as the Polar Type C28-142, 50+50 pF.

As an aid to calibration of both units, a separate 200-pF variable capacitor was found to be invaluable. A well-calibrated receiver is required also on which to check the frequencies.

Transmitter Adjustment :—Having checked by means of a suitable receiver that the oscillator is working, S_1 should be set to " 3.5 Mc/s " and this band calibrated first. The external variable capacitor should be connected in parallel with the tuning capacitor C_1, which should be set to maximum capacitance. (The fixed capacitors C_2 and C_3 should be omitted, and the trimmers C_2 and C_3 set to mid-capacitance at this stage.) The oscillator may now be tuned to the low frequency end of the band by means of the external capacitor, remembering that the oscillator is working at half the frequency of the transmitter output—i.e. the low frequency end of the " 3.5-Mc/s " range lies at 1,750 kc/s. C_1 should then be set to minimum capacitance and the frequency of oscillation sought on the check receiver ; it should be in the neighbourhood of 1,900 kc/s (half of 3,800 kc/s). If it is too high the inductance of L_1 should be reduced by removing a couple of turns, or *vice versa* if too low and the procedure repeated until the range 1,750 to 1,900 kc/s is just covered by the 180-° rotation of the tuning capacitor. The external capacitor should now be replaced by a fixed capacitor of the same value $\pm$ 20 pF ; if means of measuring the value to which the variable capacitor is set are not available an idea of the capacitance may be obtained from the amount the plates are in mesh. Final adjustments to frequency are made on the trimmer C_3. This procedure should now be repeated for the " 1.8-Mc/s " band, the oscillator in this case covering the range from 900 to 1,000 kc/s, and the top end of

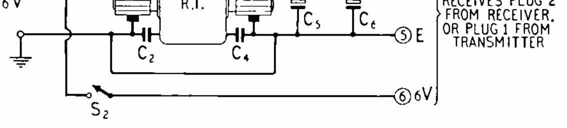
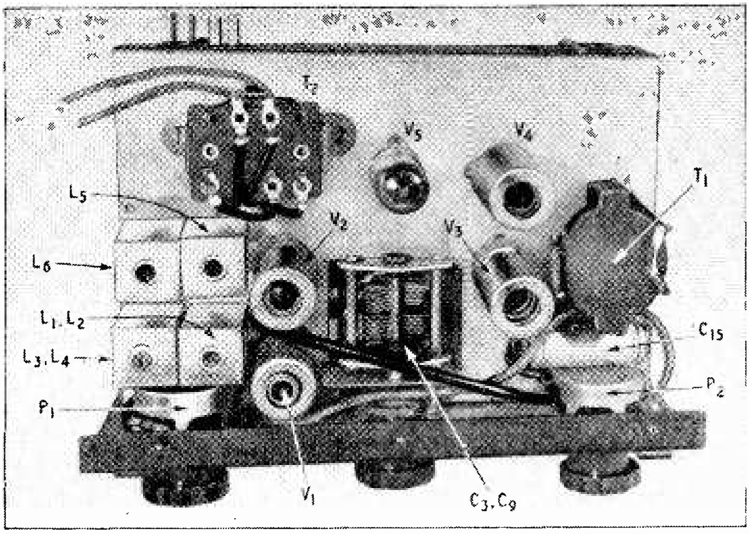


Fig. 3. Schematic-circuit of rotary-generator power supply unit. If a car battery is used the wiring should be arranged, if possible, so that the h.t. negative line is also the " earthed " lead of the battery. The extra h.t. positive output (socket 3) is provided so that the transmitter may be used without the receiver if desired.



The receiver-modulator-control unit has the r.f. coils on the left and the a.f. and modulator components on the right. The tuning capacitor occupies the centre position.

L_1 should be adjusted—i.e. the part not included in the circuit when S_1 is set to 3.5 Mc/s—so that the calibration on that band is unaffected. Final trimming for this band (1.8 Mc/s) is of course made on C_2. A check should finally be made of the calibration on the 3.5-Mc/s band in case it has been disturbed.

Having calibrated the oscillator the transmitter as a whole should be tested into a dummy load. A 100-Ω, 3-W resistor may be connected in series with a 200-mA r.f. meter between the aerial terminal and the chassis and h.t. applied to all stages. The loading controls C_{17} and S_2 should be set to approximately mid-value for the band under test, and the anode tuning capacitor C_{14} should be rotated until maximum current is indicated in the ammeter. Experimental changes in the loading capacitance followed by re-adjustment of the anode condenser may be made in order to obtain a higher value of current in the load.

The procedure described in this paragraph is to be followed in tuning the transmitter when it is connected to an aerial. Summarized it consists of:

Set VFO tuning to the desired frequency, with the control switch S_1 on the receiver unit at either "Net" or "Receive."

Set the coarse load switch S_2 on the transmitter to the mid-position for the appropriate band.

Apply h.t. to the transmitter (control switch to "Send") and rotate C_{14} to show maximum aerial current.

Vary the value of the loading capacitance (by C_{17} and S_2) and readjust C_{14}, until the absolute maximum aerial current is achieved.

Receiver Adjustment:—The method of setting the detector tuning to cover the range required is similar to that described for the transmitter, except it is suggested that the oscillator of the transmitter be used as the signal source, and the receiver adjusted to it. (Also, of course, check that the detector is oscillating on the fundamental frequency to be received.)

With the detector circuit tuning comfortably over the ranges 1,800 to 2,000 kc/s and 3,500 to 3,800 kc/s, an aerial should be connected and the r.f. gain control advanced about half way, with the tuning set to a signal approximately in the middle of one of the ranges. Fixed capacitors of the same value as were determined for the detector stage should be connected across the r.f. grid coil, and the stage tuned by means of the dust core slug in the coil for maximum gain; an increase in the noise level will also be noticed when the stage is correctly tuned, and serves as an additional guide to the proper setting. This is then repeated on the other band.

Performance:—The units described have been used on several occasions when operating portable from sites near London. The transmitter and receiver fit neatly into the glove shelf of a small family car, and with a length of fine wire (of the order of No. 34 s.w.g.) simply thrown into a tree as the aerial, Telegraphy contacts have been made with stations in all parts of the British Isles and adjacent European countries, on both the 1.8- and 3.5-Mc s amateur bands. Telephony contacts at ranges up to 50 miles are easily attainable on 1.8 Mc/s, but the high power competition on 3.5 Mc/s renders telephony working on that band extremely difficult.

In order to comply with the conditions of the amateur licence, means of measuring the transmitted frequency must be available whenever a signal is radiated. During operation, however, a general check may be maintained by comparing the dial readings of the transmitter and the receiver; should any discrepancy appear, the transmitter should not be used until the cause of the disagreement has been located and cleared.

LIST OF COMPONENTS

Transmitter Unit (Fig. 1)

Capacitors

C_1	50 pF variable
C_2	140 pF approx. (fixed plus trimmer)
C_3	170 pF approx. (fixed plus trimmer)
C_4, C_5, C_8, C_9, C_{11}, C_{12}	0.001 μF
C_6, C_{18}	100 pF ceramic
C_7	220 pF Silvered mica
C_{10}, C_{13}	150 pF Silvered mica
C_{14}	500 pF variable
C_{15}	330 pF Silvered mica
C_{16}	680 pF Silvered mica
C_{17}	300 pF variable

(All capacitors 350 V working)

Resistors

R_1, R_3, R_6	22 kΩ, ½ W
R_2	3.9 kΩ, 1 W
R_4	220 Ω, ½ W
R_5	10 kΩ, 1 W
R_7	100 Ω, ½ W

Miscellaneous

AFC_1	50 H 15 mA A.F. Choke
$RFC_{1, 2, 3}$	1.25 mH R.F. Choke. (Eddystone 1010)
S_1	Two-pole two-way rotary switch (wafer)
S_2	Two-pole six-way rotary switch (wafer)
D	Germanium diode
J_1	Jack (closed circuit when plug removed; Bulgin type J12)
J_2	Jack (Bulgin Type J11)

List of Components—Continued.

Coil Details

L_1	1 in diameter, 140 turns tapped at 47 turns from earth, 32 s.w.g. enamel close wound. (222 μH, tap 53 μH)
L_2	1½ in diameter, 60 turns tapped at 20 turns from earth, 20 s.w.g. enamel close wound. (62 μH total)
L_3	2 turns on aerial end of same former as L_2

Valves

V_1, V_2, V_3, V_4	6AM6 (EF91, Z77 etc.)

Receiver-Modulator Unit (Fig. 2)

Capacitors

C_1, C_7	122 pF approx. (see text)
C_2, C_8	200 pF approx. (see text)
C_3, C_9	2 × 40 pF variable (see text)
C_4	220 pF Silvered mica
C_5	0.001 μF
C_6, C_{11}	47 pF Silvered mica
C_{10}	100 pF
C_{12}	8 μF Electrolytic
C_{13}, C_{14}, C_{18}	0.1 μF
C_{15}	2 μF Electrolytic
C_{16}	0.01 μF
C_{17}, C_{19}	50 μF 12 V working
C_{20}	0.5 μF
C_{21}	0.05 μF

(All 350 V working, except where stated)

Resistors

R_1	150 Ω, ¼ Watt
R_2	47 kΩ, 1 W
R_3	1 MΩ, ¼ W
R_4	220 kΩ, 1 W
R_5	100 kΩ, 1 W
R_6	56 kΩ, 1 W
R_7, R_{11}, R_{15}	220 kΩ, ¼ W
R_8, R_{12}, R_{16}	4.6 kΩ, ¼ W
R_9, R_{13}	220 Ω, ¼ W
R_{10}	33 kΩ, 1 W
R_{17}	820 Ω, ½ W
P_1, P_2	500 kΩ potentiometer 3 W

Miscellaneous

RFC1, RFC2	1.25 mH R.F. choke (Eddystone 1010)
S_1	Six-pole three-way rotary switch (wafer)
S_2	Four-pole two-way rotary switch (wafer)
J_1	Jack (closed circuit when plug removed; Bulgin Type J12)
J_2	Jack (multi-circuit; Bulgin Type J20)
T_1	Microphone transformer to suit microphone used
T_2	Pentode output transformer

Coil Details

L_1	3 Turns	Wound on same former (3.5 Mc/s)
L_2	26 Turns (8.6 μH)	
L_3	6 Turns	Wound on same former (1.8 Mc/s)
L_4	70 Turns (37.6 μH)	

(All close wound with 32 s.w.g. enamel wire on 0.3-in former. Neosid Coil Former Type 5,000/6E, with iron dust core Drg 500. Top Plate Drg 5001 and Screening Can DTV 2)

Valves

V_1, V_2, V_3, V_4	6AM6 (EF91, Z77 etc.)
V_5	6AM5 (EL91, etc.)

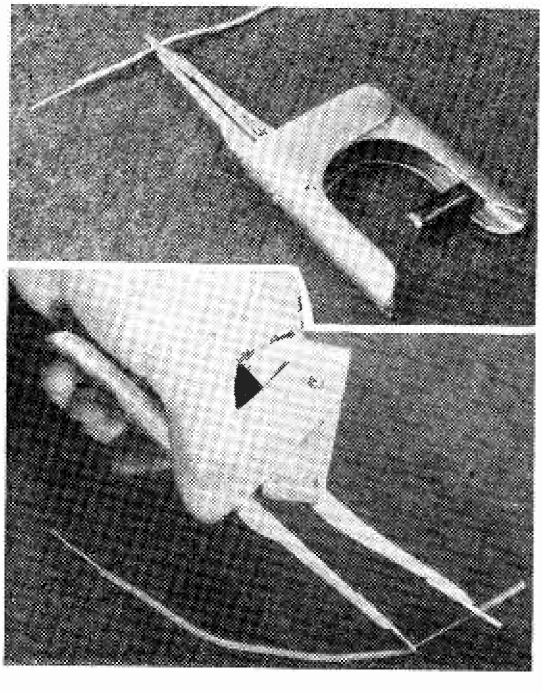
Six-Volt Power Unit (Fig.3)

Capacitors

C_1, C_2	0.5 μF 150 V Wkg.
C_3, C_4	0.1 μF 350 V Wkg.
C_5	4 μF 350 V Wkg.
C_6	16 μF 350 V Wkg.

Miscellaneous

AFC	20 H. 70 mA A.F. choke
RT	Rotary transformer 6 V; 250 V 70 mA (ex A.M. Type 47)
S_1, S_2	Single-pole on-off toggle switch



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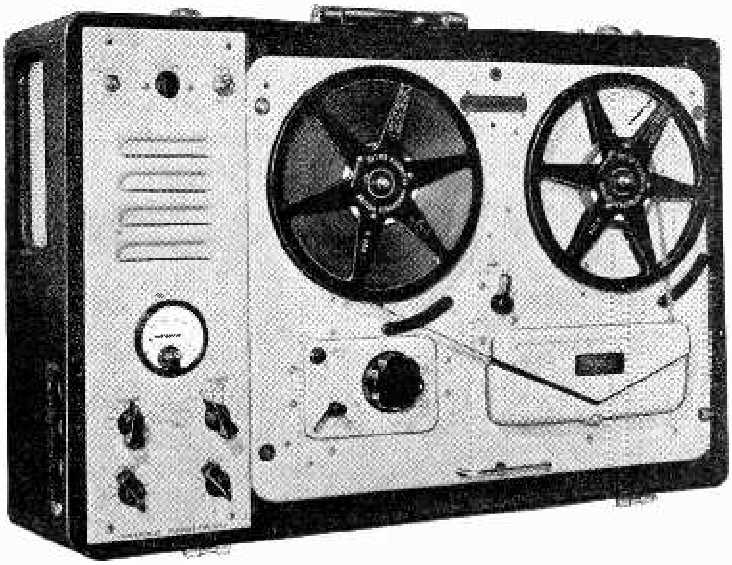
This wire stripper, which was designed by Norman E. Haley, of Cambridge, was recently shown to viewers in the B.B.C. television programme "Inventors' Club." It is understood that arrangements are being made for its manufacture.

"Modernizing the Wireless World Television Receiver": A Correction

An error in a valve type number occurred in the articles in the May, June and July issues dealing with the timebases. The frame output valve V_4 was given as type EL42; it should be EL41.

VORTEXION TAPE RECORDER



★ The noise level is extremely low and audibly the hum level and Johnson noise of the amplifier and deck are approximately equal. Only 25% of this small amount of hum is given by the amplifier alone.

★ Extremely low distortion and background noise, with a frequency response of 50 c/s.—10 Kc/s., plus or minus 1.5 db. A meter is fitted for the measurement of signal level and bias level.

★ Sufficient power is available for recording on disc, either direct or from the tape, without additional amplifiers.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load.

★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ Facilities are provided for using the amplifier alone and using power output or headphones while recording or to drive additional amplifiers.

★ The unit may be left running on record or play back even with 1,750 ft. reels with the lid closed.

The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22½in. x 15¾in. and weighs 30 lb.

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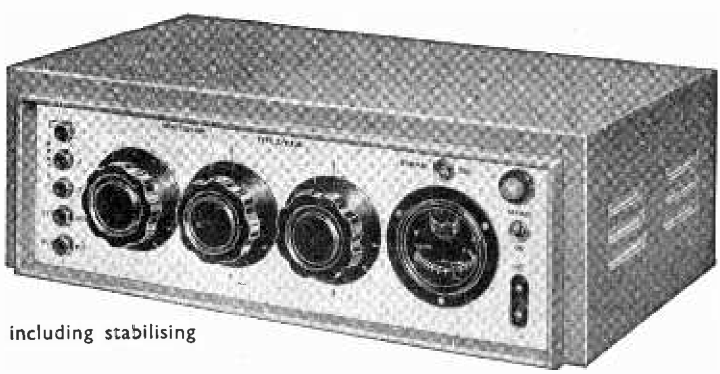

One milliwatt output on 600 ohm line (.775V) for an input of 30 micro-volts on 7.5-30 ohm balanced input.
Output balanced or unbalanced by internal switch. The meter reading is obtained by a valve voltmeter with 1 second time constant, which reads programme level, and responds to transient peaks.
Calibration in 2 db steps, to plus 12 db and minus 20 db referred to zero level. Special low field internal power pack supplies 8 valves including stabilising and selenium rectifier, consumption 23 watts.

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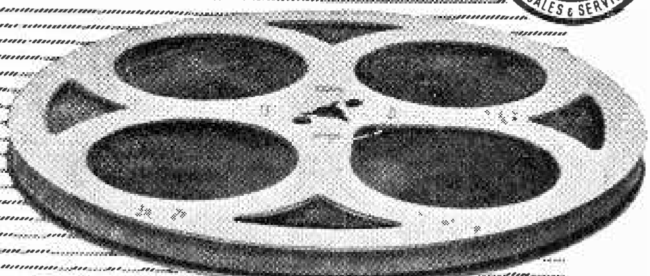

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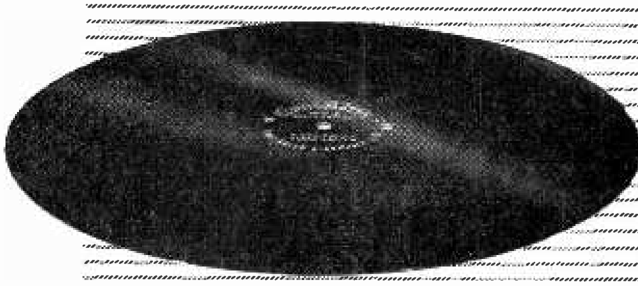

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Band 1 Colour Television

Vacant Space for an Independent Chrominance Signal?

ONE of the fundamental difficulties about the American N.T.S.C. colour television system which may go against its adoption in this country is that the colour signal is transmitted within the same band as the brightness signal (which provides the black-and-white picture for ordinary receivers). The system is designed to prevent this colour signal from getting through on to the monochrome picture, but nevertheless it seems there is still a possibility of a slight interference pattern being produced on the screens of existing sets.

A way of overcoming the trouble would be to transmit the colour signal separately in another channel where it could cause no interference—an expedient which the B.B.C. are already considering for this country. The problem of finding a suitable channel is another matter, but there is one possibility which arises in connection with the new London station to be built at Crystal Palace.

This station is being designed for double-sideband operation, like the present London transmitter, or for vestigial-sideband operation like the other British stations. When it goes on the air in about two years' time it will presumably radiate a double-sideband signal to cater for the double-sideband receivers still in use in the London area. Eventually, however, when these sets fall out of use, the transmitter can be put on to vestigial-sideband operation. This means that the upper sideband of the transmission will be partially suppressed and as a result there will be a gap left in the 41-68 Mc/s band approximately 2 Mc/s wide. It is this gap which could be used to accommodate the colour signal—which, in the N.T.S.C. system, only requires a bandwidth of just over 1 Mc/s.

Thus, with this colour signal and the existing monochrome signal a completely compatible colour transmission could be made available in the London area within the 6-Mc/s channel at present occupied by Alexandra Palace. No interference patterns would be produced on existing black-and-white receivers, and it is probable that the arrangement would make for somewhat simpler and less critical transmitters and receivers than will be necessary on the proposed American system. If the colour signal were transmitted from Crystal Palace it would, of course, serve only the London area. There is, however, the possibility that it could be "piped" around the country and radiated on the same frequency from other stations in the television network. The only problem then would be to prevent beats between the colour signals of adjacent transmitters, but no doubt this could be overcome by synchronizing the carrier frequencies.

A somewhat similar suggestion has been made in America by P. Raibourn in a booklet issued by the Hollywood station KTLA (see *Tele-Tech,* January, 1953). It is described as "adjacent-channel colour television" and the main idea is to develop colour television without affecting the market for black-and-white receivers. By using the Lawrence colour c.r. tube in all receivers, says Mr. Raibourn, it should be possible to design a standardized chassis for both monochrome and colour sets. (The Lawrence tube being "a black-and-white picture tube with colour elements added.") Conversion of a monochrome set to colour would then be possible by inserting an extra chassis to receive the adjacent-channel colour signal—at an estimated cost of not more than 50 dollars.

On the question of interference from the colour signal, Mr. Raibourn suggests that this could be avoided by seeing that the carrier frequency of the colour signal is spaced from the monochrome carrier by an odd multiple of half the line scanning frequency.

CRYSTAL PALACE TRANSMITTER

AS already forecast in our September issue (page 411), the new London television transmitter at Crystal Palace will be very different in design from the last high-power station built at Wenvoe. It will, as suggested, have a self-supporting mast (actually 640ft high) and a dual arrangement of two vision transmitters and two sound transmitters. These will be operated together to give greater reliability in much the same way as the twin Third Programme transmitters at Daventry. The power, however, will be somewhat lower than was originally thought. Each of the vision transmitters will have an output of 15 kW, making a total of 30 kW, while the sound transmitters will have outputs of 4.5 kW each. However, the station will have a high-gain aerial system, as predicted, and this will give it an effective radiated power (on vision) of approximately 250 kW—considerably higher than the 34 kW e.r.p. of Alexandra Palace and the 100 kW e.r.p. of the regional high-power stations. Provision is being made for raising the power still further if needed later on.

According to the B.B.C., this higher e.r.p. will not greatly increase the area already served by Alexandra Palace, but it will give a much stronger and therefore more interference-free signal in those parts of London where the level of interference is high. They also say that it will greatly improve the service along the south coast.

The transmitters, which are being built by Marconi's, will operate on the same vision and sound frequencies as Alexandra Palace. The vision transmitters will be made to a standardized design based on a new type of tetrode valve, giving greater simplicity and smaller physical size. They will occupy only about a quarter of the floor space of those at Alexandra Palace and Holme Moss and about half the floor space of those at Kirk o'Shotts and Wenvoe. As mentioned above, they will be capable of radiating either a double-sideband signal or a vestigial-sideband signal, as may be required. The two sound transmitters will not be standardized types but designed specially to meet the B.B.C.'s requirements.

Point Contact Germanium Rectifiers

(*Concluded from p. 514 of the previous issue*)

Principles of Operation and Their Relation to Performance and Reliability

By R. T. LOVELOCK,* A.M.I.E.E.

THE impedance of a germanium rectifier varies rapidly when the frequency exceeds a certain critical region, and for a given construction and physical configuration, the greater the "turn-over" voltage the lower the critical frequency region above which this rapid variation occurs. As a crude picture, which will enable a qualitative picture of the phenomenon to be given, one may visualize the junction barrier to be a successive series of germanium layers, each containing a little less acceptor impurity as one progresses from *p* to *n* type material. When current is passed in the forward direction the conductivity of these layers is increased by the presence of positive holes originating in the *p* material, and it is the presence of these holes in the junction which decreases its resistance and allows such a large forward current to flow. The holes are not generated in the junction, but flow into it from the *p* material at a finite velocity, and in consequence there is a delay between the application of forward voltage and the fall of resistance to its final low value. The lower the breakdown voltage of the junction the greater the impurity concentration and the thinner the barrier. Hence in these thinner barriers the distance to be traversed by the holes is less, and the critical frequency at which periodic time becomes comparable with delay is higher. It is when the periodic time of an applied sinusoidal voltage has become comparable with the delay time that the barrier never has time to fall to its minimum value of impedance, with consequent rise in equivalent forward impedance and fall of rectification efficiency.

Once the barrier layer is permeated with holes, and its resistance has fallen, removal of the forward potential does not obliterate the holes, but only ceases to replenish them as they are neutralized by free electrons. The density of holes during maintenance of forward potential is an equilibrium between the rate of arrival from the *p* material, and the rate of decay in the barrier; upon removal of forward potential they cease to arrive, but only slowly decay in density. Hence, upon removal of forward voltage there is a delay before the resistance of the junction rises to normal value, and when this delay becomes an appreciable fraction of the periodic time of a sinusoidal input voltage, it will cause a fall of equivalent reverse impedance. In commercial rectifiers the rate of decay is slower than the rate of penetration, and in consequence the frequency at which reverse resistance commences to fall is lower than that at which forward resistance commences to rise. Fall of reverse resistance causes fall of equivalent damping resistance imposed across a resonant driving circuit. Variation of rectification efficiency and damping resistance for a typical rectifier type is shown in Figs. 7 and 8.

In addition to the stray capacitance shunting the rectifier, due to leads, etc., there will be a quadrature component of current with leading power-factor, due to the mechanism of conduction within the junction. This component simulates a shunt capacitance, but the effective value of capacitance is frequency-dependent due to the delay in response just considered.

The theoretical variation may be calculated for a junction-type rectifier, and this variation is plotted in Fig. 9. The observed variation in point-contact rectifiers follows this theoretical law fairly closely, but it must be remembered that to obtain the total effective capacitance of the rectifier in its circuit the constant capacitance due to constructional strays must be added to this variable component. The capacitance plotted in the figure is that for zero applied potential: as increasing values of forward potential are applied to the junction, effective capacitance increases rapidly, but the increase on point-contact rectifiers is not so rapid as that for the junction, first because the full value of forward potential does not appear across the junction due to the presence of appreciable impedance in series with it, and secondly because as capacitance rises and impedance falls, the effect of the resistive component in series with it causes an increasing modification to the effective value. With increase of reverse voltage the effective capacitance falls, and observed variation is approximately equal to the theoretical value. When driven in a circuit by a sinusoidal voltage, it is evident that the effective capacitance is varying continuously throughout the cycle, and the effect is difficult to calculate; it is wise to measure the effective value of capacitance in the circuit to be used under various conditions of drive, and to use the observed values for calculation of performance.

Variations Between Samples.—If a batch of germanium rectifiers, all of the same nominal type be measured, it will be found that the impedance varies appreciably between the individual rectifiers. The problem in circuit design is to know the limits of this variation so that due allowance may be made for it. When calculating the spread of any parameter, it is always convenient to express it in terms of the "normal error distribution," a curve which is expressed in terms of two parameters and one variable. One parameter is the "mean value" and the other is the "standard deviation"; the variable is deviation from the mean value, and for the normal curve approximately two-thirds of the batch will lie symmetrically within one standard deviation of the mean, approximately 95 per cent will lie within two standard deviations of it, and an insignificant fraction will lie more than three standard deviations away. Even when the observed distribution does not conform to this law, it is often possible to "distort" the variable so that when plotted against the distorted scale it is "normal."

The reverse current at a particular voltage is not distributed according to this law, but if the logarithm of the current be taken it will be found to follow the normal form. In Fig. 10 the distribution of current at −50 volts is shown for a popular type of rectifier, and the current scale is logarithmic to normalize the distribution. This particular rectifier specification states a maximum value of 1 mA above which the current may not rise, and in production those few with larger currents are rejected. Another type of rectifier for use where the highest reverse impedance is important is supplied by selecting from the batch all rectifiers with currents less than 100 μA, and in consequence, although the overall distribution is as shown by the whole curve including the dotted tails, only those shown within the shaded portion will be supplied against orders for the one type. Hence the distribution of this type becomes a "curtailed log-normal curve."

If a series of rectifiers be selected with identical current at −50 volts, the current at another voltage (say −10) will not be identical for all rectifiers, but will be distributed in a log-normal curve. In consequence, if the distribution of current at −10 be plotted for all rectifiers within the shaded area in the figure, the distribution will not be a sharply curtailed curve, but one with less sharply falling extremities, as shown by the second shaded curve in the figure. The distribution of forward current at low values less than 0.5 mA will also be found log-normal, while that at high values greater than 5 mA will be found normal when plotted directly against current. At intermediate values no simple distortion of scale can be found to ease calculation.

The "turn-over" voltage is also normally distributed when plotted directly against voltage, and for a given average value of mean, the smaller the standard deviation the more consistent the rectifier. In fact this statistic will be found a good measure of consistency in the product, and if the standard deviation is less than 10 per cent of the mean value, the product is very good.

The low-frequency capacitance has a distribution with a long tail extending into high values, and it is good practice to curtail this distribution by rejecting all rectifiers with a capacitance greater than twice the mean value: it is possible by careful control of manufacturing processes to ensure that the quantity so rejected is less than 10 per cent of the whole.

The distribution of rectified current is found to be approximately normal if measured under a selected circuit condition, and it is good practice to reject the very small quantity found to be more than 2db, down on the mean value.

Non-Cyclic Variation (Instability). As a quite separate issue to the cyclic variation of impedance, due to variation of temperature, some rectifiers exhibit a distressing arbitrary variation for no obvious reason, and the object of the manufacturer should be to reduce to a minimum all such effects. By far the commonest cause of such variation is the ingress of moisture to the rectification area, and the result of moisture within the rectifier is always to cause a large and semi-permanent deterioration. A good rectifier design seals the

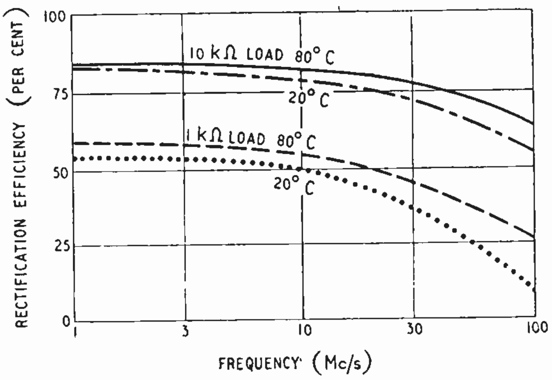


Fig. 7. Variation of rectification efficiency with frequency of typical high-reverse-voltage germanium rectifier.

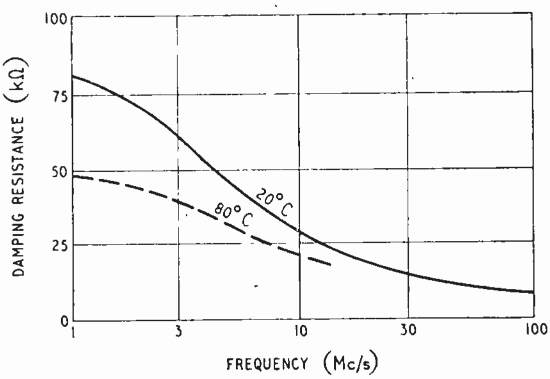


Fig. 8. Variation of damping resistance with frequency of typical germanium rectifier.

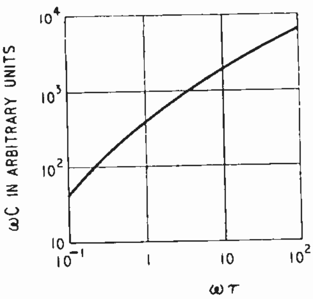
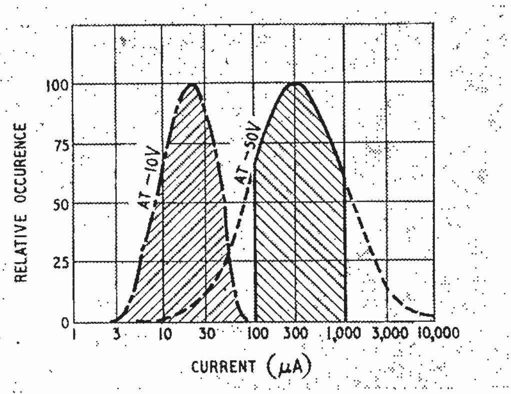


Fig. 9. Variation of capacitance due to "hole" current in n-type germanium, with variation of frequency. τ is a function of the "hole" and electron lifetime and the relative division of conductance between these carriers.

Fig. 10. Distribution of reverse current for a typical batch of germanium rectifiers.



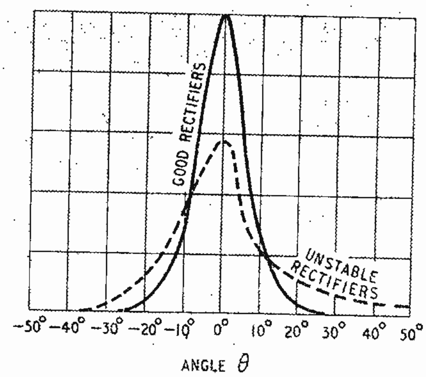


Fig. 11. Typical distribution curves for 5-60 seconds drift. $\sin^2\theta = \frac{\text{Drift (per cent)}}{100}$

rectification surface against ingress of moisture from the atmosphere and prevents the sealing of moisture into the unit during manufacture. If it is desired to test for this fault, it will be found that repeated temperature cycles will cause deterioration if moisture has been sealed into the unit, while repeated cycling in a humidity chamber will show a similar effect if the sealing against the atmospheric humidity is faulty. In a good design no appreciable trouble will be found due to this fault.

The major effect of a rectifier seal which is faulty is to cause a long-term increase of reverse current which may take several months to occur in the English atmosphere, but which will eventually increase the value to several times the original figure. In addition to this effect, some rectifiers show a short-term variation of reverse current which is not thoroughly understood at the moment. It is thought, however, that this short term variation may well be a secondary effect of moisture present within the rectifier casing, either through being sealed-in during manufacture, or through leaking-in through a faulty seal. This short-term variation may be detected by either of two simple tests. If a given value of reverse voltage within the rating of the rectifier be applied for a period and the reverse current plotted against time, a fault will be indicated by a continuous drift of current. A second method of test is to apply for some minutes a fixed value of reverse voltage, then apply for one second approximately five times this voltage (still within the rating) and then return to the original value of voltage, a faulty rectifier will show an excessive change of current at the low voltage as a result of applying the high voltage. Care must be taken when applying either of these tests not to be misled by the small change of current which normally occurs due to the heating of the rectifier.

Either of the above tests may be interpreted as a percentage variation of reverse current, the first as a percentage of the final value attained, the second as a percentage of the initial value before application of the higher voltage. If variation be examined over various periods of time with a fixed potential applied, it will be found that there is no correlation between variation over the first second of application and normal circuit performance; it will also be found that variation over a period of several days will be difficult to interpret. In practice a convenient period has proved to be one minute, and excellent correlation has been found between the drift over the period five to sixty seconds and the variation resulting from applying the higher voltage pulse for one second. In attempting to interpret either of these tests, it will be found that a few rectifiers will always exhibit a small amount of drift, and the best method of evaluating the results is to examine the "distribution" of the percentage variation. The number of rectifiers exhibiting more than 50 per cent variation should be negligible, certainly less than 1 per cent of the total, and such should be neglected in plotting distribution, as rectifiers with a definite fault, and not members of a normal batch. The distribution plotted against the percentage variation is symmetrical about zero in the case of a good batch of rectifiers, but is much more sharply peaked than the "normal law." If, however, the distribution be plotted against an angle which has a sine equal in value to the square-root of the percentage divided by one hundred, positive variations being plotted as positive angles and negative variations as negative angles, a good batch of rectifiers will be found to follow the normal law with a standard deviation less than ten degrees of arc, but a faulty batch will be found to have a much wider curve than this, quite often having an unsymmetrical tail extending into the positive region. Typical curves are shown in Fig. 11.

Other faults besides humidity will give the type of instability described above, but these are mainly faults of manufacture which are not likely to be met to-day. Whatever the cause of faults, if a given type of rectifier will stand repeated cycling in an oven between 20° C and 85° C, repeated 24-hour cycles between 20° C and 55° C in an atmosphere with relative humidity always greater than 95 per cent, and will show a standard deviation less than ten degrees of arc when tested for sixty-seconds drift of reverse current, it may be used with confidence and will give reliable service. The only other cause of failure during life will be electrical overloading, and, providing it is operated within the rating shown to be safe by the manufacturer's quality control checks, this is not likely to occur.

The object of this article is to point out the variation with temperature and frequency natural to the germanium rectifier, and the nature of faults to which it may be heir; the concentration on the black side of the picture should not be taken as an indication that it is an undesirable component, but as a guide to choose the good examples of design which are available.

BOOKS RECEIVED

Dipole Moments, by R. J. W. Le Fevre. Monograph on the measurement of dipole moments in dielectrics and their application to the solution of problems of molecular structure. Pp. 140 + vii; Figs. 27. Price 8s 6d. Methuen and Company. 36, Essex Street, London, W.C.2

Copper in Instrumentation. Comprehensive survey of the use of copper and copper alloys in electromagnetic instruments and in the manufacture of pressure and strain-responsive elements such as diaphragms, Bourdon tubes and strain gauges. Pp. 152; Figs. 45. The Copper Development Association, Kendalls Hall, Radlett, Herts. (Free of charge.)

Carrier Current on Power Lines, by André Chevallier. Reprint of lectures on the propagation of r.f. waves along high-voltage power lines and their utilization for telephony, telemetering, control and fault location. Pp. 24; Figs. 43. Price 2s 6d. *The Beama Journal*, 36, Kingsway, London, W.C.2.

Ringing-Choke E.H.T. Unit

Inexpensive 2.5-kV Supply By D. M. MELLUISH

THE ringing-choke method of e.h.t. generation has been used fairly extensively for voltages in excess of 5 kV but, so far, little use has been made of the method in the range of 2-3 kV—the voltage required for operation of the 6-in surplus c.r. tubes at present used extensively for inexpensive television receivers. Since practically all these receivers utilise push-pull line deflection, this means that whatever saw-tooth generator is used, there is a positive-going saw-tooth voltage of 100-200 volts amplitude available for input to a ringing-choke system. The method also provides a use for the "high cycle" smoothing chokes or e.h.t. transformers to be found in many ex-Government units which form the basis of many such TV receivers.

The circuit described here has proved capable of providing 2.5 kV at 250 μA from an h.t. supply of 350 volts at 10 mA. The regulation is good, the circuit is extremely reliable and offers the following advantages over other methods of e.h.t. generation of this voltage:—

(i) the initial cost is small;
(ii) no extensive screening is needed;
(iii) the circuit is non-lethal.

The basic circuit is shown in Fig. 1. The saw-tooth voltage injected at A provides auto-bias for the SP61, which draws a steadily increasing anode current as the saw-tooth voltage approaches its maximum. The fly-back carries the grid to cut-off (and beyond) with the result that a high back e.m.f. is generated at the anode as the current in the choke decays. This voltage is rectified by the diode and the smoothed output appears at B. The diode rectifier may be either an EY51 with its heater supplied from an extra winding on the choke, or a surplus VU120 may be used with a separate mains winding to supply its heater (this winding must be insulated for 2.5 kV). There are only two critical points in the design—the choke and the initial adjustment procedure.

The Choke.—To avoid insulation-breakdown troubles the choke must be of multi-layer construction with paper insulation every few hundred turns. The inductance should lie between 0.1 H and 0.9 H—the optimum values being between 0.18 H and 0.24 H for maximum efficiency. Two methods of making this choke are available. First, the choke can be wound on a ⅝-in diameter wooden former having a winding length of 1½ in (the wooden spool on which the necessary ¼ lb of 38 gauge enamelled wire is purchased makes an excellent former). 7,200 turns are required with paper insulation interleaved every 600 turns—no great care is needed in winding so long as the winding is kept reasonably even. For the EY51 an extra winding of 20 turns of 24 d.c.c. wire should be wound outside the primary—with a substantial waxed-paper insulation between the two separate windings.

An alternative method is to adapt the "high cycle" e.h.t. transformer or smoothing chokes from an ex-Government unit. In all cases, the modification is the same—simply *remove the iron core from the component*. If an EY51 is to be used an extra heater winding must then be added. Three typical modifications will serve as examples:—

(i) Indicator Unit Type 182A: smoothing choke, with core removed, inductance 0.19H; add 16-turn EY51 heater winding if required.

(ii) 1355 Receiver Unit: e.h.t. transformer with core removed and old heater winding removed and primary winding ignored; secondary inductance 0.81H; add 30-turn EY51 heater winding if required.

(iii) 1355 Receiver Unit: smoothing chokes, with cores removed, both chokes in series, inductance 0.15 H; not advised for EY51 operation owing to low value of inductance, which limits maximum e.h.t. voltage available to 2.3 kV.

Setting Up Procedure

Care is needed when making the initial circuit adjustments, otherwise, with auto-bias on the SP61 and a 350-volt anode supply, the valve may be severely over-run. Insert a milliammeter of range about 0-20 mA in the cathode lead of the SP61 and set the potentiometer to supply *maximum* available saw-tooth voltage to the valve. Upon switching on, the

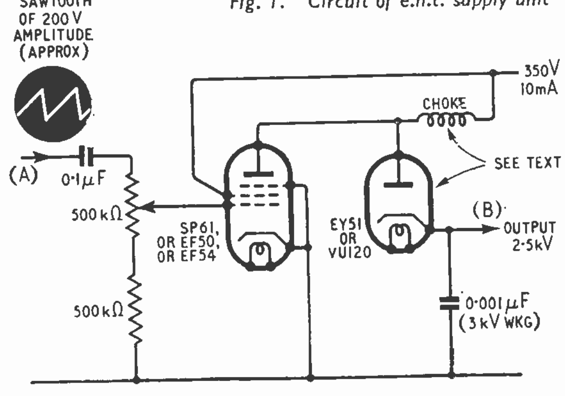


Fig. 1. Circuit of e.h.t. supply unit

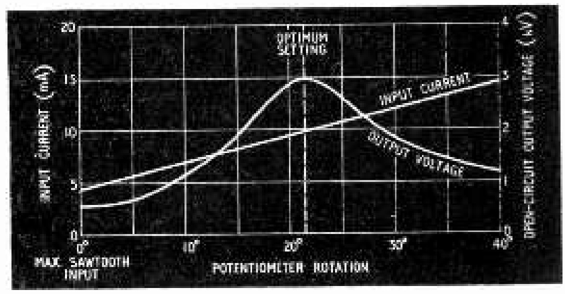


Fig. 2. Relation between saw-tooth drive and output

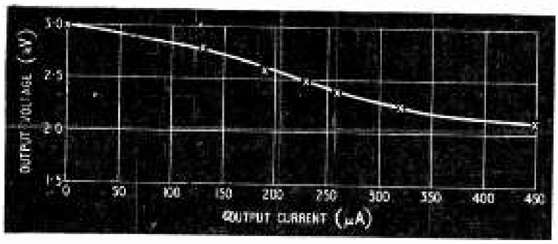


Fig. 3. Typical regulation curve.

working current should be 8 mA or less—little or no e.h.t. may be generated at this setting. Now rotate the potentiometer *slowly*, watching the cathode current reading while doing so—the current should not be allowed beyond 15 mA and before this figure is reached the maximum e.h.t. point should be attained (indicated by minimum size of raster, electrostatic voltmeter, or 0-1 mA milliammeter with 10-MΩ resistor in series across output terminals). Check anode current is between 5 mA and 15 mA at optimum e.h.t. setting, no further adjustment is required and the cathode-current meter may be removed. If an EY51 is used the heater colour should be observed during this setting-up operation and the heater winding on the choke adjusted to give correct colour.

Fig. 2 shows a typical graph relating input current, and output voltage to the potentiometer setting.

The component layout is in no way critical, though the choke should be situated on the opposite side of the chassis to the c.r. tube—but spaced about ½ in from the chassis to avoid eddy-current losses. No other screening precautions are necessary and no interference with other TV or radio equipment operating in the same room has been experienced. The SP61 may be replaced by either an EF50 or EF54—they all give almost identical results. The circuit presents a negligible load on the saw-tooth generator—or its amplifier, the most suitable connection point being the "low" h.t. side of the line-deflector plate coupling capacitor which has correct phase (positive-going saw-tooth).

Most samples of the three suggested valve types will operate satisfactorily at the 2.5-kV level, but internal flash-over occurs beyond 3 kV and for this reason it is not advisable to attempt to get more than 2.5 kV with the suggested valves.

Fig. 3 shows typical output graph using an SP61.

SWEDISH RECORD CHANGER

A Novel Design with Automatic Stylus Selection

THE completely foolproof record changer has yet to be built, but a further step towards that ideal has been taken in the Luxor RT mechanism by coupling the speed-selecting control mechanically to the pickup head, so that the correct stylus is always automatically associated with any of the available turntable speeds of 33⅓, 45 or 78 r.p.m. It is, of course, still possible to select the wrong speed (and stylus) for a given record, but the pitch will instantly proclaim the error, which can be quickly remedied. In a conventional record changer the use of the right speed but the wrong stylus may well escape detection by an uncritical listener until damage has been done either to the stylus or the groove wall.

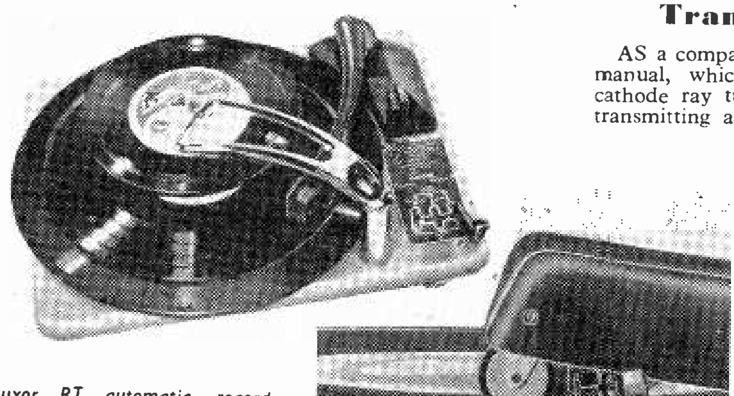
Another interesting feature of this mechanism is that it will take *any* size of record below 30cm ("12 inch") and is not tied to any series of conventional sizes. The method of finding the starting groove is the same in all cases. First the tone arm moves to the *centre* of the record where it is lowered on to a tyred roller in the pickup head. The bearings of this roller are aligned so that there is a force tending to move the tone arm outwards. When the roller "feels" the edge of the record, it drops the arm a short distance on to the edge of the record, automatically retracts, and allows the stylus to find the lead-in groove by the normal inward resultant of the frictional drag.

The tone arm is frictionally coupled to the record-changing mechanism and no damage or maladjustment can result from mishandling during operation. Other safeguards include an interlock to prevent operation of the speed-change selector, except when the mechanism is stopped and the tone arm is locked in its starting position on its rest.

The makers are Luxor Radio A.B., Motala, Sweden.

Transmitting Valve Data

AS a companion volume to the first part of their valve manual, which covered Osram receiving valves and cathode ray tubes, G.E.C. have now issued Part 2 on transmitting and industrial valves. The types included are for operation at frequencies ranging from a.f. to 9,500 Mc/s and for power outputs up to 400kW. Among the smaller valves is the familiar KT66, which, as a transmitting type, has the extra distinction of being described as a "convection cooled" tetrode. Full technical data and characteristic curves are given on current types and tabulated information on maintenance types. In addition there are sections on the design of r.f. amplifiers and oscillators, on the interpretation of ratings and on operating precautions. The book can be obtained through radio dealers at 10s or from G.E.C., Magnet House, Kingsway, London, W.C.2, at 10s 9d by post.



Luxor RT automatic record changer and (right) pickup head showing "feeler" roller and stylus selecting mechanism.

C.R.T. Insurance

Television Maintenance Schemes

FORMED as an offshoot of the Radio and Television Retailers' Association in 1950, Telesurance, Ltd., was the first organization to provide an insurance and maintenance scheme covering the replacement of defective cathode-ray tubes in television receivers. Although the secretary of R.T.R.A. (H. A. Curtis) was the originator of the scheme and is in fact a director of Telesurance, Ltd. (37, Fitzroy Street, London, W.1), the two concerns are now operated independently.

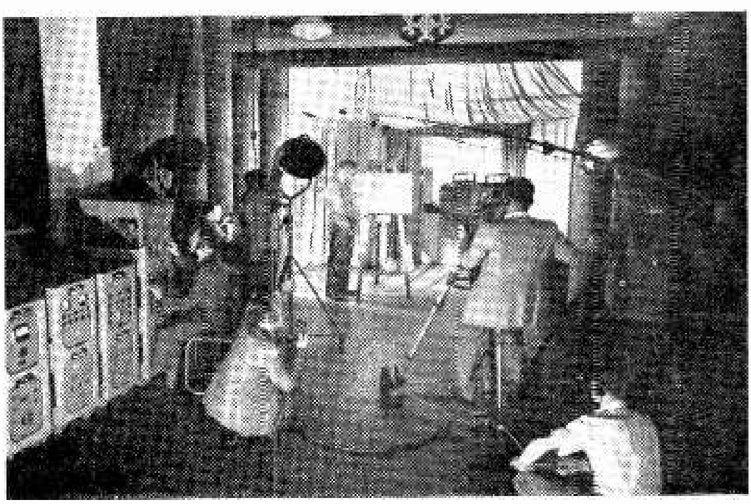
Two maintenance contracts and insurance schemes (operated through R.T.R.A. dealers) are provided by Telesurance; one for receivers up to two years old and the other for new sets. Both provide for the free replacement and fitting of all defective parts (including the c.r.t.) and insurance against fire, burglary or accidental damage, but the scheme for new sets also provides for the replacement of the c.r.t. after three years. The premiums vary, of course, according to the size of tube and the age of the set. Under the first-mentioned scheme the annual premium for the smallest tubes (9in and 10in) varies from £6 for new sets to £8 5s for receivers over one year and not more than two years old. For sets with 16in tubes or projection models it varies from £8 15s to £12 according to the age of the set. The annual premiums in the assurance plan providing for the replacement of the c.r.t. after three years, range from £9 10s for a 9in tube to £15 for 16in tubes. For projection models the premium is 10 guineas.

Since the introduction of the R.T.R.A. insurance scheme, a number of concerns have started operating maintenance schemes directly with the public. Various types of maintenance contract are provided, most of them for a duration of three years, which in some cases are renewable.

Some of the contracts cover only the replacement of the tube for as low a premium as £3 per annum, irrespective of the tube size. Others are fully comprehensive and provide for the complete maintenance of the receiver including the free replacement of all defective components, valves and the cathode-ray tube. These comprehensive schemes have a graduated scale of premiums according to the size of the c.r.t. In one instance, the annual premium varies from £6 15s for a 9in tube to £10 2s for 16in tubes. The premium for projection sets in this case is £10 10s.

The premiums quoted are irrespective of the age of the receiver, provided it is working to the satisfaction of the company's inspector. Most of the companies also provide a scheme for new receivers at a considerably reduced premium. Unlike the R.T.R.A. scheme these contracts do not cover loss or damage caused by fire or burglary, or damage by external means.

The details given in this note are based on information obtained from four companies operating in the London television service area: Television Mainstal (London), Ltd., Television Insurance and Maintenance Co., Ltd., K. L. Television services, Ltd., and King's (Fulham).



MELBOURNE TECHNICAL COLLEGE.—*This photograph, one of a series sent by the principal, R. R. Mackay, gives some idea of the facilities provided for students at the M.T.C. in Victoria, Australia. Some of the students are here shown operating television studio equipment installed in the College. The camera, incidentally, was provided by Pye, of Cambridge.*

RANDOM RADIATIONS

By "DIALLIST"

Metre-Wave Oddities

WHAT UNPREDICTABLE THINGS the metre waves are! I've lately been collecting instances in my own locality of the queer behaviour of the television transmissions from the Alexandra Palace. Here's the first. Two pairs of semi-detached houses, close together, all 450 feet above sea level, surrounding ground open. The owners of Nos. 1, 2 and 4 all obtain good reception with indoor aerials. Hence, when the owner of No. 3 recently bought a television set he had no hesitation about having one too. But it just would not work, an excessive amount of "contrast" being needed to obtain even a poor, jittery picture. Was his set less sensitive than the others? That was soon tested by temporarily swopping over No. 4's set and his. His worked beautifully in No. 4's house; No. 4's set gave a poor performance on No. 3's indoor aerial, though it was of the same type and properly installed. No. 3, then, has had to put up an H-type aerial on a chimney stack to achieve results as good as those his neighbours get with quite simple indoor affairs. No one has discovered why.

Here, Yes ; There, No

Then, there is one small area in the little town in which I live (this is about 22 miles from Alexandra Palace, by the way) in which there is a much poorer signal than anywhere else. Nothing has so far been found to account for this state of affairs. The area is not in a hollow, nor is it surrounded by tall buildings. Actually, it is at the end of the town which lies nearest to the Alexandra Palace; yet it is quite a business to get a good picture there. Those two examples are concerned with houses or areas in which the signal is abnormally poor. My third is of precisely the opposite kind of conditions. I know one house standing in the lowest-lying part of the town in which the TV signals are better received than in any of the many neighbouring houses on the same level; better, in fact, than in the majority of those on sites from fifty to a hundred feet higher. It is actually the only house within a considerable radius in which an indoor aerial gives very satisfactory results. Such aerials have been tried in not a few of the others and found to be inadequate.

Let Loose the Dogs of Law?

WRITING with reference to what I've had to say recently about motor-car interference with TV reception, a lawyer reader makes a rather horrifying suggestion. "Looking at the problem dispassionately and from the purely legal angle," he mused, "it can only be a matter of time before some sufficiently wrathful viewer gets a Legal Aid Certificate and sues his un-neighbourly neighbour for damages and injunction for his interference with television reception, basing his claim on 'Nuisance' or 'Trespass' or both." I have, as you know, little sympathy for the "unsuppressed" motorist, but I hope that this is a jest rather than a genuine view of the legal position. The possibilities are too awful to contemplate. One sees the Courts submerged by a mighty flood of suits, for there is no knowing where it would stop. Could Brown sue Robinson on the grounds of interference from his "fridge," Robinson counterclaiming that Brown's TV set caused interference with his radio reception? Smith has reason to believe that his "ghosts" have their origin in Jones's steel-framed home; has he a case? Has Jones legal legs to stand on if he bases a counter-claim on the blue-chinned Smith's not infrequent use of a radiating electric razor before dining out of an evening? Is the pilot of the 'plane which causes flutter fair legal game? And what of the Central Electricity Board and its far-flung grid? I wait anxiously for enlightenment.

Stands, Catalogues and Things

IN THE OCTOBER issue of *Wireless World* a correspondent (S. Pearce) made some points which I hope will have the very particular attention of our manufacturers of radio, television and other electronic gear. Having been unlucky enough to injure a foot on my way home from the first day of this year's Earls Court show, I was able to make only one visit instead of my usual two or three. When I came to think over what I'd seen in seven hours spent in that vast hall I realized how much time I had wasted in digging out what was new from beneath the overburden of things already familiar. The official catalogue did little to fill in the gaps; in fact, if it hadn't been for *W.W.'s* excellent reports, I should have missed a good few notable new things. The manufacturers' position is, one realizes, by no means an easy one. The great majority of those who look at their stands will be ordinary non-technical folk, either "eye-shopping" or bent on selecting their new sound or television receivers and out to collect as much "literature" as possible. Those leaflets musn't be too technical and the people who answer their enquiries must be salesmen rather than boffins. But I do wish that those who want technical information could get it more easily, both verbally and in print. And the official catalogue and guide should certainly be more descriptive than it usually is. Would it be possible to have two? A small directory affair at, say, sixpence or a shilling; and a real catalogue selling at half-a-crown, or even a bit more?

A Shaping Tool

YOU MIGHT THINK that the saddler's or shoemaker's rasp was a queer sort of tool to find a place in the wireless workshop. But I can assure you, having had one in mine for a good few years, that it is a really useful thing. The rasp, D-shaped in section, is eight inches long by ⅞-in wide. One half of both the flat and the round faces is coarse-cut and the other half fine-cut. You can buy one of these rasps from most tool shops and many ironmongers. It is the quickest and handiest thing I know for shaping non-metallic materials such as wood, ebonite, bakelite and p.v.c. The coarse-cut faces have a grand bite for roughing out. Then you finish the job by using successively the fine-cut face, a file and emery cloth or glasspaper as required.

Big Tube or Projection?

THERE'S NO DOUBT that a well-designed and well-handled television receiver with a tube 14 inches or more in diameter can provide beautiful pictures. Somehow, though, I can't believe that the right way to give people the larger pictures for which they are always clamouring is to use bigger and yet bigger c.r. tubes. They certainly have their drawbacks. Unless, for instance, the cabinet has doors behind which the "alderman's waistcoat" end of a fat tube can be decently hidden when TV reception is not going on, the set is liable to be far from a thing of beauty. The worst snag of all, though, is the cost of replacement after the guarantee period has come to an end. For these and some other reasons I'd predict great success for small projection receivers, if they could be sold at moderate prices. I was surprised not to see more projection models at the Radio Show and I don't remember seeing any of the kind I have in mind.

UNBIASED

By FREE GRID

TVHF

I WAS exceptionally interested to hear the presidential address given to the I.E.E. by Mr. Bishop, the B.B.C.'s Director of Technical Services. When talking about the Corporation's plans for v.h.f. broadcasting and suchlike matters, he seemed to speak with personal enthusiasm. This is in such marked contrast to his "t'aint wanted" attitude to stereophonic broadcasting which he adopted in a letter to the Editor of *Wireless World* some time ago, that it sets me wondering what has caused this strange but welcome metamorphosis. Maybe he has a Jekyll and Hyde personality; if so, when the other side of it takes control of him once more he will probably liquidate himself for "dangerous thoughts."

However, it is not so much about Mr. Bishop that I wish to speak as about the B.B.C.'s plans he disclosed. I cannot help feeling that neither he nor anybody else, except myself, realize how unnecessarily wasteful they will be of money, labour, and, above all, of etheric elbow room. My own plan would obviate all this waste and is obviously so much better in every way than the B.B.C.'s proposals that I make no excuse for putting it forward.

"Better without a visual accompaniment."

The B.B.C. proposes to cover the country with a network of 51 v.h.f. stations which will exist side by side with the existing m.w. and l.w. transmitters. But it cannot be doubted, I think, that in the distant future m.w. and l.w. broadcasting will disappear altogether and v.h.f. will reign supreme. The B.B.C. also has its plans cut and dried for extending its TV coverage by means of a series of low-power stations. Eventually, as Mr. Bishop reminded us, it is the hope of the B.B.C. to provide an alternative TV programme apart from any competitive service that may appear.

Now all this clutter of alternative TV stations means that a lot more etheric elbow room will be wanted and consequently TV will have to make use of higher frequencies. This won't be the only reason why higher frequencies are necessary because colour and 3-D, when they come—and come they most certainly will—will need a lot more elbow room.

It looks, therefore, as though we are eventually going to find the country covered by a network of v.h.f. "sound-only" stations and a network of television stations all working somewhere on microwaves. Why on earth not save money, labour and etheric elbow room by combining the two schemes? I will admit that many broadcasting programmes are better without a visual accompaniment; for these, only sound would be radiated. By this combined TVHF plan the B.B.C. would, in addition to lessening its capital outlay, save a lot of money in running costs as my scheme would halve the number of programme and engineering staff needed.

The B.B.C. probably won't listen to me, but after it has wasted a lot of public money on the two separate networks it will in the end be compelled to adopt my idea for nobody can doubt that "blind broadcasting" is on the way out. By the time we celebrate the Queen's Silver Jubilee it will be as extinct as silent films are to-day.

When Homer Nods

I DO NOT PROPOSE to stick my neck out by joining in the chemical warfare between two such well-known authorities as R. W. Hallows and R. W. Lewis, but I was a little surprised to find R. W. H. slavishly following popular convention by calling the carbon-manganese-dioxide electrode of a Leclanché cell the cathode (October correspondence columns). The O.E.D. tells me that the cathode is "the path by which an electric current leaves the electrolyte and passes into the negative pole . . ."; the anode is defined as "the path by which an electric current leaves the positive pole and enters the electrolyte on its way to the negative pole; *loosely*, the positive pole . ."

Thus, according to the O.E.D. the positive pole is the anode and since we all know that it is the carbon-manganese-dioxide electrode (our old friend the porous pot in the case of wet cells) which is marked with a + sign it would appear that R.W.H. and the O.E.D. are at variance. This is perhaps not so surprising as Major Hallows is very well known as a Cambridge man and he would naturally have no truck with the Oxford dictionary.

In my warped view it is impossible to apply the terms cathode and anode permanently to the electrodes of any sort of battery as they change places according to whether you are charging or discharging it. In these days of dry cell "reactivators," we battery set users do as much battery charging as car owners although the chemical process is not the same. In the case of a valve where we can only push current through one way the heater end is *always* the cathode and the plate the anode.

"Cambridge . . . no truck with the Oxford dictionary."

The reason why the O.E.D. is so dogmatic in its statement "the anode . . . *loosely* the positive pole" is I believe because Faraday, whose words it quotes, was at the time talking about electrolysis and of nothing else. Of course, we all do a bit of electrolysis when we charge our batteries but, unlike Faraday, we do it not as an end in itself but for the purpose of subsequently getting our temporary electrolytic bath to supply us with current.

When Major Hallows tells the world so emphatically that one particular pole of the battery is the cathode he probably forgets that the cathode becomes the anode and *vice versa* when the battery is put on charge; this is rather surprising as he himself once wrote a very informative article in *W.W.* on reactivating dry cells. Maybe too he temporarily overlooked the literal meaning of the words cathode and anode.

Perhaps I'm quite wrong in my views but if so I'm sure the Editor's columns are open to my technical betters and none will be more pleased than myself to have a universally accepted convention in this matter.