

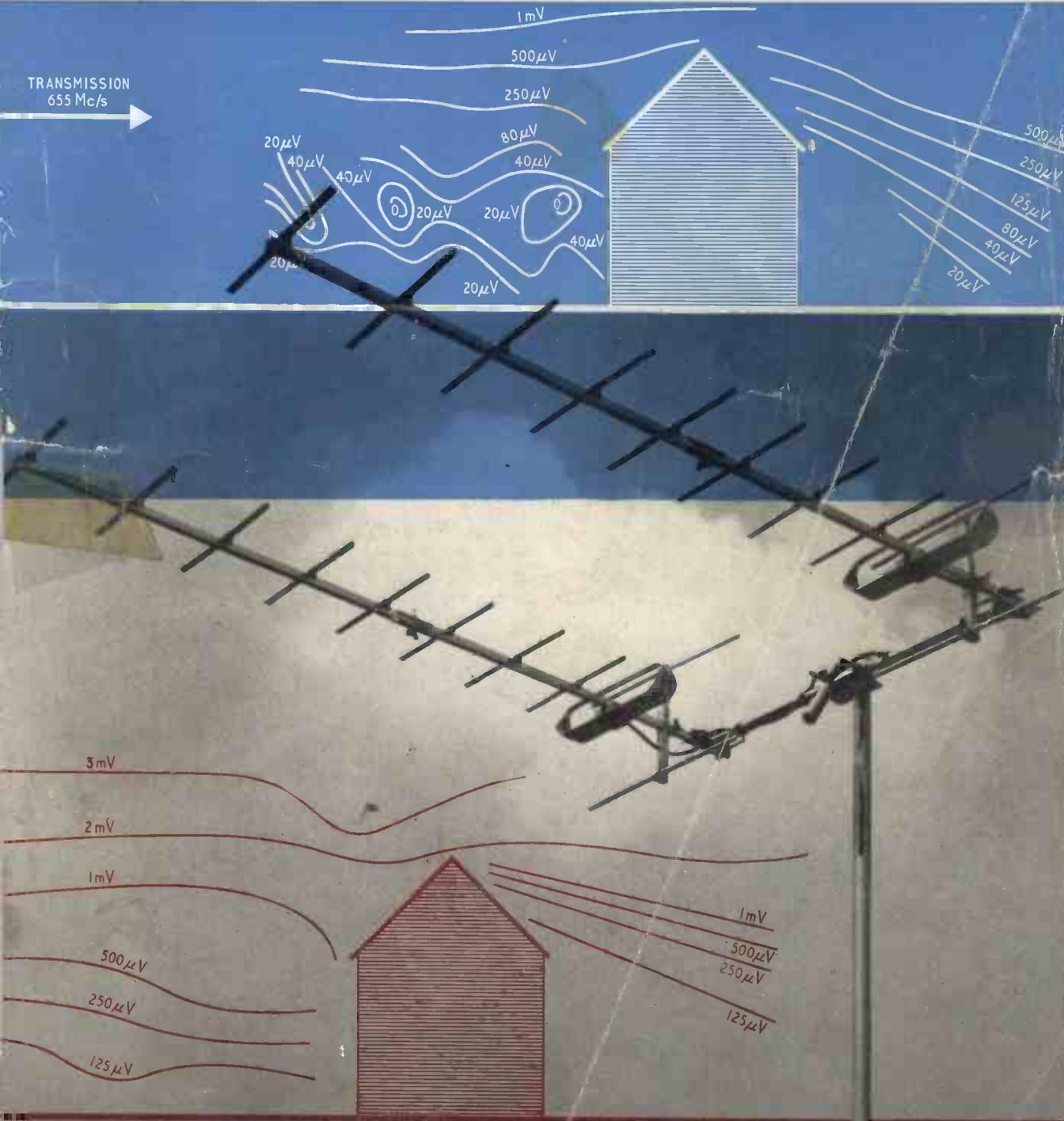
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# Wireless World

ELECTRONICS  
RADIO  
TELEVISION

AUGUST 1963

Price Two Shillings and Sixpence



The most advanced

**STABILISERS** of their kind

series TS ac voltage stabilisers



TS-3 7-7.15-4 kVA

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type	WIDE-RANGE CONNECTION			NARROW-RANGE CONNECTION		
	input voltage range	output current (A)	nominal kVA	input voltage range	output current (A)	nominal kVA
<b>single-phase</b>						
TS-1		4	0.96		8	1.92
TS-2	-17½ to +7½%	12	2.9	-8½ to +3½%	24	5.8
TS-3		32	7.7		64	15.4
TS-4	or	62	14.9	or	124	29.8
TS-5		84	20		168	40
TS-6	± 12½%	168	40	± 6½%	336	80
TS-7		252	60		504	120
<b>three-phase</b>	or			or		
TS-111		3 x 4	2.9		3 x 8	5.8
TS-222	-7½ to +17½%	3 x 12	8.6	-3½ to +8½%	3 x 24	17.2
TS-333		3 x 32	23		3 x 64	46

Ratings given are for standard 240v 47-65 c/s models (output adjustable 200-254 volts). Models are available to special order for other common voltages, e.g. 115v, and/or for other frequencies, including 400 c/s. For higher-power three-phase stabilisation up to 360 kVA, three single-phase units are used.

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# Wireless World

ELECTRONICS, RADIO, TELEVISION

AUGUST 1963

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# NEW MULLARD A.F. PACKAGE

## PCL 86 TELEVISION AUDIO OUTPUT VALVE

The Mullard PCL86 a.f. triode-pentode has been designed specifically for the sound stages of television receivers. The sensitivity of the valve is high enough to allow adequate feedback to be applied in conventional circuits, but is not so high that instability will occur. The high overall gain is achieved partly by a high amplification factor in the triode section, and partly by a high value of mutual conductance in the pentode section. A new cathode material is used in the PCL86 to reduce the likelihood of instability. With this material, there is less deposition of particles from the cathode on other members of the electrode structure.

A special electrode structure — the balcony structure — is used in the PCL86. The triode section is much shorter than the pentode section, and heat can therefore radiate freely from the upper part of the pentode section. Greater dissipation can thus be tolerated, and the anode dissipation rating of the PCL86 is consequently particularly high (9W) for triode-pentodes.

## WHAT'S NEW IN THE NEW SETS

These articles describe the latest Mullard developments for entertainment equipment

The cathode-to-heater voltage rating of the PCL86 is high (30V), and positioning of the valve in the heater chain is therefore not critical. Screening between the heater and grid leads of the electrode structure ensures a very low level of hum in the valve. The performance to be achieved with the PCL86 is thus very good, and the valve is ideally suited for the sound stages of television receivers.

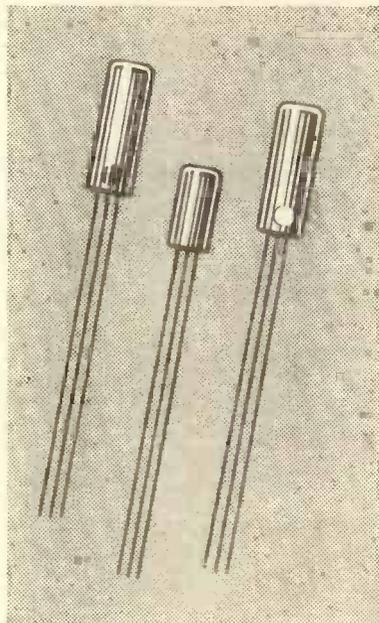
## PACKAGE for transistor portables

**D**ESIGNED for use in transformerless audio amplifiers, the new Mullard audio frequency package — the LFK3 — is now to be encountered in modern portable radio receivers.

The output pair of the package consists of the complementary matched p.n.p. and n.p.n. transistors types OC81 and AC127. The p.n.p. driver transistor type OC81D completes the package.

The current amplification factor of the output transistors is greater than 50 at 200mA and 38 at 300mA. The base currents of every pair are matched to within 20% at a collector current of 50mA, and each output transistor is cross-matched with the driver transistor to give reduced circuit gain spreads.

The peak collector current rating of the output transistors is 300mA, which enables output power of up to 500mW to be obtained using a 9V battery. The sensitivity of the package is such that outputs of up to 100mW can be achieved without a pre-amplifier, and outputs of up to 500mW necessitate only a simple single-transistor preamplifier.



## ECH 84 TRIODE-HEPTODE FOR DUAL-STANDARD TV RECEIVERS

The Mullard triode-heptode, type ECH84, is now appearing in the synchronising stages of dual-standard television receivers in this country. The valve has already been widely adopted by manufacturers producing receivers for 625-line transmission systems using negative vision modulation.

The heptode is generally operated as an interference-cancelling sync pulse separator, and the triode section as a pulse limiter. The heptode function is particularly valuable when interference pulses which are in the same sense as the sync pulses, occur in the video waveform and tend to disrupt synchronisation.

The ECH84 has been designed specifically to supersede the ECH81 in the sync separator

application. The earlier type was initially intended for use in a.m. radio receivers and was only subsequently adopted for synchronising circuits, whereas the ECH84 was designed specifically for the television application. Good operation at low voltages is thus ensured. Another consequence of this specific design is that the linearity of the control grid characteristics of the heptode section is markedly better than that of the earlier valve. In the triode section, too, higher values of mutual conductance and amplification factor have been achieved. These improved properties of the ECH84 are reflected by better receiver performance under fringe reception conditions.

## R.S.G.B.—50 Years

THE Radio Society of Great Britain has just celebrated its jubilee with a round of social events culminating in a Golden Jubilee Dinner in London at which Lord Brabazon of Tara was the guest of honour and which was attended by the presidents of the principal European amateur radio societies, by delegates from the dominions including the Canadian director of the American Radio Relay League, and by distinguished members of the broadcasting organizations, the General Post Office, the learned societies and the radio industry.

The outstanding impressions of this occasion, which will long be remembered by those who were privileged to be present, were first, the easy camaraderie which is so quickly established between radio amateurs irrespective of nationality, social standing or political opinion, and secondly the respect and esteem with which the R.S.G.B. is held in the councils of international amateur radio. It cannot claim to be as big as the ARRL or as old as the Radio Club of America, but its influence today is high because it has been fortunate in having been served by a succession of wise and responsible presidents and by vigilant and energetic secretaries of whom the present holders of these posts, Norman Caws, F.C.A. (G3BVG) and John Clarricoats, O.B.E. (G6CL) are by no means the least.

When it was founded in 1913 there were already national radio amateur organizations in America and Australia, and in England many active clubs in the provinces, notably Derby in 1911, were established before London was shamed into establishing its own Wireless Club by the late Rene Klein. Once formed, the Society rapidly overcame the handicap of its slow start by attracting the support of distinguished scientists like A. A. Campbell Swinton, J. Erskine Murray, Admiral Sir Henry Jackson, W. H. Eccles and Sir Oliver Lodge whose names not only carried weight in negotiation with the Post Office over licensing matters, but whose minds stimulated original thought on the ways in which members might contribute to the advancement of knowledge without detracting from the pleasure they derived from building and using equipment to communicate over long distances.

The outstanding achievement, shared with their American confreres, was the bridging of the Atlantic on 200 metres, a "short" wavelength which had been given to amateurs because it was thought

to be of little use as a propagating frequency. What the professionals had missed the amateurs found by patience, persistence and sheer weight of numbers. It is of the essence of amateurism that it need not be efficient in the sense of being under an obligation to show results related to the expenditure of time. It is a leisurely pursuit giving time for thought—which is not to say that it cannot be pushed along at a smart pace when the spirit moves. We can recall many controversies of the early days—"fine wire" coils and reflex circuits, for example—which engendered much heat and resulted in feverish activity between meetings to prove or disprove points raised.

We like to remember also that it was at a meeting of the Wireless Society of London in 1920 that Prof. R. Whiddington described his proximity gauge—one of the first examples of "electronics," or the application of radio-like devices in fields other than communications.

Although the trend has been away from the original concept of a scientific society and towards a more specialized organization of amateur transmitter operators, it is significant that the title of the Society's journal has in recent years been changed from *T. & R. Bulletin* to the more comprehensive *R.S.G.B. Bulletin*. In a message in the July issue this year's president, Mr. Norman Caws, writes: "There are two ways in which we can demonstrate the value of Amateur Radio; first, we should always be sure that the operation of our equipment is of the highest order, both technically and verbally; secondly, we can put all our skill and ability in our experimentation so that it is clear we have sound technical knowledge to add to the sum total of scientific progress."

These are sentiments with which we are entirely in accord, and in offering congratulations to the Society on the occasion of its jubilee we wish its members continued success in their experiments and the deeper satisfaction of strengthening international goodwill through world-wide contacts.

Now as always the amateur is threatened with restriction by the demands for frequencies of other interests, and concerted action is essential if his rights are to be preserved. No one questions his deserts, for he is of the salt of the earth, but some may need reminding of his rights, which he may legitimately claim on the record of past achievement.

# LASERS

## 1.—GENERAL PRINCIPLES: LIGHT AMPLIFICATION IN CRYSTALS

By AUBREY HARRIS, A.M.I.E.E., A.M. Brit. I.R.E.

**T**HE past few years have seen a phenomenal rate of technological development in the field of lasers. The reader may well be forgiven for his present confusion as to the method of operation of these newcomers to the field of quantum electronics and just why they promise to be of such value in the future. This review will attempt to explain how these devices work and indicate some of the fields of application.

A brief outline of the history to date is of interest. The first published reference to the theoretical extension of maser operation to the optical region was by A. L. Schawlow (Bell Telephone Laboratories) and C. H. Townes (Columbia University) at the end of 1958<sup>1</sup> and a practical demonstration that this was possible was reported by T. H. Maiman (Hughes Aircraft Corporation) in 1960<sup>2</sup>. Dr. Maiman's optical maser produced a pulsed output of visible light from a ruby crystal device. Later that year operation of another solid-state device using trivalent uranium was achieved by P. P. Sorkin and M. J. Stevenson (I.B.M.)<sup>3</sup> albeit at very low temperatures. By using a different type of optical maser, a gas discharge tube, A. Javan, W. B. Bennett

and D. R. Herriott<sup>4</sup>, at Bell Telephone Laboratories in 1961, produced continuous emission at normal temperatures; certain characteristics of this maser were found to be superior to the crystal types.

Perhaps the biggest step forward was made in November, 1962, with the virtually simultaneous announcement from G.E., I.B.M. and M.I.T. in the U.S.A. that an entirely new continuous-output optical maser had been developed. This was a gallium-arsenide semiconductor device of transistor proportions and its efficiency was stated to be in the region of 50%—some 10 to 20 times greater than that of the ruby type.

The term MASER is an acronym formed from the initial letters of the words Microwave Amplification by Stimulated Emission of Radiation. The initial of LASER indicates Light and, usually, includes Infra-red radiation, though it has been suggested that the term IRASER might be used for the invisible radiation at infra-red wavelengths.

The light output of an optical maser differs in several respects from that produced by more conventional generators of light, such as tungsten lamps, discharge lamps or the sun. All these sources

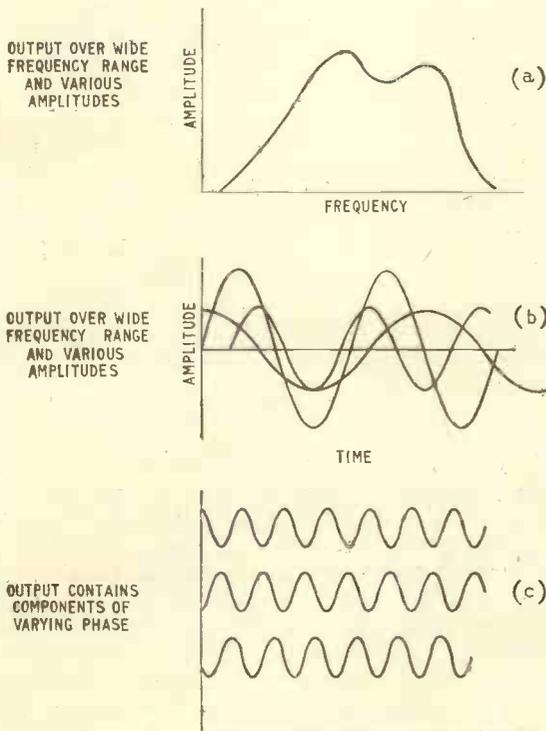


Fig. 1. Non-coherent radiation.

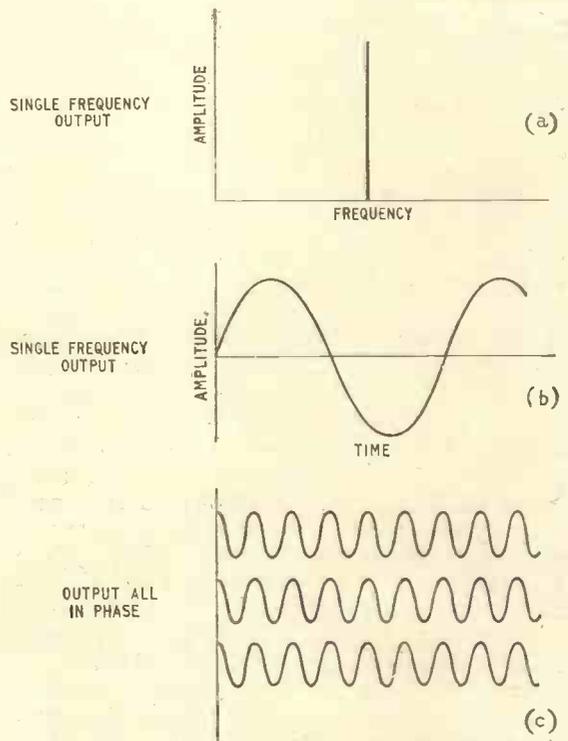
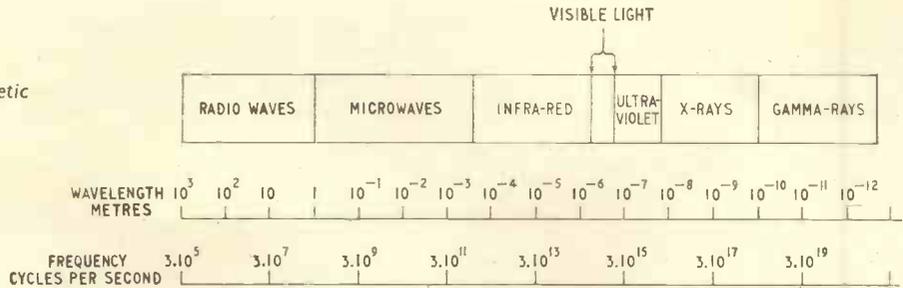


Fig. 2. Coherent radiation.

Fig. 3. The electromagnetic spectrum.



produce a relatively wide band of radiation (even a "monochromatic" sodium lamp!). They can be considered to be noise generators as their output contains radiation at a number of different frequencies and also even those components of the radiation which are at the same frequency are of differing phase-relationship, polarization and relative amplitude. (Fig. 1.)

By contrast the laser output is *coherent*. That is, the radiation is at a single frequency, it is completely in-phase and is in the same plane of polarization. (Fig. 2.) It will be appreciated then that the laser output is coherent electromagnetic wave radiation of the same form as that generated by a highly-stable r.f. signal generator. At present, high frequencies, up to 80 Gc/s such as are used for radar systems and microwave links are generated by magnetrons and klystrons, and at low powers frequencies up to 200 Gc/s have been produced by backward wave oscillators. Until the development of the laser coherent electromagnetic waves above these frequencies could not be generated. But now a whole new range of frequencies is available in the electromagnetic spectrum (Fig. 3).

The range of the visible spectrum, from 4,000 to 7,000 angstroms (1 angstrom = 10<sup>-8</sup>cm) is equivalent to a band of frequencies between 750 million and 430 million megacycles per second. Assuming the likelihood of modulating up to 1/100th of this band, it would theoretically be possible to provide simultaneously over 600,000 5-Mc/s television channels, or about 1,000 million 3 kc/s telephone circuits. Of course, at the moment it is not possible to generate coherent radiation at every frequency in the visible and infra-red spectrum, only at certain specific frequencies in the band. However, as development and research proceeds more and more operating frequencies are being found.

Apart from the advantage of coherence of the output wave the beam is parallel to a high degree, it is extremely narrow in width, and is of a very high intensity. All these factors suggest a whole range of applications for the optical maser. Optical methods may be used to focus and concentrate the output into microscopic dimensions: experiments have been conducted demonstrating how the high-power beam so produced can bore controlled diameter holes of 0.02-inch diameter through ¼-inch industrial diamond—in 200 microseconds. It was estimated that the temperature generated at the surface of the diamond was of the order of 5,500°C.

### Basic Necessities

The basic requirements constituting an optical maser are (a) a resonant cavity filled with (b) a suitable active medium (Fig. 4).

The principle of the Fabry-Perot interferometer is almost universally used for the resonant cavity. It consists of two carefully aligned parallel reflecting surfaces, the spacing between which is made equal to an integral number of half wavelengths at the required operating frequency, that is  $d = \frac{n\lambda}{2}$  (Fig. 5).

A light ray traversing the cavity (A) is reflected at one end (B) in the direction from which it came; it is then reflected at the other mirror (C) in phase with the original ray, which is then reinforced. The process is cumulative and the assembly acts as an optical band-pass filter of very high Q, accepting the required wavelength and rejecting all others.

Where light of more than one wavelength is present in the cavity it is possible to select the desired signal by the choice of the spacing between the reflectors.

The active medium must be one which is capable of possessing at least two distinct energy levels corresponding to the desired output frequency; furthermore the properties of the medium must be such that it is possible to "overpopulate" the upper energy level of the substance with respect to the

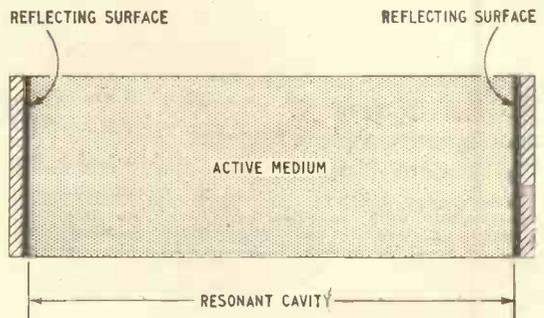


Fig. 4. Basic optical maser.

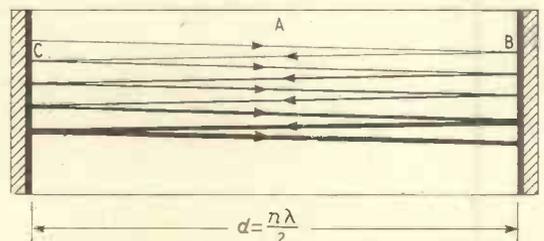


Fig. 5. Fabry-Perot resonator. Rays are successively reflected from end to end of the cavity A, reinforcing each other and producing a strong parallel beam. (Rays are shown slightly non-parallel for clarity.)

TABLE I: THE FOUR MAIN TYPES OF LASER WITH TYPICAL OPERATING CHARACTERISTICS FOR EACH TYPE.

Classification	Typical Material	Input	Efficiency (per cent)	Output		Spectral Width (c/s)	Beam Divergence	Operating Temperature	Emission Mode
				Wavelength (angstroms)	Frequency (c/s)				
Doped crystal	Ruby-chromium	250-1,000 joules	1-3	6,943	$4.321 \times 10^{14}$	$10^7-10^9$	0.1 degree	300°K (room temperature)	Pulse ( $10^{-6}$ to $10^{-3}$ sec)
Gas discharge	Helium-neon	80-120 watts	0.01-0.1	6,329 11,530	$4.740 \times 10^{14}$ $2.627 \times 10^{14}$	$10^9-10^4$	0.5 minute	300°K	Continuous
Semiconductor junction	Gallium arsenide	0.05 watts	20-50	8,440	$3.554 \times 10^{14}$	$10^{11}$	1-5 degrees	4.2°K (Liquid helium)	Continuous
Liquid	Europium-benzolate-tonate	0.01 joules	20-30	6,129	$4.894 \times 10^{14}$	$10^{10}$	0.1-0.5 degrees	140°K	Pulse

lower level or levels. This process is often known as population inversion.

A further necessity for successful operation of a laser is the provision of suitable and sufficient power input to the device, in order to raise the energy level and thus obtain overpopulation. The input power may be of light, r.f. energy or just a direct current flow, dependent upon the type of device being operated. "Pumping" is the term normally applied to the process of supplying power to the maser for the purpose of raising the energy level of the active medium.

There are four fundamental types of laser currently under investigation and use. They may be classified under the following heads, primarily indicating their active media:

- (a) Doped-crystal
- (b) Gas discharge
- (c) Semiconductor junction
- (d) Liquid

The various types have differing characteristics and properties although they all emit coherent radiation. Output frequency, spectral width, beam width, pumping requirements, efficiencies and other characteristics are summarized for convenience in Table 1.

Even at this early stage of development there are certain pointers indicating the likely application of the different types. For example, it seems highly likely that the gallium-arsenide diode type will be used widely for communications purposes, due to the apparent simplicity of modulation, high efficiency and the continuous mode of operation.

For metal working (spot welding, piercing, etc.) the doped-crystal laser will prove most convenient owing to its compactness and the ease with which the output beam may be collimated and concentrated into high-intensity, microscopic areas. The pulsed output, which is a characteristic of many of the crystal lasers will not prove unduly restrictive for most applications of this type.

The first laser to produce coherent light was Dr. Maiman's, using as active material a crystal of aluminium oxide ( $Al_2O_3$ ); this is a red form of corundum and some specimens are known as ruby. Added to the crystal during preparation was 0.05 per cent of chromium oxide ( $Cr_2O_3$ ).

The ruby crystal is normally in the form of a cylindrical rod, typically  $\frac{3}{16}$ -in diameter and 2in long. (Sizes vary from between  $\frac{1}{8}$ -in to 1-in diameter and from 1 to 8in long). With this type of laser the active material, being solid, provides an ideal basis for its own optical cavity. However, careful mechanical

work is necessary to ensure that the flatness and parallelism of the end reflectors is adequate for their precise function. Polishing and coating of the ends of the rod provide the reflecting surfaces at the extremes of the cavity. One end reflector is made to have, as nearly as possible, 100% reflectance, the other end is designed to reflect about 95-98% of the internally incident radiation. The small amount not internally reflected passes through the partial reflector as the output.

In certain cases, instead of providing one reflector with partial transmission as just described, both are of maximum reflectance. The output is then emitted through a small clear area purposely left in the coating of one of the reflecting ends.

The emission of light from optical masers is basically due to the phenomenon of fluorescence. A fluorescent material is one which, on exposure to light of a certain frequency or a range of frequencies, gives out radiation at a (usually) lower frequency. An ordinary fluorescent lamp illustrates this: the gas discharge inside the tube produces ultra-violet radiation. This, striking the fluorescent coating on the inner surface of the tube induces the coating to emit lower frequency (visible) light. In the case we are now considering the doped ruby crystal is irradiated with visible light (preferably with peak intensity in the green region) and the emission is obtained at the far-red (lower frequency) end of the spectrum.

The behaviour of the atoms in these fluorescent materials can be explained in terms of the different energy levels or amounts of energy which the atoms

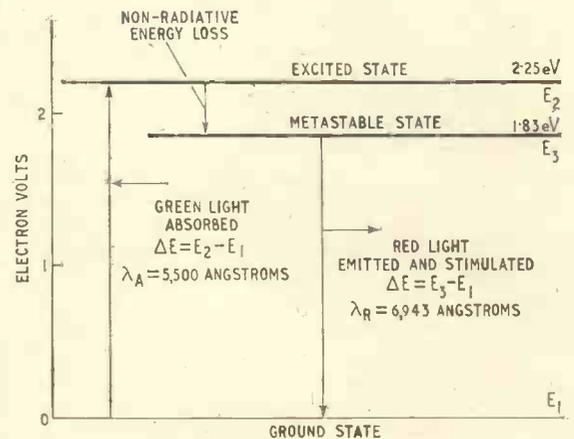


Fig. 6. Energy level diagram for the ruby laser.

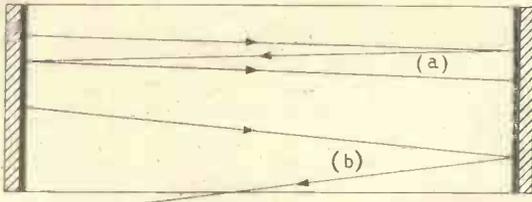


Fig. 7 (a) Light perpendicular to reflectors reinforces and stays in cavity. (b) Light not perpendicular is lost through sides.

possess. Energy can be held by atoms only at certain discreet and fixed levels. In its normal state the atom will have the lowest of its possible energy states—the ground level as it is termed. By absorbing energy (in this case green light) the atom can be raised to a higher level and is then said to be in an excited state. From this excited state the atoms fall back to lower levels and in certain cases emit energy.

The actual energy levels involved together with the frequencies of the incident and radiated energy are bound by the relationship

$$h\nu = \Delta E$$

where  $h =$  Planck's constant  $(=6.624 \times 10^{-27}$  erg-sec)

$\nu =$  frequency of radiation in cycles per second

$\Delta E =$  the difference in energy level in ergs

Thus the frequencies absorbed and radiated are proportional to the differences in relative energy levels.

Referring to Fig. 6, the energy level diagram relating to the ruby crystal, atoms in state  $E_1$ , are pumped from the ground level by the absorption of green light into the crystal, to a higher energy level  $E_2$ .

$$h\nu_A = E_2 - E_1$$

The energy level at  $E_2$  is approximately 2.25 electron volts  $(=3.6 \times 10^{-12}$  erg) and that at  $E_1$ , the ground level is zero. Thus the frequency of the light absorbed into the crystal is

$$\nu_A = \frac{E_2 - E_1}{h} = \frac{3.6 \times 10^{-12}}{6.624 \times 10^{-27}} = 5.45 \times 10^{14} \text{ c/s which}$$

is equivalent to a wavelength of 5500 angstroms.

At the  $E_2$  level there is a small, but inevitable, energy loss and the atoms quickly drop to an intermediate, or metastable level,  $E_3$ , where their life time is of the order of a few milliseconds. From the metastable state the atoms fall back to the original ground state, losing energy and emitting radiation. The energy loss and radiated energy are related by the expression.

$$h\nu_R = E_3 - E_1$$

and as  $E_3 - E_1$  is less than  $E_2 - E_1$  the radiated frequency ( $\nu_R$ ) is lower than the frequency of the light absorbed during the pumping process ( $\nu_A$ ). The difference in energy between the  $E_3$  level and ground ( $E_1$ ) is 1.828 electron volts giving the characteristic output wavelength of the ruby crystal maser of 6943 angstroms, equivalent in frequency to  $4.31 \times 10^{14}$  c/s.

With an energy input below a certain rate the atoms falling from the metastable state to ground will do so in a random manner; however, above a particular energy threshold the number of atoms initially raised to the  $E_2$  level and accumulating at the meta-

stable level is greater than that in the ground level. This is a state of population inversion. There is then an accelerated fall of these atoms giving radiation at the output frequency of the device, tending to maintain equilibrium in the crystal. The first atoms to fall radiate spontaneously and in doing so stimulate others in the  $E_3$  state to do likewise, these in turn stimulate more atoms and an intense radiation is built up that continues as long as the over-population in the metastable state exists.

Let us recall for a moment that all this action is taking place within an optical cavity with perfectly parallel and accurately spaced reflecting surfaces. These two features ensure that light of a particular wavelength and direction is favoured. Light produced within the crystal by the fall of atoms from the metastable state, which is of the wavelength for which the cavity was designed, is reflected from end to end successively throughout the active material, stimulating the atoms still in the metastable state. Further, only light which is perpendicular to the plane of the mirrors can stay within the cavity (Fig. 7) to help with the stimulation: the stimulating light moves in the same direction, is parallel to, and in phase with, the stimulated light. The fact that the stimulated light is parallel ensures that the output through the end reflectors stays as a non-divergent beam. Light which is not perpendicular to the reflectors is reflected to the sides of the cavity and does not contribute to the output beam.

The ruby crystal laser is normally pumped by a xenon type flash tube giving a burst of light of a

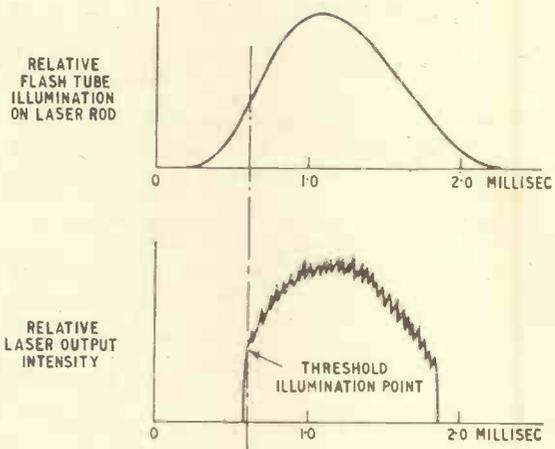


Fig. 8. Spiky output is due to momentary rapid depopulation and repopulation of metastable level.

duration between 0.5 and 2.0 milliseconds. The output from the laser is essentially of the same duration, but consists of a number of spikes each a few microseconds long (Fig. 8). This is thought to be due to the intensity of the light within the crystal building up to the point where emission is stimulated. The laser action then takes place and the metastable state is then depopulated so rapidly that the pumping light is momentarily unable to maintain a sufficient number of atoms in the metastable state to allow stimulated emission to continue. The radiation abruptly dies away until the exciting source restores the required population level. The extremely rapid pulsing of the light results from the depletion and

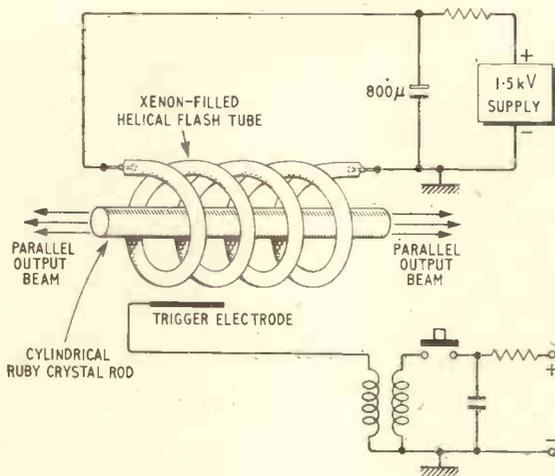


Fig. 9. Ruby crystal laser with helical flash-tube pump.

restoration of the concentration of atoms in the metastable state.

To ensure the greatest overall efficiency of the device close optical coupling is required between the pumping source and the crystal so that as much light as possible is transferred from the flash tube to the laser.

A commonly used arrangement is shown in Fig. 9. The light source is a multi-turn, xenon-filled quartz high energy helical flash tube and the crystal is mounted coaxially in the centre of the helix. Although this is a convenient arrangement, quite a lot of illumination is lost from the outer surfaces of the helix and is not usefully employed.

Fig. 10 illustrates two other rather similar methods of illuminating the crystal. Both use cylindrical type mirrors, one with a circular section (a) and the other with an elliptical contour (c): both utilize linear type flash tubes. With the circular section mirror the crystal and the flash tube are mounted as close together as possible with their long axes parallel to each other and also mutually parallel to, and on the axis of, the mirror.

The combination of the lamp and crystal is at the centre of curvature of the mirror and thus all light emanating from this region is reflected back through the same point (b).

A rather more difficult mirror to produce is the one with the elliptical contour, but it does provide greater efficiency. The lamp is placed at one focus of the mirror, the crystal at the other; once again all the long axes are parallel. It will be recalled that light

radiating from one focus of an elliptical mirror, after reflection from the surface of the mirror, passes back through the second focus (d), thus virtually all the light from the flash tube is reflected on to the crystal.

The input power required for the flash tube to produce maser action in a ruby crystal is typically 250 to 1000 joules. Coherent light output from the device is often up to 30 joules with maximum efficiencies of 2-3%. The beam width is of the order of 10 milliradians (about  $\frac{1}{2}$  of a degree).

At lower power outputs the beam spread is reduced to about one tenth of this figure. Owing to the heating effect of the very large power input it is not possible to operate a laser of this type at any higher rate than one flash every twenty or thirty seconds at room temperatures. However, commercially available devices often provide the facility for air or liquid nitrogen cooling, which permits higher power inputs or greater frequency of operation. It may be of interest to know that a complete laser and power supply equipment of this type, suitable for laboratory use costs in the region of £1,250.

Although the total output of these optical masers is relatively low it is interesting to compare the intensity with that of the sun's visible surface, which behaves much as a black body radiator at 6,000°C and is about seven kilowatts per square centimetre of its surface. This, of course, is over the complete range of wavelengths—visible light, infrared, ultra-violet, etc., but if only a narrow band were filtered out, say 1 Mc/s wide (that is, just over  $10^{-9}$  angstroms) in the green light region only, one watt of radiation would be obtained from about ten square metres of the surface. By contrast the burst of energy from the ruby crystal maser is over 10,000 watts peak from an area of one square centimetre.

The laser output can be concentrated to a spot of light one tenth of a millimetre square ( $10^{-4}$  cm<sup>2</sup>). In this minute area there will be a power concentration of  $10^8$  watts cm<sup>2</sup>. Densities of this order are, of course, far above that which are produced by the sun or any other source of radiation.

Apart from aluminium oxide there are many other solid materials which with suitable additives

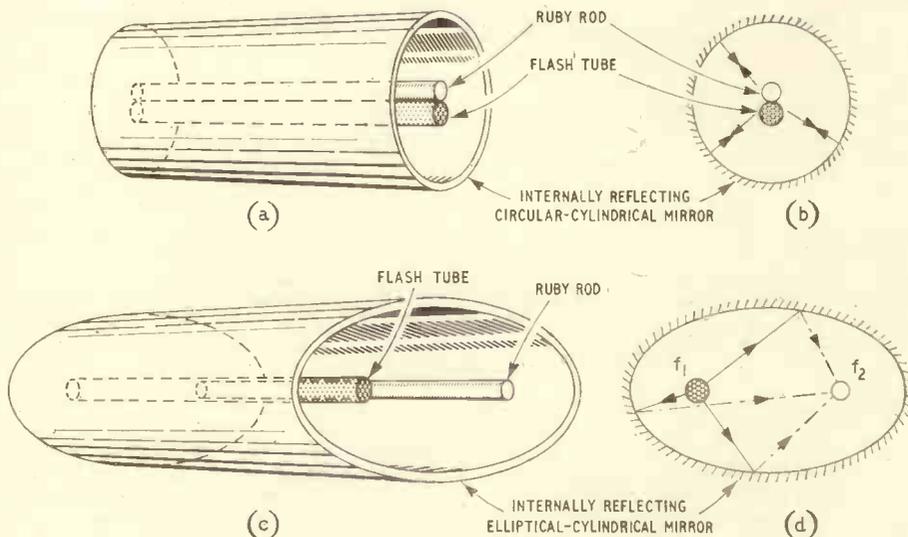


Fig. 10. Two ways of reinforcing the initial illumination.

**TABLE II: ACTIVE MATERIALS AND OUTPUT WAVELENGTHS OF VARIOUS TYPES OF LASER.**

Class	Active Material	Wavelength (angstroms)
Liquid	Europium-benzolacetate	6,129
Gas	Helium-neon	6,329
Crystal	Aluminium oxide-chromium oxide	6,943
Crystal	Calcium fluoride-samarium	7,085
Liquid	Toluene	7,463
Semiconductor	Gallium arsenide	8,440
Gas	Neon-oxygen	8,446
Crystal	Glass-neodymium	10,630
Gas	Helium-neon	11,530
Gas	Krypton	16,940
Gas	Argon	16,940
Crystal	Calcium tungstate-thulium	19,110
Gas	Xenon	20,261
Gas	Krypton	21,890
Crystal	Calcium-fluoride-uranium	25,600
Gas	Caesium (vapour)	71,800

have been made to give coherent light. Among the materials used are calcium fluoride with small amounts of samarium or uranium and even glass with neodymium. The wavelengths produced by these lasers range between 7000 angstroms and 26,000 angstroms (in the far infra-red). A fuller list is given in Table II.

Lasers using calcium fluoride crystal have been found to require less pump power than the ruby type and are in fact more efficient, also they have been made to operate in a continuous fashion instead of emitting bursts of radiation. The main disadvantage of these at the moment is that they must operate at very low temperatures.

Each crystalline material and its dopant has a particular output wavelength as is shown in the table although it is possible to vary this slightly by a change in operating temperature<sup>5</sup>. A difference of almost 20 angstroms was detected between the output of a ruby at -180°C (6934 angstroms) and that at

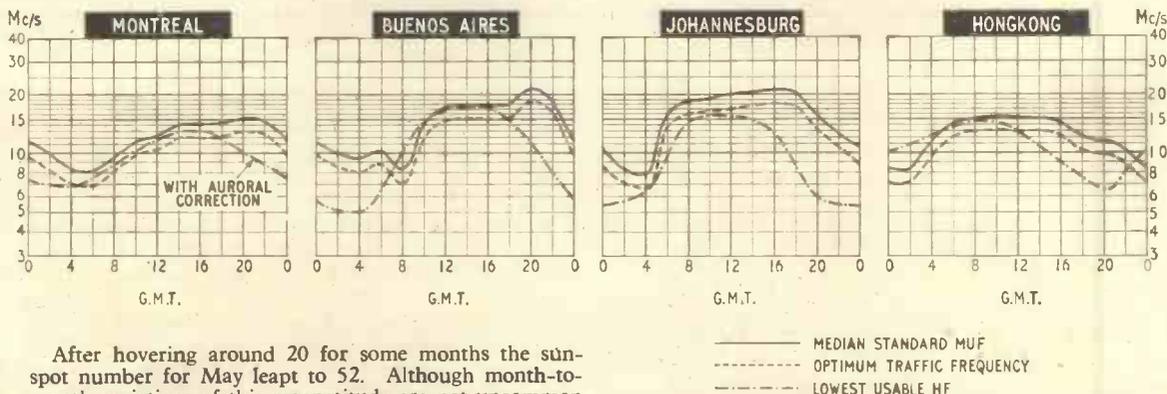
210°C (6953 angstroms). This could prove a most useful feature, for by allowing the frequencies so generated to beat together difference frequencies would be produced, just as with conventional oscillators. In this case "thermal tuning" of one maser would produce a tremendous range of output frequencies. By varying the temperatures appropriately it seems that it may be possible to generate almost any frequency between zero and 10,000,000 Mc/s with one pair of maser crystals.

(To be concluded)

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**H. F. PREDICTIONS — AUGUST**



After hovering around 20 for some months the sun-spot number for May leapt to 52. Although month-to-month variations of this magnitude are not uncommon the figure for May emphasizes that solar activity has now declined very little over a period of 2 years. A slow decline may be expected in coming months but the effect of this will be masked by the more significant seasonal changes.

The prediction curves show the median standard MUF, optimum traffic frequency and the lowest usable high frequency (LUF) for reception in this country.

Unlike the MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, local noise level and the type of modulation: it should generally be regarded with more diffidence than the MUF. The LUF curves shown are those drawn by Cable and Wireless, Ltd., for commercial telegraphy and they serve to give some idea of the period of the day for which communication can be expected.

# Transistor High-quality Pre-amplifier

SUITABLE FOR USE WITH THE MULLARD 10W CLASS AB, 10W CLASS B AND

5W CLASS A TRANSISTOR AMPLIFIERS

BY E. CARTER\* AND P. THARMA,\* B.Sc. (Hons.)

**T**HIS pre-amplifier is suitable for most crystal and ceramic pickup heads. In the magnetic pickup position, the circuit gives correct equalization for a pickup head of 500mH inductance. Other values of inductance require a different resistor in the input circuit. In the "radio input" position, the input resistance is 100k $\Omega$  and the sensitivity 100mV. Other values of input resistance and sensitivity can be obtained by altering resistor values.

Bass and treble tone controls are provided. A design is also given for simple h.f. and l.f. filters.

The pre-amplifier uses inexpensive germanium alloy transistors, type OC75 and due to the particular design of the input amplifier, the noise is well below typical user requirements. It is hoped to deal with the general problem of noise in audio amplifiers in an article in a subsequent issue.

## General Considerations

The number of amplifying stages, the location of volume and tone controls, and the signal levels throughout the pre-amplifier are governed by a number of conflicting requirements.

An important requirement is that all amplifying stages prior to the volume control should be capable of handling signals much greater than the nominal input level. This is necessary because of the wide variations of recording levels and sensitivities of pickups; and it is common practice to design the

"pre-volume-control" stages to handle an increase of input level by a factor of at least 10 without excessive distortion. Obviously it is easier to obtain large dynamic ranges if the signal levels are very low. However, too low a signal level would make the noise contributed by the circuit very much more troublesome. Thus the location of the volume control is a compromise between dynamic range and noise.

The noise requirements, which will be discussed in a subsequent article, are as follows. First, the noise introduced by the pre-amplifier should be well below the noise present with the programme material, e.g., record noise. This requires careful design of the input stage and, again, the operating conditions of the input transistor are a compromise between noise and dynamic range. The second requirement is that with the volume control turned down fully, the noise from the system under typical user conditions should be inaudible. To meet this condition, the volume control should be as late as possible in the system. This however conflicts with the dynamic range requirement and in practice a compromise is adopted.

Tone controls generally introduce a loss—a factor of 10 or more being common. Placing the tone controls before the volume control increases the signal handling problems of the pre-volume-control stages. If the tone control is placed immediately after the volume control then the signal level after the tone controls may be so low that the noise of the stage following the tone control becomes a problem. A better solution is to follow the volume control by a single stage of amplification and then the tone control circuits.

## Equalization for Magnetic Pickups

The recording characteristic (i.e., the relationship between the lateral velocity of the cutter and frequency) in common use is shown in Fig. 1. With a magnetic pickup the e.m.f. is proportional to the rate of change of flux in the magnetic circuit, and therefore the playback characteristic is identical with the recording characteristic. A correction circuit for magnetic pickups should therefore have a response complementary to the recording characteristic as shown in Fig. 2.

With valve amplifiers it is common practice to terminate the pickup with a high resistance (50-100k $\Omega$ ) and apply the full equalization of Fig. 2. A similar arrangement can be adopted with transistor circuits, i.e., the amplifier can be designed to have a high input resistance and the full equalization

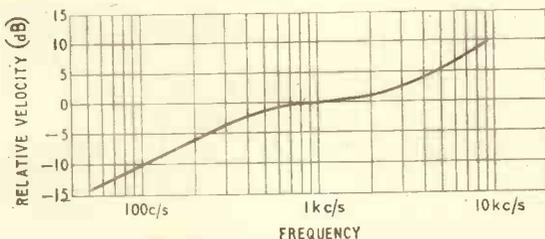


Fig. 1. British standard recording characteristic.

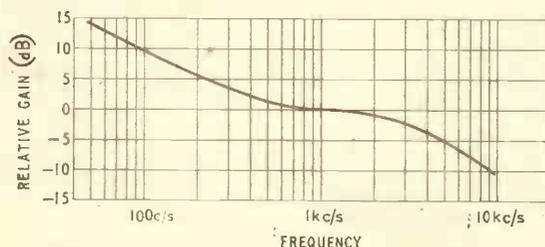


Fig. 2. Equalization required for magnetic pickups.

\* Mullard Applications Research Laboratory



Controls on the front panel.

applied in the amplifier using suitable networks. A better circuit arrangement which gives improvements in sensitivity and signal-to-noise ratio is shown in Fig. 3. In this the pickup is terminated with a low resistance such that the total resistance in the pickup circuit together with its inductance gives the upper frequency roll-off. Frequency-dependent feedback via  $R_f$ ,  $C_f$  provides the rest of the equalization, i.e., the bass lift part of Fig. 2.

### Equalization for Crystal Pickups

The equalization required for crystal pickups is somewhat different. The open circuit voltage from a crystal pickup is proportional to the displacement of the stylus, and the playback characteristic is

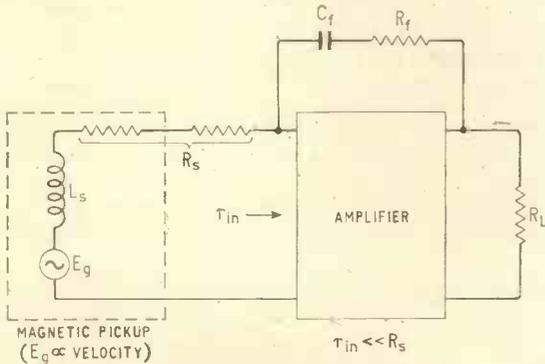


Fig. 3. Equalization for magnetic pickup.

therefore similar to the amplitude versus frequency recording characteristic. This characteristic, derived from Fig. 1, is shown in Fig. 4. With valve amplifiers the pickup is usually terminated with a high resistance (1-2M $\Omega$ ) and no further equalization is used. A similar arrangement is possible with transistor amplifiers, a high resistance (1-2M $\Omega$ ) being used in series with the pickup. A significant improvement in signal-to-noise ratio can be obtained with the circuit shown in Fig. 5. In this, the pickup is connected directly to the input stage. Since the source impedance is capacitive the signal current into the transistor increases with increase of frequency. This rising frequency characteristic is compensated by capacitive feedback via  $C_f$ . The

playback characteristic will then be similar to the amplitude versus frequency recording characteristic of Fig. 4. The "step" in the playback characteristic can be eliminated if the more complicated feedback network  $R_2$ ,  $C_2$ ,  $C_1$  of Fig. 6 is used instead of single capacitor.

The pre-amplifier circuit is shown in Fig. 6. The transistors Tr1 and Tr2 forming the input amplifier are direct coupled with overall d.c. feedback via  $R_9$  to stabilize operating conditions. The uncoupled emitter resistor  $R_{12}$  reflects a high impedance to the collector of Tr1. The voltage gain of Tr1 is therefore high, enabling high impedance feedback networks to be used for equalization.

In the magnetic pickup position,  $R_6$  in conjunction with the pickup inductance gives the h.f. roll-off. The value of  $R_6$  should be chosen to suit the individual pickup—

$L_s$	$R_6$
200mH	2.7k $\Omega$
300mH	4.7k $\Omega$
400mH	5.6k $\Omega$
500mH	6.8k $\Omega$
600mH	8.2k $\Omega$
700mH	10k $\Omega$

The bass lift equalization characteristic is provided by the feedback components  $R_3$  and  $C_3$ .  $R_4$  across  $C_3$  restricts the otherwise excessive gain at very low frequencies.

In the crystal pickup position equalization is provided by the network  $R_{22}$ ,  $C_{22}$ ,  $C_{11}$ . The component values are suitable for pickups with capacitances greater than 500pF. The lower cut-off frequency is about 80 c/s—this is equivalent to using a 5M $\Omega$  load across the pickup in conventional valve circuits.

In the radio position the gain is determined by the

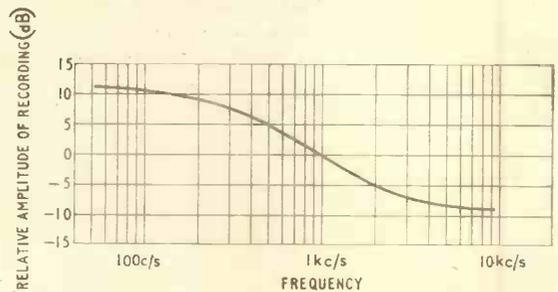


Fig. 4. Standard recording characteristic (amplitude versus frequency).

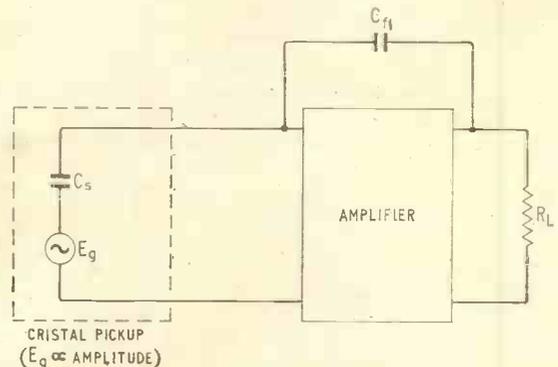


Fig. 5. Equalization for crystal pickup.

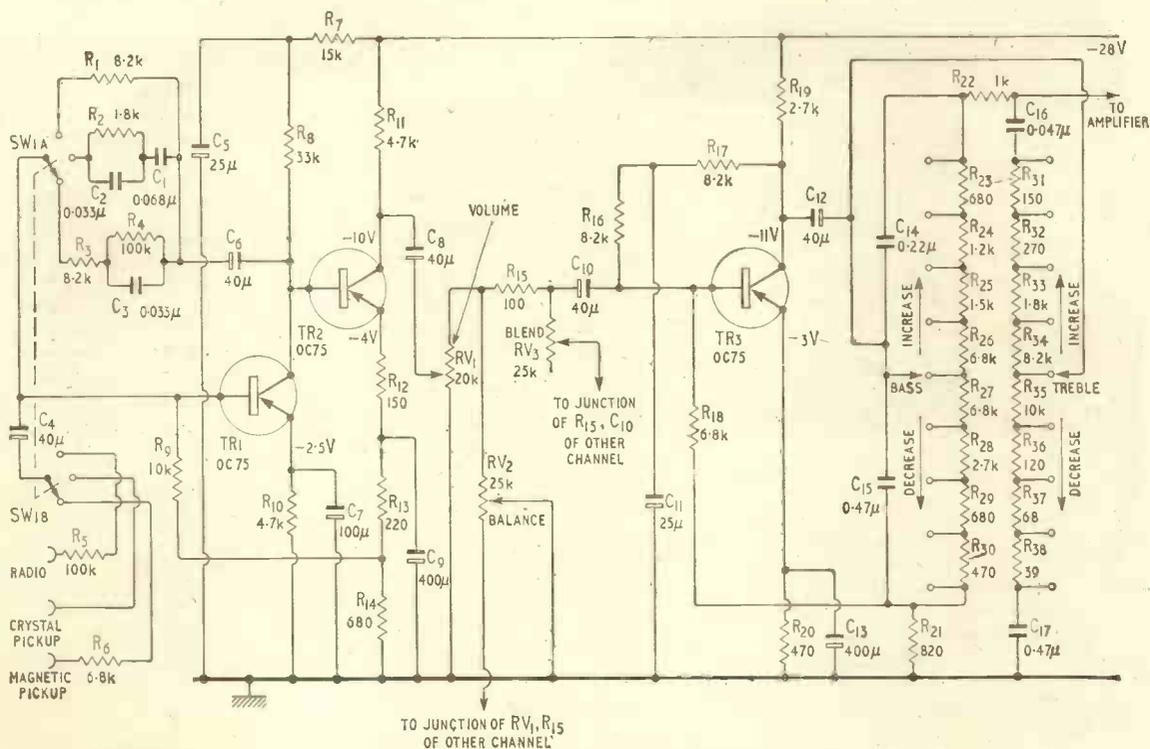


Fig. 6. Complete circuit diagram of pre-amplifier and (below) component list.

**Transistors**

- Tr1 OC75
- Tr2 OC75
- Tr3 OC75

**Resistors** Cracked carbon 1/8W ±5%

- R<sub>1</sub>, R<sub>3</sub>, R<sub>16</sub>, R<sub>17</sub>, R<sub>34</sub> 8.2kΩ 1
- R<sub>2</sub>, R<sub>33</sub> 1.8kΩ
- R<sub>4</sub>, R<sub>5</sub> 100kΩ 6
- R<sub>6</sub>, R<sub>18</sub>, R<sub>26</sub>, R<sub>27</sub> 6.8kΩ 2
- R<sub>7</sub> 15kΩ
- R<sub>8</sub> 33kΩ 4
- R<sub>9</sub>, R<sub>35</sub> 10kΩ 4
- R<sub>10</sub>, R<sub>11</sub> 4.7kΩ 4
- R<sub>12</sub>, R<sub>31</sub> 150Ω 4
- R<sub>13</sub> 220Ω
- R<sub>14</sub>, R<sub>23</sub>, R<sub>29</sub> 680Ω
- R<sub>15</sub> 100Ω 2
- R<sub>19</sub>, R<sub>28</sub> 2.7kΩ 1
- R<sub>20</sub>, R<sub>30</sub> 470Ω
- R<sub>21</sub> 820Ω
- R<sub>22</sub> 1.0kΩ 1
- R<sub>24</sub> 1.2kΩ
- R<sub>25</sub> 1.5kΩ
- R<sub>32</sub> 270Ω
- R<sub>36</sub> 120Ω

- R<sub>37</sub> 68Ω 1
- R<sub>38</sub> 39Ω
- RV<sub>1</sub> 20kΩ log. 1W potentiometer (ganged for stereo)
- RV<sub>2</sub> 25kΩ linear potentiometer
- RV<sub>3</sub> 25kΩ log potentiometer

**Capacitors**

- C<sub>1</sub> 0.068μF 125V Mullard Type C296AA/A68K
- C<sub>2</sub>, C<sub>3</sub> 0.033μF 125V Mullard Type C296AA/A33K
- C<sub>14</sub> 0.22μF 125V Mullard Type C296AA/A220K
- C<sub>15</sub>, C<sub>17</sub> 0.47μF 125V Mullard Type C296AA/A470K
- C<sub>16</sub> 0.047μF 125V Mullard Type C296AA/A47K
- C<sub>4</sub>, C<sub>6</sub>, C<sub>8</sub>, C<sub>10</sub>, C<sub>12</sub> 40μF 16V Mullard Type C426AM/E40
- C<sub>5</sub>, C<sub>11</sub> ✓ 25μF 25V Mullard Type C426AM/F25
- C<sub>7</sub> ✓ 100μF 4V Mullard Type C426AM/B100
- C<sub>9</sub>, C<sub>13</sub> 400μF 6.4V Mullard Type C426AM/C400

feedback resistor R<sub>1</sub> and the input resistance by R<sub>5</sub>. These can be chosen to suit individual requirements.

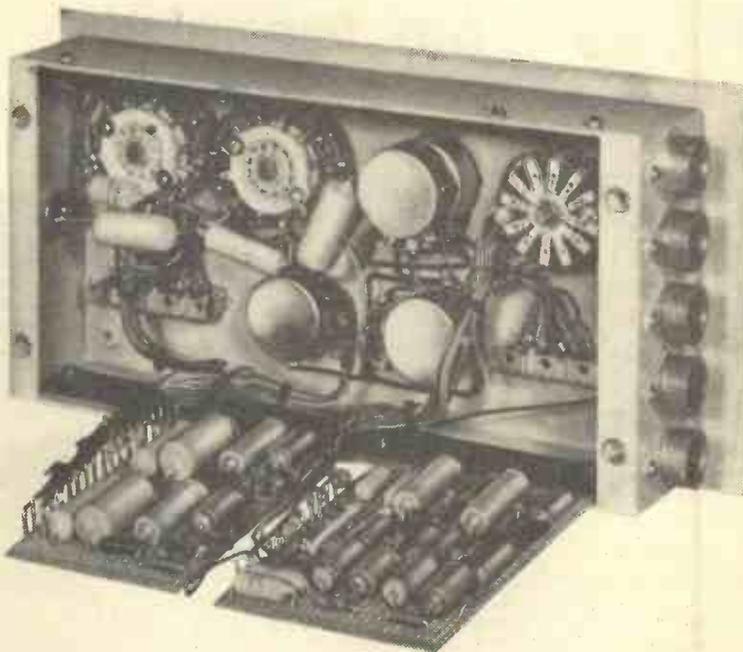
The input amplifier is followed by the volume control, and by the balance and blend controls (for stereo). These are followed by the amplifying stage consisting of transistor Tr3, which feeds the tone control network. Overall negative feedback is applied via resistor R<sub>18</sub> to reduce distortion.

Switched bass and treble tone controls are provided. By switching, it is easier to maintain identical responses between both channels of a stereo system.

Also the values of resistance for equal increments of boost or cut are such that conventional potentiometers will not be suitable. This is due to the tone control circuit being part of the feedback network. If sufficient feedback is used to reduce distortion and passive tone control circuits with conventional potentiometers used, then the loss of gain will be greater and an extra stage may be necessary.

Simple h.f. and l.f. filters can be added to the circuit of Fig. 6. The lower cut-off frequency of the pre-amplifier is about 20 c/s. This can be

Rear view of prototype pre-amplifier.



increased by decreasing the value of the coupling capacitor  $C_{12}$  (Fig. 8). Suitable values are

$C_{20} = 0.47\mu\text{F}$ , lower cut-off frequency 50 c/s

$C_{21} = 0.22\mu\text{F}$ , lower cut-off frequency 100 c/s

The h.f. response can be reduced by shunting the feedback resistor  $R_{18}$  with suitable capacitors, thus forming a h.f. filter

$C_{18} = 3300\text{pF}$ , upper cut-off frequency 8 kc/s

$C_{19} = 2200\text{pF}$ , upper cut-off frequency 12 kc/s

The sensitivity of the pre-amplifier in the magnetic pickup position is 5mV for an output current of  $140\mu\text{A}$ . This current of  $140\mu\text{A}$  is the input required by the 10W Class AB amplifier for an output of 10W. The corresponding sensitivity in the crystal pickup position is 500mV (source capacitance 500pF), and the sensitivity in the radio position is 100mV.

The total harmonic distortion at 1kc/s in the magnetic pickup position is less than 0.05% for an input of 5mV. If the input is increased to 50mV and the volume control turned down so that the output is  $140\mu\text{A}$ , then the total harmonic distortion increases to about 0.3%.

The tone control characteristics are shown in Fig. 7, and cover the range

Bass +12dB to -13dB at 100c/s

Treble +8dB to -10dB at 10kc/s

The noise spectra with the volume control at maximum and minimum are shown in Fig. 9. The spectrum of acceptable noise is plotted on the assumption that  $140\mu\text{A}$  corresponds to a sound pressure level of 90dB reference threshold. Interpretation of noise spectrum data will be discussed fully in a subsequent article. The noise is well below user requirements. A further improvement of about 3dB can be obtained if AC107's are used instead of the OC75 for Tr1 and Tr3.

The power supply requirement is about 12mA at 24-28V.

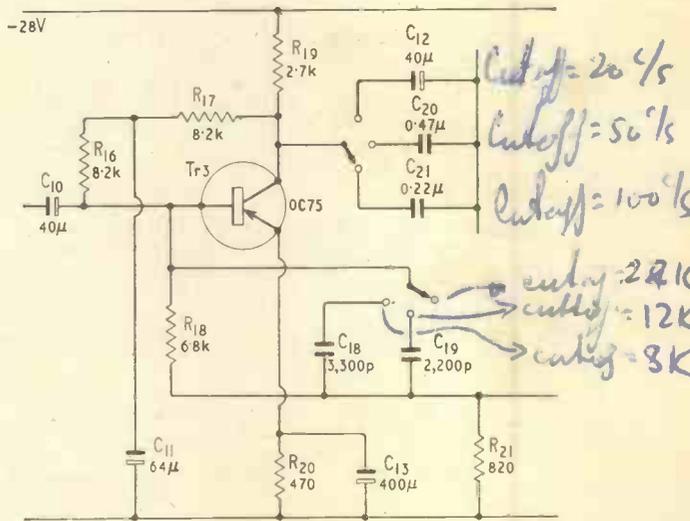


Fig. 8. L.f. and h.f. Filters.

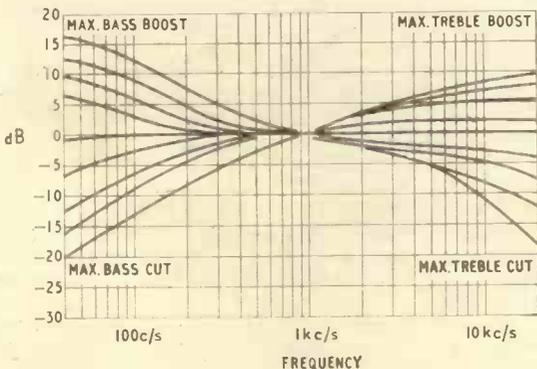


Fig. 7. Pre-amplifier tone control characteristics.

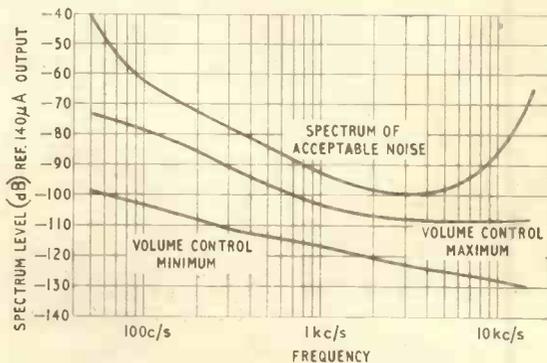


Fig. 9. Noise spectrum of pre-amplifier (magnetic pickup position).

# News from Industry

The Ministry of Aviation has placed an order to the value of £1.5M with Marconi's W/T Company for the supply of high-frequency mobile radio stations. This order follows a similar contract placed with Marconi's in 1960 and calls for a number of Type D11 and D13 transmitter-receivers, the latter type embodying two receivers for dual diversity operation.

The East African Governments announce that the branches of Cable & Wireless Ltd., in East Africa, are to be taken over from 1st January next. Announcing this in parliament, the Minister of Communications, Power and Works, Mr. Amir Jamal, said a controlling interest is to be acquired by the Posts and Telegraphs Department of the East African Common Services Organisation, with Cable & Wireless retaining the balance of shares.

The Plessey Company which through two of its main subsidiaries, Automatic Telephone & Electric Co. and Ericsson Telephones Ltd. owns a 50% interest in Telephone & Electrical Industries Pty. Ltd., of New South Wales, has now acquired the 25% interest in this company, previously owned by the General Electric Company.

**Pye-Goodmans Deal.**—The Vibrator Division of Goodmans Industries Ltd., a subsidiary of Relay Exchanges Ltd., has been acquired by Pye-Ling Ltd., a member company of the Pye organization. Pye-Ling, of Royston, Herts., will market the complete range of Goodmans vibration equipment, under the name of "Goodmans". This transaction does not affect the manufacture and marketing of Goodmans loudspeakers.

**Amphenol Borg Ltd.** has acquired Electronic Insulators Ltd., the manufacturers of cable assemblies and phasing connectors. Electronic Insulators was formed last year by G. W. Bagshaw, M.Brit.I.R.E., Assoc.I.E.E., who was associated with J. C. Graves and Co. (the pre-war set manufacturers of Sheffield) which subsequently became the Wireless Telephone Company, now part of the Plessey organization.

**Standard Telephones and Cables Ltd.** has amalgamated its Transistor Division of Footscray, Kent, and its Rectifier Division of Harlow, Essex, to form a single Semiconductor Division. The new division employs some 2,000, and is managed by J. M. Wilson who was formerly manager of the Rectifier Division.

A new company **Associated Electrical Maintenance Ltd.**, has been formed to take over the duties of Home Maintenance Ltd. which covers the service activities of the Clarke and Smith Industrial Group. G. W. Aggett, formerly with Magneta (B.V.C.) Ltd., has been appointed managing director of the new company, and also of Clarke and Smith Rentals Ltd., an associate company.

The Rank Organisation have formed a new division to be responsible for the manufacture and marketing of their Xeronic high-speed computer output printers; it will also be responsible for the manufacture of their Copyflo continuous printers. Formerly known as the Electronics Department of Rank Precision Industries, the new division is to be known as the Rank Data Systems Division and will operate under I. D. Brotherton at Woodger Road, Shepherds Bush, London, W.12.

A new division, to be known as the **Automation Division**, has been formed by E.M.I. Electronics Ltd. to take over the systems activities of the Industrial and Instrument Divisions.

**U.K.-Poland Trade Agreement.**—A five-year trade agreement was signed with Poland in June this year. Previous agreements with Poland have been for only three-year periods. Britain is the major trade partner with Poland in the west and in the last trading year, which ended 30th June, the combined value of Anglo-Polish trade totalled £69,000,000. The Polish quota of exports to Britain for the first year of the new agreement includes £150,000 worth of domestic radio, audio and television equipment and parts (including £30,000 worth of transistors and transistor equipment and £30,000 worth of domestic valves and tubes). Industrial valves and parts to the value of £5,000 are also to be admitted. The quota of British exports to Poland includes £440,000 worth of radio, audio and television equipment and components plus £550,000 worth of scientific and industrial instruments and equipment.

**Controls and Communications Ltd.**, formerly known as Radio and Television Trust, announce a profit for the year ended 31st March of £292,888 after taxation of £274,375. This represents an increase of £78,687 on the previous year. Subsidiaries of this company include Thermionic Products, Airmec, British Communications Corporation, and Modern Aerials.

**Ferranti Ltd.**—Group profit after all charges, including taxation, for the year ended 31st March amounted to £778,772 after taking account of a £368,539 deficit accumulated by its subsidiary companies. The Group profit represents a decrease of £134,245 on the previous year's figure.

Pre-tax profits of **Dansette Products Ltd.** for the year ended 31st March amounted to £251,676. This figure represents a drop of over £170,000 on the previous year's profits. Tax this year amounted to £142,213 leaving a net profit of £109,463 compared with £181,917 the previous year.

**Colvern Ltd.**—Profit, before tax, for the year ended 31st March amounted to £275,360. Tax for the year took £143,968 leaving a net profit of £131,392—an increase of £7,242 on the previous year's figure.

**Ultra Electric (Holdings) Ltd.**—Profit after taxation for the year ended 30th March amounted to £161,325. This represents a drop of over £50,000 on the previous year's figure.

**C.S.F.**—Compagnie Générale de Télégraphie sans fil, one of the major French electronics companies, announces a net profit of Frs. 12,378,938 for the year 1962. Turnover for the same year amounted to Frs. 880,620,000 of which Frs. 166,889,000 was from overseas trade.

We have received an English edition of the annual report of A.E.G. for 1961/62 which records that Telefunken contributed 60% of the DM 1,262,000,000 turnover of the subsidiaries. The parent company's turnover, without subsidiaries, rose to DM 2,067,000,000. The group net profit was nearly DM 52,000,000 (approx. £4.7M).

**International Aeradio.**—The gross turnover of the company in 1962 amounted to £3,250,000. This represents an increase of £450,000 on the previous year.

**Change of Name.**—British Electronic Industries Ltd., which was formed about three years ago to acquire the shares of Pye Ltd. and E. K. Cole Ltd., is now to be called Pye of Cambridge Ltd.

Marconi Instruments have asked us to point out that the distortion figure of 0.5% given for their TF 2100 a.f. oscillator in our review of the Components Show, page 329 of July, should have been 0.05%. However, 0.5% does apply for their TF 2101 m.f. oscillator.



Testing microminiature solid circuits at the Caswell Research Laboratory of the Plessey Company. A silicon slice containing over one hundred solid circuits is being checked with point probes.

Georg C. K. Withof, G.m.b.H., of West Germany, who were until recently represented in this country by Thorn Electronics Ltd., are now being represented in the U.K. by Research and Control Instruments, a subsidiary of N. V. Philips of Eindhoven. Withof products include industrial process monitoring, control and allied equipment. Thorn Electronics Ltd. are now marketing the range of temperature indicators and controllers, potentiometric recorders and other instruments manufactured by Hartmann and Braun A.G., of Frankfurt.

Rank Cintel, a division of the Rank Organisation, is to market some of the counter-timers manufactured by the Systron Division of the Systron Donner Corporation, of America. These instruments will supplement the range of Rank Cintel laboratory equipment and it is expected that selected models from the Systron range will shortly be manufactured in this country under the trading name Rank Cintel Systron.

Keyswitch Relays Ltd., of 120-132 Cricklewood Lane, London, N.W.2, announce that they are now handling the American Omron series of relays.

Stephenson, Mills Ltd. of New Malden, Surrey, have been appointed U.K. agents for Technical Wire Products Inc., of New Jersey, U.S.A., whose products include an extensive range of r.f. interference shields.

R. H. Cole (Overseas) Ltd., of 26-32 Caxton Street, Westminster, London, S.W.1, who for some years have been U.K. agents for Siemens & Halske components and test gear, are now also handling their special purpose valves.

Roberts Electronics, of Hitchin, Herts., have recently been appointed agents for three American companies—Ramcor Inc., Melabs Inc., and Paradyamics Inc.

A.E.P. International Ltd., of Hounslow, Middx., the U.K. associates of A.E.P. of Montreal, Canada, are now representing nearly twenty American and Canadian companies in this country. They include Lumatron Electronics Inc., Vidar Corp., Philbrick Researches Inc. and Non Linear Systems Inc.

The Burroughs Corporation of America has appointed Walmore Electronics Ltd., of London, as representative in the U.K. for the products of its Electronic Components Division.

Claude Lyons, of Liverpool, have been appointed agents for Millivac Instruments Inc. of Schenectady.

Tektronix Inc. of America have formed a British subsidiary, Tektronix U.K. Ltd., to market their range of oscilloscopes and instruments in Great Britain. Harry Sellers, previously commercial director of Livingston Laboratories, has been appointed managing director of the new subsidiary which is scheduled to come into operation next January. Livingston Laboratories are to continue distributing Tektronix equipment until 1st January 1965.

Painton & Co., Ltd., have been appointed exclusive agents in the U.K. for the sale of the entire range of products of Bourns Inc., California, U.S.A. For some time, Painton has held the manufacturing and selling rights for the Bourns Trimpot range of potentiometers.

Electrosil Ltd., up to now a sales organization, is to undertake the manufacture of metal oxide resistors, previously made by James A. Jobling, at its plant in Sunderland.

G. & E. Bradley Ltd. have been awarded an initial contract, worth over £42,000, to supply the R.A.F. with test equipment for pre-flight testing TACAN air-to-air navigational equipment.

Decca Type 424 airfield control radar is to be installed at Jersey airport in the Channel Islands. The equipment will be used primarily in the approach rôle, complementary to the I.L.S. and surveillance radar systems already in use.

Digital Measurements Ltd. have recently supplied the Admiralty with a seaborne digital data recording system. It will be used to evaluate new ship designs in terms of various motion parameters.

A 16mm vidicon tele-ciné unit manufactured by Automatic Information and Data Service Ltd. has been supplied to Tyne-Tees Television. The unit, built from standard Vidiaids equipment, is designed for 405-line operation.

British Brown-Boveri Ltd. have moved to Glen House in Stag Place, London, S.W.1. (Tel.: TATe Gallery 9422.)

The new London headquarters of the General Electric Company is 1 Stanhope Gate, London, W.1. (Tel. HYDe Park 8484.)

## OVERSEAS TRADE

**O.B. Television Vehicles.**—Masinimport of Bucharest, Rumania, have placed an order with Marconi's W/T Company for a complete four-camera outside broadcast vehicle and a complete three-camera studio for Bucharest. Mark IV 4½in image orthicon cameras will be used in both the studio and O.B. vehicle. Radio Television Belgrade has also ordered a four-camera O.B. vehicle from Marconi, bringing their sales of these vehicles up to 54, of which 32 are for abroad.

The Belgian Television Authority has ordered eight camera channels and two 16-channel audio mixing units from Pye T.V.T. Ltd. to re-equip its Brussels studios.

Redifon Ltd. has received a contract, worth £30,000, to supply and install five radio beacon stations for the Ports and Lighthouses Administration of the United Arab Republic. The stations to be sited at Alexandria and Rosetta are to operate on 303.4kc/s and those at Damiatta, Port Said and El Tor on 310.3kc/s.

Germany's largest independent producers of TV programme material, Riva TV and Film Studios, have ordered four 4½in image orthicon cameras and an 8-channel vision mixer, for a new studio from E.M.I. Electronics Ltd.

The New Zealand Civil Aviation Authority has ordered four instrument landing systems from Pye Telecommunications of Cambridge. Two of these installations are to be fitted at Auckland's new airport and the other two at Christchurch airport.

# MANUFACTURERS' PRODUCTS

## NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

### D C. Micro-Volt-Ammeter

A WIDE-range voltage and current measuring meter the Type MV-07 C manufactured by Millivac Instruments is available in the U.K. through Claude Lyons Ltd., Valley Works, Hoddesdon, Herts. The instrument is capable of measuring direct voltage from  $10\ \mu\text{V}$  full scale to 1,000 V full scale and direct current from  $10\ \mu\text{A}$  to 1 mA in seventeen ranges. The manufacturers claim that the greatest error over this range is  $\pm 4\%$  of full scale on the most sensitive voltage and current ranges improving to  $\pm 2\%$  of full scale on the  $100\ \mu\text{A}$  to 1 mA ranges and  $\pm 1\%$  of full scale of the  $250\ \mu\text{V}$  to 1,000 V ranges.

The low noise characteristic of the equipment, quoted as better than  $\pm 0.5\ \mu\text{V}$ , p-p, referred to the input, is achieved by a low-drift chopper circuit, the use of a double triode in cascade for the amplifier input stage and a twin-T circuit in one of the feedback loops. For further information circle 301 on Service Sheet.



Millivac Instruments Type MV-07C d.c. micro-volt-ammeter.

English Electric pulse tetrode Type C1149/1.

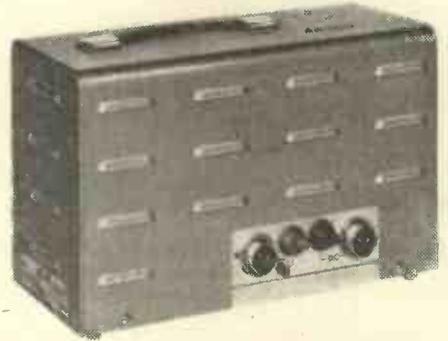


### Pulse Tetrode

A NEW pulse tetrode, C1149/1, for use in radar modulators has been produced by the English Electric Valve Company. Features of this valve, which is a development of the C1133, include a strengthened electrode assembly, to reduce the chance of short circuits under vibration and a cathode coating which is claimed to be immune to flaking and peeling. The base pins have been made more pliant to minimize glass breakage. The valve is specified to withstand intermittent vibrations up to 50g from 20c/s to 1,500c/s, and each valve is subjected to a shock test of 200g. The pulse output power is rated at 330kW with a maximum anode dissipation of 60W at 20kV and a pulse current of 18A. For further information circle 302 on Service Sheet.

### Transistor Inverters

OPERATION of mains-powered equipments in the field can be achieved by use of two new transistor sine-wave inverters Models ICV80 and ICV150 manufactured by Advance Components of Hainault, Ilford. D.v. inputs range from 12 to 28V with maximum load ratings of

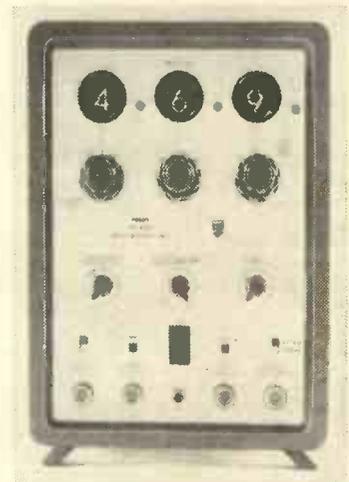


Advance transistor sine-wave inverter, Model ICV80.

80 and 150 W depending on the type. The 240V a.v. output has a frequency stability within  $\pm 0.5\%$  and an harmonic content of less than 5%. The efficiency on full load is approximately 70%. The output voltage variation for a fixed load does not exceed  $\pm 3\%$ . Both equipments may be operated over an ambient temperature range of  $-10^\circ\text{C}$  to  $+50^\circ\text{C}$ . For further information circle 303 on Service Sheet.

### Trigger Delay Unit

THE versatility of many oscilloscopes can be increased by the use of a trigger delay unit. This enables the triggering of a timebase to be delayed so that the trace begins at any desired point during the period of the signal. Thus, examination in detail can be made of any particular portion of a signal by adjusting the delay unit and the oscilloscope so that that portion occupies the whole width of the display. A single line of a television video signal may be displayed by feeding the frame pulse to the input of the delay unit and using the delayed output pulse to trigger the oscilloscope. The delay time is variable from  $2.5\ \mu\text{sec}$  to 100 msec in four ranges and is

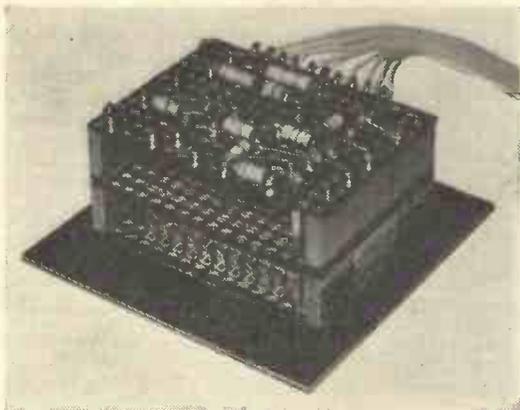


Philips trigger delay unit, Type GM4585.

indicated by digital read-out tubes. Additional facilities include sawtooth and gate-pulse outputs that can be used for x deflection and unblanking of the oscilloscope. A sync separator is also included to aid stable triggering on video frame pulses and to allow the delayed trigger pulse to be locked to line sync pulses. The unit is manufactured by Philips and is designated the Type GM4585. It is marketed in the U.K. by Research and Control Instruments Ltd., 207 King's Cross Road, London, W.C.1. For further information circle 304 on Service Sheet.

### Computer Patch Boards

THE usefulness of the Sealect board computer programming board is further extended by the addition of a built-in circuit deck. Turret lugs mounted on a  $\frac{1}{4}$  in grid carry circuit elements; input and output ter-



Sealectro programming board with circuit deck.

minations are available in the plane of the circuit deck. The unit is manufactured by the Sealectro Corporation, Hersham Trading Estate, Walton-on-Thames, Surrey. For further information circle 305 on Service Sheet.

### Rectifier Kit

BOTH development engineers and amateur experimenters should find the Electro Automat rectifier kit a useful accessory. The kit consisting of three sizes of rectifier plates, contacts, contact washers, insulation washers, spacing washers, plated steel nuts, insulating tube, mounting spindles, tags and wire enables rectifier stacks of different specifications to be built up. The plates provided are suitable for reverse voltages not exceeding 30V r.m.s. The instruction leaflet provided, lists the



"Automat" experimental metal rectifier kit.

current ratings for the plates when used in common circuit configurations. The standard kit costs £7 7s and may be obtained from Electro Automat Ltd., Swinton, Manchester.

For further information circle 306 on Service Sheet.

### Voltage Calibration Source

THE problem of calibrating voltmeters, oscilloscopes and other voltage sensitive devices can be solved by the use of a new precision voltage calibrator Model 420, manufactured by Ballantine Laboratories Inc. The instrument can deliver both alternating (1 kc/s) or direct voltages from zero to 10V. Three different outputs can be selected, d.v., r.m.s. and peak-to-peak. The output is accurate to within  $\pm 0.5\%$  of the indicated value but this may be improved to  $\pm 0.25\%$  when using the calibration chart provided. The short-term drift is less than  $\pm 0.05\%$  per hour after a suitable warm-up time. The total distortion (including hum and noise) of the a.v.



Ballantine Model 420 precision voltage calibration source.

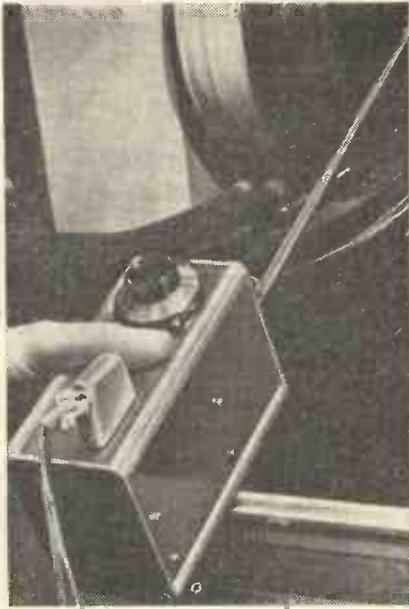
source is less than 0.25%. The price of the instrument is £175, alternatively a rack mounting version can be supplied for £184. The Ballantine agents in the U.K. are Livingston Laboratories Ltd., 31 Camden Road, London, N.W.1. For further information circle 307 on Service Sheet.

### Pressure-operated Switch

A REDUCTION in size by a factor of six compared with previous designs, is the salient feature of a new hermetically sealed pressure switch, the Klixon 2PS, introduced by Metals and Controls Inc., a division of Texas Instruments. This is designed as a pressure limit safety device in, for example, aircraft refrigeration equipment and fuel boost systems. All internal surfaces are of stainless steel and the actuating element is a snap-action disc. The switch is rated to break 5A at 28V d.v. or 110V a.v. in a resistive circuit or 2.5A in an inductive circuit. Actuating pressures (with a tolerance of  $\pm 10\%$ ) between 20 and 500 lb/in<sup>2</sup> can be provided for, and it is claimed that the actuating pressure shift over a temperature range of  $-300^{\circ}\text{F}$  to  $+500^{\circ}\text{F}$  is less than 1 lb/in<sup>2</sup>. The pressure port is designed for  $\frac{1}{4}$  in tubing. For further information circle 308 on Service Sheet.

### Proton Resonance Magnetometer Kit

THE underlying technique involves nuclear magnetic resonance, in which the nucleus of an atom at a given magnetic field strength absorbs radio-frequency energy. The frequencies involved are generally from 10-70 Mc/s. Scientifica, 148 St. Dunstan's Avenue, Acton, London, W.3, have introduced a proton resonance magnetometer kit of all the parts necessary to build the instrument, including a one-valve oscillator and a 3-stage transistor amplifier. A small probe head can be filled with different liquids for nuclear resonance comparisons. If used in



Scientifica proton resonance magnetometer being used to measure the strength of a magnetic field.

an academic institution the equipment can be easily dismantled after a set of experiments so that other students can rebuild it prior to further experimental work. The instruction manual includes a number of experiments that can be performed including the determination of nuclear magnetic moments. The complete kit costs £22.

For further information circle 309 on Service Sheet.

### Magnetic Tape Instrumentation

TWO recording channels are provided in the new Elliott-Tandberg magnetic tape instrumentation system. Three tape speeds are available; frequency modulation or direct recording modes can be selected by push-button switching on either or both channels. At  $7\frac{1}{2}$  in/sec and with a 12 kc/s carrier the f.m. system has a frequency response of z.f. to 2.4 kc/s  $\pm 1$  dB; at  $3\frac{3}{4}$  in/sec and 6 kc/s carrier the response is z.f. to 1.3 kc/s; at  $1\frac{7}{8}$  in/sec and a carrier of 3 kc/s the response is z.f. to 600 c/s. When recording directly, the frequency responses for speeds of  $7\frac{1}{2}$ ,  $3\frac{3}{4}$  and  $1\frac{7}{8}$  in/sec are 40 c/s to 16 kc/s, 40 c/s to 10 kc/s and 55 c/s to 5 kc/s respectively. The complete system costs £550 and is marketed by Elliott-Automation Ltd., 34, Portland Place, London, W.1.

For further information circle 310 on Service Sheet.

### Variable Capacitor

A MINIATURE ceramic-dielectric variable capacitor, a special feature of which, is that the vanes are metallized directly on to the dielectric to reduce microphony is available from the Havant Components Division of the



Plessey metallized ceramic vane variable capacitor Type 83.

Plessey Company. Designated the Type 83, the component is intended for use in medium and long wave receivers and is semi-sealed against dust. Two versions are available, 20-300 pF and 20-500 pF. The power factor at 1Mc/s is less than 0.002. Both the capacitance law (normally linear) and the maximum capacitance can be varied to suit customer applications. For further information circle 311 on Service Sheet.

### Components for Colour Television

R.C.A. Great Britain Ltd., Lincoln Way, Windmill Road, Sunbury-on-Thames announce that certain receiver parts in kit form can be obtained from them. Designed for 625 line, N.T.S.C. standards operation, the parts available are, a 21in., colour mask, 70 degree, aluminized tube Type 21FJP22 and a kit of parts consisting of a colour-purity ring magnet, deflection yoke, convergence assembly, lateral magnet assembly and line output transformer. The tube is priced at £62; the other parts are sold collectively at £15 9s.

R.C.A. also announce that their new colour television receiver Type 14F61MU will sell at £292 net. Sets will be delivered in the U.K., with Band-I channel aligned for test purposes to vision carrier 55.25 Mc/s, sound carrier 61.25 Mc/s—unless otherwise ordered. For further information circle 312 on Service Sheet.

### Video Recorder

A NEW video tape recorder using transistors throughout is announced by Ampex International. Designated the VR1100, the equipment is thought to be the smallest compatible broadcast recorder available at present. The unit is capable of two-speed operation ( $7\frac{1}{2}$  or 15 in/sec) and is housed in a single cabinet  $60 \times 24 \times 42$ in. in size. Accessories designed for the Ampex VR1000 series may



Ampex International Type VR 1100 video recorder.

be used with this recorder. Specifications include a bandwidth of 10c/s to 4Mc/s  $\pm 2$  dB (525 line), 10c/s to 5Mc/s  $\pm 2$  dB (625 lines), a signal-to-noise ratio of 40dB or better, peak-to-peak video to r.m.s. noise, an input level of 0.5 volts peak-to-peak minimum and a linearity (video response) better than 10%. For further information circle 313 on Service Sheet.

# U.H.F. Television Reception

PROPAGATION PROBLEMS AFFECTING AERIAL DESIGN

By A. C. ROBB,\* M.Eng., Ph.D., A.M.I.E.E.

**W**ITHIN a few months a third television programme will become available to a section of the British public. Transmissions will be in the ultra high frequency range of Bands IV and V, and will be based on a 625-line picture standard. No revolutionary technical problems will be involved in starting the service, but there are nevertheless severe practical difficulties to be met. It is therefore quite probable that these difficulties may have an unexpected influence on the popular reaction to the new programme.

It is important to appreciate the circumstances in which the new service will be introduced. They are entirely different from the context in which an alternative British programme first became available. At that time any new and different picture had inherent originality and novelty which easily offset most of the early teething troubles. Moreover at a time

programmes of considerable length. Has the domestic viewing public the sticking power of the theatre-goer and the concert-goer? The attraction of colour which probably alone could stimulate a wave of interest in the new service, is unlikely to be added for some time. It seems, in fact, as though the main popular attraction of the new service will initially be centred on the new 625-line picture standard. There is, however, little immediate gain in picture quality, and if there are receiving problems which result in an inadequate or a poor signal these will only add to the difficulties in developing a new service which cannot easily achieve striking originality and can only expand as rapidly as the public investment in new receivers.

## Frequency Allocations

Bands IV and V cover the ultra high frequency range between 470 Mc/s and 960 Mc/s. The allocation of bandwidths and national and regional transmission frequencies is based on decisions covering these transmissions which were reached at the 1961 Stockholm Conference.<sup>1</sup> It was then decided to adopt an 8 Mc/s bandwidth as standard for all channels within the u.h.f. bands, and also to allocate four channels to each service area disposed by number in the series  $n, n+3, n+6$  and  $n+10$ . Where this is not practicable, the preferred alternative will be  $n, n+4, n+7$ , and  $n+10$ .

A British extension to this principle establishes that, wherever possible, all u.h.f. transmitters covering any single service area will be co-sited. In practice this co-siting will frequently be based on the positions of existing lower frequency transmitters and aerials, although where secondary or "satellite" u.h.f. transmitters are required this overall concentration will clearly break down. The general principle involved is, nevertheless, attractive and important, because it encourages the use of single complex domestic receiving aerials, covering either the bandwidth of at least the eleven u.h.f. channels for a locality or a combination of this coverage with channels in Bands I, II, and III.

In order to achieve very wide bandwidth u.h.f. reception, Yagi-type aerials are now almost universally adopted, although a major change in design philosophy has taken place. This involves consideration of the phase velocity of signals received in the aerial directors in conditions analogous to those of a corrugated waveguide.<sup>2</sup> Although relatively complex and bulky, aerials which also accommodate channels in the lower v.h.f. bands are economically attractive; erection and alignment costs are relatively low, with the built-in multiplex coupling to the down lead simplifying the electrical installation.

The area which a Band IV or V transmitter can adequately serve is broadly similar to that which

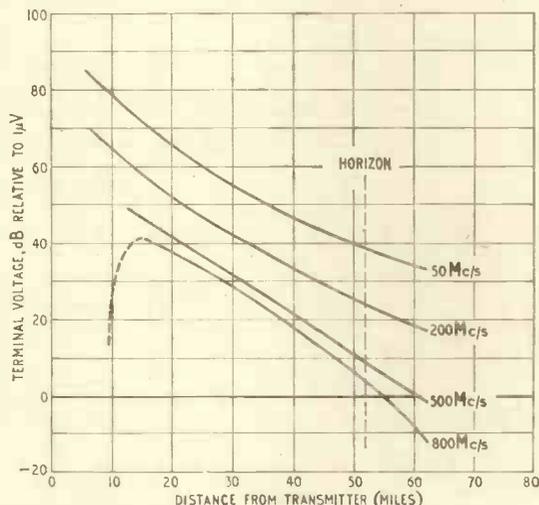


Fig. 1. V.h.f. and u.h.f. propagation characteristics. The transmitting aerial is a half-wave dipole with an e.r.p. of 1 kW.

when parliamentary feeling was running unusually high, the public was invited to study the controversial profile of a commercial television service. It is also relevant that there were then no particular technical innovations being offered to the public.

The present position is very different. Originality has now less to recommend it, and there is less controversy about the character of the new service. Indeed, there seems to be much that will restrict rather than extend its appeal. It has been suggested that evening transmissions will often include pro-

\* Belling & Lee Ltd.

can be covered by an equivalent transmitter in the lower three bands. The effect of the higher frequency is, however, to increase the propagation losses and to reduce diffraction at the horizon. This results in rapid deterioration of the available signal beyond line-of-sight distance from the transmitting aerial. An indication of the quantitative range of this effect is provided in Fig. 1.<sup>3</sup>

The effect of this deterioration on the secondary service area will be to concentrate the demand for satisfactory fringe reception into a comparatively narrow annular region only a short distance from the transmitter horizon. In some cases this may bring the problems of fringe reception into areas of high urban concentration.

This contraction of the service area necessarily leads to an increase in the number of stations required to provide adequate national coverage. U.h.f. service areas will be more generously lapped and

many low-power secondary stations will be necessary to provide a service where, for topographical reasons, the available signal from main stations is inadequate. Rather more than sixty main transmitter locations are envisaged. Table 1 and the accompanying map, which are based on the decisions reached at Stockholm, show the main station allocations for the British u.h.f. television services. Secondary transmitters are not shown and can only be finally planned as the services develop.

### Field Strength and Sensitivity

The relatively small size of Band IV and V dipoles reduces the basic aerial sensitivity, but this is not, in practice, as important as is often made out. The conditions for energy transfer between transmitter and receiver, neglecting propagation losses, are substantially independent of frequency. More impor-

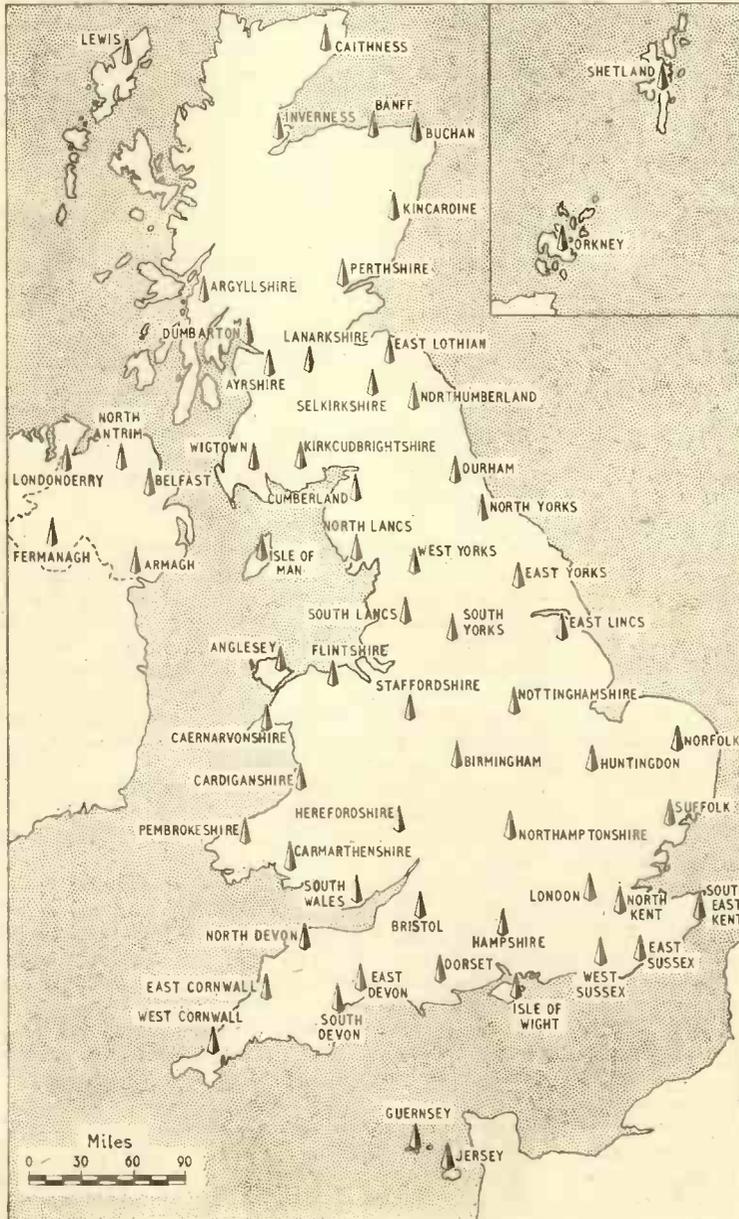


TABLE 1.—The channels allocated at Stockholm to the 64 main stations for the U.K. are listed below and the general disposition of the transmitters is shown on the map. The frequency limits and vision carriers for each channel were given in the December issue of *Wireless World* (p. 592).

Belfast	21	24	27	31
Caithness	21	24	27	31
Cardiganshire	21	24	27	31
East Lothian	21	24	27	31
Huntingdon	21	24	27	31
Isle of Wight	21	24	31	41
West Yorks	21	24	27	31
Argyllshire	22	25	28	32
Cumberland	22	25	28	32
East Cornwall	22	25	28	32
East Lincs	22	25	28	32
Fermanagh	22	25	28	32
Herefordshire	22	25	28	32
Kincardine	22	25	28	32
Ayrshire	23	26	29	33
Banff	23	26	29	33
East Devon	23	26	29	33
Lewis	23	26	29	33
London	23	26	30	33
North Yorks	23	26	29	33
Staffordshire	23	26	29	33
West Sussex	27	55	58	66
Isle of Man	30	34	48	52
Shetland	32	34	45	49
Flintshire	39	42	45	49
Hampshire	39	42	45	68
Inverness	39	42	45	49
Northumberland	39	42	45	49
Birmingham	40	43	46	50
Dorset	40	43	50	67
Lanarkshire	40	43	46	50
North Kent	40	43	46	65
North Lincs	40	43	46	56
Orkney	40	43	46	50
Pembrokeshire	40	43	46	50
Buchan	41	44	47	51
Caernarvonshire	41	44	47	51
Jersey	41	44	47	51
Kirkcubrightshire	41	44	47	51
Londonderry	41	44	47	51
South Yorks	41	44	47	51
South Wales	41	44	47	51
Suffolk	41	44	47	51
West Cornwall	41	44	47	51
Guernsey	48	52	54	56
East Sussex	49	52	64	67
South East Kent	50	53	56	68
Anglesey	53	57	60	63
Carmarthenshire	53	57	60	63
East Yorks	53	57	60	63
Northamptonshire	53	57	60	63
Perthshire	53	57	60	63
South Devon	53	57	60	63
Wigtown	53	57	60	63
Armagh	54	58	61	64
Bristol	54	58	61	64
Dumbarton	54	58	61	64
Durham	54	58	61	64
Nottinghamshire	54	58	61	64
Norfolk	55	59	62	65
North Antrim	55	59	62	65
North Devon	55	59	62	65
Selkirkshire	55	59	62	65
South Lincs	55	59	62	65

tant considerations are the available input terminal voltage necessary to ensure a high signal-to-noise ratio at the receiver, wide local variations in the available field strength, and effects of shadowing and reflection, already familiar in the v.h.f. bands but appreciably increased at higher frequencies.

For any given signal-to-noise ratio the minimum acceptable input signal to an u.h.f. receiver is determined by the thermal noise of the first stage. This is dependent both on the channel frequency and on its bandwidth. At 600 Mc/s thermal noise on an 8 Mc/s channel is about 9 dB higher than for a 3.5 Mc/s channel in Band I. There is also a greater loss of input signal due to down lead attenuation which, for an average run of 30-40ft, may represent a further 1.5-2 dB. A signal from the aerial generally about 12 dB higher than for Band I is therefore desirable for adequate signal-to-noise ratio in the u.h.f. bands. The necessary aerial gain will depend on the effective radiated power of the transmitter, or the terrain over which propagation is taking place, and on the receiving aerial position and height.

The e.r.p. of the transmitter may be increased by using transmitting aerials of high gain, designed to radiate intensely in the area between the mast and horizon but not significantly above the horizon. The design of such aerials is a sophisticated compromise involving transmitter and mast economics, mast stability, and careful attention to the available field strength in close proximity to the transmitter. Particular attention must also be paid to the tangential radiation at the horizon, which must be unaffected by severe wind loading on the mast. Present technology indicates that a representative economic service may cover a radius of about 25 miles from a 600ft mast, with an e.r.p. of the order of 1 MW. B.B.C. test transmissions on channels 34 and 44, however, have an e.r.p. of only 160 kW.

The transmitter e.r.p. is not alone a criterion of satisfactory propagation; the severe shadowing effects already referred to introduce local variations in the available field strength which are very much more pronounced than at lower frequencies. Fig. 2, for example, illustrates the kind of variation which may be encountered at the front of and in the shadow of a fairly ordinary suburban house, the

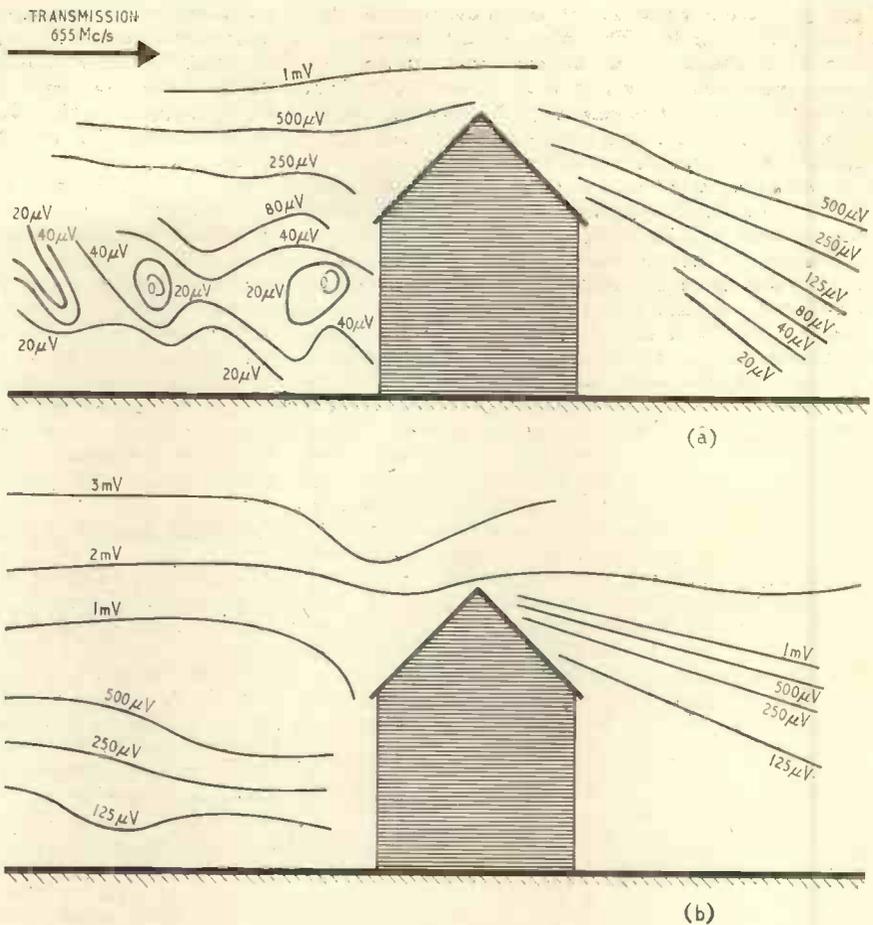


Fig. 2. Terminal voltages from aerial plots adjacent to a suburban two-storey house; (a) using a  $\lambda/2$  dipole and (b) using a Yagi with a 12 dB forward gain relative to a dipole.

front effects being due to reflections and standing wave phenomena.<sup>1</sup> More complete shadowing will of course occur behind hills, as indicated in Fig. 3. The comparative results for Bands III and V involve aerials with gains corrected for the differing effective captive areas. Wide variations in the necessary receiving aerial gain will clearly be encountered, but these will be less directly related to propagation distance than at lower frequencies.

### Receiving Aerial Performance

Receiving aerial performance involves three basic criteria:—

1. Forward gain,
2. Directivity and
3. Front-to-back gain.

Forward gain will determine the terminal voltage at the receiver for any given circumstances of field strength and down-lead attenuation. We have already seen that wide variations in desirable gain may be involved within quite small physical displacements. It is also clear from Figs. 2 and 3 that an increase of height may well be the most important general means for improving a poor signal.

Directivity is related to forward gain, high gain and narrow directional characteristics being generally, for any given bandwidth of performance,

directly related. Directivity will be important where reflected signals cause serious "ghosting," and much experience has been gained in Band III on these problems. The effects in Bands IV and V should not be conspicuously different, and from recent small-scale field tests seem, if anything, rather less serious than anticipated.

Clearly, since height is advantageous, a low aerial is likely to be troublesome. In a large urban concentration with many flat dwellers, a considerable proportion of whose premises face away from the transmitter, here are likely to be problems associated with ground floor and basement reception. Many reflections from adjacent buildings are likely to complicate reception, and these reflections may be quite strong compared with a severely shadowed and attenuated primary signal. In such circumstances polar discrimination against reflection paths will be a natural consequence of providing the necessary gain to use any severely attenuated but adequate primary signal. It is therefore probable that much latent "ghosting" trouble has been concealed by the inevitable use of high-gain, and therefore highly directional, receiving aerials. However, this argument becomes less valid in areas of very high field strength—possibly on hill tops, or, in some cases, close to the transmitters. Here, even close to the ground low-gain aerials may be acceptable but may lack adequate angular discrimination against reflections. It may then be appropriate to

use an aerial of considerably higher gain than necessary in order to take advantage of its superior directional properties. In very exceptional circumstances this may even be coupled to the receiver through a compensating attenuator, although very close to the transmitter, direct pick-up within the receiver itself may introduce a further complication.

A high forward-to-backward gain is necessary to discriminate against reflections in the immediate vicinity of the aerial mounting. Such signals may be relatively strong and may cause the serious standing wave patterns and field strength nulls illustrated in Fig. 2. They may also cause short time delays which will impair visual resolution. There is a further small chance of co-channel interference from a distant transmitter, or second channel interference from the tenth channel above that which is being received, if receiver selectivity is inadequate; these are, however, unlikely to be troublesome except in particularly unusual circumstances.

### Practical Aerial Arrangements

All outdoor aerials for Bands IV and V meet the requirements already set out, in greater or lesser degrees. Fig. 4, indicates the appearance of representative broadband aerials with nominal forward gains relative to a half-wave dipole of 3, 6 and 9 dB, and shows approximate directional characteristics for each. Higher forward gain and greater directional discrimination may be obtained by using longer director arrays or possibly by fitting side rows, as shown in Fig. 5a, but this approach to performance improvement becomes less rewarding as arrays become larger and involves very large structures even to achieve a nominal gain of 12 dB. Where higher gain is necessary, smaller arrays can be more successfully coupled in broadside arrangements as shown in Fig. 5b.

It is, for the reasons already presented, difficult to generalize about receiving aerial requirements, but Table II and the accompanying map, collate a variety of information obtained during recent field tests in the Greater London area<sup>2</sup>. Many viewers will be able to use relatively low-gain aerials at considerable distances from the transmitter—always assuming good roof-top mounting positions are available. It seems, however, that considerable difficulties arise as soon as reception is attempted below rather than above the main topographical irregularities. Once the receiving aerial becomes submerged below the mean surrounding roof level, multiple reception paths are introduced which involve both the attenuation and reflection of adjacent buildings. A particular irritant associated with low aerials is transient reflection from moving vehicles, a far more frequent nuisance than passing aircraft on v.h.f. channels.

There remains the problem of indoor and set top aerials. Attic aerials of comparable gain to outdoor arrays have much to commend them; they are protected from the effects of the weather and are of convenient size for such mounting. The attenuation due to roof cladding is normally only about 1-2 dB but may be worse in some cases when it is raining. A further comparatively new hazard affecting such aerials is the use of metal foil roof insulation. This, of course, renders many of these arrangements virtually useless. Set top aerials are more difficult to generalize about; interior wall reflections may be

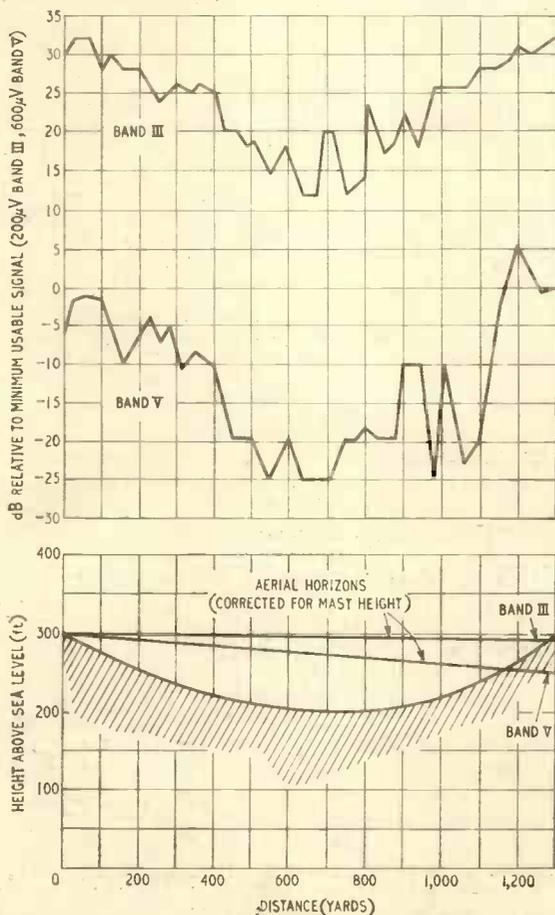


Fig. 3. Field variations within a 100ft. depression.

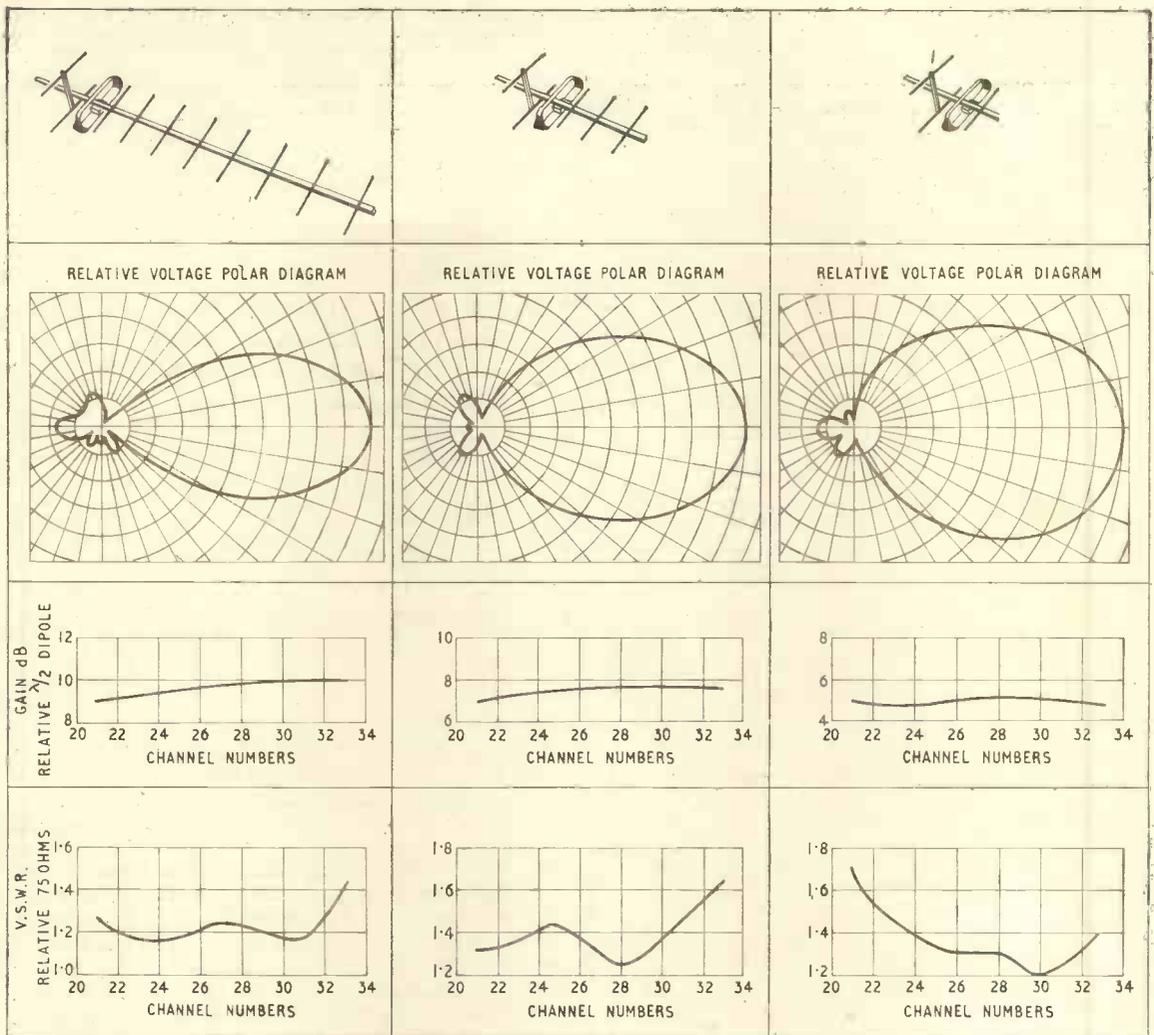


Fig. 4. Typical performance figures for wide-band u.h.f. aerials.

troublesome unless the aerial is carefully positioned, and the movement of people in adjacent rooms may have real nuisance value.

Some recently published American results<sup>6</sup> have tended to confirm the findings of these preliminary tests in Greater London, but have brought out one or two further and important observations. Often when the receiving aerial is below the average roof line, it is extremely difficult to analyse the nature of picture degradation, and the amount of degradation which is acceptable varies considerably with the type of picture content. In this condition of immersion within the building "clutter"—the American term—it is also often preferable to use an aerial of only moderate gain and polar discrimination as the alignment of high-gain narrow-angle aerials is frequently critical and unreliable.

In conclusion a few words about colour. The effects of multiple path distortions and poor signal strength on the quality and character of colour reproduction depend fundamentally on the system in use. They also, in some cases, depend significantly on the transmitter aerial alignment. During the tests described in Table II, temporary transmitter aerials were in

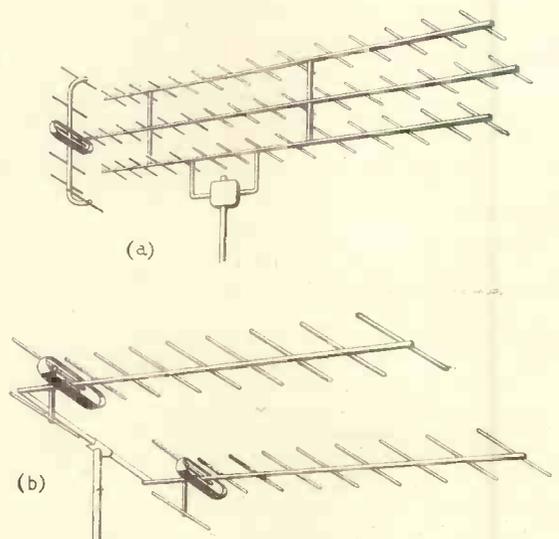
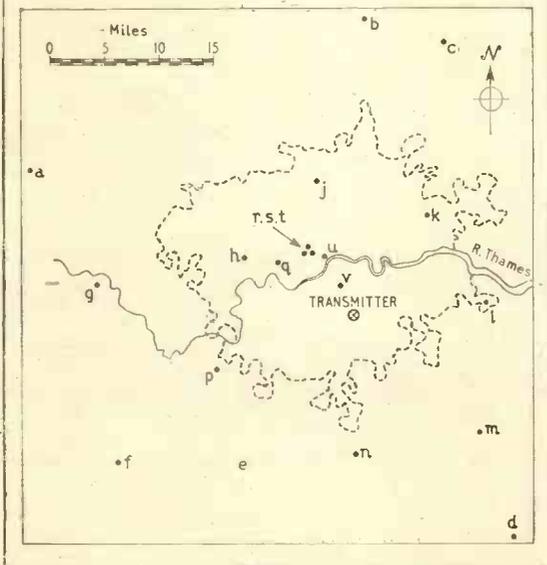


Fig. 5. Techniques for increasing u.h.f. aerial gain and directivity; (a) using director side rows and (b) broadside coupling.

TABLE II.—Summary of results of u.h.f. tests conducted in the Greater London area. The places referred to in the table are indicated on the sketch map. It must be stressed that local results vary widely and that the figures given are random rather than representative. Low tabulated results, therefore, do not necessarily indicate a low average signal in the specified area. All tests were conducted with a 36ft mast.

Test Position and Character					Reception Conditions			Picture Quality			Notes
Map Ref.	Place	Dist. from Transmitter (miles)	Terrain	Buildings	Chan-nel	Aerial Gain Ref. to Dipole (dB)	Average Receiver Terminal Voltage (mV)	General	Noise	Reflections	
a.	High Wycombe	36	Hilly	Semi-open	44	9	0.79	Fairly good	Slight	V. slight	
b.	Ware	28	Low	Residential and light ind.	34	9	0.28	Poor	Moderate	None	Behind hill
c.	Harlow	25	Flat	Urban car park	34	9	0.40	Fair	Slight	Slight	
d.	Tunbridge Wells	24	High	Residential	34	9	0.14	V. poor	V. slight	Moderate	
e.	Dorking	18	Low	Commercial, etc.	34	9	0.16	Fairly good	V. slight	V. slight	
f.	Guildford	22	Mod. high	Commercial, etc.	34	9	0.79	Fairly good	Slight	Slight	
g.	Windsor	25	Low	Residential	34	6	0.71	Fair	Slight	V. slight	Just clear of castle shadow
h.	Ealing	13	Flat	Residential	34	9	11.2	V. good	V. slight	None	
j.	Wood Green	13	Low	Residential	34	6	0.20	V. poor	Moderate	Slight	Behind hill
k.	Ilford	11	Flat	Residential	34	6	0.28	Good	V. slight	V. slight	Behind large building
l.	Dartford	11	High	Residential	44	6	0.25	Fairly good	Slight	V. slight	
m.	Sevenoaks	14	High	Residential	34	9	0.28	Good	V. slight	V. slight	
n.	Godstone	12	Low	Residential	34	9	0.10	V. poor	—	—	Very poor picture synch.
p.	Esher	15	Flat	Commercial	34	9	6.30	Good	V. slight	V. slight	
q.	Shepherds Bush	10	Flat	Residential	34	9	6.30	Good	V. slight	V. slight	
r.	Oxford St.	9	Slope	High commercial	34	9	0.45	Poor	Moderate	Severe	Severely screened
s.	Regent St.	9	Flat	High commercial	34	9	6.31	V. good	Nil	Nil	Clear towards transmitter
t.	Leicester Square	8	Flat	High commercial	34	9	0.45	Poor	Nil	Severe	Severely screened
u.	Savoy Place	7	Low	Riverside	34	9	1.00	Good	V. slight	V. slight	Fairly open
v.	Camberwell	5	High	Residential	44	3	1.12	Fair	Nil	Moderate	



use and it was known that some local peculiarities in colour reception were probably very much influenced by the aerial radiating characteristics. At a time when the selection of a standard colour system is urgent, nothing is to be gained by cluttering the debate with misleading impressions and tenuous deductions. It is probably enough to observe that, in general, the areas where colour reception has been poor have also been immediately recognizable as characteristically difficult areas for monochrome reception, although in some cases colour reception

has been very disappointing where monochrome reception has been quite acceptable.

The objective of studies in u.h.f. reception must, in the end, be a practical one. So far field tests have confirmed the wide variations in local field strength associated with these frequencies, and the complexity of the field patterns involved. What we must now develop through our working experience, is a modest range of conventional solutions to a great diversity of particular problems. The time that it will take to acquire this experience and facility will depend on the rate of expansion of the new service; effectively on the attractiveness of the new programmes and the success with which the public can be persuaded to change their receivers.

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- <sup>2</sup> Ehrenspeck, H. W., and Poehler, M., "A New Method of Obtaining Maximum Gain from Yagi Antennas" (*I.R.E. Transactions, Antennas and Propagation*, Vol. AP.7, No. 4, Oct., 1959).
- <sup>3</sup> Smith-Rose, R. L., "Radio Wave Propagation and the Problems of Television Bands IV and V." (*Journal of the Television Society*, Vol. 8, No. 2, April-June, 1956.)
- <sup>4</sup> Whitbread, C. F., "Receiving Aerials for UHF Television." (Paper to the Television Society, Leicester Centre—Feb., 1963.)
- <sup>5</sup> Belling-Lee Technical Report (unpublished).
- <sup>6</sup> Peterson, Donald W., "Comparative Study of Low-VHF, High-VHF and UHF Television Broadcasting in the New York City Area." (*R.C.A. Review*, Vol. XXIV, No. 1, March, 1963.)

# WORLD OF WIRELESS

## U.H.F. Television

THE areas to which the B.B.C.'s second television service will be extended following its introduction in London next April have now been announced by the P.M.G. The first eight high-power stations, to be opened by the end of 1965, will be in the Midlands, Lanarkshire, South Wales, Lancashire, South Yorkshire, Northern Ireland, the Isle of Wight and North-east England. A further nine stations, which it is hoped to open in 1966, will be in the Bristol Channel area, Norfolk, Anglesey, Kincardineshire, South-east England, Nottinghamshire, Suffolk, North Yorkshire and Northamptonshire. A list of the frequencies allocated to these stations at the Stockholm Conference, 1961, and a map showing the distribution of the 64 main u.h.f. stations provisionally planned for the U.K. are given on page 386 of this issue.

Seven of the 17 stations will be built at the sites of existing B.B.C. Band I transmitters (Sutton Coldfield, Wenvoe, Rowridge, Pontop Pike, Divis, Tacolneston and Llanddona), and five at or near the I.T.A. stations at Winter Hill, Emley Moor, Black Hill, Durriss and Dover.

## Extending 405-line Coverage

BOTH the B.B.C. and the I.T.A. have been given the go-ahead by the P.M.G. to build additional Band III stations to extend the coverage of their existing services. The B.B.C. is to have six Band III transmitters, including that already announced for Wenvoe (Channel 13), which will radiate a Welsh programme. The five additional transmitters will be at Moel-y-Parc, near Denbigh (Channel 6), Sandale, Cumberland (Ch. 6), South-west Lancashire (Ch. 12), Mid-Lancashire (Ch. 7) and East Lincolnshire (Ch. 13). The Moel-y-Parc transmitter will share the existing I.T.A. site.

The I.T.A. is also to build six additional v.h.f. stations to serve Central Berkshire (Channel 12), Bedford-Peterborough (Ch. 6), East Lincolnshire (Ch. 7), Scarborough (Ch. 12), Dundee (Ch. 11) and Caithness-Orkney (Ch. 8). The East Lincolnshire station will be constructed with a view to its future use by both the B.B.C. and I.T.A. for u.h.f. transmissions. Some of the channels quoted are provisional allocations.

The P.M.G. stated in the Commons that the three transmitters to operate in Channel 6 will for a time have to limit their hours of transmission from noon to midnight to avoid interference with the sky survey of the Northern Hemisphere which is being conducted by the Mullard Radio Astronomy Observatory at Cambridge using frequencies within this channel.

## Aviation Electronics

DIPLOMAS and prizes were presented to 114 students at the College of Aeronautics, Cranfield, by the Minister of Aviation, Mr. Julian Amery, on July 5th. Seventy-five of the students were from the U.K., 22 from the Commonwealth and the remainder from ten other countries. The college is a Government-sponsored establishment providing engineering, technical and scientific training in aeronautics. A two-year course is given to selected graduate students leading to the award of the diploma of the college (D.C.Ae.). Students in the final year specialize in the work of one of the six departments (including electrical and control engineering) and produce a thesis.

Of the six recipients of the D.C.Ae. in the Department of Electrical and Control Engineering, Flight Lt.

Colin W. Andrews, B.Sc., also won one of the nine special prizes. His thesis was on a 450 Mc/. tunnel diode amplifier in a stripline configuration.

The college also awards a diploma in advanced engineering (D.A.E.) on the completion of a one-year course in one of several subjects of advanced engineering science offered by the various departments. The only recipient of the D.A.E. for the course in aviation electronics was A. K. Majumdar, M.Sc., formerly with International Computers and Tabulators, of India, whose thesis was "The role of radar in air traffic control."

## Not Yet

THE proposal put forward by Paul Adorian and referred to in our April issue that this country should adopt a 525-line 60-field/625-line 50-field dual television standard, has been considered by the Television Advisory Committee to be "quite impracticable to introduce . . . for at least another 10 years." The committee's advice has been accepted by the Postmaster General.

Although such a dual system "might prove to be worth while in the long term" the committee gave among its reasons for delaying its introduction that, although it might be possible eventually to provide receivers capable of being used on both 625 and 525 lines, it would be wrong to introduce additional complications in receiving sets during the period when definition standards are changing over from 405 to 625 lines; and, that even were it practicable to introduce such a system now (and the Committee is convinced it is not), so drastic a change in plan on the eve of the start of the B.B.C.'s second programme on 625 lines would result in a serious set-back for the radio industry.

This year's Paris Radio and Television Show, which will be held from 5th-15th September, will, for the first time, be international. Organized by the F.N.I.E. (Fédération Nationale des Industries Electroniques) it will cover domestic radio and television (819 and 625 lines will be demonstrated) and sound reproduction.

Italy's 29th National Radio & Television Show, to be held in Milan from 7th to 15th September, will this year include the first International Electronic Components Fair to be held in Italy. The organizers, Associazione Nazionale Industrie Elettrotecniche, are also planning to hold a convention during the Components Show.

B.S.R.A.—At the annual general meeting of the British Sound Recording Association, J. C. G. Gilbert was elected president for the year 1963-1964 with M. J. L. Pulling, A. P. Monson, G. A. Briggs and D. W. Aldous as vice-presidents. The Hon. J. Dawnay, R. J. Barton, R. E. Cooke, J. W. Maunder, P. M. Clifford and P. B. Cooper were elected members of the council. S. W. Stevens-Stratten was re-elected hon. secretary.

The Paul Instrument Fund Committee, administered by the Royal Society, the I.E.E. and the Institute of Physics and Physical Society, has recently made the following grants:—£15,320 to Professor H. M. Barlow, F.R.S., Pender professor of electrical engineering at University College, London, for the development of a microwave electrostatic wattmeter and the construction of instruments for the measurement of electrical power at very high frequencies by the absorption of the angular

momentum of a circularly polarized wave; £950 to K. G. Nichols, M.Sc., lecturer in electronics, University of Southampton, for the construction of apparatus giving an improved method for vacuum deposition of thin films of high melting point materials; and £1,800 to Dr. E. E. Schneider, reader in solid-state physics, King's College, Newcastle-upon-Tyne, for the development of superconducting cavities for use in magnetic resonance spectrometers.

**E.E.A. Space Committee.**—The Electronics Engineering Association's co-operation in looking into the communication/electronics aspects of the proposed U.K. satellite has been requested by the Minister of Aviation. The Association has, therefore, formed a space committee to "enable the industry to co-ordinate its efforts and speak to the Government with a single voice on space communications." The members are:—W. D. H. Gregson (Ferranti) who is chairman, W. S. Graff-Baker (A.E.I.), Gp. Capt. E. Fennessy (Decca), W. R. Thomas (Elliott), Air Vice-Marshal W. E. Oulton (E.M.I.), R. A. G. Dunkley (G.E.C.), A. W. Cole (Marconi's), S. J. Robinson (Mullard), J. M. C. Dukes (Plessey), T. C. B. Talbot (Rank-Bush Murphy) and P. H. Bourne (S.T.C.).

**Technology, life and leisure** is the subject of the Thomson lecture, to be given by Dr. Dennis Gabor, F.R.S. (professor of applied electron physics at Imperial College), on 24th October at the Royal Institution. Admission is by ticket obtainable from the Society of Instrument Technology, 20 Peel Street, London, W.8.

**Trawler Radio Jubilee.**—The fiftieth anniversary of the first fitting of wireless in fishing vessels was celebrated by Marconi Marine in June. Vessels equipped for this "interesting experiment . . . with a view to determining the extent to which wireless telegraphy could effectively and economically be applied to steam fishing vessels" were the trawler *Othello* and the carrier *Cæsar* owned by Hellyers of Hull. Following the lead set by these vessels we stated in our January 1914 issue "it is not improbable that wireless will be generally adopted by the fishing industry"!

Results of the **Radio Amateurs' Examination** held in May have just been announced by the City and Guilds of London Institute. A total of 1,229 sat for the exam. and 861 passed. Eleven blind students, who were examined separately, are included in the total and of these nine were successful.

A symposium on a **multi-standards studio centre** is being organized jointly by the Television Society and ABC Television Ltd. for 30th October. It will be held at the I.E.E. headquarters, Savoy Place, London, W.C.2. Further details are obtainable from the Television Society, 166 Shaftesbury Avenue, London, W.C.2.

**A.P.A.E. Symposium.**—The Association of Public Address Engineers is holding a symposium at the Queens Hotel, Manchester, on 22nd September. Admission will be by ticket obtainable free from the A.P.A.E. at 394 Northolt Road, South Harrow, Middlesex.

The **Iraqi Ministry of Guidance** has now been given the go-ahead by the government to put out tenders for five, 15 to 25 kW, television stations and five sound relay stations, for use in the provinces. The scheme designed to provide 80% of Iraq with a television service, includes stations at Musol, Kirkuk, Alemara, Elsamawa and Basra.

The **Ministry of Education** has approved increases in the salary scale of the more senior teachers in Colleges of Advanced Technology. The increases take effect from 1st April, 1963, and add £150 to a senior lecturer's salary bringing it up to £2,150 (max.). At the other end of the scale, a Grade VII departmental head receives an additional £325 bringing his maximum salary up to £3,400.

## TECHNICAL EDUCATION

A lecture course on **u.h.f. television techniques** is to be given by the Television Society this autumn. This course is of particular interest to those on the servicing side and will be held for five successive Friday evenings at the London School of Hygiene and Tropical Medicine, Keppell Street, London, W.C.1, starting 4th October. The fee for non-members is £1 15s and enrolment forms are available from the Television Society, 166 Shaftesbury Avenue, London, W.C.2.

Two courses leading to the graduateship of the Brit.I.R.E. are listed in the 1963/64 prospectus of the **Northern Polytechnic**, London, N.7. One is a three-year, full-time course in electronics and telecommunications and the other a six-year, part-time day release course. Special short advanced evening courses being provided in the Department of Electronics and Telecommunications during the coming year include pulse circuit analysis, colour television, network theory and microwave techniques. The four-year Dip. Tech. sandwich course in the physics and technology of electronics carries exemption from examination requirements for Grad.Inst.P. and Grad.I.E.E.

In addition to the normal courses in preparation for the C. & G. exams in radio and telecommunications, the **Norwood Technical College**, London, S.E.27, conducts a four-term full-time course for the P.M.G.'s marine radio certificate and a three-year course in telecommunication engineering which covers the syllabi of the Brit.I.R.E. graduateship examination. Short courses listed in the 1963/64 prospectus include v.h.f./u.h.f. techniques, transistors, colour television and medical electronics.

**Telecommunication Technicians' Course.**—The complete four-year syllabi, plus supplementary studies, in preparation for taking the examination for the City & Guilds Telecommunication Technicians' Certificate, has been prepared as a home study course by C.R.E.I. (London). A brochure covering the course is available from C.R.E.I. (London), 132/135 Sloane Street, London, S.W.1.

**National Certificate**, block release, two-year course for mechanical, electrical and civil engineers is being conducted by the Twickenham (Middlesex) College of Technology in the coming session. The course is common to the three branches except for the choice of two alternative subjects in the second year. Students are alternately at college and in industry for six-week periods. Fee £12 17s.

Part-time day and evening courses in preparation for the various radio and electronics examinations of the City and Guilds of London Institute are being offered by the **Weston-Super-Mare Technical College** during the coming scholastic year.

## CLUB NEWS

**Halifax.**—During August the Northern Heights Amateur Radio Society has undertaken to provide demonstration stations at three local functions; at a charity gala at Warley (3rd), Halifax Agricultural Show (10th) and at Forest Cottage, Illingworth (17th).

We have been notified of the following **Mobile Rallies**:—R.A.F. Stradishall, near Newmarket, July 28th (details from Flt. Lt. G. C. Moore (G3MCY), R.A.F., Stradishall, Newmarket, Suffolk).

Derby, Rykneld School, August 18th (F. C. Ward (G2CVV), 5 Uplands Ave., Littleover, Derby).

**M.A.R.S.** (American Military Affiliate Radio System) is organizing a "Hamfest" in Heidelberg for August 3rd and 4th to which British amateurs visiting the area are invited. Details from Russ Lawson (DL4BS), Postfach 3049, 6100 Darmstadt.

# Personalities

**G. L. Hutchinson**, Ph.D., recently appointed head of the Electronics Group of the Physics and Electronics Department at the Royal Radar Establishment, is a graduate of King's College, London, where he also obtained his doctorate. In 1939 Dr. Hutchinson joined the Air Ministry Research Establishment at Dundee, and was later seconded to the R.A.F. to assist with the installation of the coastal radar chain. In 1943 he joined the staff at the Telecommunications Research Establishment, Malvern, and from 1948 until 1954 he was at the Royal Aircraft Establishment, Farnborough. Dr. Hutchinson was posted to the British Joint Staff Mission in Washington in 1954 and returned to the R.R.E. in 1957.

**G. B. Townsend**, B.Sc., A.K.C., F.Inst.P., M.I.E.E., has joined the Rank Organisation as technical manager of the Professional Television Equipment Division of Rank Cintel. Mr. Townsend was formerly with the G.E.C., having joined their Research Laboratories at Wembley in 1940 where he worked on radar and secret weapons and was subsequently responsible for the research work on television problems. In 1961 he transferred to G.E.C. (Electronics) Ltd., as manager of the new Television Equipment Department. He is joint author, with P. S. Carnot, of the book "Colour Television." Mr. Townsend is president of the British Amateur Television Club and chairman of the Council of the Television Society.

**Lord Hill** of Luton has been appointed the new chairman of the Independent Television Authority in succession to Sir Ivone Kirkpatrick. Lord Hill, as Dr. Charles Hill, was Postmaster General from 1955 to 1957.

The guest of honour at this year's Radio and Electronic Industry dinner, which is to be held at the Dorchester, London, on 12th November, is to be the Rt. Hon. **Julian Amery**, M.P., Minister of Aviation. **Lord Brabazon** of Tara, who has been president of the Radio Industry Council since 1957 and has agreed to serve for a further year, will preside at the dinner.

**B. V. Northall**, A.M.Brit.I.R.E., has received from the City and Guilds of London Institute the Insignia Award in Technology (C.G.I.A.). His thesis was entitled "Factors affecting the design of an audio-frequency magnetic recording system." The Insignia Award in Technology was instituted in 1952 since when 245 awards have been made of which 54 have been to those in the electrical and telecommunications fields. Mr. Northall, who is 44, is senior executive engineer at the Post Office Research Station. He joined the Post Office Engineering Department as a youth-in-training in 1937 and during the war served in the Royal Signals.

**Leon A. Smulian**, B.Sc., A.M.Brit.I.R.E., has joined the Elliott-Automation Group as joint general manager of Elliott-Litton Ltd. After the war, during which he served as a signals officer (radar) in the R.A.F., he joined Ultra Electric as senior engineer in charge of the special products division, and when he left the company in 1955 he was chief engineer radio and television and assistant chief engineer of the company. In 1955 he started his own company, Gate Electronics, and since 1961 has been with the British Aircraft Corporation on a special assignment as industrial products officer.

**R. S. Chadwick**, a draughtsman apprentice with the Marconi Company in Chelmsford, has been selected by the City and Guilds of London Institute as one of 31 apprentices to represent the United Kingdom in the twelfth International Apprentice Competition, which this year is being held in Dublin. Mr. Chadwick, who is 21, joined Marconi's in 1958 and is at present studying for his Ordinary National Certificate.

**John A. Saxton**, D.Sc., Ph.D., M.I.E.E., who has been deputy director of the D.S.I.R. Radio Research Station, Slough, since 1960, has been appointed director of the United Kingdom Scientific Mission in Washington, D.C., and Scientific Attaché at the British Embassy in Washington. He succeeds Dr. **Harry Hookway** and will take up his new appointments early next year. Dr. Saxton, who is 49, joined the Department of Scientific & Industrial Research in 1938. He has been active in the affairs of the International Scientific Radio Union (U.R.S.I.) and the International Radio Consultative Committee (C.C.I.R.) for a number of years and has on three previous occasions worked in the U.S.A. In 1945, and again in 1950, Dr. Saxton undertook a tour of duty as radio physics liaison officer in the United Kingdom Scientific Mission, and at the invitation of the University of Texas, he recently spent a year there as a visiting professor of electrical engineering.



Dr. J. A. Saxton

J. A. Clark

**John A. Clark**, managing director of The Plessey Company, has taken over the chairmanship of Ericsson Telephones in succession to **J. H. Reed** who has recently retired from this position. Mr. Reed, who joined Ericsson's nearly sixty years ago and was appointed managing director in 1947, will continue as a director of the company.

**J. F. Watkinson**, Ph.D., B.Sc., has been appointed manager of the Magnetic and Materials Division of Standard Telephones and Cables Ltd. Dr. Watkinson, who is 34, graduated in metallurgy at Sheffield University in 1950 and for four years he carried out research on the torsional fatigue strength of steels at Sheffield. For this work he received his doctorate in 1954 and was awarded the Brunton Medal for Metallurgical Research. Prior to this appointment, Dr. Watkinson was general manager of B.S.A. Metal Powders Ltd.

**R. de B. McCullough**, Assoc.Brit.I.R.E., is to fill the newly created B.B.C. post of Superintendent, Television Technical Operations, in which he will have overall responsibility throughout the Corporation for the work of the television technical operations staff. Mr. McCullough joined the B.B.C. in 1939 as a maintenance engineer at the London television station at Alexandra Palace. In 1953 he became a senior television engineer at the Lime Grove studios and since 1957 has been head of technical operations (television studios).

**E. G. Chadder**, O.B.E., senior superintendent engineer of the B.B.C., retired in June after completing 40 years' service. Mr. Chadder joined the B.B.C. as an assistant maintenance engineer, at Cardiff, and was promoted to engineer-in-charge of the Aberdeen station two years later. After holding several superintendent engineering

posts he was appointed senior superintendent engineer in 1950. This title lapses with the retirement of Mr. Chadder. Following this move the post of superintendent engineer (transmitters), held by W. E. C. Varley, M.Brit.I.R.E., Assoc.I.E.E., has been changed to chief engineer (transmitters), and the post of superintendent engineer (lines), held by G. Stannard, B.Sc., M.I.E.E., A.C.G.I., re-designated superintendent engineer (communications).

**Air Cdre. J. C. Millar, D.S.O.**, Commandant of the Central Signals Establishment at R.A.F. Watton, Norfolk, for the past two years, has been appointed Provost Marshal of the Royal Air Force. Air Cdre. Millar joined the R.A.F. in 1934 and has held a number of appointments in the signals field throughout his career including two-and-a-half years as Command Signals Officer of Bomber Command in the mid-fifties.

**Gp. Capt. John Goodman, M.Brit.I.R.E.**, who has for the past year commanded the Radio Engineering Unit at Henlow, has been appointed Commandant of the R.A.F. Central Signals Establishment with the acting rank of air commodore. He joined the R.A.F. in 1932 as an apprentice at the Electrical and Wireless School, Cranwell, and was commissioned in the Technical Branch in 1940. **Gp. Capt. T. C. Imrie, Assoc. Brit. I.R.E.**, who succeeds Air Cdr. Goodman at the Henlow Radio Engineering Unit, joined the R.A.F. in 1939 as a wireless operator/air gunner and was commissioned two years later. After taking a technical signals conversion course, he transferred to the signals branch of the R.A.F. in 1948. Prior to his new appointment, **Gp. Capt. Imrie** was officer commanding 30 Group, (Maintenance) R.A.F. Sealand.

**P. E. Axon, O.B.E., Ph.D., M.Sc., D.I.C., A.R.C.S.**, managing director of Ampex Electronics Ltd. and Ampex Great Britain Ltd., has been assigned several additional responsibilities and now directs all the Ampex manufacturing, engineering and marketing activities in Europe, Africa and the Middle East. Dr. Axon, who joined Ampex in 1958, was previously head of the recording group in the Engineering Research Department of the B.B.C.

The Governors of the Borough Polytechnic have made the following appointments to the academic staff:—**D. D. Randall, B.Sc., Ph.D., A.Inst.P.**, senior lecturer in physics; **B. Graham, M.Sc., A.Inst.P.**, senior lecturer in electrical engineering; **J. G. Hargrave, B.Sc., D.C.Ae.**, lecturer in electrical engineering; **L. F. Spence, B.Sc., B.Sc.(Econ), A.M.I.E.E.**, promoted to principal lecturer in electrical engineering; and **G. R. Arney, B.Sc.**, promoted to senior lecturer in electrical engineering.

**G. C. Pope, M.Eng., A.M.I.E.E.**, has been appointed general manager of Advance Components, of Hainault, Essex. Educated at Liverpool University, where he specialized in electronics, Mr. Pope was a sales manager in the Radio and Electronic Components Division of Associated Electrical Industries, prior to joining Advance.

**Major J. H. T. Fairhurst** appointed chief engineer for W. H. Sanders (Electronics) Ltd., was for 5 years in the Radar Development Laboratory of Decca Radar Ltd. which he joined after nearly 20 years military service.

The name of **Chung Lian Fatt, Assoc.I.E.E.**, deputy chief broadcasting engineer of Radio Sarawak, should be added to those listed in our last issue who were appointed M.B.E. in the Queen's Birthday Honours. Mr. Chung joined the Government service in 1939.

**Dr. B. Y. Mills, F.R.S.**, is no longer in the Division of Radiophysics of the C.S.I.R.O., Australia, as stated in the Royal Society's announcement mentioned in our May issue (p. 220), but is a reader on the staff of the School of Physics of the University of Sydney which he joined in 1960.

## OUR AUTHORS

**Dr. A. C. Robb**, who writes in this issue on the problems associated with u.h.f. television reception, has been technical manager of Belling & Lee Ltd. for the past two years. A graduate of Liverpool University, where he obtained his M.Eng. degree for post-graduate work, he received his Ph.D. as a result of work on the design of high-voltage particle accelerators when a research fellow at Glasgow University.

**Mrs. Elsie Carter**, who with **P. Tharma** contributes the fourth of the series of articles on the design of transistor amplifiers in this issue, spent several years as a laboratory assistant in the Mullard Valve Quality Control Laboratory at Mitcham. Since 1959 she has been in the Applications Research Laboratory working on problems associated with transistor audio amplifiers.

## OBITUARY

**Dr. Ernest Metzler**, head of the radio section of the Swiss P.T.T. and, since 1956, director of the International Radio Consultative Committee (C.C.I.R.), died on 20th June at the age of 63. Dr. Metzler, who received his doctorate from the Federal Polytechnic School in Zurich for a thesis on aerial radiation, joined the Swiss P.T.T. in 1929 and became head of the radio section in 1953. An international figure in the world of telecommunications, he undertook special technical assignments for the United Nations in several middle east countries.

**Ernest G. Rowe, O.B.E., M.Sc., A.C.G.I., D.I.C., M.I.E.E.**, died on 6th July at the age of 54. Following engineering training at Devonport dockyard and the City & Guilds Engineering College, London, he joined the M-O Valve Company in 1933 as a development engineer and was appointed chief development engineer in 1939. In 1948 Ernest Rowe joined the Brimar Valve Division of S.T.C. at Footscray as chief receiving valve engineer where he initiated the programme of development of "special quality" valves on which he contributed articles to *W.W.* His appointment in 1958 as manager of the Valve Division gave him responsibility for engineering, manufacturing and sales of all S.T.C. valves until July 1960 when he transferred with the Brimar valve and c.r. tube division to Thorn Electrical Industries. Since this merger Mr. Rowe had been senior executive of the new company Thorn-A.E.I. Radio Valves & Tubes Limited.

**Horace B. Dent**, who was on the editorial staff of *Wireless World* from 1927 until his retirement two years ago, died on 17th June aged 67. He came to *Wireless World* from Igranic Electric which he joined after spending a few years in Yugoslavia following service in World War I during which he transferred from the Army to the Royal Flying Corps for special radio duties. During the last war Wing Commander Dent served in the R.A.F.V.R. first at Fighter Command Headquarters, where he was closely associated with the operation of the radar chain and fighter control, then in the Ministry of Aircraft Production and from 1943, until his return to *W.W.* in 1945, in the Air Ministry Directorate of Signals. "H.B.D.'s" wide knowledge and experience enabled him to contribute to all sides of this journal's work but his particular interest was in the amateur field and his call sign G2MC is well known.

**George Earnshaw Partington, B.Sc., A.M.I.E.E.**, chief engineer of Marconi's Broadcasting Division, died in St. Andrews Hospital, Billericay, on 13th June at the age of 47. George Partington, a graduate of Manchester University, joined the Marconi Company in 1938 and after a year at Marconi College, entered the Research Division. He started work on the development of television equipment in 1947, was appointed deputy chief television engineer in 1956 and became chief engineer in 1959.

# A.C. Meter Calibration

A PHOTOMETRIC METHOD FOR LOW-VOLTAGE INSTRUMENTS

By JOHN F. SUTTON, M.Sc.(Eng.)

**T**HIS article deals with the problem of obtaining specified values of a.c. by direct reference to a d.c. indicating instrument of known calibration. It describes a precise method of setting up an a.c. potential divider, making use of the relation between the brightness of, and the current through, a filament lamp. Since brightness is independent of the direction of current through the filament, and depends upon the r.m.s. value of an alternating current, a relation can be established between direct and alternating currents of the same r.m.s. value. The method is especially suitable for radio workshop or servicing use.

Nearly all alternating-voltage meters for radio workshop use are now of the moving-coil-with-rectifier type. While these have the advantage of great sensitivity, reliability, and low current consumption, a difficulty arises in checking their calibration unless they can be compared with a standard instrument on a.c. Moreover, since moving-coil instruments with a permanent magnet indicate the mean and not the r.m.s. value of a fluctuating current, attention must be paid to waveform of the supply. That is to say, if they are to be fitted with a rectifier and calibrated directly against a standard a.c. instrument, the supply voltage should be of simple sine-wave form. The house mains will be good enough in this respect for providing the a.c. supply, but it is worth noting that if a moving-coil instrument without a rectifier is calibrated on d.c., a battery supply should be used and not rectified a.c., unless this is effectively smoothed. The scale divisions of a moving-coil-plus-rectifier alternating-voltage meter will not be uniform over the whole scale and will depend upon the rectifier characteristics; they may therefore need revision with a renewal of rectifier.

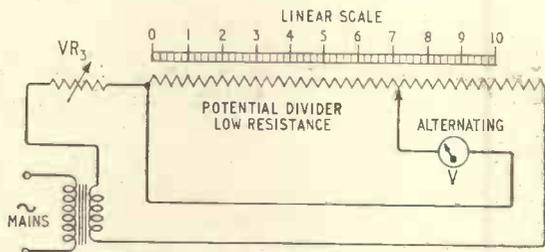


Fig. 2. Calibration of scale divisions.

For radio servicing a voltmeter is used frequently in the 0-10V range, and on this range the characteristics of the rectifier have a large influence on scale divisions; therefore a method of calibrating over the whole of this range is necessary. In a well-equipped laboratory a standard instrument would be available for direct comparison, but it is unlikely that the service workshop would have this facility.

However, if precise readings can be made at a few voltages or even at one selected voltage the remaining values can be obtained from a potential divider of suitable current-carrying capacity. It is assumed that a reliable direct-voltage meter is available, since one must start somewhere, and moving-coil voltmeters or milliammeters are readily obtainable and can be expected to be within the limits of accuracy required for workshop use. They can be converted to the required voltage range with high-stability carbon resistors.

If a good quality moving-iron, thermo-junction, or hot-wire voltmeter of unknown accuracy can be obtained, this can be calibrated direct from d.c. and used on a.c., giving r.m.s. indications. Such instruments are not readily available and in any case certain precautions must be taken with each type. A moving-iron instrument will of necessity have an inductive coil in its circuit, and will therefore be sensitive to frequency; and the older types of hot-wire instruments may have inductive ballast resistors. Moreover, both types need a fair current for operation and this affects their use with a potential divider.

The method outlined below is described because it requires no other indicating instrument than an accurate m.c. voltmeter and is capable of precise results. The principle is simply that of using metal filament lamps as hot-wire meters to indicate a single reading of current. A lamp does not suffer from the disadvantages of the conventional hot-wire meter, which are (a) that it needs frequent zero setting, and (b) that it is sensitive to air currents and external temperature changes. The hot-wire meter can be

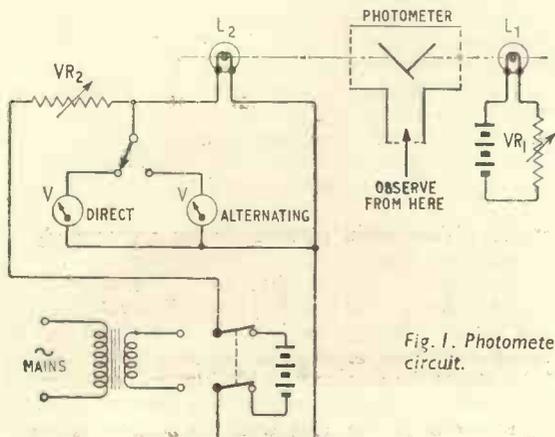


Fig. 1. Photometer circuit.

made independent of frequency up to the megacycle range and it has no hysteresis error. A special advantage of the filament lamp method is that brightness, when operating at full voltage, is very sensitive to voltage changes; a 1% change of volts across the terminals corresponds to about 15% change in brightness. The accuracy obtainable is in effect dependent only on the degree of refinement with which the apparatus is set up and measurements made. Fig. 1 shows the circuit and layout. The method is to use a lamp  $L_1$  in, say, the 3-6V range, operated from a battery and variable resistor, as an unknown but constant comparison standard. A second and similar lamp  $L_2$  is operated alternatively from a d.c. or a.c. source, in conjunction with a d.c. instrument of known accuracy and the a.c. instrument to be calibrated. The former is adjusted to a given value by  $VR_1$ , and then  $L_1$  and  $L_2$  are balanced on a simple photometer by adjusting  $VR_2$ .

The supply is then switched to a.c. and  $L_2$  is adjusted by  $VR_2$  to balance the photometer. The alternating volts across the meter will have the same r.m.s. value as the original d.c. meter reading. The construction of the photometer is simple. The illuminated surfaces are made from thin white card with a smooth *matt* surface, fitted into a dark cardboard tube about 2 inches in diameter to exclude unwanted light. The front or dividing edge between the two illuminated areas of white card must be sharp and thin so that it becomes invisible when

optical balance is obtained. The two lamps can be 3.5V torch bulbs in batten holders, both being fixed on a board with the photometer, roughly equidistant from it and well shielded from direct light. When operating it is as well to work in semi-darkness and take voltmeter readings with the aid of a torch. The eyes should, of course, be well shielded from direct light.

After calibration at one or more spot readings a potential divider can be set up, Fig. 2, to check the meter over its whole range. This can be made from the 1kW wire-wound bar element of an electric fire, which will have a resistance when cold of about 50 $\Omega$  and can be arranged to give, say, 1 volt per inch of length. As the element wire has an appreciable temperature coefficient of resistance, and will warm up slightly with 10 volts across it, the circuit should be given time to settle before taking readings.

Various minor precautions are necessary to obtain stability and these will become obvious when the sequence of readings is repeated a few times. An occasional requirement in the radio workshop is to calibrate a high frequency probe unit which is generally made in the form of a rectifier and resistance capacitance network, in a small shielded tube connected, by external leads to the d.c. indicator. This can be checked on the mains-frequency potential divider by removing the small capacitor in series with the probe, and substituting externally a low voltage capacitor of 1 $\mu$ F or greater.

## THE MAGNETIZATION CURVE

By E. V. SMITH,\* M.Sc.

AN EQUIVALENT DERIVED OPTICALLY FROM FERRIMAGNETIC DOMAIN PATTERNS

**T**HE interpretation of magnetism in materials has of recent years been made in the light of domain theory (see, for example, the article by Dr. D. H. Martin, *Wireless World*, January 1958). The importance of new materials and the explanation of their function in the light of this modern theory is obvious and was fully stressed in the above article.

Since this publication the existence of transparent ferrimagnetic garnet materials has been discovered<sup>1</sup> and the interest aroused in these important materials has been enhanced by the fact that domain photographs are readily observed, without the necessity for the difficult and tedious process of electrolytic polishing. The garnets are of the very highest fundamental importance as has clearly been shown by the recent developments of ferrimagnetic resonance experiments and combined microwave-optical experiments which have been carried out with them.<sup>2</sup>

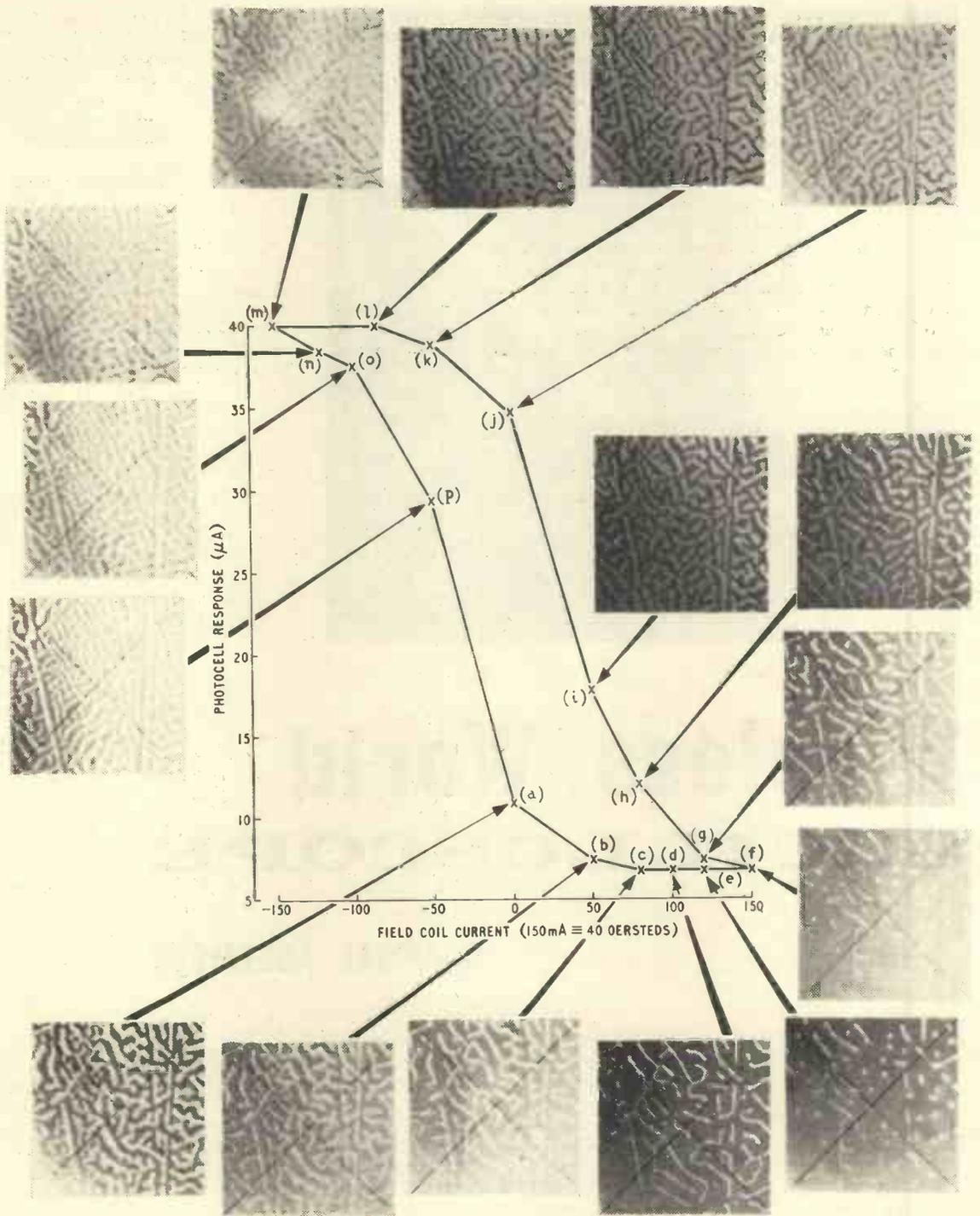
The aim of this note, however, is to emphasize their importance in domain theory interpretation, and to show that the growth and decay of domains, when measured by transmitted light, do in fact trace out a curve of similar shape to that of the magnetic hysteresis curve.

The garnets have the chemical formula  $M_3Fe_5$  ( $FeO_4$ )<sub>3</sub>, where M represents any one of the rare earth atoms, samarium, yttrium, erbium, or gadolinium. The specimens photographed here are gadolinium iron garnet, chosen because comparatively low fields are required to produce saturation.

The photographs show clearly that in low magnetic field conditions a number of preferred directions of magnetization exist (a) but as the field increases one group of domains (the dark ones) grows at the expense of neighbouring domain areas (the light ones). In this case the first group are favourably directed with respect to the field in comparison with the second group. The field is applied axially, i.e., perpendicular to the surface of the specimen which is mounted on an ordinary microscope slide and is of about  $\frac{1}{4}$ in diameter and 1/1000in thick. Notice that at first the pattern changes rapidly for comparatively small field change, (a) to (b). (150mA through the field coil gave a field of about 40 oersteds.) This rapid pattern change corresponds to a steeply sloping region of the magnetization curve and it is seen that the "black" domain regions have grown considerably. Beyond point (d) the pattern changes less rapidly, and at (e) and (f) obviously saturation is near. Reduction of the field (g) restores the pattern, the black areas now decreasing (g) to (j) and this process continues as the field is reversed (k) to (m) until saturation is again

\*Rugby College of Engineering Technology.

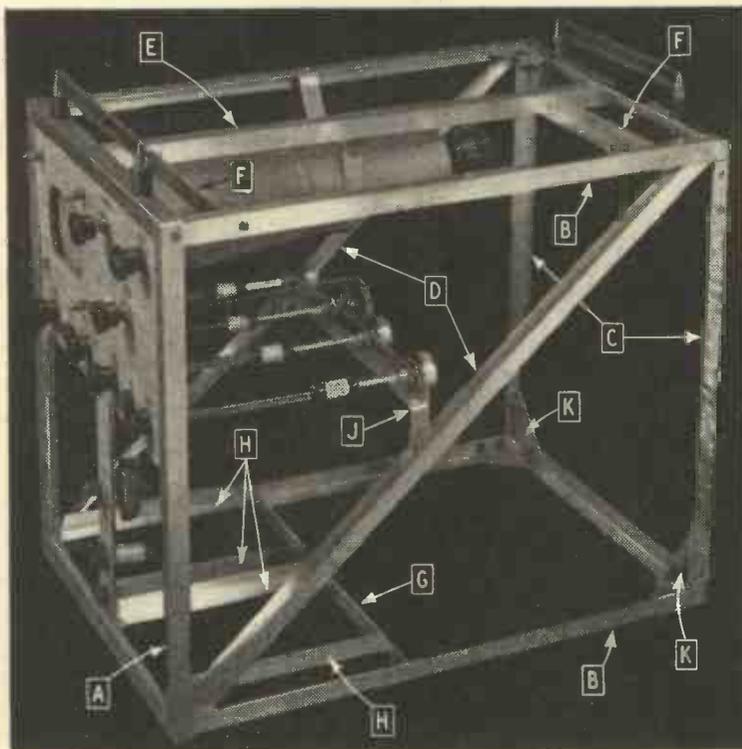
1. Dillon, J. F. *Bull. Am. Phys. Soc. Series 2*, Vol 2, p. 238, 1957.  
2. Dillon, J. F. *J. Applied Physics*, Vol. 29, No. 3, pp. 539-541, March, 1958.



Hysteresis curve derived from the light transmitted by a translucent specimen of ferrimagnetic garnet with variation of field strength and direction.

approached in the opposite direction. The final three photographs, (n), (o), (p), show the dark areas once again growing at the expense of the "light" ones and the series of photographs give a striking demonstration and explanation of the well-known experimental phenomenon of hysteresis in terms of ferrimagnetic domain structure. The observation of

the domains was made possible by the use of polarized light, the polarizer being placed between the mirror and the stage of the microscope and the analyser between the objective and the eye-piece. All the photographs shown were taken by R. T. Hoffmann, a senior year student at the Rugby College of Engineering Technology.



Completed frame and tube mounting. Corner brackets are as originally made, but drawing should be followed. Nuts on tube-mounting screws are cycle valve caps. References are to frame drawing.

# Wireless World

## OSCILLOSCOPE

### 6.—FINAL ASSEMBLY

**T**HE constituent circuits of the oscilloscope are now completed, and it remains to construct a frame to carry them and install the inter-unit wiring. The material is the  $\frac{1}{2}$ in aluminium angle used for the plug-in units. The drawings are self-explanatory, and only a few words of discussion are needed.

The front panel is made in the same way as those of the plug-in units. That is, sheet aluminium is faced with "Formica" or "Warerite," the bond being made by "Evostik," although a cheaper way would be to use "Contact" or "Fablon" plastic covering, or even a coat of paint. This liberal use of trade names does not imply that they are the only suitable materials; they are merely suggestions. If the front panel is given a slight bend during the facing process (aluminium on the concave side) this will help to avoid deformation, which is probably something to do with shrinkage of the adhesive and plastic face.

The graticule is made from a piece of celluloid, with horizontal lines scribed at 4mm intervals over 4cm, and short vertical lines at 6mm intervals over 6cm. Increased trace contrast is obtained by the use of green-tinted material, which cuts down reflections from the tube face and allows the green light of the tube to pass freely.

#### Tube Circuit

Fig. 1 shows the circuit of the tube supplies. The  $\pm 900V$  supply is the "floating" output previously mentioned. Into the "bottom" end of this goes the blanking pulse from the timebase, emerging from the brightness control superimposed on a direct voltage of  $-850V$ , or thereabouts. This cuts the tube off during the timebase flyback but, due to stray capacitances, would not do this quickly enough but for the presence of  $C_2$ , which allows the high

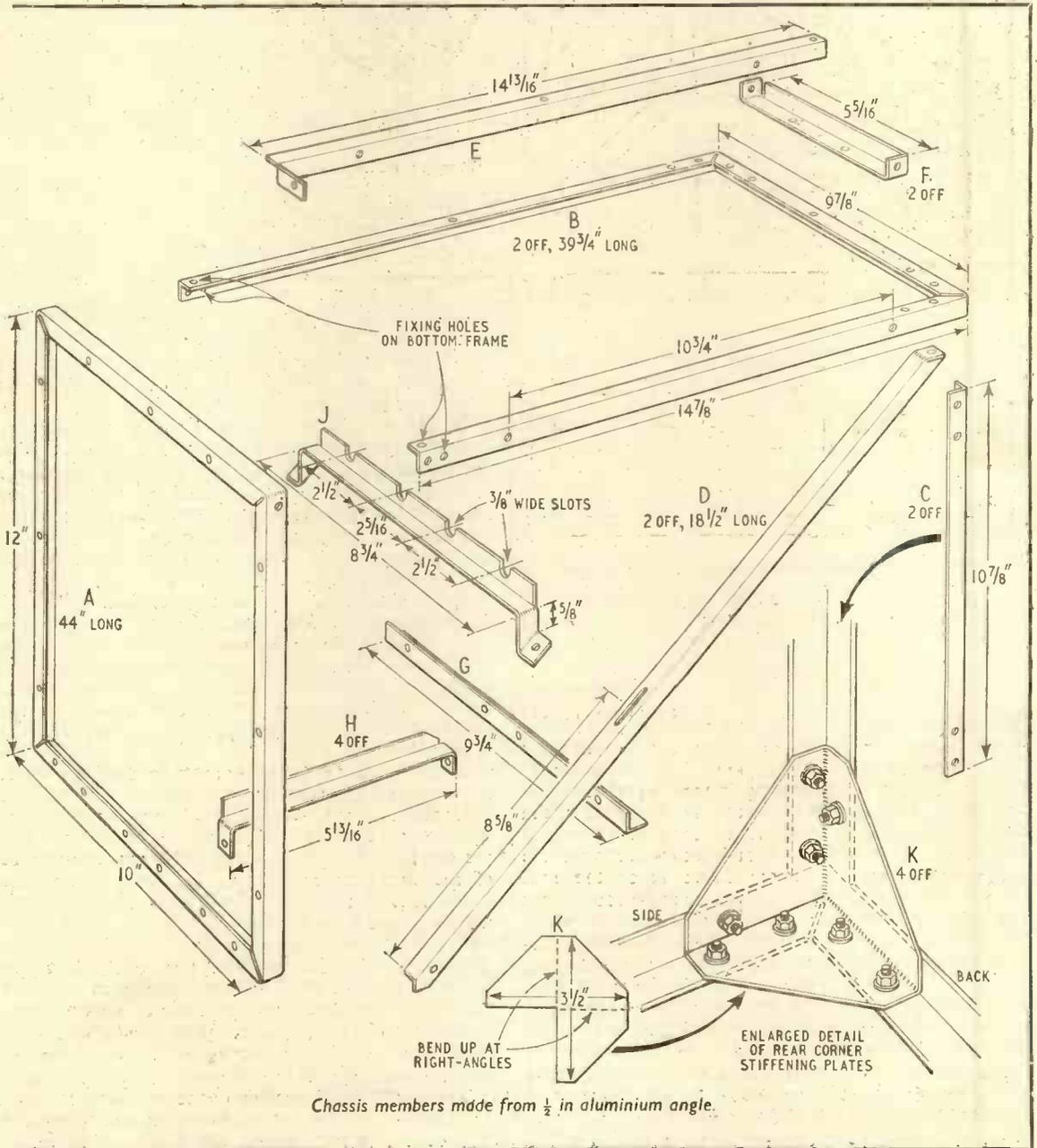
frequencies contained in the blanking pulse to pass straight to the tube grid.

It is recommended by the manufacturers that the final anode is held at or about the same potential as the average of the deflection plates. If this is not observed, the spot tends to become astigmatic, that is, it is defocused in either a vertical or horizontal direction and the trace is thickened. For best results, the final anode potential is made slightly variable about this point, and the adjustment potentiometer is made a front panel control, labelled "ASTIG." The function of the focus control is obvious, and the two controls should be adjusted together to obtain the finest trace.

It is possible that some tubes may suffer from

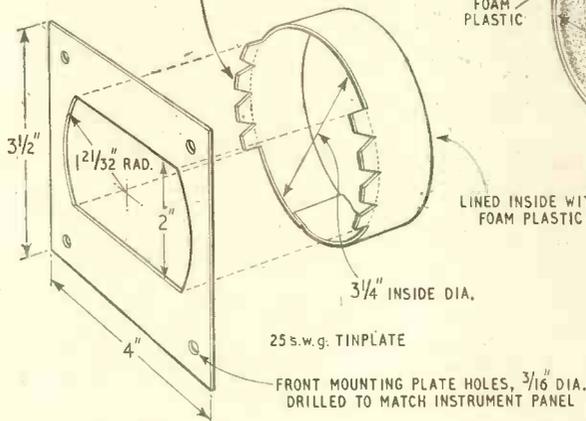
pincushion or barrel distortion. We have not experienced this trouble, but if it is found, the inter-plate shield, pin 5, may be disconnected from the final anode and fed by a similar variable potentiometer to the astigmatism control. The Mu-metal c.r.t. screen was found to be necessary, but if the constructor wishes, a sheet steel screen can be tried. We have no experience of this, but it seems to be worth a try.

$R_1$  and  $R_2$  are made fixed resistors, but should be selected for best results, as the determining factors are somewhat variable.  $R_1$  should be selected so that the neons in the e.h.t. unit never extinguish under maximum brightness conditions, so taking into account variations in e.h.t. transformers. Our

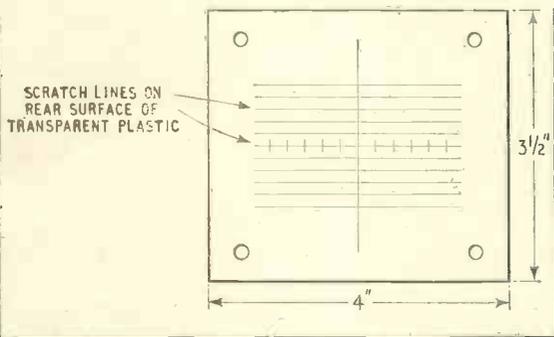


Tube supporting components.

THE NICKED-OUT PORTION IS PASSED THROUGH FRONT PLATE, UNTIL BODY OF TUBE BUTTS AGAINST PLATE, THE "EARS" ARE BENT OUTWARDLY FLAT AGAINST PLATE, THEN SOLDERED



Graticule cut from transparent green plastic 1/8 inch thick or as convenient. Scribed lines should face tube.



value was 680k $\Omega$ .  $R_{16}$  is set so that the trace is evenly illuminated along its length, our value being 27k $\Omega$ .

### Modifications

Since the instrument was first made, several alterations have been made which improve performance and enhance reliability.

Under certain conditions, it was found that external fields could interfere with the operation of the y amplifier, and an aluminium screen was made to shield it. If it is found that interference from the timebase or e.h.t. oscillator shows up on the c.r.t. the screen will get rid of it. It may be found that this is not necessary, and, in any case, all earth connections and screens should be checked for tightness before going to the trouble of making it.

If the timebase is run at a much lower speed in relation to the signal frequency than is normal, it may be found that sync pulses, which appear on the Miller valve screen grid, due to inter-electrode capacitance, show up as a darkish horizontal band. This can be cured, if necessary, by the insertion of an OA81 between pin 8 of  $V_1$  and pin 7 of  $V_2$ . From this latter point, the cathode-follower grid, a 470k $\Omega$

resistor should be taken to h.t. and a 150k $\Omega$  resistor to chassis. This has the effect of further clipping the top of the screen waveform, and with it, the superfluous sync pulses. The diode "cathode" is connected to  $V_1$ , pin 8.

In order to accommodate a wider tolerance in sensitivities of c.r.t.s and to cater for ageing valves, the anode loads of the x amplifier valves have been increased by 2.2k $\Omega$  to 12k $\Omega$ . This will always give at least 10% overscan between the overload points of the amplifier. This may not be needed by the majority of constructors, but it will avoid any cramping that may be visible at the end of the time-base.

After using the expanded trace facility of the instrument, we decided that the amount of expansion given erred a little on the generous side, and was not particularly useful. If the reader feels the same way about this, the amplitude can be cut down by adjustment of the cathode circuit. A 470 $\Omega$  resistor should be placed in series with  $VR_1$ , the gain control of the x amplifier.

As the trigger stage was drawn in the June issue, it was responsible for an odd effect. Any sudden adjustment of the y shift control caused the brightness to vary slightly. This was due to the fact that the amplifier  $V_{3b}$  was drawing heavy current because of the long time-constant  $C_5 R_{15}$ , and loading the unstabilized h.t. supply. This upset the "floating" output of the e.h.t. oscillator on the tube grid. The easiest way out of this is to drop the supply to  $V_{3b}$  by the insertion of an 18k $\Omega$  resistor at the h.t. end of  $R_{17}$ , with an 8 $\mu$ F, 350V electrolytic to earth from the junction. Removal of the capacitor  $C_6$  prevents distortion of the signal fed to the trigger stage  $V_4$  at high signal levels, and the effect is further improved by increasing  $R_{16}$  to 680 $\Omega$ .

There is very little space in the instrument for air circulation, and we have found that heat from the transformer is a problem. In order, therefore, to

Front panel consists of 18 s.w.g. aluminium faced with decorative plastic sheet.

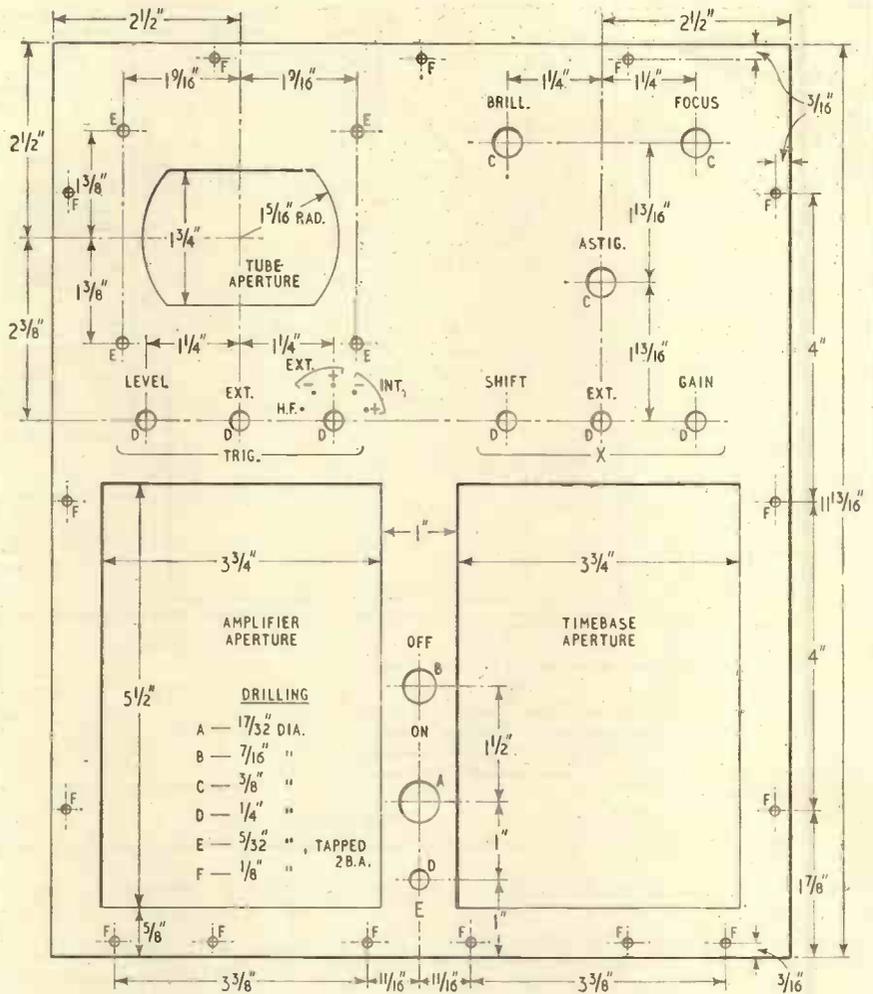


Fig. 1. Tube circuit.

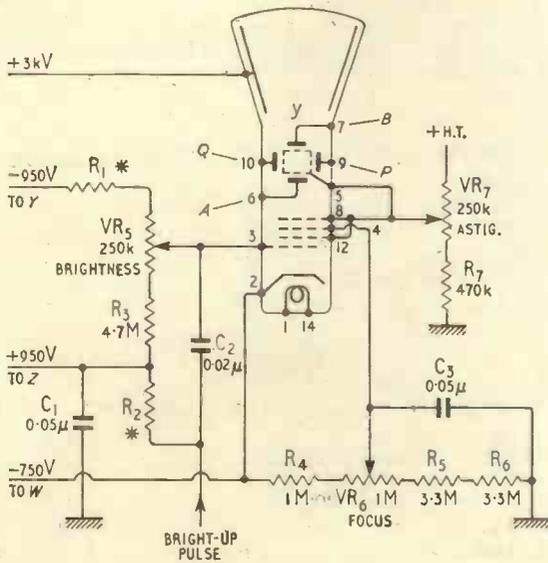
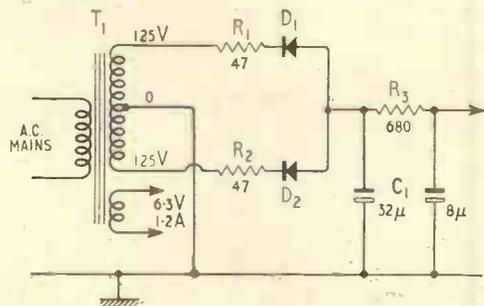
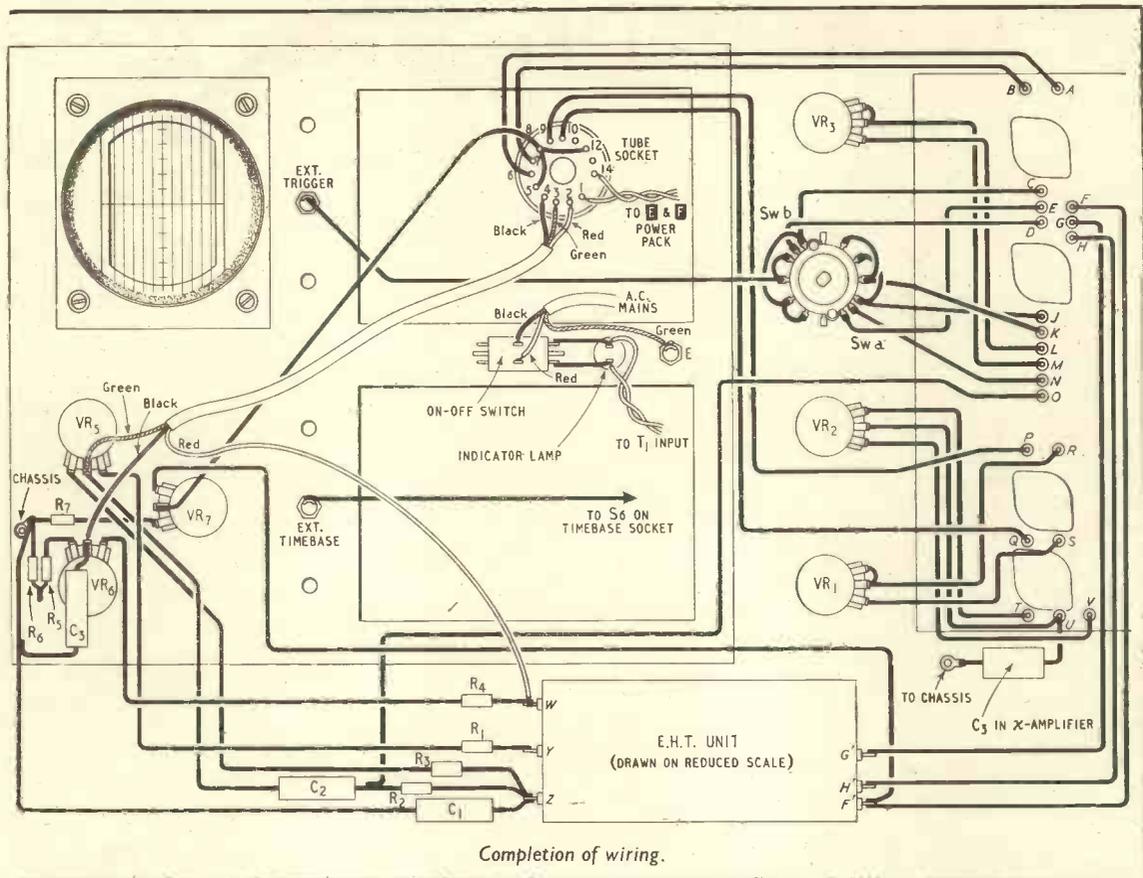


Fig. 2. Modification to power unit.





reduce heat generation, we have altered the circuit a little.

The main source of heat is the negative supply. This draws extra current from one half of the main transformer and also, as it provides many more volts than are required, heat is developed in the dropper resistors  $R_{32}$ ,  $R_{33}$ . The best solution to the heat problem is the use of a separate transformer to supply the negative line, and we chose the Radiospares miniature mains type. This possesses a 125-0-125V secondary and the new circuit is as shown in Fig. 2. It also helps to reduce loading if the heater windings AB and EF are changed over. The transformer can be mounted on the side wall of the main chassis between  $C_1$  and  $C_{12}$ ,  $13$ , which should be moved slightly rearwards.

Calibration of home-built instruments is always a difficult problem. This could be done, rather inaccurately, by the use of the 50c/s mains waveform, but we propose to describe a more accurate system later, and also some applications of the instrument.

#### COMPONENTS LIST

* $R_1$	680k $\Omega$	$\pm 10\%$	$\frac{1}{2}$ W
* $R_2$	27k $\Omega$	$\pm 10\%$	$\frac{1}{2}$ W
$R_3$	4.7M $\Omega$	$\pm 10\%$	$\frac{1}{2}$ W
$R_4$	1M $\Omega$	$\pm 10\%$	$\frac{1}{2}$ W
$R_5$	3.3M $\Omega$	$\pm 10\%$	$\frac{1}{2}$ W
$R_6$	3.3M $\Omega$	$\pm 10\%$	$\frac{1}{2}$ W
$R_7$	470k $\Omega$	$\pm 10\%$	$\frac{1}{2}$ W
VR <sub>5</sub>	250k $\Omega$	$\pm$ linear	
VR <sub>6</sub>	1M $\Omega$	$\pm$ linear	

VR <sub>7</sub>	250k $\Omega$	$\pm$ linear
C <sub>1</sub>	0.05 $\mu$ F	250V
C <sub>2</sub>	0.02 $\mu$ F	1kV ceramic
C <sub>3</sub>	0.05 $\mu$ F	350V
DN7-78 cathode-ray tube (Mullard)		
Mu-metal screen for DN7-78 (Telcon)		
Double-pole on/off switch		
4 $\times$ 5-in length of $\frac{1}{4}$ -in polystyrene rod		
4 $\times$ spindle couplings (Radiospares)		
Three-core mains cable		
7 $\times$ Miniature Instrument knobs (Radiospares)		
2 $\times$ Red Single sockets, insulated (Radiospares)		
1 Black Single sockets, insulated (Radiospares)		
* See text		

#### COMPONENTS LIST FOR MODIFICATIONS

##### Timebase

OA81 diode	
470k $\Omega$	$\pm 10\%$ $\frac{1}{2}$ W resistor
150k $\Omega$	$\pm 10\%$ $\frac{1}{2}$ W resistor

##### Power Unit (Fig. 20)

$R_1$	47 $\Omega$	$\pm 10\%$ $\frac{1}{2}$ W
$R_2$	47 $\Omega$	$\pm 10\%$ $\frac{1}{2}$ W
$R_3$	680 $\Omega$	$\pm 10\%$ 3W
D <sub>1</sub> D <sub>2</sub>	—rectifiers already used	
C <sub>1</sub>	32 $\mu$ F	250V
T <sub>1</sub>	Midget mains transformer (Radiospares)	

##### Trigger Stage

18 k $\Omega$	$\pm 10\%$ $\frac{1}{2}$ W resistor
680 $\Omega$	$\pm 10\%$ $\frac{1}{2}$ W resistor
47k $\Omega$	$\pm 10\%$ $\frac{1}{2}$ W resistor ( $R_{18}$ )
8 $\mu$ F	350V

##### X Amplifier

2 $\times$ 2.2k	$\pm 10\%$ $\frac{1}{2}$ W resistors
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# The BC-221 Frequency Meter

HINTS ON ADJUSTMENT AND USE OF A POPULAR DISPOSALS INSTRUMENT

By R. L. CONHAIM

ONE of the most versatile pieces of surplus electronic gear is the BC-221 Frequency Meter. Oddly enough, based upon the amount of advertising one sees for this instrument, there are more of them available in Great Britain than in the United States. In the U.S., it has been popular among amateurs, small manufacturers, Citizens Band users, service technicians and communications users.

The BC-221 is a heterodyne frequency meter consisting of a dual-range, variable frequency oscillator and a crystal-controlled fixed oscillator operating at 1 Mc/s. The variable frequency oscillator operates in the ranges 125 to 250 kc/s and 2,000 to 4,000 kc/s on fundamentals. The outputs of both oscillators are rich in harmonics so that the instrument can be used well into the v.h.f. range. It is calibrated on harmonics to 20,000 kc/s. Each instrument has been individually calibrated, and each is furnished with a calibration book, marked with the serial number of the instrument. Some of the instruments were furnished with wooden cases, while others were contained in aluminium alloy cases. The instrument, when supplied complete with headset and batteries, was known as the SCR-211. Few surplus meters are so furnished, but practically any headset can be used and either battery or a.c. power (using a separate

power pack) will operate the BC-221 satisfactorily.\*

Valve complements vary from model to model and are shown in Table 1 which also indicates special features. Those meters with modulation provide for modulating the v.f.o. This feature is used mainly for receiver calibration. The model BC-221-AN has provision for modulating either the crystal or variable oscillators. Modulation frequency is 375 or 400 c/s.

The warm-up feature refers to a special switch position in which all current is off except the heater current for the variable oscillator. This feature permits somewhat more stable operation without excessive warm-up period. When such equipped instruments are not in use, they can be left in the warm-up position with very little current consumption, but time must be allowed for the crystal oscillator to stabilize.

The BC-221 can be used to check transmitter frequencies, receiver dial setting accuracy, signal generator accuracies, amateur radio band edges and other similar applications. In normal use, the variable frequency oscillator is calibrated against the internal crystal oscillator at various check points. These points are listed on each page of the calibration book. The fundamental or some harmonic of the v.f.o. is calibrated against the fundamental or some harmonic of the crystal oscillator. The "Corrector" control is tuned for a zero beat indication in the headphones. The function switch is then set to the "Operate" or "Het. Osc." position and the main tuning dial set at the desired frequency as determined from the calibration book. Crystal oscillator output is available in the "Crystal" or "Xtal" positions.

In addition to the crystal check points shown in the calibration book, there are many others. Those shown in the book will provide the loudest heterodyne beat in the headphones. The intermediate ones which can be heard, should not be used since the instrument was calibrated against those shown in the book. It should also be noted that the instrument will not operate unless headphones are plugged in to one of the "Phones" jacks. These are switching types which turn off the valve heaters unless a plug is inserted.

**Accuracy of the BC-221:**—There has always been a question about the accuracy of this instrument, and lively discussions have taken place in U.S. journals. Some users claim an accuracy of 0.01%, while others insist the BC-221 cannot achieve such accuracies. If we consult the original technical manual covering

\* The headphones are isolated by a single capacitor (see Fig. 4) and for mains operation an additional double-wound output transformer should be used to conform to British Standard 415:1957.—Ed.

TABLE 1

BC-221 Letter Suffix	Valve Complement, Commercial	Military Valve Designation**	Modulation	Warm-up
A,C,D	77 6A7 76	VT-77 None VT-76	No	No
E	7G7 7B8LM 7A4	VT-193 VT-208 VT-192	No	No
B,N,Q, AA, AE, AG	2 of 6SJ7 6K8	VT-116 VT-167	No	No
F,J,K,L	6SJ7* 6A7 76	VT-116B None VT-76	No	No
R, AC, P, T, AF AH, M, O	6SJ7* 6K8 6SJ7	VT-116B VT-167 VT-116	No	No
AK, AN	2 of 6SJ7 6K8	VT-116 VT-167	Yes	Yes
AJ, AL	6SJ7* 6K8 6SJ7	VT-116B VT-167 VT-116	Yes	Yes

\*\*Military valve designations are no longer used, but some surplus valve from World War II are marked with these designations.

\*6SJ7Y has a special low-loss base. In an emergency, it can be replaced by standard 6SJ7 with some loss of accuracy. However, the 6SJ7Y is still being manufactured.

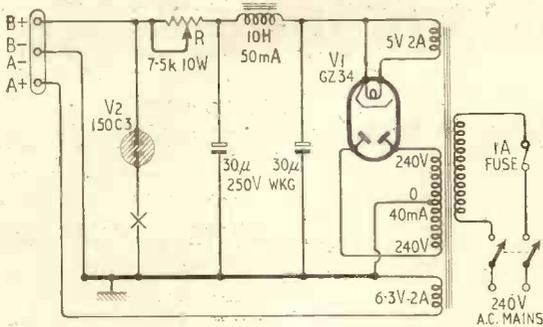


Fig. 1. Voltage-regulated power supply suitable for use with BC-221 frequency meter. R is adjusted to give 15 mA in a milliammeter inserted at X.

this instrument, we find that the maximum errors at 4,000 kc/s are as follows:

Small shocks, caused by handling	100 c/s, maximum.
Locking the dial	30 c/s, maximum.
Warming up	100 c/s, maximum.
Changing of load on antenna post†	50 c/s, maximum.
A drop of 10% in battery voltage or a change of 5°C. in ambient temperature	325 c/s, maximum.
Error in calibration	500 c/s, maximum.
Error in crystal frequency	250 c/s, maximum.
Total maximum error	1,355 c/s or 0.034% at 4,000 kc/s

Maximum possible errors at other frequencies are: 985 cycles at 2,000 kc/s, 180 cycles at 250 kc/s and 180 cycles at 125 kc/s. These are theoretical maximum errors under field conditions. However, these errors are not necessarily additive, so that from a practical standpoint, the errors under such usage amount to about 50% of those shown. This would mean an accuracy of about 0.017% at 4,000 kc/s. But the interesting point is that most of these errors can be considerably reduced or even eliminated. For example, we need not lock the dial; the instrument can be left on at all times for maximum stability; the load on the antenna post need not be changed during use; a voltage-regulated a.c. power supply can be substituted for the battery supply and the crystal can be calibrated against MSF at 5 or 10 Mc/s.

To determine how such measures would affect accuracy, the author tested six BC-221 models with an electronic counter. In each case, sufficient warm-up time was allowed, and the crystal was calibrated against the internal crystal of the counter. Checking in the 27 Mc/s range, accuracies better than 0.01% were consistently achieved, and using the additive method, which we will discuss below, accuracies greater than 0.0025% resulted with all six samples.

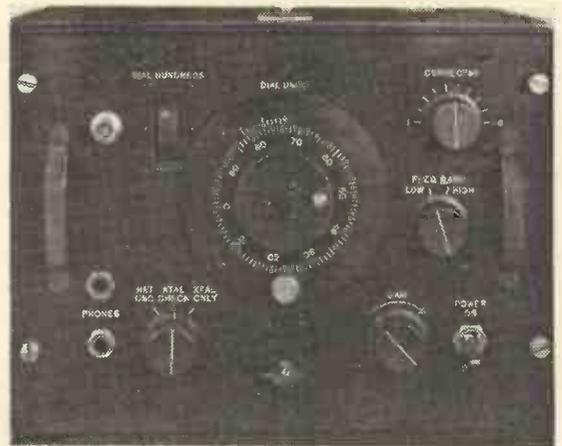
**The Voltage-regulated Power Supply:**—A simple voltage-regulated power supply is shown in Fig. 1. This supply is easy to build, parts should be readily available, and layout is not critical. Although the battery voltage originally was 135V d.c., we found that a 150V d.c. supply worked admirably, and without sacrifice in accuracy. The worst feature of using

† The aerial terminal stamped "ANT" in the standard model. It may be convenient to replace this by a coaxial input socket.

an a.c. supply is the possibility of hum in the headset. This can be eliminated by using d.c. on the heaters of the valves, but in most cases, this is unnecessary because hum is not that objectionable. Some models of the BC-221 will present worse hum conditions than others. The power supply is located several feet from the BC-221 to avoid the possibility of heat affecting the frequency meter.

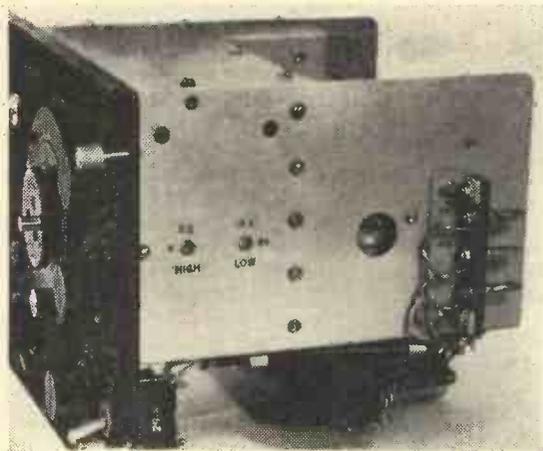
**Setting the Crystal Frequency:**—Most models of the BC-221 contain within the crystal oscillator circuit, a trimmer capacitor which allows zero-beating the 1 Mc/s crystal with an external standard. This trimmer capacitor location varies from model to model. In many models, the capacitor is located behind the nameplate, as shown in Fig. 2. In other models, the trimmer cannot be made accessible without removing the instrument from its case. This means either making a wiring harness so the instrument can be operated out of its case, or drilling a hole in the case at the trimmer location. The author has used the latter technique with complete success. A plug is placed in the hole to keep air currents out of the instrument.

To set the crystal frequency, use a receiver capable of receiving MSF at either 5 or 10 Mc/s. A receiver with an "S" meter will be most satisfactory, since it will provide a visual, and consequently more precise, indication of zero-beat. An oscilloscope connected across the receiver output may also be used as a visual indicator. Tune to MSF and loosely couple a short length of wire from the aerial terminal of the BC-221 to the input connection of the receiver. Some adjustment in the closeness of coupling may be required. While observing the "S" meter, adjust the crystal trimmer capacitor of the BC-221 very slowly. As the crystal oscillator is brought close to 1 Mc/s, you will notice the "S" meter needle begin to vibrate. These vibrations become slower and slower as you approach the correct 1 Mc/s adjustment, and the needle excursions become greater. With this technique, you can achieve a short term crystal accuracy of 1 part in 10<sup>6</sup>, or better. In practice, the author leaves the BC-221 on at all times, and checks the crystal each time the meter is to be used. For this



(Photo courtesy "Electronics World".)

Fig. 2. BC-221-0 with nameplate removed to show trimmer capacitor for adjusting crystal oscillator frequency.



(Photo courtesy "Electronics World").

Fig. 3. BC-221 removed from case showing location of adjustment capacitors and power supply plugs.

purpose, the nameplate is removed from the BC-221-O and left off at all times for quick access to the crystal trimmer capacitor.

**Internal Adjustments:**—While most instruments advertised are tested and guaranteed before sale, it is possible that the suggested use of a 150V d.c. supply, or the subsequent disuse of the instrument for long periods of time may cause internal changes in circuit capacity. This will be evidenced by the impossibility of finding zero-beat "Corrector" settings for all the indicated calibration points in the calibration book. However, internal adjustments can be made to bring the instrument within range of the "Corrector" capacitor at all calibration points. The physical location of these adjustments is shown in Fig. 3. The location may vary from model to model and those shown are for the BC-221-O. Make a three-wire cable harness with plugs and jacks to fit the appropriate connectors in your BC-221. These are usually the "banana" type. After the unit has warmed up outside the case, check each crystal check point on the "Low" band. If

some points cannot be made to reach zero-beat with the "Corrector" capacitor, make the correct setting for the lowest crystal check point in the book and centre the "Corrector" knob on its scale. Now adjust the "Low" internal capacitor for zero-beat in the headphones. If possible, check with a calibrated low-frequency receiver to be sure the meter is emitting a 125 kc/s signal. Check the highest checkpoint in the "Low" band to see if zero-beat can be reached by the use of the "Corrector" control. By varying the initial setting of the control, either a little to the left or right of its centre position and adjusting the internal capacitor, some point will be found which will allow the "Corrector" capacitor to be adjusted for zero-beat on all check points in the "Low" range. The procedure should then be repeated using the "High" internal capacitor for "Corrector" settings in the "High" range. After long periods of disuse, you may find it necessary to repeat these procedures, but they will not affect the accuracy of the instrument.

**The Additive Method:**—The most accurate (but most difficult) way of using the BC-221 is known as the additive technique. In this procedure, the crystal oscillator is left on at all times and the output is the sum or difference of some crystal harmonic plus the v.f.o. fundamental or harmonic. Suppose, for example, you wanted to check the frequency of a transmitter at 28.240 Mc/s. In the additive method, you would use the 28th harmonic of the crystal oscillator plus the fundamental of the v.f.o. at 240 kc/s in the "Low" range of the instrument. To do this, you first make the correct calibration setting indicated in the calibration book on the page containing the setting for 240 kc/s. Then you set the frequency dial to the indicated setting for 240 kc/s. Leave the function switch in the "Check" or "Xtal Check" mode. Now, loosely couple the antenna wire from the BC-221 to a dummy load connected to the transmitter output. Key the transmitter and listen in the headset for a heterodyne tone. Adjust the coupling as required. Turn the frequency dial of the BC-221 until zero-beat is heard. Then read the dial and by direct reading or interpolation between settings shown in the calibration

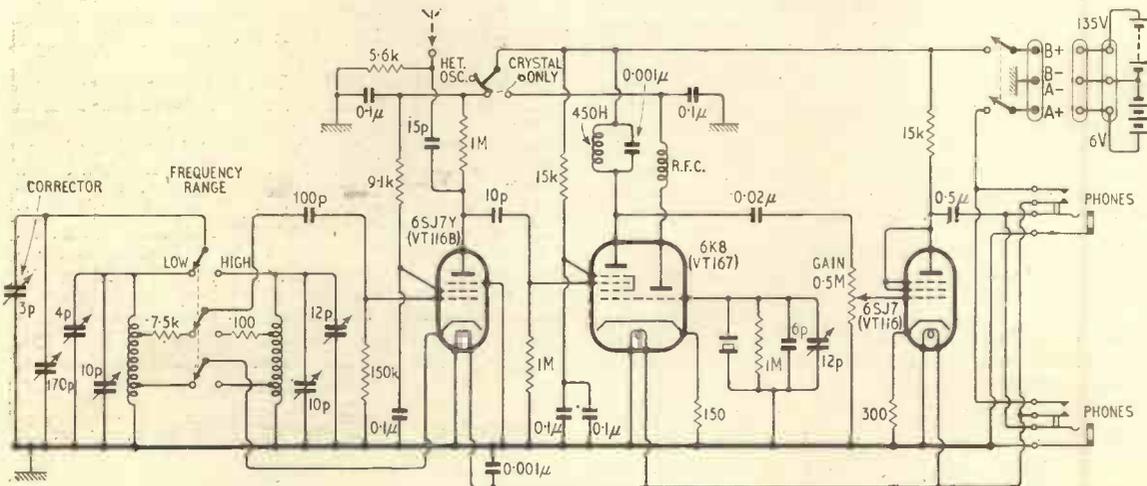


Fig. 4. Circuit diagram and components list of BC-221-O. This is typical of most models.

book, determine the frequency. This is the frequency at which the transmitter is operating.

The one disadvantage of the additive method is that a number of beats may be present, and it may be difficult to determine which is the correct beat. The simplest technique is to key the transmitter on and off while listening in the BC-221 headphones. The correct beat note will only be heard when the transmitter is keyed on. All the other beats should be ignored. With this technique, you can achieve outstanding accuracies for an instrument of this type. The author has used it consistently on U.S. Citizens Band transmitters operating in the frequency range of 26.965 Mc/s to 27.255 Mc/s. Checks with an electronic counter show accuracies in the range of 0.0001% to 0.0025%.

Leaving the instrument on at all times does consume current, but assures greater stability. Valves have been replaced as required without change in accuracy. Experience of the author has shown that the 6K8 requires changing more often than the other valves.

Considering its price, the BC-221 is a very good buy and with careful use, it is able to achieve accuracies that rival those of much more costly laboratory standards. It is an instrument of great versatility. Generally, you will find accuracies greater on the "Low" range, since its total frequency spread is only 125 kc/s as compared to 2,000 kc/s on the high band for the same dial spread.

The calibration book will provide 1,251 dial frequency settings spaced 100 cycles apart for the "Low" range, and 2,001 settings spaced 1000 cycles apart for the "High" band. Several harmonic readings are also given for each of these discrete settings.

No attempt has been made in this article to provide complete operating instructions. Brief instructions are provided in the calibration book accompanying the instrument including methods for interpolating between listed settings. While technical manuals are no longer in print, if you are able to find technical manual, TM-11-300, you will have complete instructions for all models. A change to the manual, TM-11-300 C1, gives further information on setting the internal capacitors.

Maximum accuracy is achieved by operating the BC-221 in a room free from draughts and in which the temperature is reasonably constant. Leaving the instrument on at all times contributes to stability, but if you find this impossible, turn the instrument on about two hours before use. Before making any frequency readings, under these conditions, first calibrate the crystal oscillator against MSF. Repairs can be made to the crystal oscillator or the audio section of the instrument, but any changes in the variable oscillator, such as changing parts or even moving any of the wires, will require recalibration of the instrument against laboratory standards.

## BOOKS RECEIVED

**Transistor Television Receivers**, by T. D. Towers, M.B.E., M.A., B.Sc., A.M.I.E.E., Grad. Brit. I.R.E., is an up-to-the-minute survey of circuits used in the U.S.A., Great Britain, France, Germany, Italy, Russia and Japan. This is not a catalogue of current models but a comparative analysis, stage-by-stage through the receiver, of the design methods adopted and should be of value not only to students of design but also to servicemen in gaining advance information of this growing class of receiver. Pp. 194, Figs. 188. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 55s.

**The Application of Transistors to Sound Broadcasting**, by S. D. Berry, Assoc. I.E.E. (B.B.C. Engineering Division Monograph, Number 46: February 1963) describes a number of transistor audio amplifiers and associated apparatus designed for general use in the sound broadcasting services of the Corporation. The characteristics of some frequently used circuit configurations are considered and a treatment is given of some of the properties of the input circuits of transistor microphone amplifiers with regard to noise. Pp. 20. British Broadcasting Corporation (Publications); 35 Marylebone High Street, London, W.1. Price 5s.

**Proceedings of the International Conference on The Ionosphere** (held at Imperial College, London, July 1962). Papers from this conference appear under four main sections: ionospheric constitution and ionizing radiations, geomagnetism and the ionosphere irregularities and drifts in the ionosphere and the mathematics of wave propagation through the ionosphere. Each section is introduced and summarized by an invited contributor. Also included are three papers giving preliminary results from the UK1, "Ariel" satellite. Pp. 528. Published by The Institute of Physics and the Physical Society and distributed by Chapman and Hall Ltd., 37 Essex Street, London, W.C.2. Price £5 5s.

**Radio and Line Transmission. Volume 2** by G. L. Danielson, M.Sc. (Tech.), B.Sc., A.M.I.E.E., and R. S. Walker, Grad. I.E.E., Grad. Brit. I.R.E., covers the syllabus of the City and Guilds of London Technicians Certificate examination in Radio and Line Transmission B. and forms part of the Telecommunication Technical Series. Pp. 295, Figs. 226. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 21s.

**Wireless Servicing Manual**, by W. T. Cocking, M.I.E.E. This standard reference book now appears in its tenth edition to which a chapter on transistors has been added as an extension of the principles discussed earlier in connection with valve equipment. Pp. 286, Figs. 135. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 25s.

**Radio Research 1962.** The report of the Radio Research Board and the Director of Radio Research in D.S.I.R. gives outlines of the principal activities centred on the Ditton Park, Slough, station. These include the calculation of ionospheric structure at heights up to 100km to fit the field strengths observed by three mutually perpendicular aerials in an exploratory rocket; preliminary results of observation from the Canadian "topside sounder" satellite made at Slough; and the phenomenon of "resonance rectification" which results in a sharp increase of flow of a direct current from a probe electrode in the ionosphere when an alternating voltage is applied at a specific frequency. Pp. 26. H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 3s (3s 2½d by post).

**Marconi and the Discovery of Wireless**, by Leslie Reade. A popular, non-technical account (in the "Men and Events" series) of Marconi's life and worth. Pp. 166. Faber and Faber Ltd., 24, Russell Sq., London, W.C.1.

# LETTERS TO THE EDITOR

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

## Interference from Vacuum Lamps

THE attention of one of the authors was drawn to a particularly bad case of v.h.f. (f.m.) interference which was found on investigation to come from an old "hairpin-filament" vacuum lamp. This phenomenon was fully discussed with reference to television interference, in the correspondence columns of *Wireless World* in 1953 and 1954, culminating in an explanation by "Cathode Ray"<sup>1</sup>, who showed that the oscillations were basically of the Barkhausen-Kurz type. At any given instant the negative end of the long filament would emit electrons, and the positive end behave as the positive grid. The negative anode, which provides the decelerating field necessary to produce these oscillations, was assumed to correspond to a tungsten coating on the inside of the bulb, evaporated from the filament.

A total of five lamps of this type were found and tested for oscillation, using an f.m. receiver. Four of these, which had been in normal service for many years, gave rise to oscillations at differing power levels, but the remaining lamp showed no inclination to do so. This lamp had been employed exclusively for photometric work, and had been used only very infrequently. It was decided to investigate the reason for its refusal to produce interference, especially as it was of similar construction and size to the (40-watt) lamp first found to exhibit this phenomenon so strongly. The glass of the original offender was, however, slightly discoloured and it was obvious that its bulb had an internal coating due to evaporation. It was decided to test for the existence of this coating, by the method of Reynolds and Rogers<sup>2</sup>, and three parallel silver rings ( $\frac{1}{2}$ in wide and  $\frac{1}{2}$ in apart) were painted around the outside of the bulb, each in a plane perpendicular to the bulb axis. The centre ring was earthed and the admittance between the outer rings measured using a transformer bridge of the type described by Calvert.<sup>3</sup> This bridge has the advantage of separate independent adjustments for capacitance and conductance, and is also particularly adapted to 3-terminal measurements. As shown by Reynolds and Rogers, the existence of an internal coating causes an increase in the capacitance from which the resistivity of the coating may be calculated. Since the glass thickness was not known, a quantitative estimation of film resistivity was not possible. However, typical results of measurement at 1000 c/s are given below, for three of the lamps:—

	Capacitance (pF)	Conductance ( $m\mu$ mho)	
Test jig alone	0.55	0.6	
Test jig + lamp A	39.4	96.5	(40-watt lamp—strong oscillation)
Test jig + lamp B	2.5	5.0	(25-watt lamp—weakest oscillation)
Test jig + lamp C	2.2	0.6	(40-watt lamp—no oscillation)

These figures show that the bridge used has detected the change of capacitance due to the internal coating, also that the equivalent conductance of the system is a more sensitive measure of the presence of the coating than capacitance at this frequency. Lamp A has a considerable

1. "Cathode Ray," "Vacuum Lamp Interference"—*Wireless World*, Vol. 60, May 1954, p. 245.

2. Reynolds, F. H., and Rogers, M. W., "A New Method for the Detection of Thin Conducting Films in Thermionic Valves," *Proc. I.E.E.*, Vol. 104B, May 1957, p. 337.

3. Calvert, R., "The Transformer Ratio-Arm Bridge"—*Wayne Kerr Monograph No. 1*.

coating, and this is present to a much smaller extent on lamp B. With lamp C, however, the conductance measured is the same as for the test jig alone, demonstrating that there is no detectable coating on the inside of the bulb.

Thus it appears that an internal coating on the glass bulb is a necessary requirement for oscillation to occur, as "Cathode Ray" correctly deduced.

B. C. BRODRIBB  
K. W. E. GRAVETT  
Electrical Engineering Department,  
Brighton College of Technology.

## "R.M.S." and "Effective" Values

IN his article on "Non-linear Inductance" (July issue, page 361) "Cathode Ray" comments that "the whole idea of r.m.s. values is founded on linearity." I have far too much respect for "Cathode Ray" to believe that his thinking is faulty, but perhaps the expression could be improved.

It seems to me that when the waveform of current is known, the r.m.s. value can always be found; it is the result of a mathematical operation on the waveform. It does not depend on the linear or non-linear nature of the resistance through which the current flows. Whether the r.m.s. value, when found, is useful or not is another topic, but at any rate the r.m.s. value can be expected to be shown on a moving-iron or thermo-couple meter.

If we think of the effective value of current (that value of direct current which, flowing through a given resistance for a given time, dissipates the same energy as does the varying current) then, when resistance is not constant throughout the cycle, the effective value is not defined: what we would like to do would be to divide the mean power by the resistance, to give  $I^2$ , when  $I$  is the effective value of the current. If resistance is not constant, we cannot perform this division.

I may be quibbling but rather than say that r.m.s. values are based on linearity, I would prefer to say that the effective value can only be found when there is linearity; and when there is linearity, the effective value is numerically equal to the r.m.s. value.

Unfortunately this does not agree with the British Standards Institution Glossary of Electrical Terms. For them, "r.m.s." and "effective" are synonymous (and they tell me that when they say "effective" they have in mind energy as the basis of comparison).

Surely whenever there is a repetitive time-function, and the waveform is known, the r.m.s. value can be evaluated whether we are interested in energy or not. If the people who walk across London Bridge each day have regular habits, it would be possible to find the r.m.s. value expressed in people per minute. And whether there is linearity or not in their motion is of no more importance than the linearity of the electrical circuit (unless of course someone's non-linearity is so marked that he falls off the bridge).

All this may seem very trivial; but the confusion between "effective" and "r.m.s." can mislead students in problems dealing with non-linear resistance.

Kew, Surrey.

T. PALMER.

## The author replies:

It is quite true, as Mr. Palmer points out, that the r.m.s. value of any periodic quantity can be calculated, given its waveform, without reference to any other quantity. But surely this would be a rather pointless

mathematical exercise. The r.m.s. idea only makes practical sense when applied to a quantity which appears to the second power in a formula with at least one other factor which is invariable with respect to the first.

The r.m.s. quantities that come first to mind are current and voltage, with resistance as the other factor in the formula for power; but of course the same principle applies to such things as magnetic flux. If the resistance, etc., varies with the r.m.s. quantity, then the purposes for which r.m.s. values are normally used cannot be fulfilled. That is what I meant when I said that the whole idea of r.m.s. values was based on linearity. I am still to be convinced that r.m.s. values apart from linearity, or a distinction between r.m.s. values and effective values, serve any useful purpose.

"CATHODE RAY."

## Technician Engineers

IN your issue for June 1963 you referred to the recently published I.E.E. Report of the Joint Committee on Practical Training in the Electrical Engineering Industry, a report which, as you said, is intended to serve as a guide to those who are concerned with the education and training of electrical technician engineers.

At the end of your editorial comment (p. 262) you said, and I quote:

"At present there is no organization which caters specifically for the increasingly large number of men in this category, and while the I.E.E. itself cannot take them under its wing it is apparently prepared to foster their recognition as engineers provided that the term is appropriately qualified."

The Association of Supervising Electrical Engineers, founded in 1914, concerns itself closely with the education and training of electrical technician engineers, and is recognized by the I.E.E. as being an eminently suitable body to do so. This point was brought out by Professor Sir Willis Jackson, F.R.S., Chairman of the Joint Committee on Practical Training in the Electrical Engineering Industry, in his remarks from the

Chair at the meeting at the I.E.E. in May, when the Report was introduced to the Press and others.

The Association, with its rapidly growing membership, does in fact "cater specifically for the increasingly large number of men in this category," and in doing so is encouraged, and aided in very many ways, by the Institution of Electrical Engineers.

London, W.C.1.

E. A. BROOMFIELD,

General Secretary,

Association of Supervising Electrical Engineers.

## Tape Recorder Flutter Distortion

A KNOWN source of "flutter" distortion is the felt pressure pad used extensively in many machines. Some manufacturers have eliminated this method of getting the tape into close contact with the heads with a consequent marked reduction of flutter distortion. The felt pads give rise to flutter due to the high, but non-constant, coefficient of friction possessed by the felt.

Polytetrafluoroethylene (p.t.f.e.) is a plastic with a very low coefficient of friction. I have found that if a very thin film of this material (0.003 in) be placed between the felt pad and the tape there is a marked reduction of flutter distortion. The advantages of the soft "bedding" characteristics of the felt are retained, while the undesirable friction characteristic of the felt is eliminated.

Unsintered p.t.f.e. should be used and the grade made for pipe thread sealing as supplied by Messrs. Turner Brothers Asbestos Co. Ltd., of Rochdale, is very suitable. Croydon.

W. P. SKINNER.

## Flag Day

IN response to "Free Grid's" request (May issue) for suggestions about a suitable heraldic device for the patron saint of radio, St. Gabriel, here is mine.

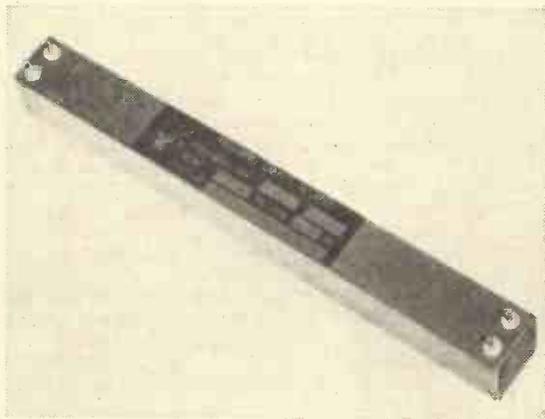
I think nothing could be more "simple or striking" than, say, a herculean figure destroying a pocket transistor radio with a very large sledgehammer.

London, N.13.

GEORGE STRATTON.

# DELAY LINES FOR SECAM

ONE of the factors which will influence the decision to be made by the European Broadcasting Union on colour television standards is the cost of receivers. The



Glass delay line for SECAM colour television by Corning Glass International.

comparative simplicity of SECAM, which at first sight would make a cheaper receiver, is to some extent offset by the need to use a delay line. "SECAM," it will be recalled, is short for "Séquentiel à mémoire," which means that the two transmitted sets of colour information, red and blue, come one after the other. The "mémoire" part of the name means that each line of colour is stored in a memory for the duration of a line so that the colours are brought into step and are applied to the tube simultaneously. (Green is transmitted with the luminance signal and does not enter into the discussion.) Each line scan occupies about  $64\mu\text{sec}$ , and all the frequencies contained in the colour signal must be passed by the delay line.

A lumped-constant line or delay cable to give this order of delay and bandwidth would be difficult and costly to make, and to overcome this difficulty, Corning Glass International have developed a simple glass delay line working on the ultrasonic principle. The signal is launched into and extracted from the glass by ceramic transducers, and the glass used will give a variation in delay time of less than  $0.1\mu\text{sec}$  from  $-10^\circ\text{C}$  to  $55^\circ\text{C}$ . Corning say that, in the numbers needed by an internationally-agreed system, the lines could be produced for \$5 each. A small quantity of these lines is held by Electrosil Limited, Colnbrook By Pass, Slough, Bucks.

# Overload Protection of Transistor Regulated Power Supplies

By F. BUTLER, O.B.E., B.Sc., M.I.E.E., M.Brit.I.R.E.

A GOOD deal of information is available on the design of transistor regulated power supplies but little appears to have been published about current limiters or overload trips to give short-circuit protection. This feature is built into some commercial units and it may be of interest to describe three simple systems which can be incorporated in new units or added to existing power supplies to safeguard them from accident or abuse. In certain cases it may also be possible to protect the connected equipment from the effects of a sustained overload. It can be said at once that ordinary fuses are quite useless for this purpose since they are far too slow in action and this is also true of many types of electromagnetic circuit breaker. Catastrophic damage can be done to transistors in a matter of microseconds and, to be of any value, protective gear must act almost instantaneously.

Three basic circuits will be described. In one of them the maximum possible output current is limited to a preset value. This protects the power supply unit from damage but does not necessarily safeguard the equipment which constitutes the load. In the other two a silicon controlled rectifier, capable of switching in a few microseconds, is used to cut off the power. Under favourable conditions this may clear the fault so rapidly that there is not much, if any, consequential damage. High-speed protection must be applied intelligently; for example it is useless to cut off the supply current if a high-energy reservoir capacitor remains connected across the load.

## Series-transistor Voltage Regulators

One of the simplest and best-known regulator circuits is that shown in Fig. 1. The transistor Q1 acts like a variable resistance between the input voltage and the load. The voltage drop across Q1 is determined primarily by its base bias which is varied in such a way as to compensate for supply voltage or load current changes. The base bias is taken from the junction of  $R_1$  and Q2. The collector current drawn by Q2 is in turn a function of its own base bias. The latter is determined in part by the potential divider  $R_3$ ,  $R_4$  connected across the regulated output. The Zener diode Z in the emitter lead of Q2 is fed through  $R_2$  and develops a constant voltage which is applied as negative bias to the emitter of Q2. The effective base bias on Q2 is thus the difference between the Zener voltage and the potential at the junction of  $R_3$  and  $R_4$ . The former is fixed while the latter varies with any change in the output voltage. Such a change constitutes an error signal which causes Q2 to draw

a changing collector current. In turn, this alters the base bias of Q1 in such a sense as to tend to correct the initial error. The system is in effect a negative feedback amplifier, operative down to d.c., and to exercise strong control high gain is required. One simple way of achieving this is to use compound-connected transistors instead of the single transistor Q1. Alternatively, a 2-stage amplifier may be used instead of Q2 but it must be so arranged as to retain the negative feedback characteristic. The system is not only effective in correcting slow changes in supply voltage or load current but serves also to reduce supply voltage ripple. Because Q1 acts like an emitter follower, its output impedance is low and the good regulation in respect of load changes may be regarded as a consequence of the emitter follower characteristic.

With a fixed bias and emitter load resistance the collector-voltage/collector-current characteristic of a transistor is almost flat, corresponding to a high slope resistance. This effect is partly responsible for reducing the effect of supply voltage changes, including ripple components. However, for maximum ripple suppression the base bias of Q1 should be filtered by RC or LC circuits. Unfortunately this results in a sluggish response to sudden load or supply voltage changes and the technique is not often used in practical regulator circuits. An example of such a scheme will be given later in which some filtering is used without serious time-constant difficulties or penalties.

The problem of voltage control is somewhat simplified if the associated power supply unit has inherently good voltage regulation. In this respect, types which have a capacitor-input filter are notoriously bad. Choke-input filters have a much lower percentage regulation and they make the most of power transformer and rectifier ratings. To reduce ripple to an acceptable level normally requires a second LC filter stage and this puts up the cost so much that the cheaper system is often preferred,

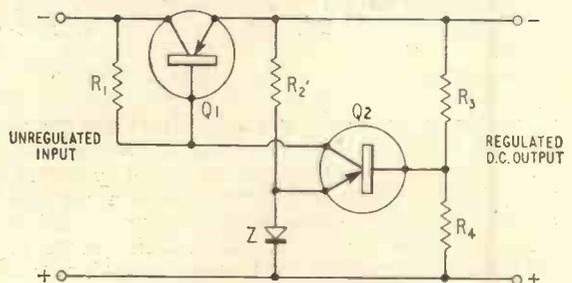


Fig. 1. Elementary regulator circuit.

particularly as the output voltage is a good deal higher. The use of a series-transistor regulator will cut down choke-input filter ripple to a low level without requiring a second stage of smoothing. The regulator circuits and overload protection systems to be described are intended for use with power supplies of the type shown in Fig. 2. Even with this type of circuit there is a sharp rise of output voltage under no-load or very light load conditions and to avoid this it is usual to connect a permanent ballast resistance across the filter capacitor or across the regulator output. It need draw no more than five per cent of the full load current.

### Protection by Current Limiting

Examination of Fig. 1 will show that, for a given input voltage, the output could be reduced by connecting a resistance between the base of Q1 and the positive d.c. line. This would reduce the forward bias on Q1 and increase the collector-emitter voltage drop. A variable resistance serves to produce a variable output voltage. Similar effects would be observed if a transistor were used instead of this resistance and in this case the output voltage could be controlled by variation of the base bias on the third transistor. In particular, it would be possible to supply so much forward bias that this transistor would saturate and so reduce the forward

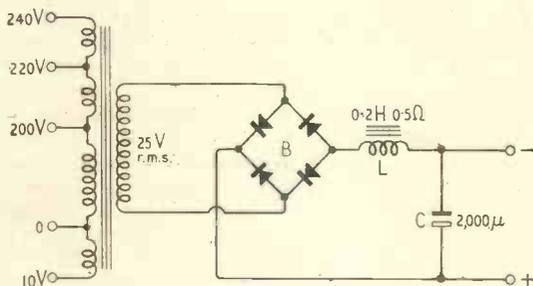


Fig. 2. Power supply unit with choke-input filter.

bias on Q1 that the load current could not exceed a safe maximum value, even if the output terminals were short-circuited.

This principle is embodied in the practical circuit shown in Fig. 3. Here the compound-connected transistors, Q3, Q4 and Q5, mounted on a common heat sink, together constitute the series regulator element. Because of the compound connection, only a minute change in the base current of Q3 is required to cause large changes of collector current in Q5. The transistor Q6 and its associated components form the error-signal amplifier. The remaining units Q1 and Q2 provide the current-limiting feature.

Q2 is normally cut off and does not affect the regulator operation while in this state. It can be turned on by base current derived from the collector circuit of the low-power n-p-n transistor Q1. This, too, is normally cut off by taking its emitter to the junction of  $R_1$  and  $R_2$  which form a potential divider across the unregulated d.c. input. Some forward bias is applied to Q1 in consequence of the voltage drop across the low resistance R caused by the presence of load current. At some critical value of load current the voltage drop across R will

be sufficient to bias Q1 into conduction. The resulting collector current puts forward bias on Q2 and initiates the sequence of events described above. By selecting the value of R so that, with full load current through it, Q1 remains cut off, it can be seen that any further rise of load current can be checked. In practice the regulation characteristic can be made quite flat up to some preset maximum. A short circuit on the output will not cause more than a 20 per cent increase in this figure.

To set up the system it is best to remove Q1 and Q2 from the circuit and first get the regulator working properly. Q3 and Q6 are low-power transistors with a collector voltage rating well in excess of the unregulated d.c. input voltage. Q4 is an intermediate power transistor while Q5 is rated to carry the full load current. Its power dissipation rating can be estimated by taking, as an extreme case, the unregulated input voltage and multiplying this by the full load current. Q5 must be fitted on a well-designed heat sink with free air circulation. The resistors  $R_4$  and  $R_5$  give some protection against thermal runaway, though this is an unlikely contingency. Ignoring  $R_7$  for the moment, the output voltage is dictated by the values of  $R_3$ ,  $R_8$  and  $R_9$ . Reducing  $R_3$  or  $R_9$  will have the effect of increasing the load voltage, while an increase in  $R_8$  also increases the output. By making any of these resistances semi-variable the output voltage can be set at any value between wide limits. The resistance  $R_7$  may be chosen to give a slight rise of load voltage in response to an increased load current. Initial settings of the regulator are best made at about half load. Minor variations in component values can then be made to secure good regulation over a wide range of load current.

Once proper operation of the main regulator has been achieved, attention can be turned to the protective circuit. Q1 and Q2 should be connected in position and either R or  $R_1$  adjusted so that Q1 and Q2 remain cut off until full load current is being drawn at the rated output voltage. Any increase in load current should then bias Q1 and Q2 into conduction and cause a marked fall in the voltage developed across the load.

This simple circuit gives adequate protection against all but sustained short circuits. Under these conditions the power dissipation in Q5 is a maximum since the full unregulated voltage is applied to it and it is carrying a current slightly in excess of the rated full-load current. Ample time is available to disconnect the load before the temperature rise becomes excessive.

By adjusting R (continuously or in steps), the protective circuit can be brought into operation at any selected value of load current. This feature is useful, particularly when a wide variety of loads are likely to be operated from the supply unit.

### Overload Trip Using a Silicon Controlled Rectifier

A controlled rectifier is a solid state device analogous to a thyatron. It has anode, cathode and gate electrodes. It blocks current in the direction which makes the anode negative but will conduct current in the other direction (anode-to-cathode), provided that the gate electrode is positively biased. Without positive gate bias, the device blocks current in both directions. Once triggered into conduction by for-

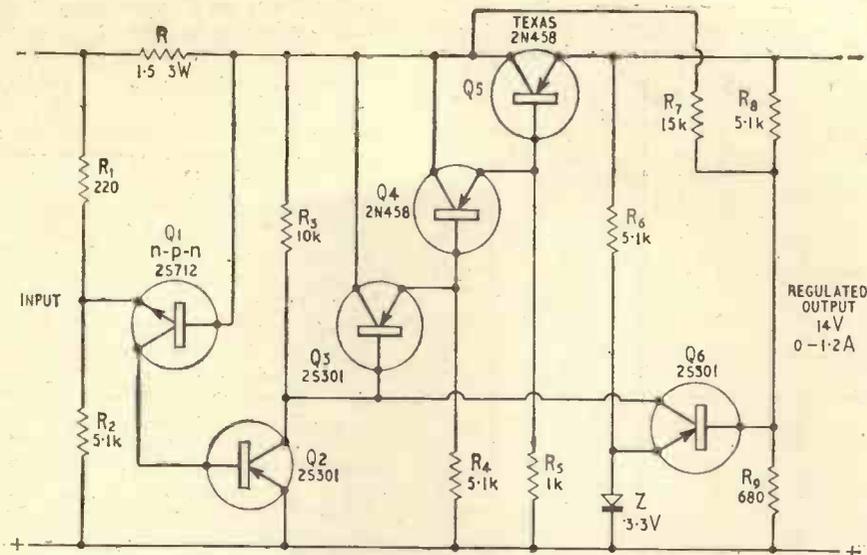


Fig. 3. Transistor regulator with current-limited output.

ward gate bias, the gate electrode exercises no further control and current can only be interrupted by switching, reversing the applied voltage or introducing a very large resistance into the anode circuit.

The circuit of Fig. 4 shows one way of using an SCR to cut off the load current at any preset value. Transistors Q1-Q5 correspond to Q2-Q6 in Fig. 3 and the actual regulator circuits are identical. The choke L and capacitor C act as a filter circuit for the base bias supply by Q2. They are not essential but they do result in a substantial reduction in the ripple voltage developed across the load. The SCR is connected in series with a reset button (normally closed), and the two resistors  $R_1$  and  $R_2$ . The resistance R carries the main load current and the voltage developed across it is applied through  $R_4$  to the gate electrode of the SCR. With normal full-load current in R the resulting gate current of the SCR is insufficient to trigger it into conduction. Any increase in load current beyond the preset value fires the SCR and it passes a current which is determined by the unregulated input voltage and the components  $R_1$  and  $R_2$ . Actually there is a small voltage drop across the SCR in its conducting state but its effect is negligible. The voltage drop across  $R_2$  is applied as forward bias to the transistor Q1. This is normally cut off and in this state has no effect on the regulator action. When Q1 is forward biased to saturation the series regulator stage Q5 is

practically cut off and the load current drops to an insignificant fraction of its normal value.

The SCR remains conducting even when the load current in R is small and the gate bias is far below the level required to initiate conduction. To restore operation to normal after the circuit has been tripped it is necessary to press the reset button. This momentarily opens the SCR anode circuit and interrupts the current. It cannot start again until sufficient forward bias is again applied to the gate electrode. If the circuit has been tripped because of a load short circuit it is obviously

necessary to clear the fault before pressing the reset button. While this is open the circuit is unprotected.

By suitable choice of the value of R the circuit can be arranged to trip with any desired value of load current. The switching action is virtually instantaneous and is certainly fast enough to protect an ammeter in series with the load even when the output terminals are short circuited. This instantaneous protection is not given if a capacitor is used in parallel with the load. This point should be borne in mind if one wishes to make full use of the high speed switching characteristics of SCRs.

### Protection by Silicon Controlled Switch

The silicon controlled switch is another semiconductor device which is ideally suited for short-

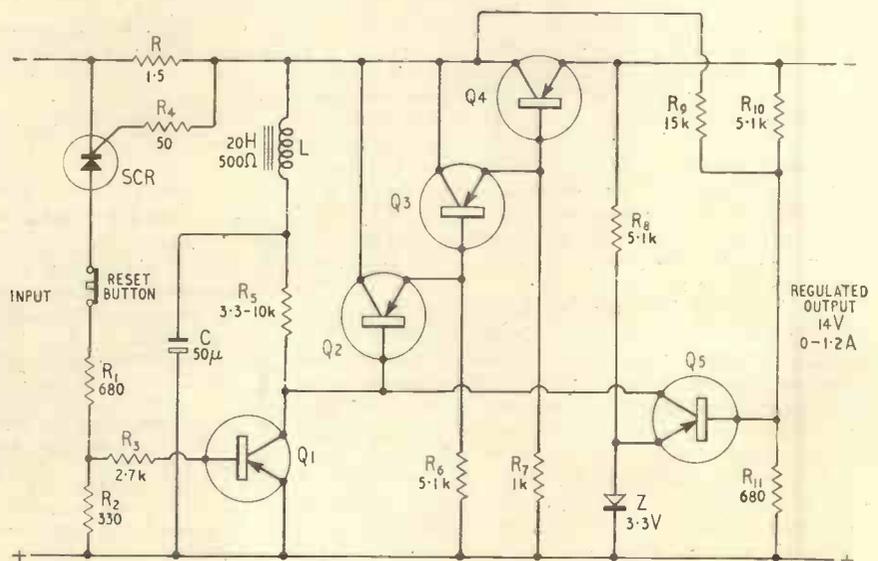


Fig. 4. Overload trip action is provided by this circuit, using a silicon controlled rectifier.

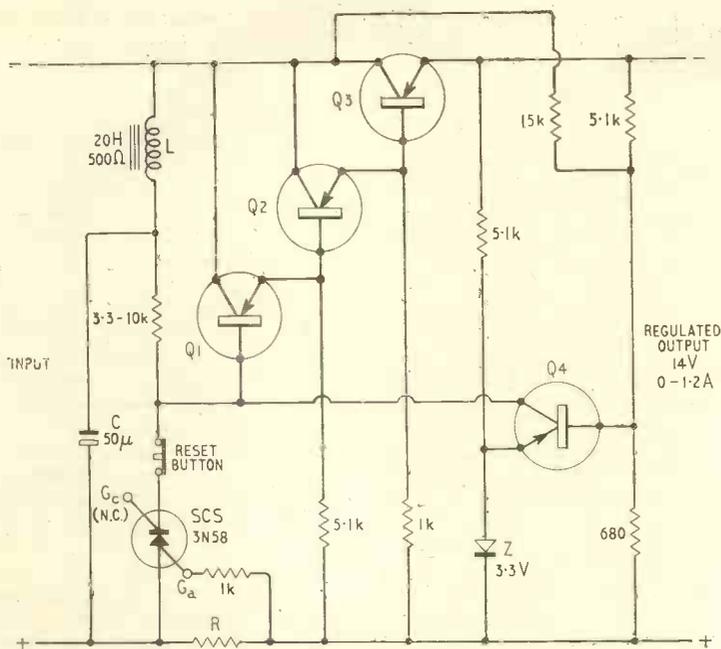


Fig. 5. Overload trip using silicon controlled switch.

circuit protection. One form of this device, developed by the General Electric Company (U.S.A.) and described in their "Transistor Manual," is a low-power SCS which is provided with two gate electrodes,  $G_a$  adjacent to the anode and  $G_c$  next to the cathode. Either gate may be used to trigger the SCS into conduction. If  $G_c$  is used it requires a positive drive signal while, if  $G_a$  is employed, the gate signal must be negative. In either case an extremely small trigger current is effective from a low voltage source. The existence of two gate electrodes makes the SCS more versatile than the normal SCR. The cost is also lower than even the smallest controlled rectifier. The G.E. Type 3N58 is priced at about 25 shillings in small lots and its switching capability is more than adequate for the protection of most regulated power supplies.

Fig. 5 is the complete circuit diagram of a voltage regulated supply incorporating this form of overload protection. The action is essentially the same as in Fig. 4. The SCS is normally non-conducting except for a very small leakage current. The resistance  $R$  is so chosen that with full load current the gate bias on  $G_a$  is insufficient to trigger the switch. Any increase in load current is sufficient to fire the SCS and bring the base potential of  $Q_1$  down to earth or H.T. +.

As in Fig. 4 the value of  $R$  may be chosen to trigger the SCS at any desired value of load current. Complete cut-off takes place in about 1 microsecond and to restore normal action after tripping it is necessary to remove the overload and press the reset button or momentarily switch off the main power supply and then switch on again. In one sense the SCS as employed in Fig. 5 may be regarded as a complementary SCR. If  $Q_1$ - $Q_4$  were all replaced by n-p-n transistors the regulator could be used to give an output with reversed polarity. In this case a standard SCR could be used in place of the SCS. Its cathode would be connected to H.T. -

and in this case the voltage drop across  $R$  would be used to put positive bias on the gate electrode. Such an arrangement would be simpler than that shown in Fig. 4 but it would be more expensive because of the requirement for n-p-n transistors, probably silicon instead of germanium. The reversal of polarity would, of course, call for a reversal of the connections of the Zener diode as well as a change in transistor types.

When the highest possible trigger sensitivity is required in the SCS it is recommended that the unused gate electrode should be left open and unconnected.

### Choice of Protective Measures

Each of the methods described has its own particular field of application. Fig. 3 is ideally suited for use with d.c. motors. These can be switched direct-on-line and the starting current will only just exceed the normal maximum load current. The motor will quickly accelerate to full speed. By contrast, switching a motor load on to the circuits of Figs. 4 or 5 will cause them to trip every time before the motor has begun to move.

All three circuits are equally reliable and give complete protection without interfering in any way with the normal regulator action. A small voltage drop across  $R$  and a trivial power loss in it are the only penalties incurred.

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# (1 + x)

By THOMAS RODDAM

A MULTI-PURPOSE FUNCTION WHICH IS ALWAYS TURNING UP

**E**INS within a space and a wearywide space it wast I promulgated in these columns some ipsofacts and sadcontras about some of the design problems of feedback amplifiers. Much of what I had to say, reduced to instant form, lies enshrined in the Radio Designer's Handbook (Iliffe Books Ltd.). The increasing weight of this and my own growing weakness make it likely that I shall never see the results again. Even before then, and very much since then, we have seen the coupling and decoupling networks of amplifiers analysed. Just to remind you of the process, let us choose the simplest form of all, the LR network shown in Fig. 1, and write down the equation

$$V_1/V_2 = 1 + j\omega L/R$$

In this we write  $\omega_0 = R/L$  and we can jump directly to the result

$$|V_1/V_2|^2 = 1 + (\omega/\omega_0)^2$$

From this we get the frequency response

$$20\log|V_1/V_2| = 10\log [1 + (\omega/\omega_0)^2]$$

Now we write  $(\omega/\omega_0)^2 = x$  and we are dealing with the function  $\log(1+x)$ . When we are roughing out amplifier designs we use a very simple approximation for this function. So long as  $\omega$  is less than  $\omega_0$ , so that  $x < 1$ , we take  $(1+x) \approx 1$ . When  $\omega$  is greater than  $\omega_0$ , so that  $x > 1$ , we take  $(1+x) \approx x$ . The frequency response of the network in Fig. 1 is then represented by two straight lines, a zero loss line up to the frequency  $\omega_0$  at which  $\omega L = R$ , and a 6dB per octave slope above this frequency. We may go on to note that at  $\omega = \omega_0$  the loss is in fact 3dB, and sketch a curve through this point with the straight lines as asymptotes. When we have a number of factors of this kind the errors may leave us with too much uncertainty, but we can easily produce an exact response of an amplifier with decoupling and step circuits by using a template for the function  $\log(1+x)$ .

I have frequently preached the doctrine that an engineer should be a lazy man. The modern engineer confronted with the task of building the Pyramids would not have begun by hiring personnel officers. In the great days of T.R.E. he would probably have devoted all his energies to showing that Pyramids were unwanted, unnecessary and incompetent. Convinced that the return in foreign exchange justified the capital expenditure (just think what the Duke of X— could have made out of the Sphinx) the engineer would design a Pyramid building machine. The only trouble would be that in no time at all he would be transferred to making a smaller model to produce pyramids, anti-tank.

Anyway, we have our template of  $\log(1+x)$ . We do not need to regard this simply as a device for drawing amplifier responses; it has a number of other uses and, since we have the template, we might just as well apply it. Just how often this approach is

really valuable is a matter upon which I will express no opinion because I feel that it could only be a reflection of my own personal attitude. You will find that some engineers choose to plot out every curve for itself, as it were; that others will try to normalize all their sets of graphs into one, and, given the chance, will choose the scales so that they have just a straight line; while yet a third class never draw graphs at all. What one member of one class considers useful, another man may regard as totally unnecessary. I think you may find some use in this technique but anyway, you do not have to use it.

To begin let us take the rather simple case of a resistance bridging a line. The connection of such a resistance introduces what is called a bridging loss and we often have to design systems in which a

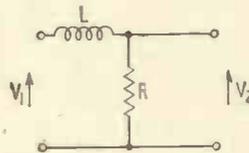
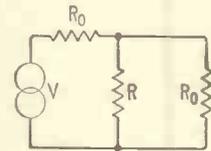


Fig. 1. Simple LR network.

Fig. 2. Resistance bridging a line.



minimum value is prescribed. The resistance may be an amplifier or a monitoring loudspeaker; indeed this is a recurrent problem whenever a signal is carried on a common busbar which can be reached by a number of loads. The standard form is that shown in Fig. 2, where we have a generator of impedance  $R_0$  with a matching load of  $R_0$  and an optional tap along the line at which a second load  $R$  can be connected. The voltage across the load  $R_0$  is easily seen to be  $V/2(1 + R_0/2R)^{-1}$ , which when  $R$  is infinite reduces to  $V/2$  as we should expect. The bridging loss, the factor which controls the effect of  $R$  is simply  $20\log(1 + R_0/2R)$ dB. In this we must write  $R_0/2R = x$ , so that we have for the bridging loss the result  $20\log(1+x)$ dB. There are two points to note here. In our previous use of this template we have been dealing with  $10\log(1+x)$  and we must modify the scale accordingly. We have also been thinking in terms of  $\omega$  although the plot is based on  $\omega^2/\omega_0^2$ . As we are using a logarithmic scale there is a second factor of two which must be taken into account. Between them these two factors give us the result that the bridging loss is 6dB when  $R = R_0/2$  and the bridging loss increases by 20dB per decade of  $R$  when  $R$  is much less than  $R_0/2$ . The result is

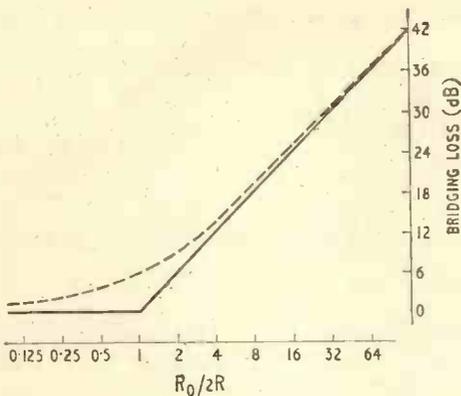


Fig. 3. Bridging loss produced by resistance  $R$  across a line, with generator and load impedances  $R_0$ .

the graph shown in Fig. 3, which was drawn using a template which I had cut in about 1949.

This example illustrates the only danger in this attempt to use one shape of graph for many jobs; it is very easy to get into trouble with the factors of two. I do not think there is any automatic protection which can be provided here: it is probably always wise to check the  $x = 1$  point (3 or 6dB) and the asymptote. I cannot make up my mind whether this whole example is trivial or not. My own inclination would be to stick to the slide rule, but I have seen Fig. 3 plotted out painstakingly both for internal use in a large organization and in one or two books, so obviously the graphical form has its adherents. Indeed, looking back, I recollect using those graphs myself.

The effect of a resistance in series, the series insertion loss, is another  $(1 + x)$  form which can be calculated in exactly the same way as the shunt insertion loss and will be left to the reader while we press on in all other directions.

One rather useful form for quick assessments is found in the field of feedback amplifiers. When we are designing amplifiers for instruments, and also, in a more specialized world, when we expect to have a whole string of amplifiers in tandem, we may be more concerned with providing constant gain than with any other aspect of the problem. Some of us may have been at work with scissors and paste to convert Mr. Edwin's calculator\* (actually Mr. Felker†, to whom we owe the ability to see an American drinking soda water at the very instant he does so, described this device) into a working model, but what with shrinkage and errors of construction we may find our model is in error by the odd decibel. We can use our template for the following calculation.

Let us write the gain with feedback as

$$\mu_f = \mu / (1 + \mu\beta)$$

where  $\mu\beta$  is a positive number with negative feedback. Then rearranging:

$$1/\mu_f = \beta(1 + 1/\mu\beta)$$

This we have seen many times before and we know that  $1 + 1/\mu\beta$  is the finite gain correction to the simple form  $1/\mu_f = \beta$  or  $\mu_f = 1/\beta$ . If we call this correction  $C$  we can plot  $20\log C$  as a function of  $\log \mu\beta$ , or  $\log 1/\mu\beta$ , it is the same with reversed

scales. I really cannot draw Fig. 3 all over again. When  $\mu\beta = 1$  the correction is 6dB: when  $\mu\beta = 2$  the value of  $1/\mu\beta$  is 0.5 and the correction is 3.55dB by slide rule or 3.6dB from Fig. 3, using the  $R_0/2R$  scale as a  $1/\mu\beta$  scale. Suppose now we have this system and put in high-gain devices so that  $\mu$  is doubled, making  $1/\mu\beta$  fall to 0.25. The correction factor falls, from Fig. 3, to about 2.2dB so that the change in overall gain will be 1.4dB. Notice that this chart-reading is not tremendously accurate, but it does offer a quick way of getting our ideas into the right region. A very rough calculation is often sufficient to lay down the lines along which a detailed design will develop. Time spent in reconnaissance is seldom wasted.

Moving away from these simple applications let us look at something rather different. The inductance of a coil of  $n$  turns wound on a core of area  $A$  and permeability  $\mu_0$ , with an average flux path length of  $l_c$  in the core and  $l_g$  in an air-gap is given by the well-known expression

$$L = \frac{1.25A n^2}{l_g + l_c/\mu_0} \times 10^{-9} \text{ henries}$$

We can rearrange this in the form

$$L = \frac{1}{1 + \mu_0 l_g/l_c} \times \frac{1.25n^2 A \mu_0}{l_c} \times 10^{-9} \text{ H}$$

in which we have the second term, the inductance with zero air-gap, multiplied by the gap-effect factor  $1/(1 + \mu_0 l_g/l_c)$ . If we consider the behaviour to be plotted on log-log scales, the only factor we can vary with this particular form is the gap length, and by thinking in asymptotic terms we see how when the gap length  $l_g$  is less than  $l_c/\mu_0$  it has not very much effect, while if  $l_g > l_c/\mu_0$  the gap begins to take complete control.

Let us change our view-point. Instead of doing what comes naturally, putting an air-gap in a core, let us put a core in a coil. Then we write the inductance as

$$L = \frac{1}{1 + l_c/\mu_0 l_g} \times \frac{1.25n^2 A}{l_g} \times 10^{-9} \text{ H}$$

The physical interpretation of this is that the inductor is planned as a system using material of infinite permeability and the inductance is then found to be modified by a "finite permeability factor",  $1/(1 + l_c/\mu_0 l_g)$ . For a system of high stability we shall have  $(l_c/\mu_0 l_g)$  on the below-unity side in Fig. 3 and we can use the curve to estimate just how much the inductance will vary as  $\mu_0$  changes either from sample to sample of material or as a result of d.c. flowing through the winding. There are some interesting possibilities here which I have been meaning to examine for some time. At the moment there is quite another application for our standard curve to be considered.

If we have a four-terminal network with hybrid parameters,  $h_{11}$ ,  $h_{12}$ ,  $h_{21}$  and  $h_{22}$ , and we drive the terminals 1, 1' from a source of impedance  $R_0$  and load the terminals 2, 2' with  $R_l$ , we can calculate the impedances presented at the terminals by applying any of the standard methods. Those of us who dislike effort keep a collection of tables of matrix forms so that we can avoid having to work out these expressions over and over again. "Enough is enough", as one politician is reported to have said to another. The mention of the hybrid parameters will have suggested to the reader that the black box of the

\*Wireless World, June 1962, p. 281.

†Proc. I.R.E., Oct. 1949, p. 1204.

four-terminal does not contain the answer to the world's ills (that box, I am afraid, is empty) but is a classy way of talking about a transistor complete with its power supplies.

The input resistance, and we shall assume that we are concerned only with low frequencies and can forget any reactances, is given by the equation:

$$R_{in} = (h_{11} + \Delta h R_l) / (1 + h_{22} R_l),$$

where  $\Delta h$  is the determinant  $h_{11} h_{22} - h_{12} h_{21}$ . Let us consider plotting this, and let us use log-log paper. We shall then be considering

$$\log R_{in} = \log h_{11} + \log (1 + \Delta h R_l / h_{11}) - \log (1 + h_{22} R_l)$$

Let us choose some values for a typical transistor. If we take the sort of numbers we might find in a common-emitter connection, say

- $h_{11} = 1,000$  ohms
- $h_{22} = 100 \mu\text{mhos}$
- $h_{21} = 100$
- $h_{12} = 7.5 \times 10^{-4}$

we have  $\Delta h = 0.1 - 0.075 = 0.025$ , so that  $h_{11} / \Delta h = 40,000$  and  $1/h_{22} = 10,000$ . Do not, I pray, try to identify this transistor, because the parameters were chosen to give these last two results. I see, however, that the figures are not very different from those given for the OC75 so that you may accept them as being quite realistic. This is the danger in faking parameters to get round numbers: you may get numbers which are hopelessly out of line with reality.

When we short-circuit the output, the collector, we have the input impedance as simply  $h_{11}$ , 1000 ohms. (We need not use the primes on the  $h$ 's.) As we increase  $R_l$  the two other factors operate against each other. Each factor is of the form  $(1 + x)$  and so we can look for two "characteristic impedances,"  $R_{l1} = 1/h_{22}$  and  $R_{l2} = h_{11} / \Delta h$ . These are

- $R_{l1} = 10,000$  ohms
- $R_{l2} = 40,000$  ohms

Interpreting the equation for  $\log R_{in}$  we see that,

as we have said, when  $R_l$  is small the input impedance is just  $h_{11}$ . Working with asymptotes this condition will hold up to the resistance  $R_l = R_{l1}$  above which the logarithmic characteristic falls under the control of the term  $-\log (1 + R_l / R_{l1}) \approx -\log (R_l / R_{l1})$ . When  $R_l$  reaches the value  $R_{l2}$ , however, the term  $+\log (1 + R_l / R_{l2})$  comes into action, and as this is  $\approx +\log (R_l / R_{l2})$  the input impedance becomes constant again. We can thus draw the asymptotic characteristics shown in Fig. 4 very quickly. Using the template construction for this step circuit, we can draw the exact shape for the curve, too.

Suppose, however, that the transistor were being used in the common-collector mode. The hybrid parameters for the same transistor would then be

- $h_{11} = 1,000$  ohms
- $h_{22} = 100 \mu\text{mhos}$
- $h_{21} = -101$
- $h_{12} = 1 - 7.5 \times 10^{-4} \approx 1$
- $\Delta h \approx 101$

The input impedance with zero load is still, of course  $h_{11} = 1000$  ohms, because it makes no difference whether the short-circuited load is in the collector lead or the emitter lead. Now, however, we have

- $R_{l1} = 10,000$  ohms
- $R_{l2} = 10$  ohms

This implies that as soon as the load exceeds 10 ohms the input resistance begins to rise, and it will rise until the load resistance is 10,000 ohms, when it will be 1 megohm. We can add this characteristic to Fig. 4.

The third mode is the common-base mode. For this we have, approximately,

- $h_{11} = 10$  ohms
- $h_{12} = 0.25 \times 10^{-3}$
- $h_{21} = -0.99$
- $h_{22} = 1 \mu\text{mho}$
- $\Delta h = 0.25 \times 10^{-3}$

The values of  $R_{l1}$  and  $R_{l2}$  are obviously

- $R_{l1} = 10^4$  ohms
- $R_{l2} = 40,000$  ohms

No more calculations are needed to draw the set of

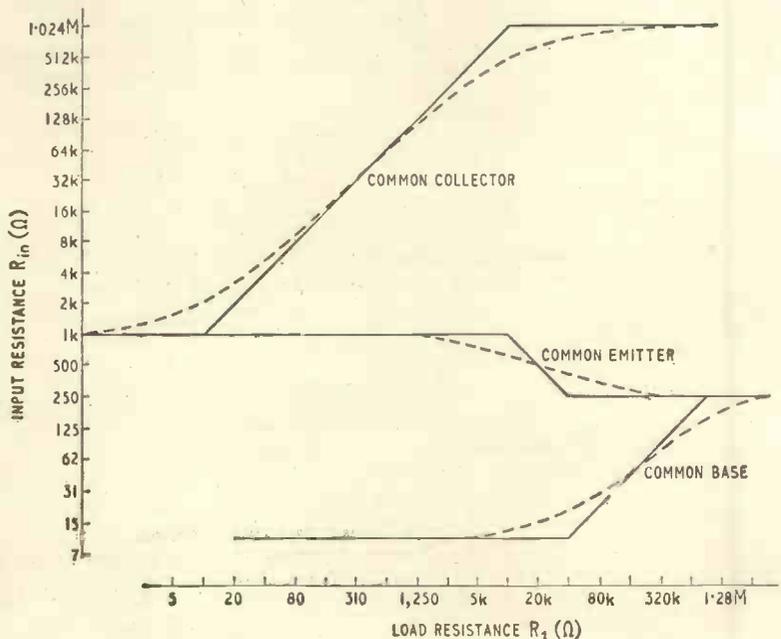


Fig. 4. Input resistance of a transistor as a function of load resistance in the three modes of operation.

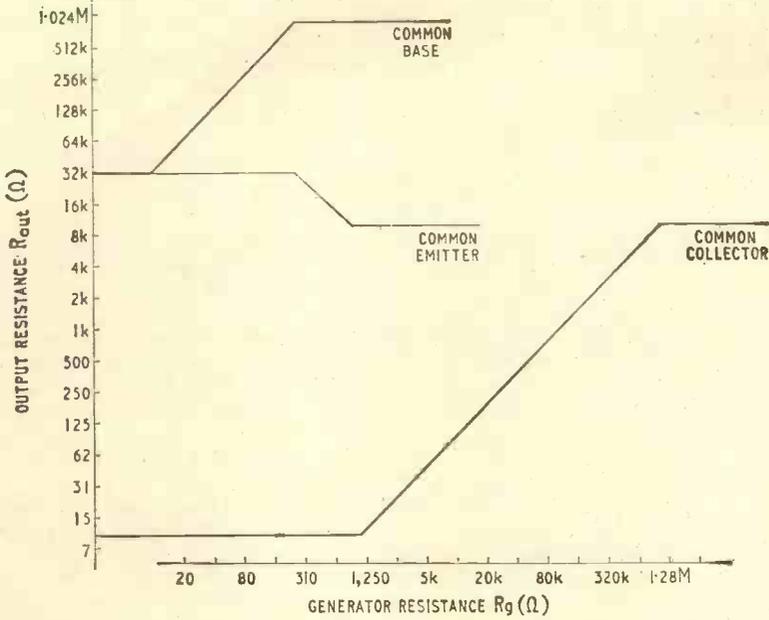


Fig. 5. Asymptotic behaviour of output resistance of a transistor as a function of source resistance.

curves shown in Fig. 4: these show the complete behaviour of the input resistance of a transistor in the three modes of operation as the load resistance is varied. There has been a little dirty work with the scales in order to simplify the drawing and to avoid awkward numbers but this is, I think, fair when the transistor itself has been faked to give illustrative results.

It is possible to produce this diagram with rather fewer calculations, but I prefer to follow the course given above and to note the following check points. The common-emitter mode shares one characteristic resistance with the common-collector mode and the other with the common-base mode. At zero load the common-collector and the common-emitter input impedances are the same, while with an open-circuit load the common-emitter and common-base input impedance are the same. The ramp portion of the common-emitter asymptotic characteristic, when extended, bisects the ramp portions of the other two characteristics.

The output resistance of our transistorized black box has the form:

$$R_{out} = (h_{11} + R_g) / (\Delta h + h_{22} R_g)$$

We write

$$\log R_{out} = \log(h_{11}/\Delta h) + \log(1 + R_g/h_{11}) - \log(1 + h_{22}R_g/\Delta h)$$

Here we have the same sort of behaviour, with the two characteristic impedances  $R_{g1} = h_{11}$  and  $R_{g2} = \Delta h/h_{22}$ .

For the common-emitter connection the starting value  $h_{11}/\Delta h = 40,000$  ohms, while  $R_{g1} = 1,000$  ohms and  $R_{g2} = 250$  ohms. For the common-collector mode we have initially  $R_{out} = 10$  ohms, and  $R_{g1} = 1,000$  ohms,  $R_{g2} = 10^8$  ohms. For the common-base mode, initially  $R_{out} = 40,000$  ohms,  $R_{g1} = 10$  ohms,  $R_{g2} = 250$  ohms. Notice again how one characteristic resistance is shared by the common-emitter and common-collector modes, and another by the common-emitter and common-base modes. Only the asymptotic characteristics have been drawn in Fig. 5, because of the author's natural laziness and also his belief that these characteristics show the founda-

tions of the behaviour in a way which is hidden by the true smooth characteristics. This seems to be especially true of the common-emitter characteristic.

There is one more transistor equation which fits into this sort of approach and that is the current-gain equation. If the input current is  $I_1$  and the output current is  $I_2$  we have

$$|I_2/I_1| = |h_{21}/(1 + h_{22}R_L)|$$

Notice that the signs are left to look after themselves. As always we take logs, and write

$$\log |I_2/I_1| = \log h_{21} - \log(1 + h_{22}R_L)$$

Note that the gain asymptote has its corner at  $1/h_{22} = R_L$ . We know that the values of  $h_{22}$  are the same for the common-emitter and common-collector modes, while apart from the minus sign the values of  $h_{21}$  are nearly the same: the difference between  $h_{21}$  and  $1 + h_{21}$  is just meaningless in this context. We thus need only consider two curves, the driven base and the grounded base. For the grounded base

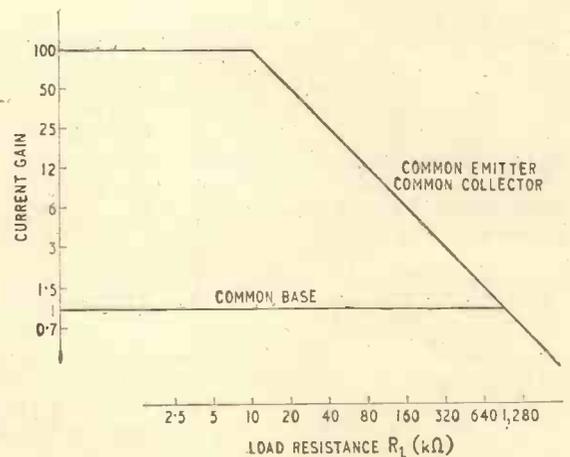


Fig. 6. Asymptotic behaviour of current gain of a transistor as a function of load resistance.

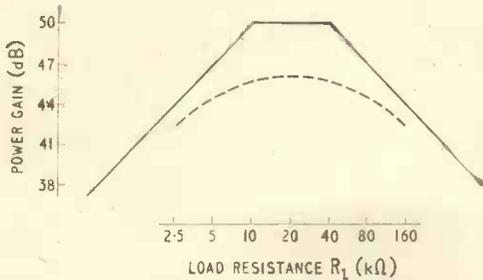


Fig. 7. Power gain of a transistor as a function of load resistance (common-emitter mode).

the gain is, of course, just on unity and the cut-off load resistance (by analogy with cut-off frequency) is  $\beta/h_{22e}$ , where  $h_{22e}$  is the common emitter value for  $h_{22}$  and  $\beta = 1+h_{21e}$ .

The asymptotic ramp where  $R_L \rightarrow \infty$ , is just the line

$$\log|I_2/I_1| = -\log(h_{22} R_L/h_{21})$$

This is independent of the configuration so long as we accept that  $\beta$  is much greater than unity so that  $\beta$ ,  $(1+\beta)$  and  $(\Delta h_e + \beta)$  are all the same. Looking back to the typical transistor, in the common-emitter mode we have  $h_{21} = 100$  and  $1/h_{22} = 10,000$  ohms. Fig. 6 shows the asymptotic characteristics and enables us to do some simple reasoning. Let us consider only the common-emitter connection. Comparing Fig. 4 and Fig. 6 we see that the input resistance starts its downward run at the same load as the turning point of the current gain. For loads below 10,000 ohms the input voltage needed for a given input current is constant, and the current gain is constant. The voltage gain therefore increases in direct proportion to  $R_L$ . Above 10,000 ohms the ratio of volts-out/current-in remains constant, since we are on the sloping part of the  $1+x$  characteristic. However, the input resistance is falling, so that the input voltage for a given current is getting smaller and thus the voltage gain continues to rise. When we reach a load of 40,000 ohms the input resistance becomes constant again and so therefore does the voltage gain. From these results it is very easy to generate a power-gain characteristic but it is worth noticing that, as you can see in Fig. 7, the asymptotic characteristic is rather optimistic. It indicates the correct load, but it is about 4dB too high in gain because of the rounding losses. Even so, it is useful to be able to get a quick picture of what is going on. The common-emitter mode is particularly prone to error in this respect because the step is such a short one.

It is not too difficult to hunt out some more examples of the use of this function. Some time ago I analysed the rather queer things which happen when you have a short-circuited turn. The problem, of course, is why a shorted turn is bad on a transformer and yet seems to be harmless if a brass slug is used for an r.f. tuning arrangement. In the analysis, which no doubt will be given a reference\*\* by the Editor, although I have forgotten it, we get two of these factors  $(1+x)$  cropping up and one of the typical figures is, I hope, reproduced as Fig. 8.

I find this way of using the function as a guide

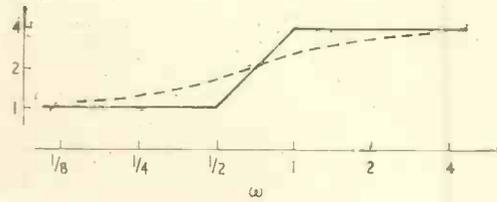


Fig. 8. Typical step figure arising in analysis of short-circuited turn.

very useful because it enables the first rough calculations, estimates might be a better word, to be made very quickly. With just the asymptotic characteristics one can frequently sort out a situation into the possible or impossible class: with the template, or even one's memory of it, many of the doubtful solutions can be assessed. Then you have more time left free for the real plodding work of producing a full solution of the problem. Watch out for that  $(1+x)$ .

## High Power Pulse Modulator

THE photograph shows the cathode temperature being measured during the exhaust schedule of the M-O Valve Company's E2986 hot-cathode modulator thyatron. This valve has power ratings of 200MW (peak) and 150kW (mean). It is thought to be the largest of its type available in the world at present. A metal envelope construction is used to enable all the the electrodes to be easily watercooled. By eliminating grid emission and gas density changes due to hot-electrodes, this also enables a very high power to be achieved in a relatively small envelope. This valve is filled not with hydrogen, but with deuterium, whose greater dielectric strength enables an anode voltage of 40kV to be achieved. While the valve is in use the deuterium gas filling is continuously replenished by means of a titanium deuteride reservoir. The heater of this is controlled by a barretter and thermistor to counteract the effect of changes in the supply voltage or ambient temperature on the gas pressure. An impregnated tungsten cathode is used in association with a secondary emitter to give a maximum peak current of 10,000A with a heater power of 1.8kW.



\*\*Wireless World, March 1957, p. 114.

# UNBIASED



By "FREE GRID"

## Breach of Security

IN June there was a lot in the newspapers about security, and when I heard that an exhibition was to be held in the New Horticultural Hall, Westminster, called "The International Security, Police & Fire Exhibition" I was determined to visit it.

From what I read in the preliminary publicity it seemed to be easy nowadays to use applied science—and more especially electronics—to turn our homes and offices into well-nigh impregnable fortresses. I gathered that any malefactor seeking entry would not only trigger off local visual and audible warnings, but also send a signal to Scotland Yard or local police H.Q.

It so happened that an early opportunity was vouchsafed to me to test this much-vaunted impregnability, for by pure mischance as I walked along the side of the building, I mistakenly entered by a door which I realized later was really an emergency exit which had been opened because of the excessively humid heat of the afternoon. It was not until I was well inside the building with my 2s entrance money still in my hand that I realized my position.

This incident rather destroyed my confidence in all the very remarkable security arrangements on show as naturally I could not help thinking that if the manufacturers of these ingenious devices could not protect their own exhibition building, what faith could I have in their ability to protect my home or office? However, on reflection I realized it was not their fault but that of the organizers who had failed to make the necessary security arrangements; I wonder how many others made the same mistake as I did?

Actually some of the protective schemes on show, many of which used electronic devices of all kinds, were highly ingenious and first-class in every way, but the thing which chiefly interested me was the new pocket transmitter/receiver for use by individual police officers to enable them to communicate with their stations.

This instrument was very compact and light, and could easily be carried in the pocket. Beyond the fact that its average range is 30 miles, obviously varying according to local screening conditions, I can give no details as I was told that all technical literature was exhausted. I am still wondering if this was the truth or whether the manufacturer's representative withheld information

because he thought I looked too much of an anti-social type to be trusted with it. Time will tell, as I asked that full details be sent to the Editor who maybe will receive a visit from the police instead.

## Wireless Cribbing

NO doubt some of you noticed in your daily newspapers recently that a report from Lisbon recounted how a schoolboy was caught cheating in an examination by an ingenious but misguided use of wireless.

He had a large surgical dressing over one ear which hid a transistor set by means of which he was able to signal to his brothers outside the examination room who supplied answers to his questions. This method of cribbing by wireless is very old, and I referred to an earlier instance of it in these columns over a quarter of a century ago.

In those primitive days, telegraphy and not telephony was used, and the offender was not successful owing to the difficulty of transmitting by morse a very complicated equation in a mathematical paper. It would, I think, be equally difficult to transmit such an equation by telephony, and so would-be cribbers will have to wait until the days of fully miniaturized TV with a screen the size of a watch face.

Maybe the Editor won't be able to spare the space for me to repeat the equation here, and so those of you who haven't still got the issue of 28th April, 1938, will have to ring him up. If so he may try reading it out to you in order to prove my words about the difficulty of getting it over correctly by telephony.\*

\* My line is often busy, so I had better read it now: Jay (bar) equals pi ee squared eff tau over em into integral delta en nought by delta vee into vee cubed dec vee into (square bracket) integral, nought to pi, sine cubed theta dee theta minus integral, nought to pi by two, sine cubed theta dee theta one over tee into integral nought to tee exponential minus zed over lambda nought cos theta dee zed minus integral, pi by two to pi, sine cubed theta dee theta one over tee into integral, nought to tee, exponential tee minus zed over lambda nought cos theta dee zed (close of square bracket).—Ed.

## What is a Machine?

SOME more information has been received by the Editor from the managing director of the firm whose troubles of technological terminology I tried to tackle in the June issue.

He has now written to tell the Editor that he has had further cor-

respondence with the British Standards Institution from which he gathers that in the Institution's opinion, a static device such as a transformer is not a machine. But he is rather puzzled by the B.S.I.'s reference in one letter to "rotary machines" as this seems to imply, in his opinion that a stationary device can also be a machine.

In my opinion, however, this is not so as the Institution may be using the term "rotary machine" to distinguish it from one having only a reciprocating motion such as the "make & break" mechanism of an induction coil which we used in the old spark transmitter days.

Actually the word "machine" does not imply the possession of any moving parts if we go right back to its basic meaning. Therefore, a static transformer is a machine even though it has no moving parts, or at any rate ought not to have any although in some of them, when under heavy load, one can sometimes detect a faint humming noise, indicative of a certain amount of lamination liveliness.

However, we can discount this, as also we can the suggestion that the electrons shuffling backwards and forwards in the transformer windings constitute moving parts. I realize, of course, that at rock bottom electrons are indeed moving physical objects unless we follow the present tendency to take a sort of metaphysical view of the ultimate nature of electrons by thinking of them as merely a mathematical concept, or as being merely "a strain in the ether," a phrase which I once heard used by an N.P.L. pundit.

Now where are we? We have just decided that a machine does not necessarily have moving parts. The dictionaries—even the heaviest of them—do not help a lot as they refer to a machine as a device or contrivance. They also say the Romans used the word (*machina*) a lot in connection with lifting weights which were too heavy to be dealt with manually. This leads me at once to think of that excellent sort of lever which we usually call a crowbar. It would seem to have no moving parts, and yet when in use, one end of it, as in the case of an oar, does move relative to the other. It is no use trying to dodge the issue by saying a crowbar is a tool; so is an electric drill which is also most certainly a machine.

I think I'm getting rather out of my depth, and must leave to you savants the question in the title of this note. In my opinion it is incumbent upon us to assign our own

agreed meaning to all words we employ as we have already done in the case of "atom" which nowadays we all use with an arbitrary meaning quite different to its literal one of "indivisible."

### R.F. at Interplas

A FEW weeks ago I paid a visit to "Interplas," or in other words the International Plastics Exhibition, at Olympia. In addition to the use of plastic cases and coverings for domestic receivers plastics also play an important part in the matter of insulation and other things inside the box.

However my real reason for going to the exhibition was to examine the many r.f. heaters used in the plastics industry, which were on view there. The frequencies used seemed to be 35Mc/s or so but I noticed that one firm (Radyne) was urging the superiority of its 80Mc/s machines for certain purposes. I was a little surprised at the use of this frequency as it is, I believe, in one of the bands allocated internationally for radio astronomy.

I therefore approached an expert on the stand for enlightenment. His reply was that the machine was so completely suppressed that it complied with the requirements of authorities not only in this country but even in Germany; these latter requirements, he said, were much more stringent than those over here. In reply to my further questions, he stated that even if his firm's apparatus were to be installed in a laboratory devoted to radio astronomy, the suppression was so perfect that no interference would be caused.

### More ψ

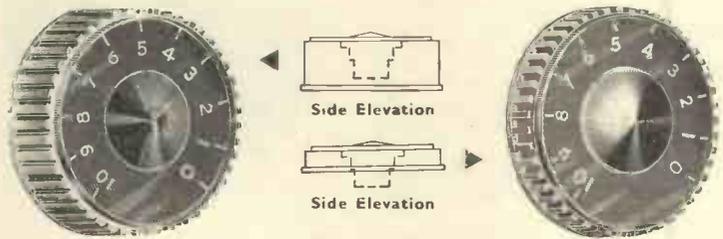
AS I mentioned in the issue of June 1959, the symbol ψ (actually the Greek letter which immediately precedes omega) is used to describe telepathy and other kinds of extra-sensory perception about which we know little or nothing.

The only reason I am dragging in ψ again is that I see a report that the Russians are planning to transmit thought waves between Cambridge and Leningrad. Hitherto I had always thought that telepathists had stated that thought waves were *not* radio waves of a certain λ. But since the expression "thought waves" is used they are obviously waves in some medium or other, and if they can indeed be transmitted between Cambridge and Leningrad, it looks as though they may at least be first cousins of radio waves.

It is all rather disturbing, for obviously if telepathy once got established on a firm basis, it would wreck the radio and industry and make all our apparatus just so much scrap iron.

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# DECCA D202 RADAR

EXTENSIVE use has been made of transistors in the latest marine radar installation designed by Decca Radar Ltd., Albert Embankment, London, S.E.1. Although magnetrons and klystrons have not yet been replaced in the transmitter and receiver most of the other stages have been transistorized with the result that the D202 is much more compact than earlier valve-operated equivalents. It is further expected that reliability will be improved, not only because of the long life of the transistors themselves but because other components will be functioning in a lower ambient temperature. The total consumption is only 320 W at 24 V.

Two pulse lengths of 0.1 and 0.5  $\mu$  sec are provided for good picture quality at short range and better sensitivity at long range. There are six ranges giving maxima from  $\frac{1}{2}$  to 24 miles.

The price of the D202 is £950 compared with £1,500 for earlier valve models, but it is in no sense a "cheap" version, indeed, the performance meets the requirements of and has already been given type approval by the British, American and German authorities. One of the first



Above: The end-fed slotted waveguide aerial of lightweight construction gives a beam width of  $1.9^\circ$  with a 4ft horizontal aperture.

Left: The display unit of the Decca D202 in a welded stainless steel housing is suitable for bulkhead, deckhead or pedestal mounting, at a "safe" distance of anything over 18in from a magnetic compass.

orders was for the new 48ft R.N.L.I. lifeboat and it is expected that there will be considerable interest from

coastal shipping lines operating small vessels, as well as from ocean-going vessels requiring a stand-by radar.

## Commercial Literature

A leaflet describing automatic oscilloscopes, manufactured by the California Instruments Corporation, is available from A. Dunkley, 14 Wellington Road, Ashford, Middx. The manufacturers claim that a waveform is automatically positioned to provide a "clear meaningful picture, regardless of amplitude, frequency or d.c. offset." This scope also displays in digital form vertical sensitivity, horizontal sweep speed and d.c. offset. (314)

The 1963 Mullard valve and tube Equivalents Guide is now available from the Government and Industrial Valve Division of Mullard Ltd., Mullard House, Torrington Place, London, W.C.1. Its companion publication abridged data on current types of valves and tubes for industry, communications and radar is available from the same address. (315)

Feroba ceramic permanent magnets are described in a leaflet obtainable from Darwins Ltd., Fitzwilliam Works, Tinsley, Sheffield 9. Details of the physical and magnetic properties of the discs, rings and bars they manufacture are included together with demagnetization curves. (316)

A leaflet describing 7,000Mc/s portable outside broadcast link equipment for television is available from the Transmission Systems Division of Standard Telephones and Cables Ltd., North Woolwich, London, E.16. (317)

A loose-leaf technical catalogue containing information on Belling-Lee products is now available to senior designers and engineers on application, from the head of their department, to Belling and Lee Ltd., Great Cambridge Road, Enfield, Middx. (318)

A leaflet describing public address equipment manufactured by C.T.H. Electronics is obtainable from their Burford Works, Burford Street, Hoddesdon, Herts. (319)

A transistor portable radio telephone designed for single channel operation in the 50 to 140Mc/s band using amplitude modulation and 25kc/s channel spacing, is described in a leaflet obtainable from the Radio Communications Company, of Crewkerne, Somerset. (320)

A.E.I. publication 5887-71, which gives details of a wide range of components from anti-corona tags and crystal holders to valve holders and voltage selector panels, is obtainable from the London sales office of Associated Electrical Industries, 51-53 Hatton Garden, E.C.1. (321)

Micro-electronic devices and integrated circuits are described in one of the "special series" of catalogues from the Components Group of Standard Telephones and Cables Ltd., Footscray, Sidcup, Kent. This catalogue (No. 8) includes information on integrated tunnel diode circuits and thin film circuits. (322)

Keyswitch Relays Ltd., of 120-132 Cricklewood Lane, London, N.W.2, have produced a reference chart for use with their 3,000 and 600 type relays. This "calculator" contains all the relevant information required to select the right type of relay for a specific job and also the recommended coil values, in tabular form, for relays with up to 12 contacts working on voltages up to 250V d.c. (323)

A leaflet describing the Danish Raaco industrial storage cabinets, which have transparent plastic drawers, is now obtainable from Raaco Ltd., Bath House, 57-60 Holborn Viaduct, London, E.C.1. (324)

Surge suppressors, for the protection of germanium and silicon rectifiers, are described in the Westinghouse Engineering Publication 19-13. Titled "N Series Selenium Surge Suppressors," it includes electrical and mechanical specifications along with typical circuit configurations and is available from the Westinghouse Brake and Signal Co., 82 York Way, King's Cross, London, N.1. (325)

A leaflet describing a new range of relays is now available from A.D.S. Relays Ltd., 89-97 St. John Street, London, E.C.1. The relays included in this brochure are approved by A.I.D., A.R.B. and the Admiralty. (326)

For the convenience of readers a number has been appended to each of the above items so that when applying for literature all that is necessary is to circle the appropriate number on the Information Service form at the back of this issue.



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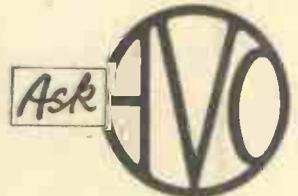
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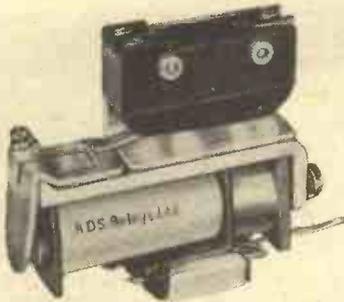
close  
the  
gate  
on

**CORROSION**

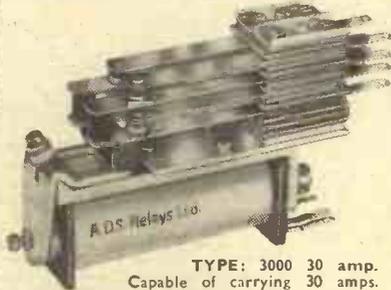


MEMBER OF THE  
GROUP OF COMPANIES





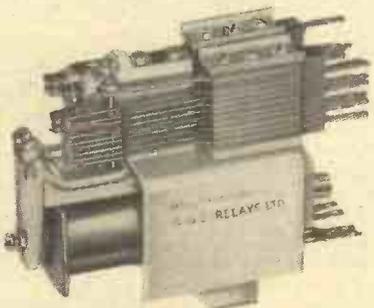
**TYPE: 3000 MICRO SWITCH**  
Can be fitted with any type of micro switch; light and heavy duty contact sets as required. Coil: 2 to 80,000 ohms.



**TYPE: 3000 30 amp.**  
Capable of carrying 30 amps. at 250 v. A.C. with maximum build up of 4 makes or 4 breaks. Coil: .1 to 80,000 ohms.



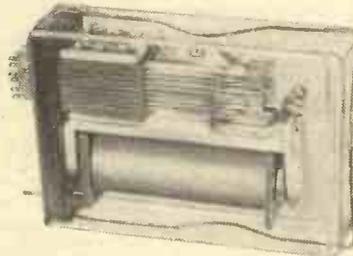
**TYPE 3000: Transistorised Relays**  
T.1. Operates from 300 to 500 micro/amps. at 1½ volts D.C.  
T.2. Operates from 3 to 5 micro/amps. at 1½ volts D.C. Maximum contacts 2 change overs light duty or 2 change overs heavy duty.  
T.3. Operates from 15 to 30 micro/amps. at 1½ volts D.C. Maximum contacts six change overs light duty.  
T.1, T.2, T.3. Energised 12 to 18 volts D.C.



**TYPE: 3000 B.O.3.**  
With its own bracket for fitting in any position, so designed to interlock with each other. Coil .1 to 80,000 ohms.

# There are 1001 uses for 3,000 TYPE RELAYS

A.I.D. A.R.B  
ADMIRALTY  
APPROVED



**3000 TYPE P.I.**  
Plug in Relay

**GENERAL INFORMATION:**

All relays supplied to B.P.O. standards.

With the exception of 30A and B.O.3, all relays can be supplied as a plug in version.

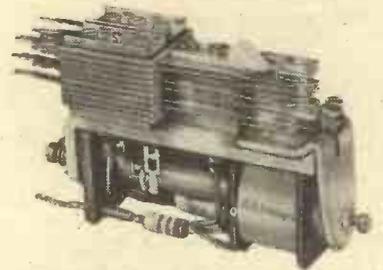
**TYPES: M1.30A.B.O.3. LI.T3000.**  
Can be supplied for A.C. operation 6 to 250 volts.

**INSULATION**

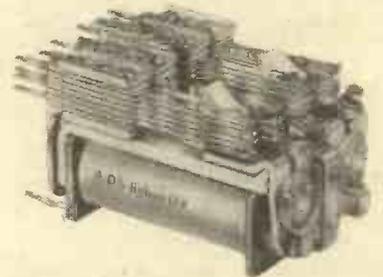
Coil and Spring Sets.  
100 volts—650 volts A.C.



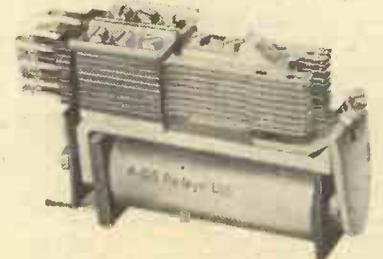
**TYPE: 3000 Twin-Armature**  
This relay is a space saver! Two relays in one. Two coils, two armatures, working independently. Contacts maximum 4 change overs light duty or 2 change overs heavy duty. Coils: Maximum 10,000 ohms.



**TYPE: 3000 Delay Relay**  
This relay can be supplied with operate/delay up to 25 seconds from supply of 6 to 50 volts D.C. Release delay up to 25 seconds with trigger circuit of 1½ volts D.C. Energised from 6 to 50 volts D.C. Contacts maximum 6 change overs light duty.  
With adjustable resistor giving plus or minus 2 seconds of nominal figure on operate and release relays.



**TYPE: 3000 Mechanical Latching Relays**  
Built to customer's requirements. Coils: .1 to 80,000 ohms.



**TYPE: 3000 Standard**  
This relay is also available for A.C. operation with built-in rectifier—6 to 250 volts A.C.

# A.D.S. RELAYS LTD

89-97, ST. JOHN STREET, CLERKENWELL, E.C.1

Telephone: CLERKENWELL 3393/4/5

### D-C MOBILE RECTIFIER SETS

100 W TO 150 kW  
FIXED OR  
VARIABLE OUTPUT  
1 PHASE & 3 PHASE

Electro-Plating, Plasma  
Arc, Arc Welding, Electro-  
Magnets, Carbon Arc,  
Battery Charging and other  
uses.



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Variable output  
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Low voltage high  
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techniques. Power Control  
by saturable reactors and  
other methods.

### AMP MOBILE TRANSFORMERS

## TRANSFORMERS

1 PHASE AND 3 PHASE  
0.5 kVA TO 250 kVA



QUICK DELIVERIES



## VOLTMOBILE 64-STEP ON LOAD SWITCHING AUTO-TRANSFORMERS

Output 1.6% to 100% or 125% of input volts in  
64 steps or 80 steps. A control device for many  
loads — resistance furnaces, rectifier sets, bat-  
tery charging, anodising, heating and other uses.

1 Phase and 3 Phase  
18 Models

Output currents from 20 A to 200 A. VERY FAST DELIVERIES.

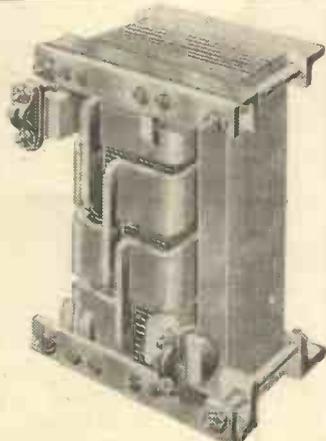
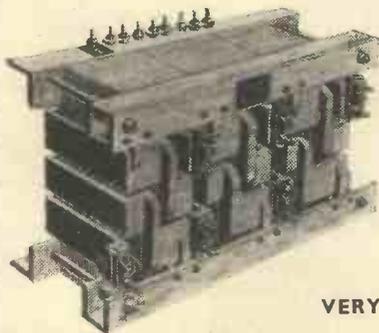


### S-MOBILE HEAVY CURRENT TRANSFORMERS

1 PHASE & 3 PHASE  
Output currents of hun-  
dreds and thousands of  
amperes for Furnaces, Rec-  
tifier Sets, Heat Runs,  
Short Circuit Testing and  
other uses.

Examples: 5 V 300 A, 10 V 1,000 A,  
20 V 3,000 A, 5 V 6,000 A

VERY QUICK DELIVERIES.



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CENtral 4281

**HARMSWORTH, TOWNLEY & CO.**  
2 Jordan Street Manchester 15

## Famous Brand Names... New Quality Products from MORHAN

### H. H. SCOTT AMPLIFIERS

#### 299C Complete Stereo Amplifier



The most widely used, highly respected stereo amplifier made. Featuring rugged 80-watt output stage assuring low-distortion reproduction, special signal lights to operate system; stereo selector switch for choosing stereo or monophonic; separate scratch and rumble filters; front panel stereo headphone output; and derived center channel level control.

Models 200, 222C, 299C and Kits supplied in 110/220V. 50/60 cy.

### LABORATORY SOUND INSTRUMENTS



#### Model 450 Sound Meter

Self-scaling . . . Transistorized. Compact, rugged and operates on only one ordinary 22.5V battery.

The #450 is ideal for field measurements and surveys of noise and sound. Weighs 1 lb. 7 oz. Write for complete catalog and prices.

### irish Magnetic Recording Tape

IRISH makes a quality tape for every purpose for both the amateur and professional.

IRISH is the only premium-quality tape at a standard price. Exclusive Irish

Ferro-sheen process prevents shedding of abrasive oxide . . .

assures reduced head and tape wear, superior sound quality. 3", 4", 5", 5 1/4" and 7" reels available in standard, long playing and double play. FREE—"Signature Tape" binding with every 5", 5 1/4" and 7" reel. Write for complete catalog and prices.



### GENERAL Capacitors—Selenium Rectifiers

Rigid codes of testing and quality control give General Instrument capacitors long-life and dependability. Every General Instrument capacitor is individually tested and fully guaranteed. Type TM is supplied in grounded aluminum containers to provide maximum protection against moisture. It has low leakage and long shelf life. No artificial barrier layer is used to Tri-Amp Selenium Rectifiers, thus eliminating the cause of

aging and high voltage drop. A complete line of capacitors, electrolytics, by-pass molded type, tantalum and Mylar capacitors available. Write for complete catalog and prices.



### REK·O·KUT

#### Turntables, Arms and Speakers Model R320A



World's only true turntable with fully automatic operation, 33 1/3 rpm; single push-button operation; custom built hysteresis synchronous motor with sealed lifetime lubrication; exclusive life-time Rekothone Belt not affected by temperature or humidity; minus 57 db rumble. Write for complete catalog and prices.

### TERADO Converters—Fully Transistorized Model 50-202

"Dual Continental"—550-600 watts—

heavy copper clad base with ventilating fan.

60 cycle frequency stable within 1/2 cycle with varying input voltage and load. Filtered for use with tape recorders. Also available for 50 cycles. Write for complete catalog and prices.



### FREED for Precision Laboratory Testing... Incremental Inductance Bridges Type 1110-C

Maximum superimposed DC up to 2 amperes. Direct in-line readings of inductance and conductance of iron core component at audio frequencies with or without superimposed direct current. Uses five decade resistors with maximum resistance of 111,110 ohms in steps of 1 ohm. Frequency range: 20 cycles to 10 KC. Write for complete catalog and prices.



### ORRTRONIC JETSTAR 300 Continuous Background Music Record/Playback Unit



A fresh concept in complete automatic sound programming. Completely transistorized — an efficient low-cost system for continuous play applications of recorded sound.

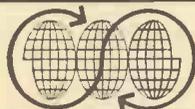
Extensive catalog of recorded music and educational material available. As a recorder, provides an easy and automatic way to record family events, off-the-air recordings, language learning, speeches and rehearsals. 12 transistors and 4 diodes weighs only 11 pounds. 4" x 6" speaker, 8 watts, 150 to 10,000 cps. Tapette cartridge protects tape, eliminates threading and rewinding.

### CADRE Citizens Band Radio—Fully Transistorized Model 515



NEW! 19 Transistors—7 Diodes, Highest power allowed; excellent selectivity; completely transistorized; maximum reliability. Press the switch and you are "on the air" with the clearest 27 MC "talk" power possible—5 watts, transmission range up to 20 miles on land, 30 miles over water. Perfect contact assured by 5 crystal-controlled transmit/receive channels. Features include noise limiter, adjustable squelch, advanced receiver circuit, weighs only 6 pounds, built-in dual power supply.

Complete Lines of Radio, Industrial and TV Tubes, Speakers, Resistors, Semi-Conductors, Diodes, etc. Write or Cable for Complete Catalogs.



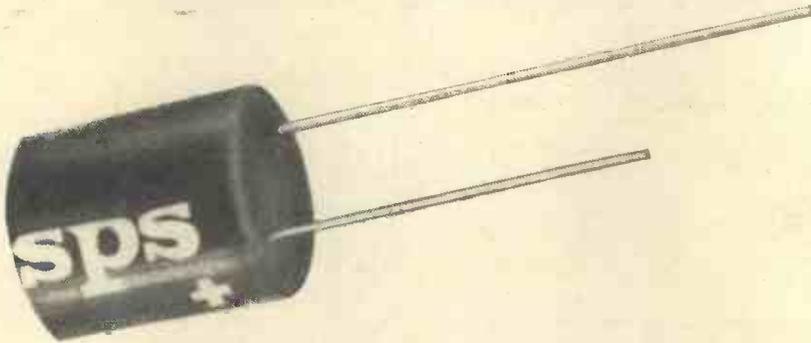
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## IN ELECTROLYTIC CAPACITORS

ALUMINIUM FOIL CAPACITORS FOR TRANSISTOR AND OTHER LOW VOLTAGE CIRCUITS



### ALL-MOULDED PLASTIC ENCAPSULATION

- ★ HERMETICALLY SEALED ALL-PLASTIC ENCASEMENT
- ★ ULTRA-SMALL SIZES WITH CAPACITIES TO 200 $\mu$ F
- ★ CLOSE TOLERANCE DIMENSIONS
- ★ LEAD SPACING TO  $\pm 0.015$ "
- ★ HIGH RELIABILITY BY CLOSE QUALITY CONTROL PROVEN IN THE EXACTING U.S. MARKET
- ★ SURPRISINGLY LOW COST
- ★ FAST DELIVERY

FOR FULL DETAILS WRITE OR PHONE:

# SPSI

#### TECHNICAL

**CAP. TOL.**—20% + 100% OF RATED  
**DISSIPATION FACTOR** EXTREMELY LOW—  
 LESS THAN 8% AT 50 WVDC  
**D.C. LEAKAGE:** EXTREMELY LOW—LESS THAN  
 6  $\mu$ A AFTER 1 MIN. APPLIED WVDC  
**OPERATING TEMP.** 65° C AT RATED WVDC

## SPS

INTERNATIONAL LTD.  
 SHANNON AIRPORT  
 IRELAND

TEL. SHANNON 245

# Variac

REGISTERED

## VERSATILITY



THE MOST VERSATILE INSTRUMENT EVER DEvised FOR THE CONTROL OF VOLTAGE CURRENT POWER HEAT LIGHT SPEED

### BASIC VARIACS

Basic Variac units are available in open or covered form in power ratings from 100 VA to 7.5 kVA and provide smooth continuous adjustment of AC voltage from zero to line voltage and above.

### GANGED VARIAC ASSEMBLIES

Variacs are available in ganged assemblies of 2, 3 and up to 6 units controlled from one shaft, including 3-gang assemblies for 3-phase star operation and parallel-connected assemblies of the larger models for increased power output.

### PORTABLE VARIACS

These models provide a compact and rugged portable source of variable AC voltage—ideal for general test purposes. With carrying handle, input cable, switch, fuse and outlet socket or terminals. Also voltmeter or ammeter if desired.

### HIGH-FREQUENCY VARIACS

A large range of Variacs is available for operation at 400 c/s and other high frequencies and can be supplied in ganged or motorised assemblies.

### MOTOR-DRIVEN VARIACS

Single units and ganged assemblies are available with motor drive for remote control applications. Standard speed 1 r.p.m. Alternative speeds are available to order.

## Variac—the original and best variable transformer

Variacs range from single small units for laboratory or instrument use to ganged assemblies for high power 3-phase operation. In addition to the types shown above, there are dual-output, low voltage and narrow-range types, metal-clad, oil-immersed and flameproof models, plus many 'specials'. Write for illustrated technical literature to Publicity Department, Hoddesdon.

Variacs are made in England by The Zenith Electric Co. Ltd, London and exclusively distributed in the UK, Eire and British Colonies by —

### CLAUDE LYONS LTD

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Hoddesdon 4541 Telex 22724  
76 Old Hall Street, Liverpool 3  
MARitime 1761 Telex 62181

# Claude Lyons

# ANNOUNCING

## TWO NEW TAPE RECORDERS FROM BRENELL

### FOR STEREO

#### THE STB 1



£120

This new stereo tape recorder from Brenell contains many new features which will appeal to the discriminating amateur and professional alike. It is beautifully designed, both mechanically and electrically, and incorporates twin recording and twin replay pre-amplifiers, designed for use with existing high fidelity amplifying equipment. Some idea of the versatility of this new machine will be gathered from this very brief specification:—

4 speeds  $1\frac{7}{8}$ ,  $3\frac{1}{4}$ ,  $7\frac{1}{2}$  and 15 i.p.s.—mixing—superimposing—sound-on-sound—immediate comparison of original and recorded signals—2 edgewise meters—replay facilities for  $\frac{1}{2}$ ,  $2/2$ ,  $\frac{1}{4}$  and  $2/4$  track pre-recorded tapes.

### FOR MONO

#### THE MARK 5 Series 2



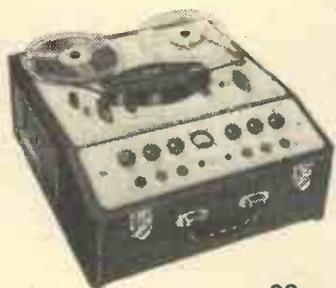
69 gns.

This new machine replaces the MARK 5 and offers a number of improvements both in appearance and electrically. The cabinet is finished in dark grey with chrome trim and the deck and amplifier have light grey masks giving the whole machine a very pleasing appearance. The amplifier has been redesigned to give an improved frequency response at all speeds on both record and playback. The output remains the same at 4 watts.

Specification: 4 speeds  $1\frac{7}{8}$ ,  $3\frac{1}{4}$ ,  $7\frac{1}{2}$  and 15 i.p.s.—3 independent motors (synchronous drive to capstan motor)—instant stop without spillage—pause control—monitoring—superimposing—up to  $8\frac{1}{2}$  in. reels—fast rewind (1,200ft. in 45 seconds).

*and we continue*

#### THE MARK 5 Type M



88 gns.

A high class semi-professional machine, the Type M has earned itself an enviable reputation for quality and reliability. Its superb finish and performance will match any high fidelity equipment which is available today—just consider this brief specification:—

4 speeds  $1\frac{7}{8}$ ,  $3\frac{1}{4}$ ,  $7\frac{1}{2}$  and 15 i.p.s.—separate record and replay heads and amplifiers—reels up to  $8\frac{1}{2}$  in. dia.—fast rewind (1,200ft. in 45 seconds)—mixing—superimposing—recording level meter—adjustable rotary tape guide.

The Mark 5 Series 2 deck, amplifier and power unit are available separately for installation in your own Hi-Fi system. Write for leaflets.

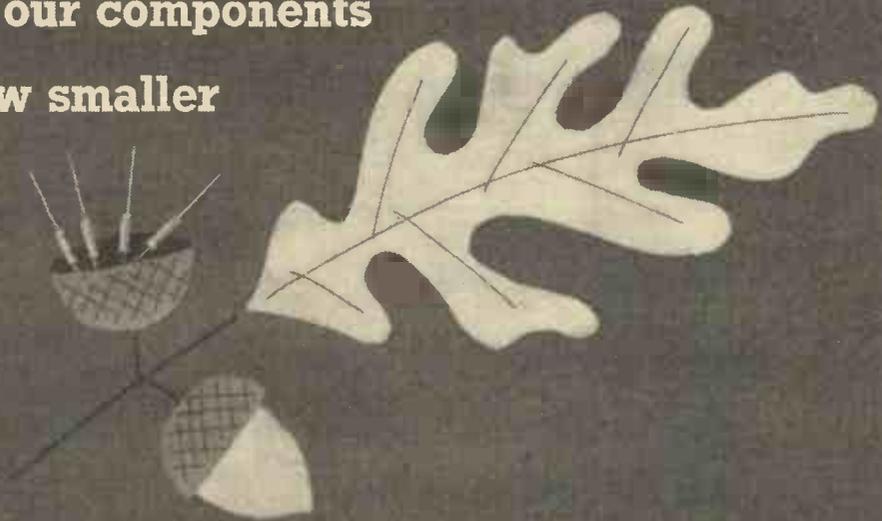
Sole manufacturers:

# Brenell

**BRENELL ENGINEERING COMPANY LIMITED**

1a Doughty Street, London, W.C.1. Tel.: HOLborn 7356/8

as we  
grew larger  
our components  
grew smaller



If you want a capacitor that will stand up to seventy degrees of frost, or the searing heat and shock of rocket blast-off—see Dubilier. For since the very first days of the 'wire-less' receiver, Dubilier have been the cat's whiskers in capacitor development. The early Dubilier capacitors had bulk as well as capacity. Today, you could cram fifty 0.01 $\mu$ F Greycons into the space of a matchbox—and engineers quite often do! But if you would like fifty years of experience packed into one capacitor, we repeat—see Dubilier!

**DUBILIER**

Leaders in capacitor development for more than fifty years

# MULTITONE

## POCKET PAGING

### pays its way!



*The Multitone Type 9 miniature transmitter.*

Small, large, or very large, whatever the size of your organisation a Multitone 'Personal Call' Pocket Paging system will pay its way. Multitone Pocket Paging enables you to contact key personnel *in seconds* selectively and without disturbing anyone else. On telephone working alone, this elimination of irritating delays in finding people increases the inestimable value of customer goodwill through instant location of personnel and immediate acceptance of calls. On outgoing calls, the number of "call backs" is substantially reduced with a consequent saving on telephone bills, often sufficient to offset the cost of the system—a few shillings per week, per man on call.

Systems calling from 15 to 400 individuals are available to cover virtually any area. Each brings you greater all round efficiency and saves you countless wasted man hours.

Multitone Pocket Paging pays its way. Post this coupon now for further information.



# MULTITONE

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**The world's largest manufacturer of Pocket Paging Systems**

**MULTITONE ELECTRIC COMPANY LIMITED**  
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Telephone: Clerkenwell 8022

Please send me full details of the Multitone 'Personal Call' Pocket Paging Systems

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## Measures From 50 $\mu$ V to 500V on 12 Ranges and can be used as an Amplifier

# TRANSISTOR

## A.C. VOLTMETER TYPE TM2B

### SPECIFICATION

#### VOLTMETER RANGES

1.5mV, 5mV, 15mV . . . 500V f.s.d.

#### ACCURACY

$\pm 2\%$  of reading  $\pm 1\%$  of f.s.d. at 1kc/s.

#### dB RANGES

-80dB to +56dB relative to 1mW into 600 $\Omega$ .

#### FREQUENCY RESPONSE

$\pm 3$ dB from 6c/s to 250kc/s.  
 $\pm 0.7$ dB from 10c/s to 100c/s.  
 $\pm 0.2$ dB from 20c/s to 50kc/s.  
 $\pm 0.1$ dB from 30c/s to 30kc/s.

#### INPUT IMPEDANCE

1.8M $\Omega$  and 20pF on 1.5V to 500V.  $> 0.8$ m $\Omega$  and  $< 60$ pF on 5mV to 500mV.  
 $> 0.5$ M $\Omega$  and  $< 65$ pF on 1.5mV.

#### INPUT NOISE LEVEL

$< 15\mu$ V for zero source resistance.  
 $< 30\mu$ V for 100k $\Omega$  source resistance.

#### AMPLIFIER RANGES

10dB steps up to 60dB with frequency response and input impedance as above; 80dB gain from 10c/s to 30kc/s with input impedance  $> 50$ k $\Omega$ .  
Output 1.5V to 10k $\Omega$ .

#### MICROVOLT INDICATOR RANGE

$< 150\mu$ V f.s.d.  $< 10\mu$ V readable from 30c/s to 30kc/s.

#### MAXIMUM INPUT VOLTAGES

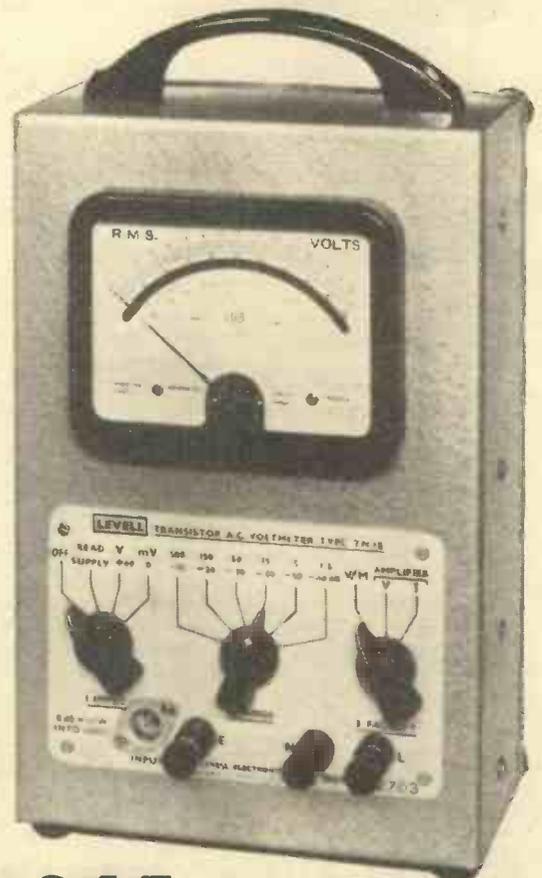
75V A.C. and 350V D.C. on "mV."  
750V A.C. peak plus D.C. on "V."

#### SUPPLY

Self-contained PP9 batteries; typical life 1,000 hours.

#### SIZE AND WEIGHT

10in. high  $\times$  6in. wide  $\times$  4in. deep; 6 pounds.



# LEVELLE

## PORTABLE INSTRUMENTS

Price complete with batteries and low capacity lead . . . . .

# £45

Mains Power Supply Unit . . . £9.0.0 extra

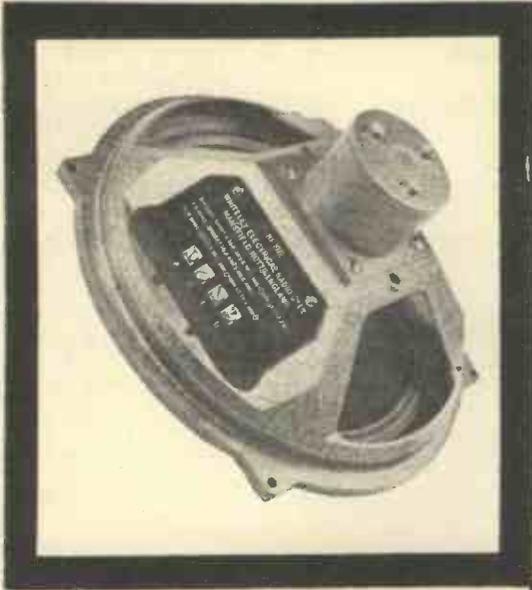
Leather Carrying Case . . . . . £3.10.0 extra

Fully detailed leaflets available on our full range of portable instruments.

## LEVELLE ELECTRONICS LTD

PARK ROAD, HIGH BARNET, HERTS

Telephone: BARNET 5028



# Stentorian

## MODEL H.F. 1012 SPEAKER

10in. die-cast unit, incorporating 12,000 gauss magnet. Fitted with cambric cone and universal impedance speech coil providing instantaneous matching at 3, 7.5 and 15 ohms. Handling capacity 10 watts. Frequency response 30 c.p.s. to 14,000 c.p.s. Bass resonance 35 c.p.s.

Price £4/7/6

## THORESBY SLIM-LINE CABINETS

This enclosure has been designed to accommodate any of the Stentorian range of 8in. or 10in. units. Provision is made for the addition of either pressure or cone type tweeter and a crossover may be used.

The cabinet is substantially constructed and acoustically proportioned to give a balanced reproduction with the chosen units. Available in mahogany or walnut. Height 31in. x width 20in. x depth 9 $\frac{1}{4}$ in.

Price: Mahogany £8/15/-. Walnut £9.

### BASS REFLEX CONSOLE CABINETS

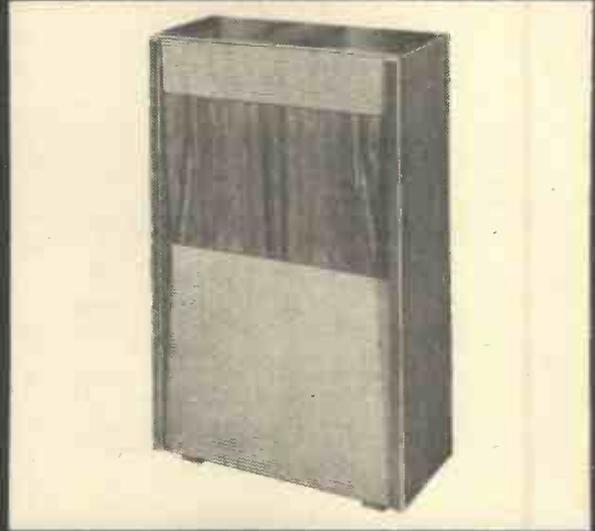
Height 31in. x width 19 $\frac{3}{4}$ in. x depth 18in.

Price: Mahogany £12/12/-. Walnut £12/19/6.

### HI-FI EQUIPMENT CONSOLES

Height 31in. x width 19 $\frac{3}{4}$ in. x depth 18in.

Price: Mahogany £14/14/-. Walnut £15/4/-.



## T.359 CONE TWEETER

Provides a very high standard of reproduction when used in conjunction with "Stentorian" 10in. or 12in. units. Incorporates High Sensitivity 9,000 gauss magnet, special cone and lightweight coil.

Frequency response: 3,000-15,000 c.p.s. Overall size: 3in. dia. x 2in. deep. Voice coil impedance: 15 ohms or 5 ohms. Power handling capacity: 15 watts when used with a 3,000 c.p.s. crossover.

Price £1/10/6.

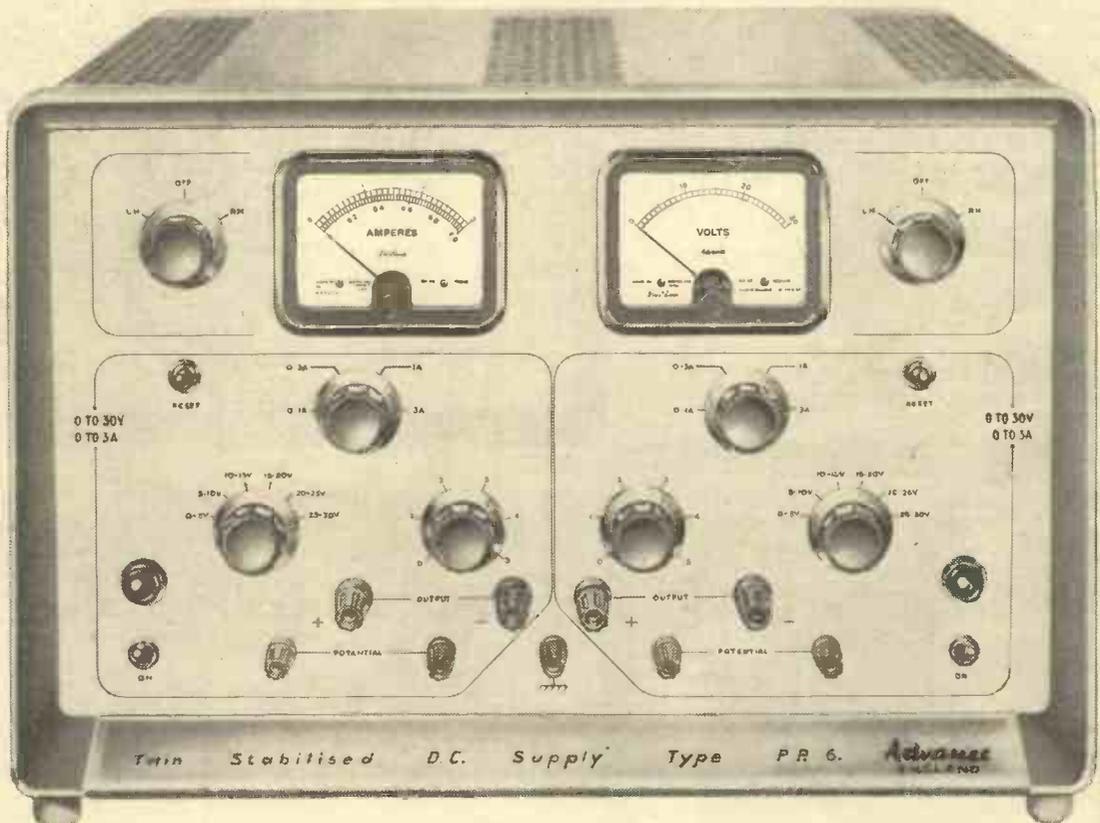


*Supplies of leaflets on all  
Whiteley products available  
on request.*

This high quality instrument from the Advance range of power supplies, provides current up to 3A at any voltage up to 30V from each output. The mains input transformer of each section is a Volstat constant voltage transformer which together with the control circuit gives an overall stabilisation figure of greater than 3000:1. Electronic circuits are used to provide protection against overload. If required, the two sections can be connected in series to give a maximum output of 60V at 3A.

## The twin-output D.C. supply PP6

- \* TWO COMPLETELY INDEPENDENT UNITS
  - \* OUTPUT VOLTAGES VARIABLE FROM 0 TO 30V D.C. WITH RIPPLE OF LESS THAN 1mV PEAK TO PEAK
  - \* CURRENTS OF 0 TO 3A AT ANY OUTPUT VOLTAGE
  - \* OUTPUT RESISTANCES LESS THAN 0.02 OHMS
  - \* OUTPUT IMPEDANCES, UP TO 100 kc, s. LESS THAN 0.2 OHM
  - \* STABILISATION GIVES LESS THAN 3mV CHANGE IN AN OUTPUT OF 30V FOR A MAINS VOLTAGE CHANGE FROM 204V TO 276V r.m.s.
- NETT PRICE IN U.K. £175**



**ADVANCE COMPONENTS LIMITED**  
VOLSTAT DIVISION  
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A HBC90 GU12 AR300 150B3 IW3/4 6057  
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 12AX4GTB B65 TH5221 QS75-20 OB3 PY88  
 CC84 5977 5691 EF184 6BW4 2E29 GZ32  
 7699 6U8A 6688 6AK5W FZ35 829B 6005  
 D120A/S 6922 816 1A7GT BK4 DM70 567  
 8224 QY4-250 2D21 1A7GT EF37A 3816  
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 2BN6 15DQ8 12AT7A 6T6 SU101 10L14  
 O 5726 6AV5 E9000 6060 L6G 6N7GT 6B  
 CM5 872A 7699 C18 100 M8100 7N7  
 O65 QS150-40 OA3 ESU572 6CM7 100TH 6  
 6227 AH238 7F7 9AQ8 121W 173 E80F G  
 150 AH221 6146 6J6W 5827 6A7EA OM5B  
 O3 UABC80 5993 TXM100 OC3 6AH6 N14 9  
 O OG3 6R7G 6AR8 12AY7 5879 5V4WGT EC  
 AN4 4X150A 5687WA 6BW7 6CU7 RL21 6AU  
 50 6AN6 5686 108C1 6BA6W E92CC 5814  
 832A SU61 12AX7W 38172 5750 95A1 66K  
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 O74 811A 27J12 ASG5121 U251 5031 HY9  
 D90M 6189 6AV6 4B32 X81M Y63 6BL4 M8  
 6201 141TH 62VP 6201 50BM8 M8196 G25

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# INDUSTRIAL VALVES



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Take this difficult problem that was recently submitted to us: a large face-plate was needed for a new tube with:

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The optical glasses supplied by SOVIREL to the electron tube industry are strictly controlled to the highest specifications. Their homogeneity is perfect. With the optical quality are combined the electrical, sealing and chemical properties of SOVIREL's basic glasses for electronic applications.

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S 801.51	S 747.01	FeNiCo alloys (Nilo K, Kovar) Molybdenum
S 805.91	S 191.11	Copperclad, SYLVANIA N° 4

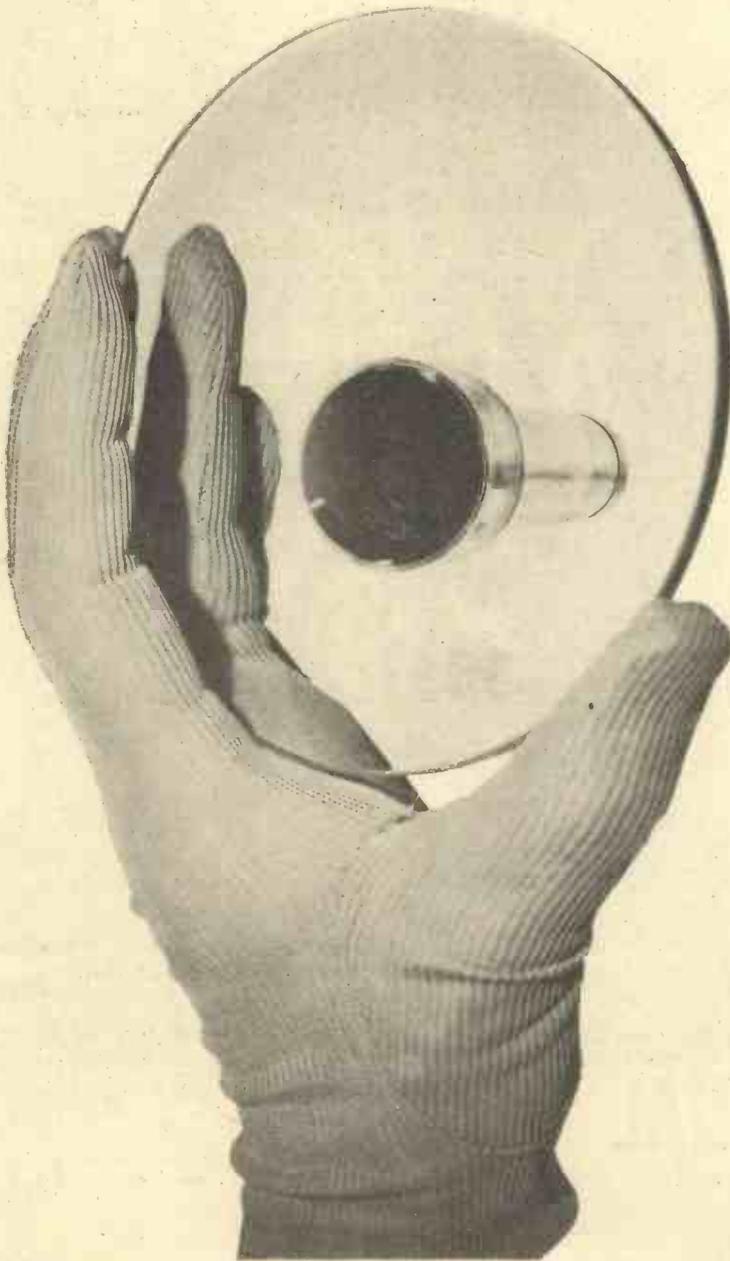
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AGENT IN GREAT BRITAIN : Mr. CHEVALLIER, NAPIER HOUSE, 24, HIGH HOLBORN, LONDON W C 1

# Airmec

## Electronic Laboratory Instruments

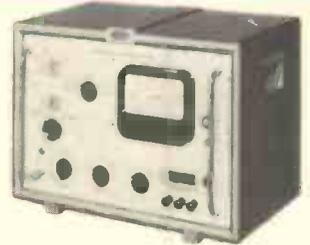
Illustrated on these two pages is a selection from the comprehensive range of peak quality electronic instruments which Airmec have for years been designing and manufacturing for use in laboratories and workshops.



### High Speed Counter 298

Frequency Range: 0-50Mc/s direct  
 Time Range: 1 $\mu$ sec-10<sup>3</sup>sec  
 Single or two line operation  
 Transistorised—compact 12 figure display  
 Oscillator Stability 1 part in 10<sup>7</sup>

*Airmec instruments combine the highest standards of accuracy and reliability with robust design and construction.*



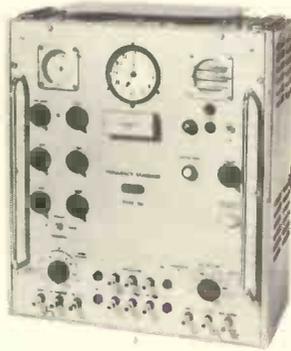
### Modulation Meter 210

Frequency Range: 2.25 to 600Mc/s  
 Input Level: 5mV to 10V  
 A.M. Range: 0 to 100%,  
 F.M. Range: 0 to  $\pm 100$ kc/s in 4 ranges  
 Accuracy: A.M.  $\pm 3''$ ; F.M.  $\pm 5''$



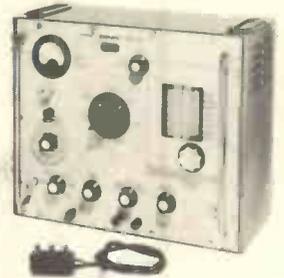
### Millivoltmeter 301

D.C.: 100 $\mu$ V-10V in ten ranges  
 A.C.: 300 $\mu$ V-3V in eight ranges  
 Frequency Range: 100c/s-900Mc/s  
 Input Impedance: d.c. 5M $\Omega$   
 a.c. 100k $\Omega$  and 3pF at  
 100kc/s and 52 $\Omega$  and 75 $\Omega$



### Frequency Standard 761

Stability: 1 part in 10<sup>6</sup> over 2 hours  
 Crystal: 100kc/s in oven  
 Outputs: 100c/s, 1kc/s, 10kc/s  
 100kc/s, 1Mc/s  
 Pulse and sinusoidal  
 all simultaneously



### H.F. Signal Generator 201

Frequency Range: 30kc/s to 30Mc/s in 7 bands  
 Accuracy:  $\pm 0.05\%$  using internal crystal calibrator  
 Stabilised  
 Output Level: 1 $\mu$ V to 1.1V in 75 $\Omega$   
 Attenuators: 0-100dB (20dB steps)  
 0-20dB (2dB steps)  
 0-2dB variable

Send for details of

# Airmec

## Electronic Laboratory Instruments

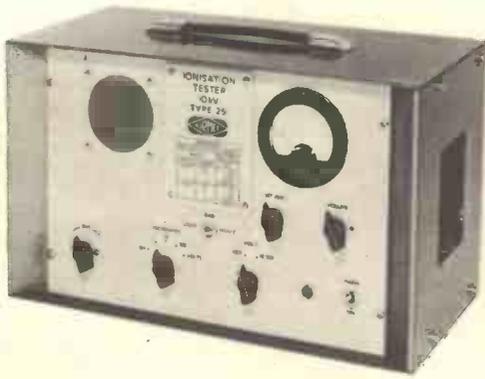
For details of the instruments shown and others in the Airmec range, complete (over), detach and return the attached pre-paid card.

Postage will be paid by Licensee

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

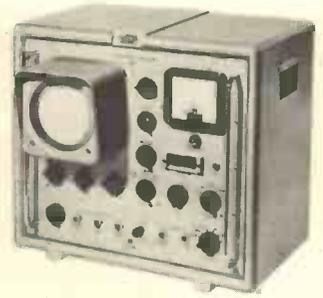
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**Ionisation Tester 251**

*Test Voltage :* 100-1000V and  
1000-10000V d.c.  
*Source Impedance :* 10M $\Omega$   
*Indication :* Aural and Visual  
*Measurement :* Applied Test Voltage  
*Facilities :* Ionisation Current  
D.C. Leakage Current  
Insulation resistance



**V.L.F. Phase Meter 281**

*Frequency Range :* 0.01c/s-1kc/s  
*Phase Measurement :* Direct reading of  
phase obtained in  
one cycle on  
CR Tube  
*Amplitude Measurement :* D.C. shift  
technique using  
built in meter



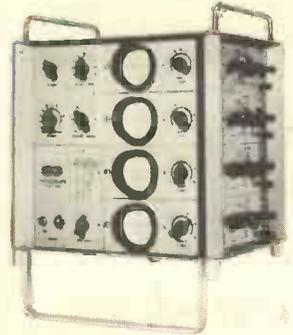
**Automatic Continuity Tester 859**

*Tolerance :* 5, 10 and 20%  
*Circuits :* Up to 100 parts of a circuit  
may be tested with respect to  
four points  
*Alarm :* Tester stops and indicates  
line on which fault exists  
*Speed :* 1-6 tests per second



**V.H.F. Wave Analyser 248**

*Frequency Range :* 5-300Mc/s in 6 bands  
*Signal Input Range :* 5 $\mu$ V-1.5V  
*Bandwidth :* 20kc/s, 70 kc/s and  
500kc/s  
*Accuracy :* IF Attenuator Coarse  
 $\pm 0.1$ dB  
IF Attenuator Fine  
 $\pm 0.1$ dB



**4-Channel Oscilloscope 249**

*Y Amp Bandwidth :* D.C. to 3Mc/s  
*Y Amp Sensitivity :* 33mV pk to pk per cm  
*Input Impedance :* 1M $\Omega$  in parallel  
with 14pF  
*Time Base Range :* 0.3 $\mu$ sec to  
100msec per cm

Please tick as appropriate

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Airmec Catalogue with price list.

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Short Form Catalogue.

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Please send me details of your  
type No. . . . .

Please ask your technical representative  
to telephone for an appointment to  
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Company \_\_\_\_\_  
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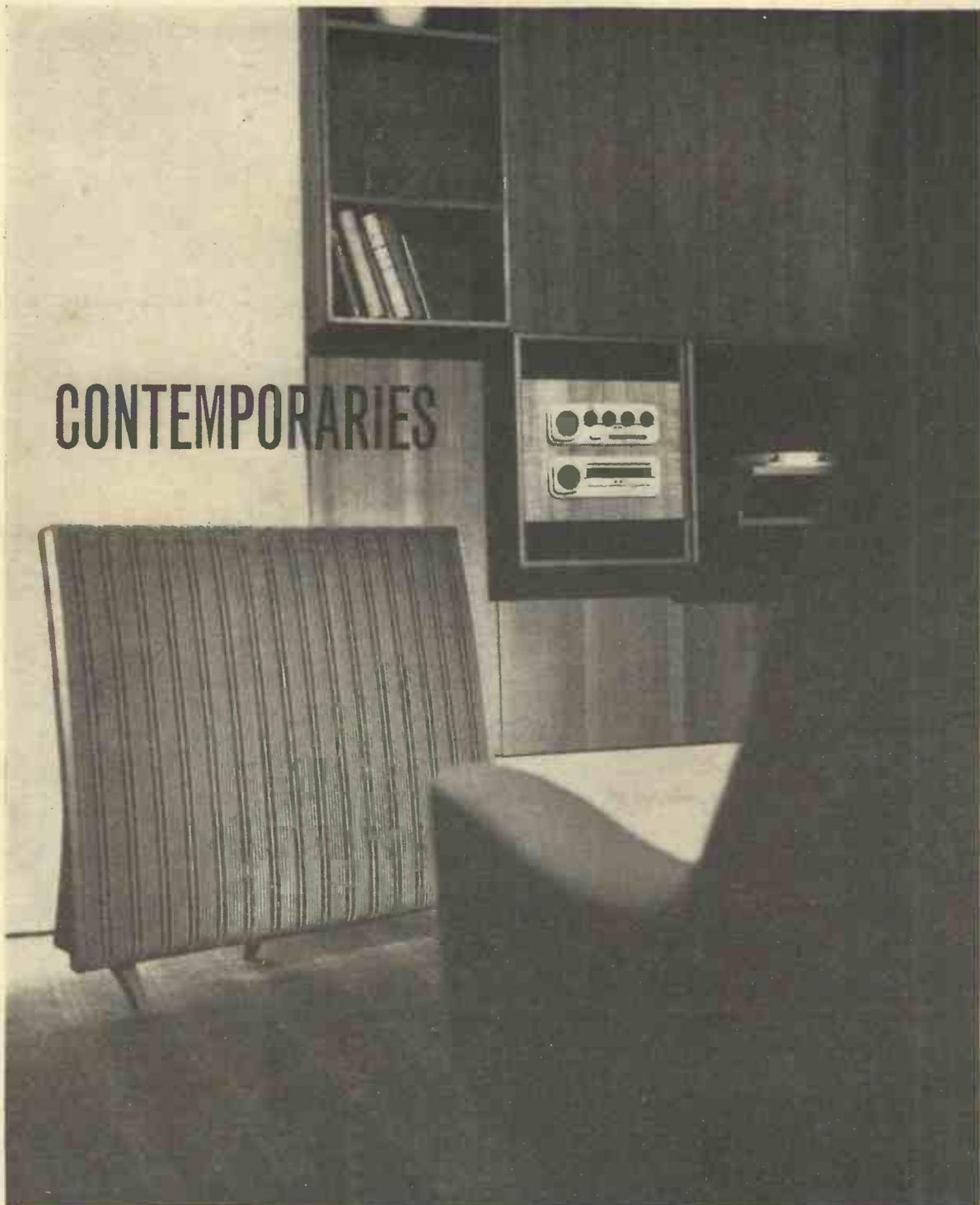
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# CONTEMPORARIES



**QUAD**

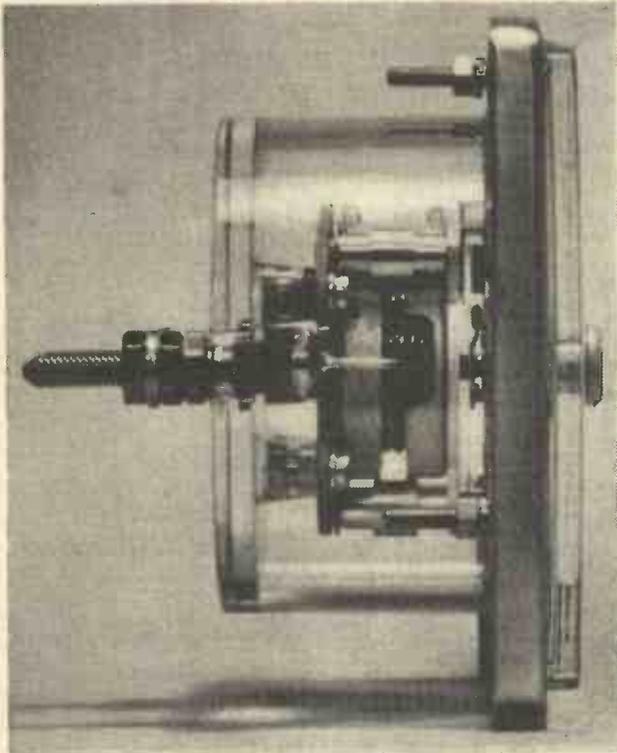
The design of QUAD is such that it will harmonize with both contemporary or traditional styles . . . its ease of installation is an important practical asset. See it, for example, in the new modular fittings by Heals of London.

for the closest approach to the original sound

*Illustrated brochure on request from Ref. w.w.*

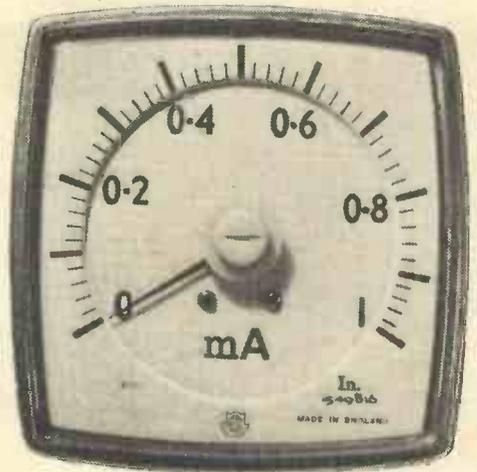
**ACOUSTICAL MANUFACTURING COMPANY LIMITED**  
Huntingdon, Hunts. Tel: Huntingdon 361.

## PRECISION

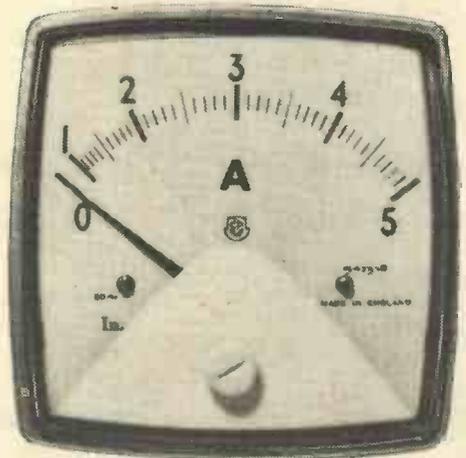


Fiesta instruments are not only accurate and reliable enough for readout as well as monitoring functions but, with their clean lines and contemporary design, they do a great deal for the appearance of modern electronic equipment. Here are some of their important features:

- Accuracy to BS.89 and to American Standard C39.1—1959
- Two scale lengths: 5 in. circular, with no-parallax platform scale, or 3 in. short scale
- Flush Mounting
- Contoured static-free windows
- Bezels in anodised silver or black
- Window-rims in red, yellow, blue or white
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## PLUS PRESENTATION



As attractive in price as in appearance.

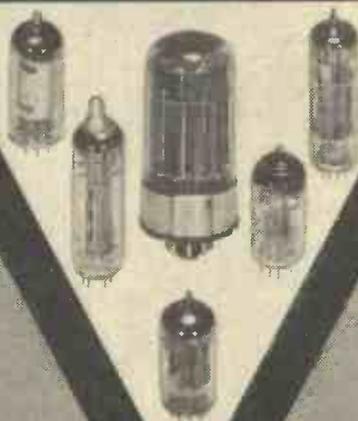
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INSTRUMENTS  
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## Crompton Parkinson

# RADIO VALVES



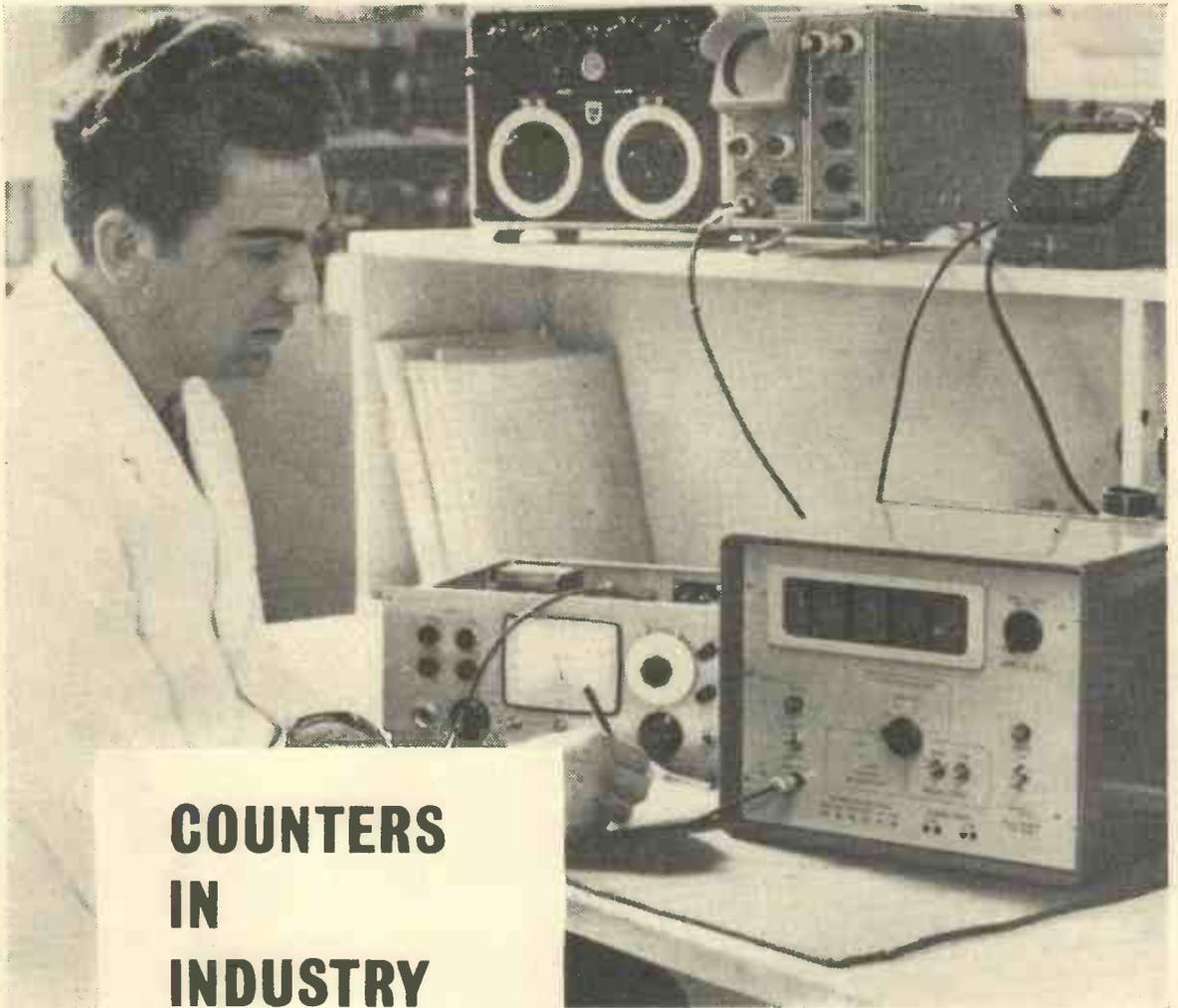
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## COUNTERS IN INDUSTRY

Fresh possibilities for the industrial use of electronic counters are constantly appearing and in the July issue of **INDUSTRIAL ELECTRONICS**, now on sale, some of their less well-known applications are described—in one of many articles showing how electronics can cut costs and increase productivity in all kinds of industrial processes. **INDUSTRIAL ELECTRONICS** is vital to all who must use electronics to meet ever-increasing competition. Other articles in the current issue are summarised at right; August issue will include *Cleaning by Ultrasonics*.

#### ALSO IN JULY ISSUE:

- **NEW AIDS FOR INDUSTRIAL TRAINING**  
Interest in new ways of training has led to a range of new training aids from special books to adaptive machines. **INDUSTRIAL ELECTRONICS** describes some of these and outlines special characteristics and advantages.
- **WEIGHING TABLE-TENNIS BALLS ELECTRONICALLY**  
A simple automatic machine which weighs table-tennis balls and sorts them into three categories.
- **APPLICATIONS OF STORAGE TUBES IN INSTRUMENTATION**  
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**In situ Capacitance measurement**  
0.002pF to 100µF

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**Phase sensitive detectors**

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**Direct reading, long scale length dials**

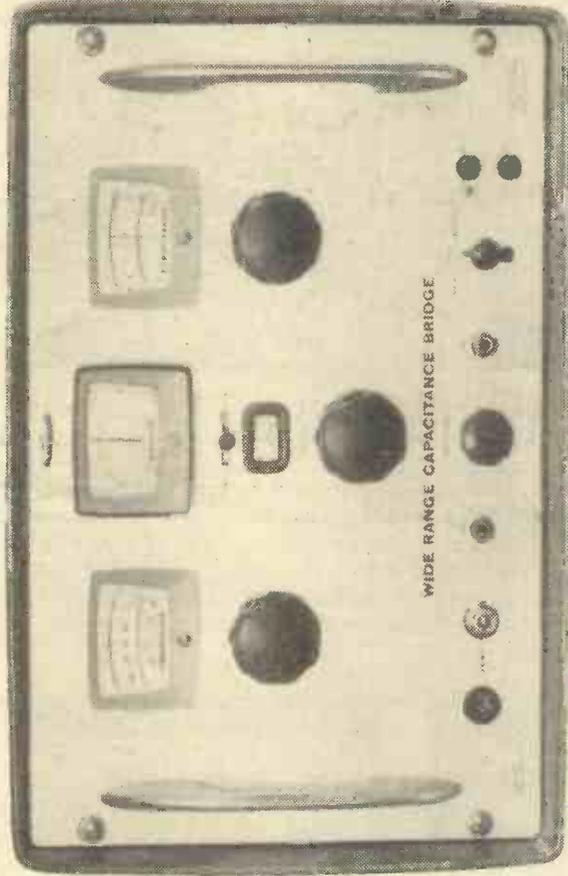
**All transistor circuitry**

*Full technical brochures are available on application*

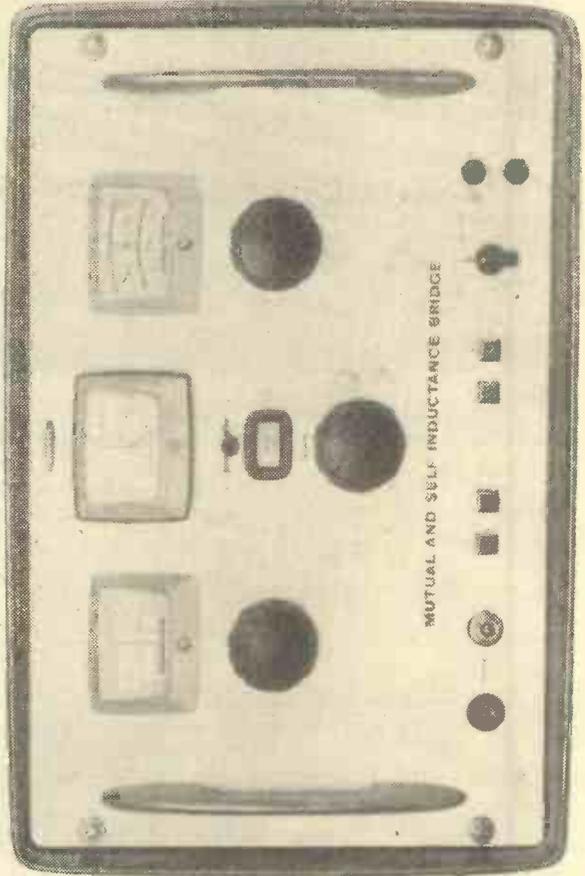
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Rank Cintel Division  
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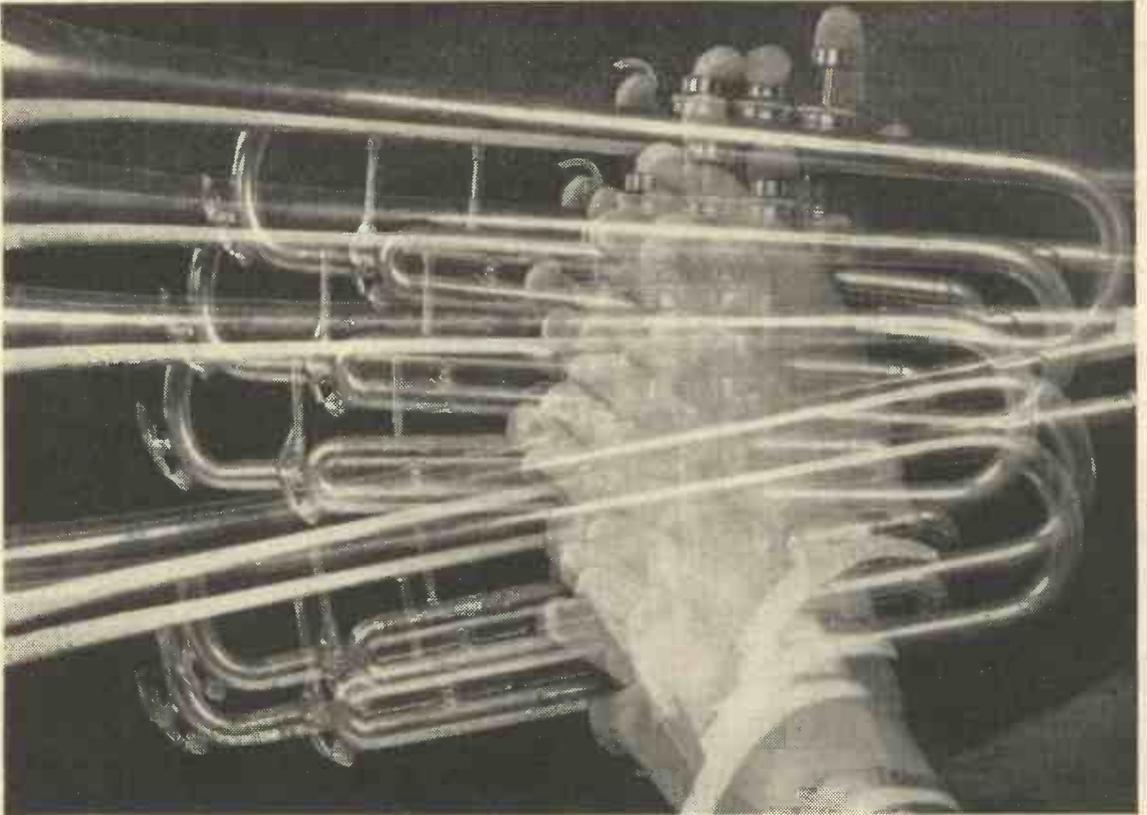
**RankCintel**  
instruments



**wide range  
capacitance  
bridge**



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## Garrard—sounds of '63

**Builders of fine sound reproduction equipment for over forty years,** Garrard supply transcription motors and record players to major broadcasting companies all over the world. Even the lowest priced models in the Garrard range are so stringently quality controlled before they leave the factory that they can be compared in performance and appearance to the best in other manufacturers' ranges. The best in the Garrard range are incomparable—take these three, for example:



### 301. Three-Speed Transcription Motor

The model 301 is used by major broadcasting companies all over the world including the BBC and Radio Luxembourg. It has an extremely low wow and flutter figure and each of the three nominal speeds is adjustable by means of a specially designed eddy current brake. Individual test report, supplied with each unit.



### A.T.6 Auto Turntable

A high performance unit which is ideal for manual playing yet embodies automatic selection of all types of records when required. The Model A.T.6 has a heavy turntable with a dynamically balanced tubular aluminium pick-up arm which has the unique Garrard Stylus Pressure Adjustment fitted as standard and is professional in every aspect.

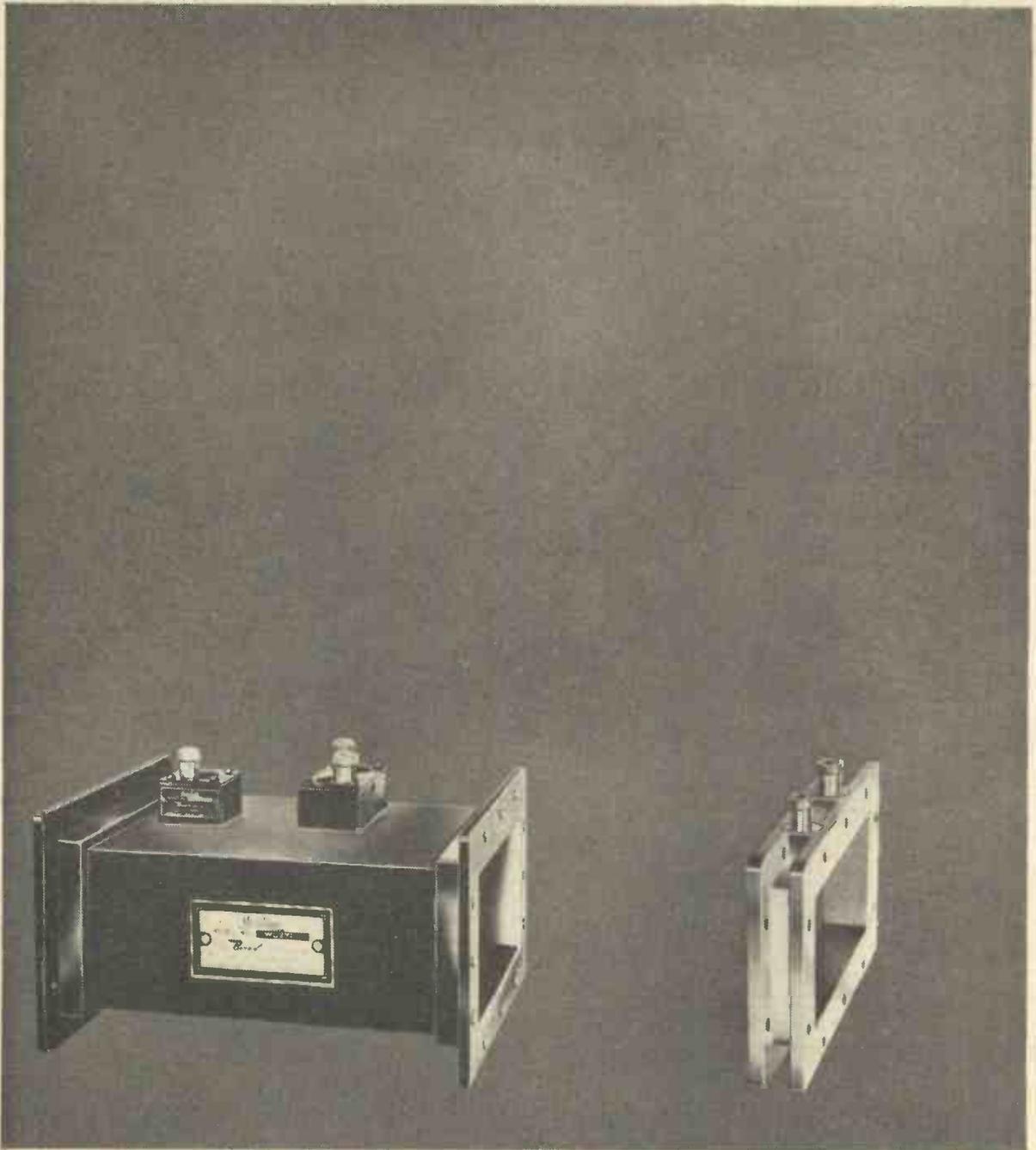


### Type 'A' Laboratory Series Auto Turntable

The Type 'A' incorporates a scientifically designed precision mass counter-balanced pick-up arm with inbuilt stylus pressure adjustment and dual channel muting switch and switch click suppressor. A heavy sandwich construction non-magnetic turntable is fitted as standard to provide ideal operating conditions for the most sensitive pick-ups.

Write or 'phone for full details of these and other models in the Garrard range.

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If space requirements are cramping your style, look to MicroGuide® for the answer to your power and VSWR measurement problems. They're available in any waveguide from WR770 (low L band) to WR75 (high X band).

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All this in a package 1/10th the size of previous compact waveguide couplers. Additional sampling probes are available with no increases in length.

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### **AMPLIFIERS KITS**

CMA15. Kit of MA15 Mk. II amplifier ..	£17 15 0
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These are the only kits available at the moment, but other kits will be introduced later.

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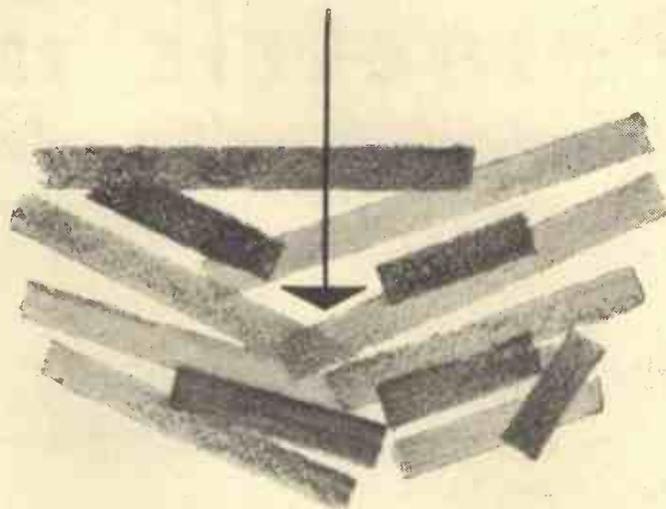
Further information on all the above products is available from your dealer or direct on application.

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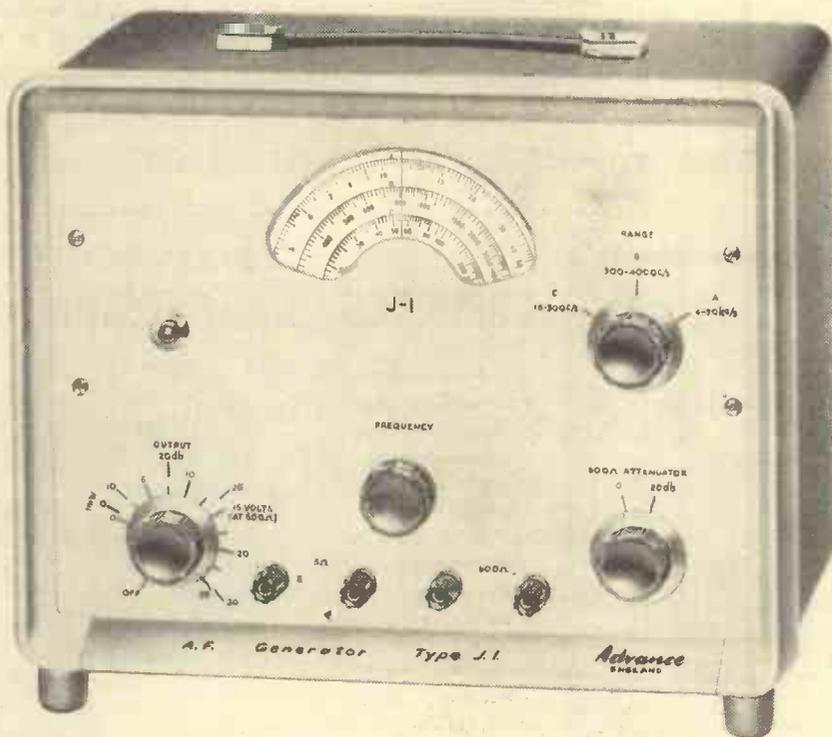
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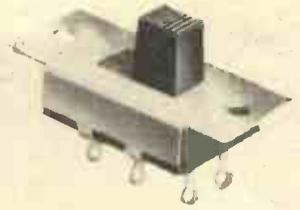
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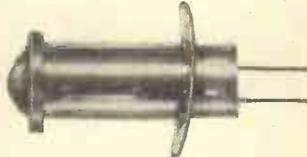


T.906



T.225

S.L.266: Very small low cost  
mains neon indicator



S.L.266

S.L.60: Miniature L.E.S. Lampholder



S.L.60

T.906: New, very small push button  
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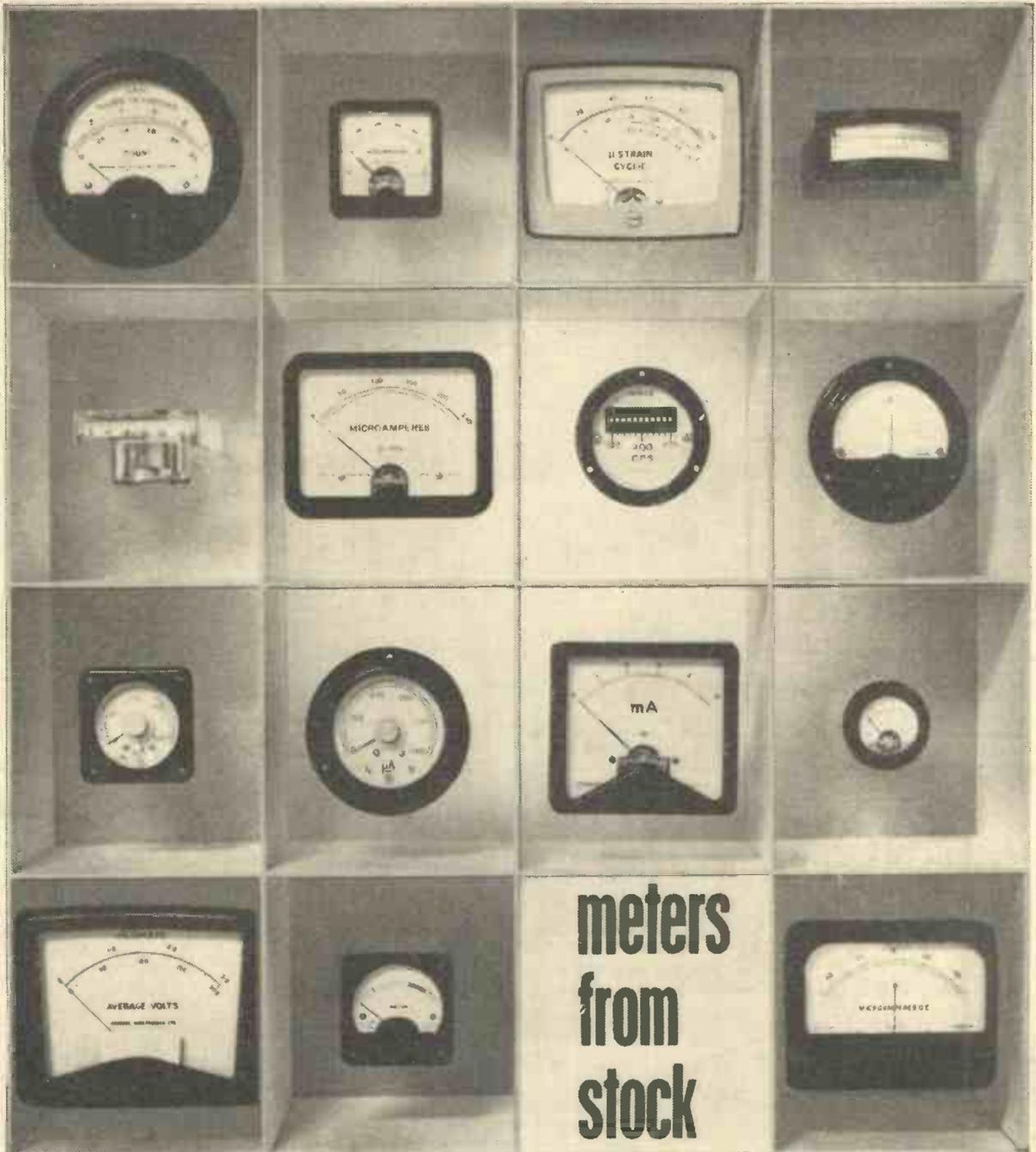
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QUICK DELIVERY



TYPE	PRESSURE (max) lb/in. <sup>2</sup>	VACUUM in. Hg	SPEED ft <sup>3</sup> /min
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606 G	10.7	22	1.77

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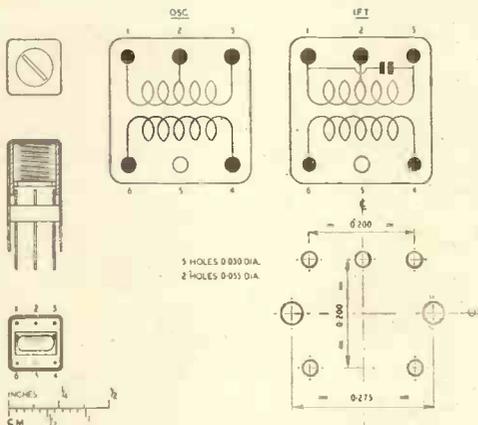
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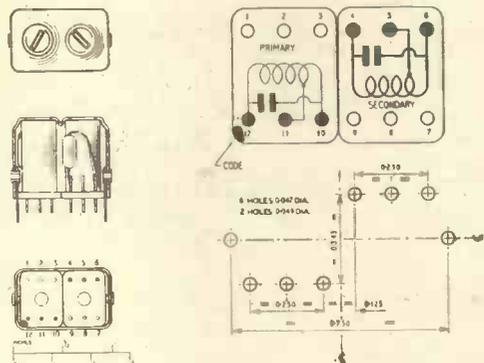
# TWO NEW TYPES OF "WEYRAD" I.F. TRANSFORMERS FOR SET-MAKERS

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### TYPE P10

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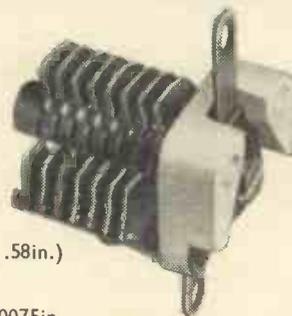
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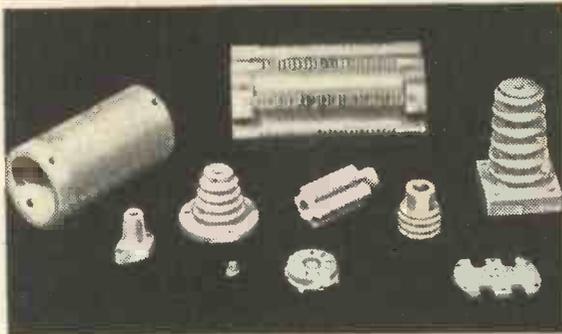
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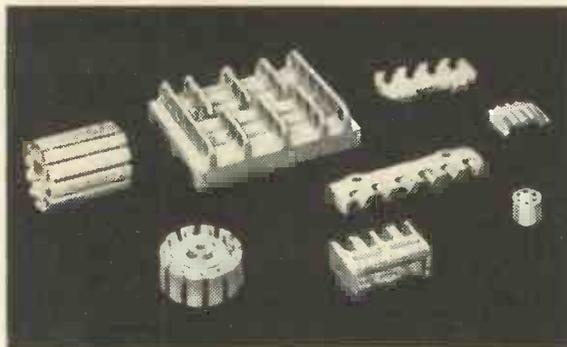
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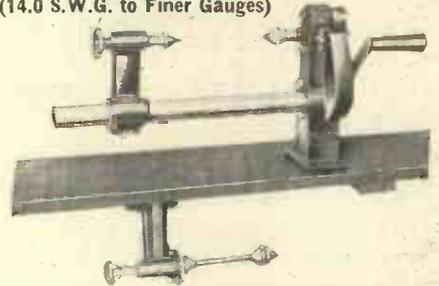
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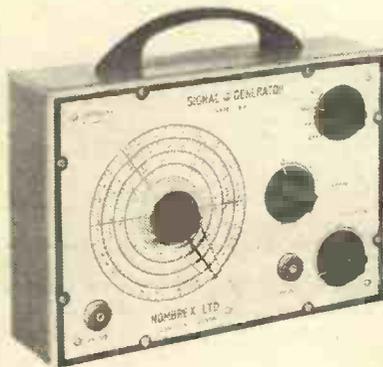
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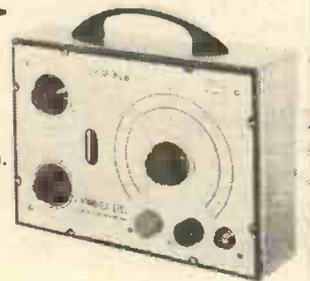
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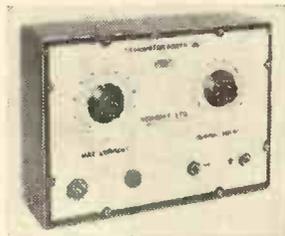
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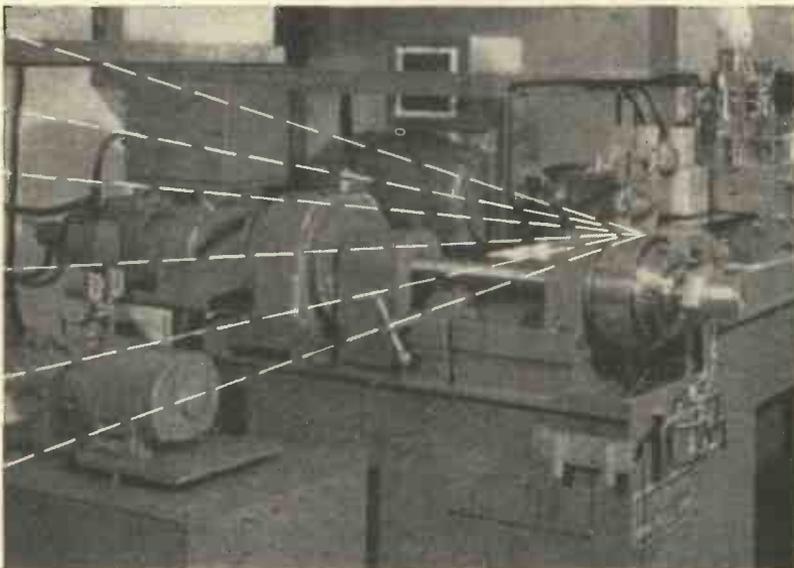
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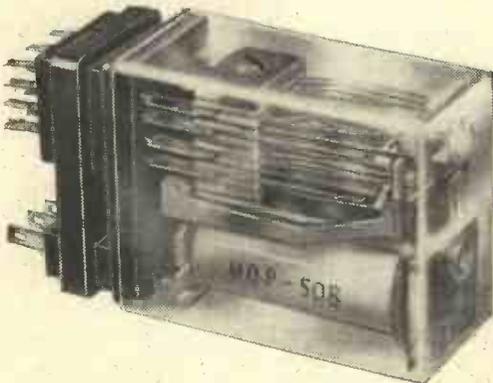
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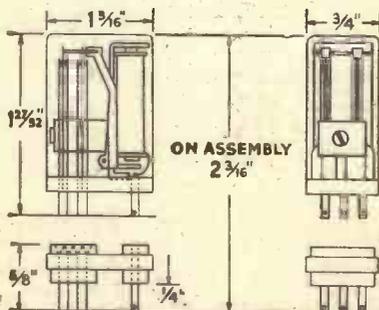
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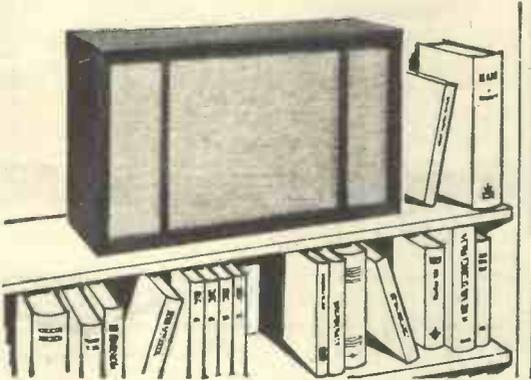
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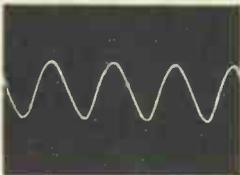
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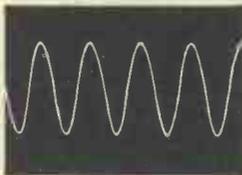
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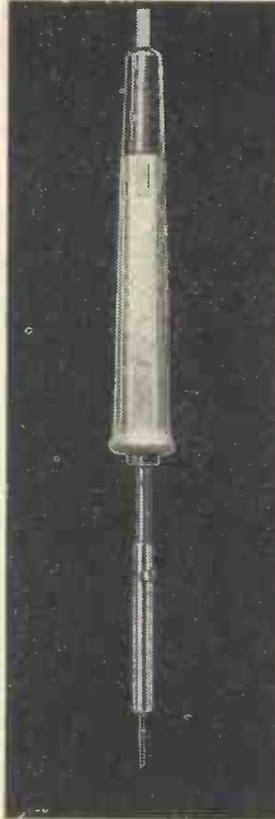
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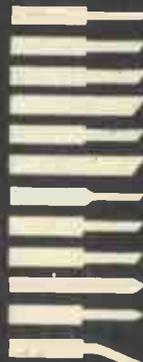
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240	220	110
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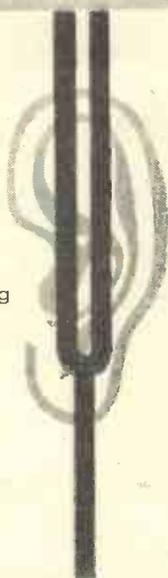
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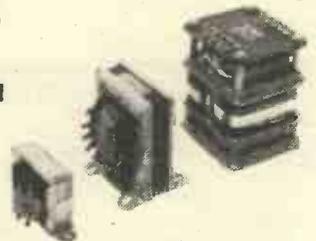
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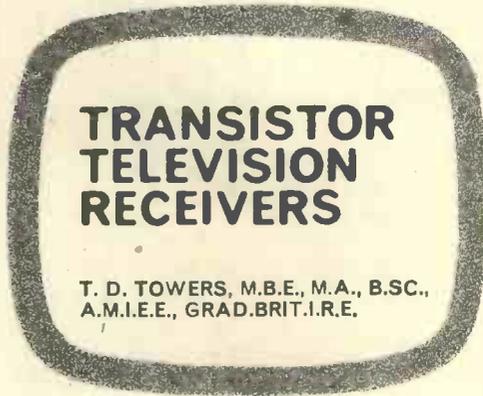
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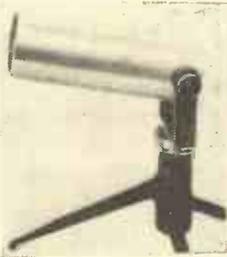
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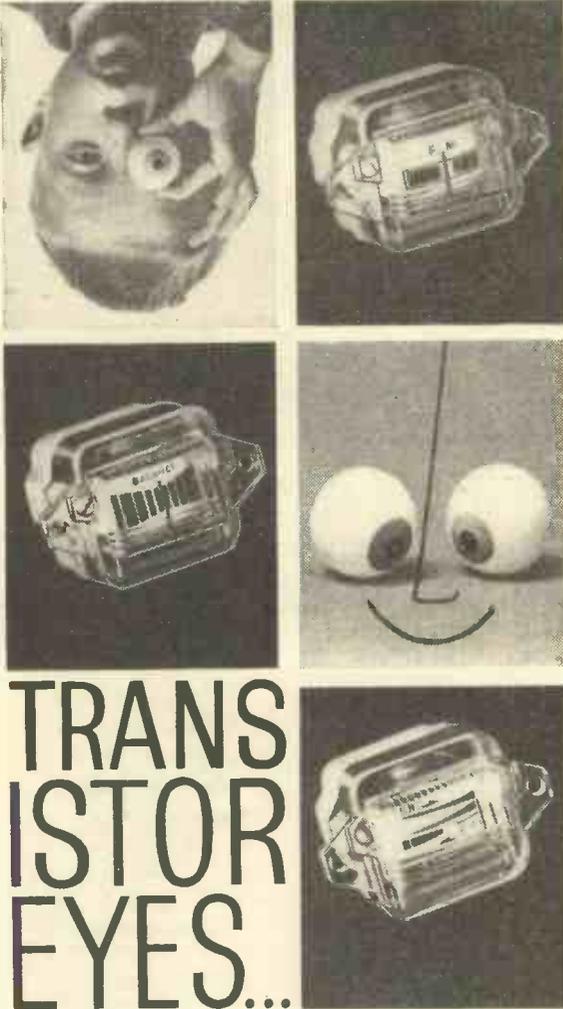


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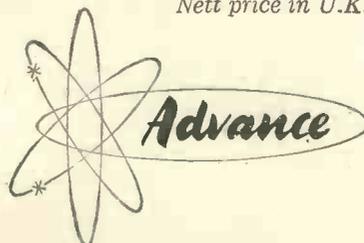
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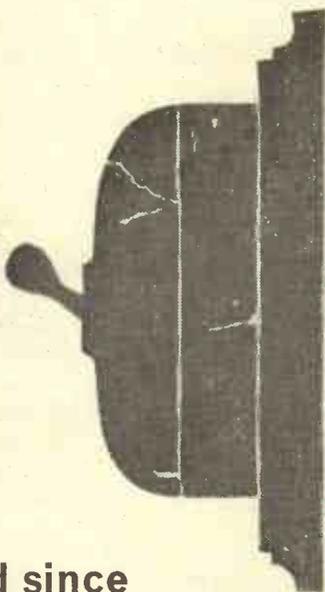
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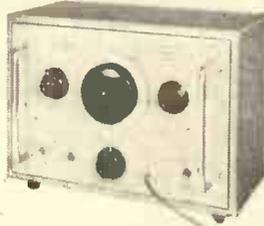
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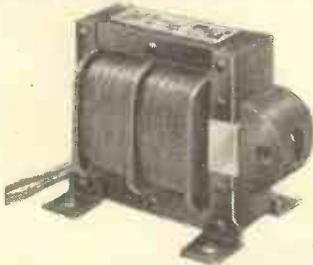


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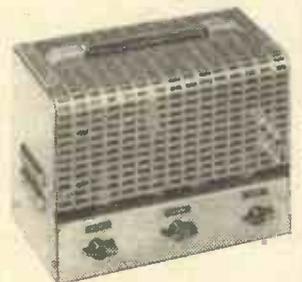
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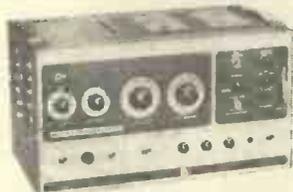
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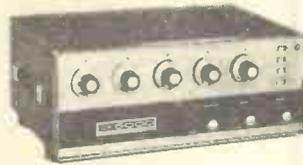
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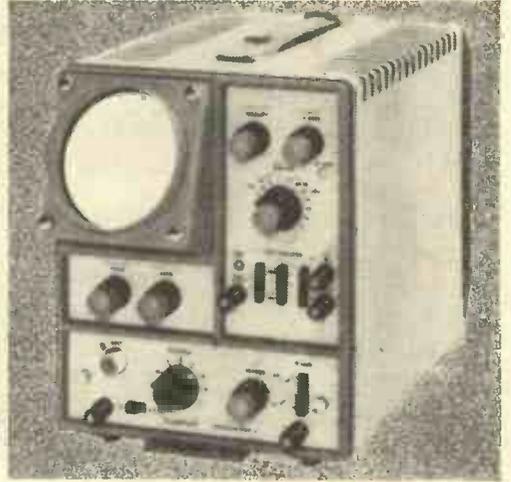


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*with general purpose amplifier*

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has 18 pre-set sweep speeds from 1  $\mu$ sec/cm to  $\frac{1}{2}$  sec/cm (or slower if necessary) and a variable control covering intermediate speeds.

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# Wireless World

ELECTRONICS, RADIO, TELEVISION

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# NEW MULLARD A.F. PACKAGE

## PCL 86 TELEVISION AUDIO OUTPUT VALVE

The Mullard PCL86 a.f. triode-pentode has been designed specifically for the sound stages of television receivers. The sensitivity of the valve is high enough to allow adequate feedback to be applied in conventional circuits, but is not so high that instability will occur. The high overall gain is achieved partly by a high amplification factor in the triode section, and partly by a high value of mutual conductance in the pentode section. A new cathode material is used in the PCL86 to reduce the likelihood of instability. With this material, there is less deposition of particles from the cathode on other members of the electrode structure.

A special electrode structure — the balcony structure — is used in the PCL86. The triode section is much shorter than the pentode section, and heat can therefore radiate freely from the upper part of the pentode section. Greater dissipation can thus be tolerated, and the anode dissipation rating of the PCL86 is consequently particularly high (9W) for triode-pentodes.

## WHAT'S NEW IN THE NEW SETS

These articles describe the latest Mullard developments for entertainment equipment

The cathode-to-heater voltage rating of the PCL86 is high (30V), and positioning of the valve in the heater chain is therefore not critical. Screening between the heater and grid leads of the electrode structure ensures a very low level of hum in the valve. The performance to be achieved with the PCL86 is thus very good, and the valve is ideally suited for the sound stages of television receivers.

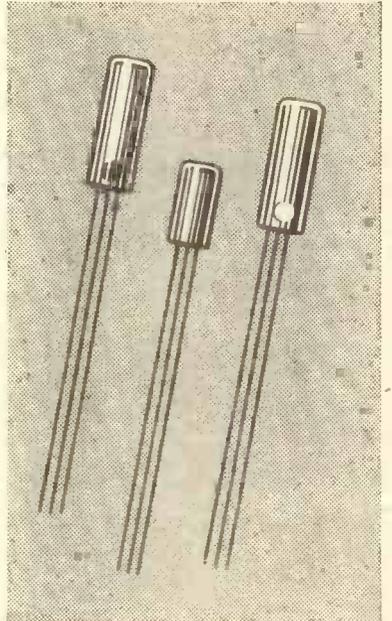
## PACKAGE for transistor portables

**D**ESIGNED for use in transformerless audio amplifiers, the new Mullard audio frequency package — the LFK3 — is now to be encountered in modern portable radio receivers.

The output pair of the package consists of the complementary matched p.n.p. and n.p.n. transistors types OC81 and AC127. The p.n.p. driver transistor type OC81D completes the package.

The current amplification factor of the output transistors is greater than 50 at 200mA and 38 at 300mA. The base currents of every pair are matched to within 20% at a collector current of 50mA, and each output transistor is cross-matched with the driver transistor to give reduced circuit gain spreads.

The peak collector current rating of the output transistors is 300mA, which enables output power of up to 500mW to be obtained using a 9V battery. The sensitivity of the package is such that outputs of up to 100mW can be achieved without a pre-amplifier, and outputs of up to 500mW necessitate only a simple single-transistor preamplifier.



## ECH 84 TRIODE-HEPTODE FOR DUAL-STANDARD TV RECEIVERS

The Mullard triode-heptode, type ECH84, is now appearing in the synchronising stages of dual-standard television receivers in this country. The valve has already been widely adopted by manufacturers producing receivers for 625-line transmission systems using negative vision modulation.

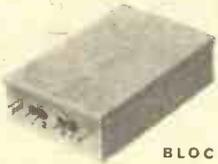
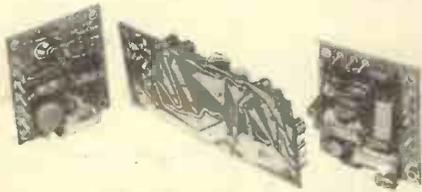
The heptode is generally operated as an interference-cancelling sync pulse separator, and the triode section as a pulse limiter. The heptode function is particularly valuable when interference pulses which are in the same sense as the sync pulses, occur in the video waveform and tend to disrupt synchronisation.

The ECH84 has been designed specifically to supersede the ECH81 in the sync separator

application. The earlier type was initially intended for use in a.m. radio receivers and was only subsequently adopted for synchronising circuits, whereas the ECH84 was designed specifically for the television application. Good operation at low voltages is thus ensured. Another consequence of this specific design is that the linearity of the control grid characteristics of the heptode section is markedly better than that of the earlier valve. In the triode section, too, higher values of mutual conductance and amplification factor have been achieved. These improved properties of the ECH84 are reflected by better receiver performance under fringe reception conditions.



These Advanced Features give the Vanguard **EXTRA PERFORMANCE**  
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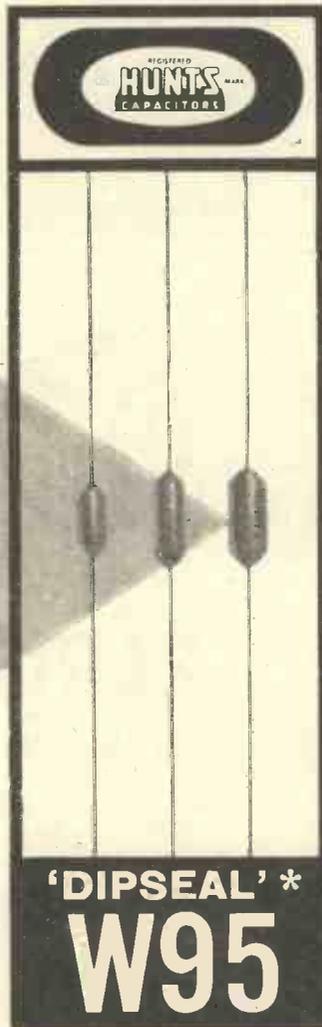
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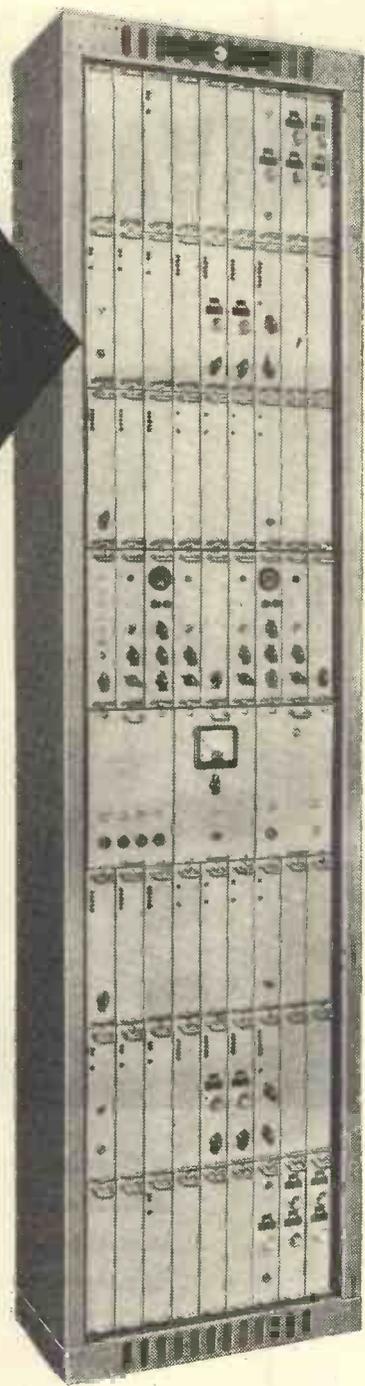
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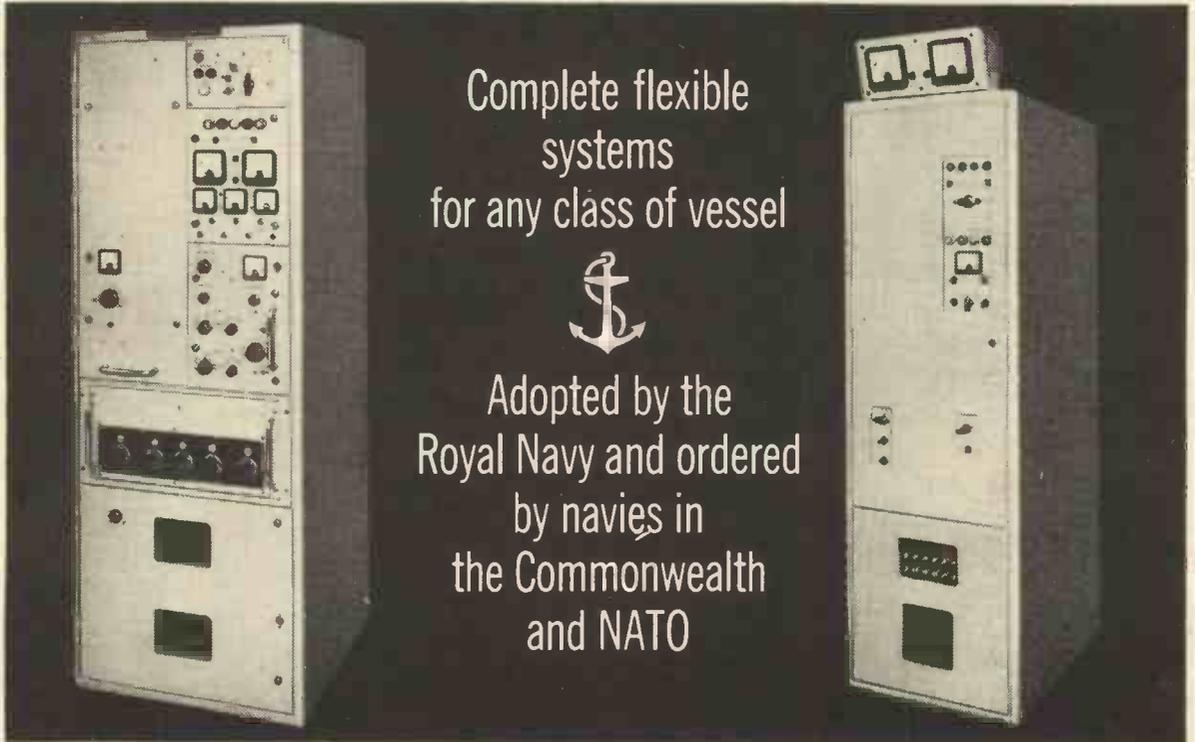
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It is available in our standard steel case with Baxandall tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.

Price with 4 mixed inputs £59.0.0d.

The 12-way electronic mixer has facilities for mixing 12 balanced line microphones. Each of the 12 lines has its own potted mumetal shielded microphone transformer and input valve, each control is hermetically sealed. Muting switches are normally fitted on each channel and the unit is fed from its own mumetal shielded mains transformer and metal rectifier.

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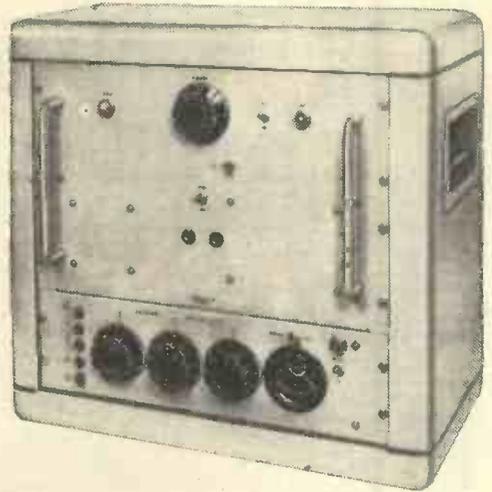
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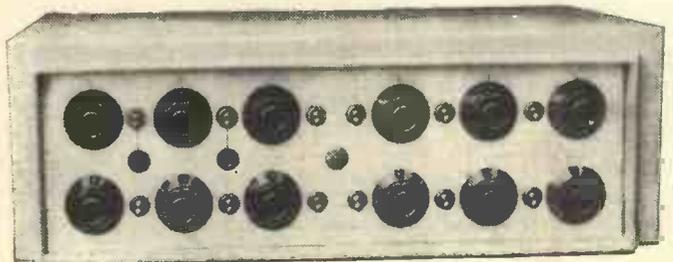
## ELECTRONIC MIXER/AMPLIFIER

This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxandall tone controls. The standard model has 4 inputs, two for balanced 30 ohm microphones, one for pick-up C.C.I.R. compensated and one for tape or radio input. Alternative or additional Inputs are available to special order. A feed direct out from the mixer is standard and output impedance of 4-8-16 ohms or 100 volt line are to choice. All inputs and outputs are at the rear and it has been designed for cool continuous operation either on 19 x 7in. rack panel form or in standard ventilated steel-case.

Size 18 x  $7\frac{1}{2}$  x  $9\frac{1}{2}$ in. deep.

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Price of standard model £98.0.0d.



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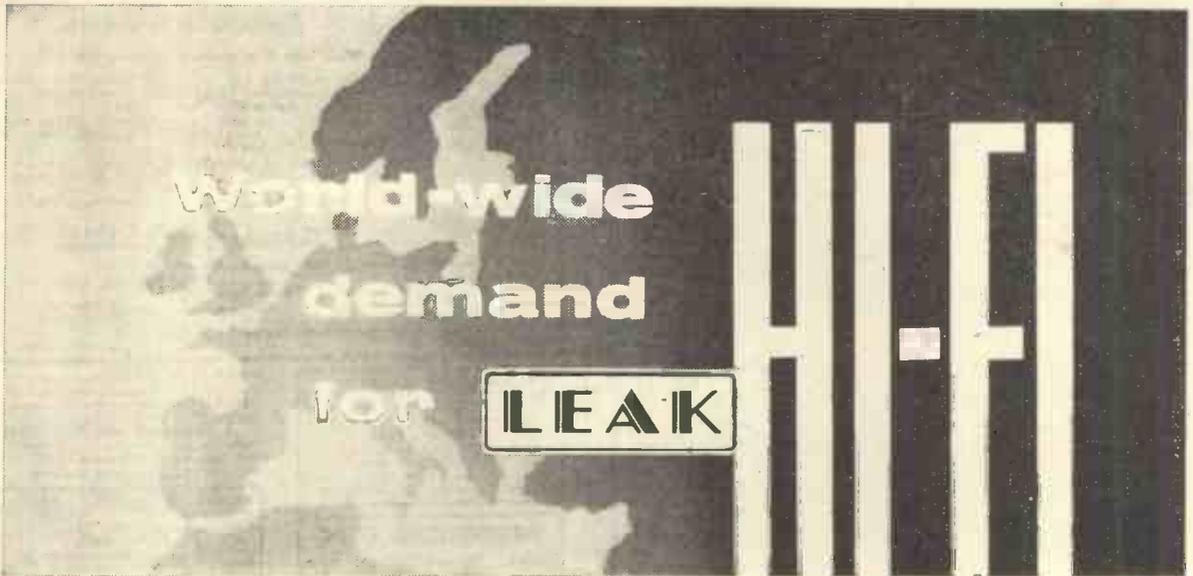
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690L2	8/6	EL43	10/6	EL41	7/6	PY82	8/3	X78	26/2	OC171	10/6
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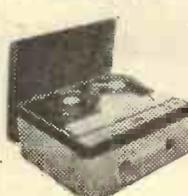
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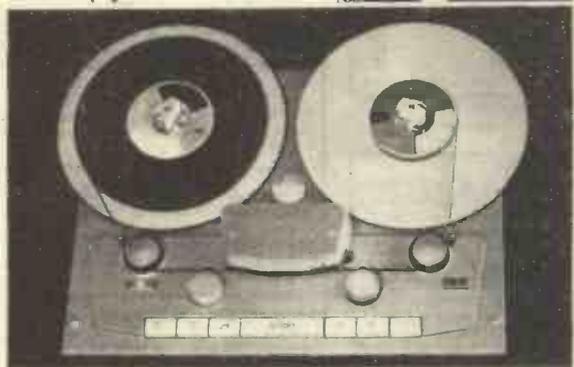
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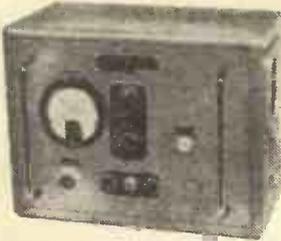
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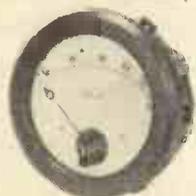
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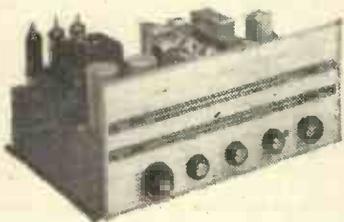


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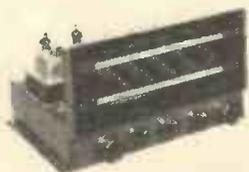
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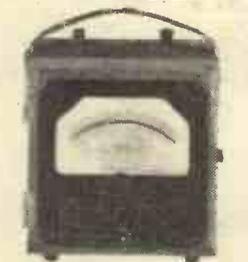
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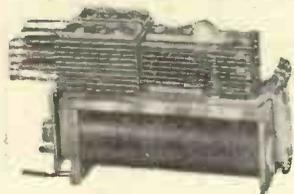
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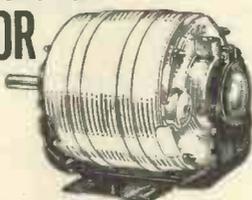
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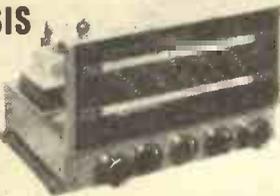
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125	6/-	6K36	5/-	EB241	8/-	PCL84	10/-
155	6/-	6L6G	5/-	EB281	8/-	PL81	10/-
174	3/-	6N7M	5/-	EBF80	9/-	PL83	8/-
2X2	2/-	6Q7G	6/-	ECH42	9/-	PY33	15/-
254	7/-	6SN7	5/-	ECH81	9/-	PY80	7/-
3V4	7/-	6V6	5/-	ECL80	9/-	PY81	8/-
345	7/-	6X4	5/-	ECL82	10/-	PY82	7/-
414	6/-	6X5	6/-	EF35	6/-	QPS2	7/-
5Y3	6/-	12A7	7/-	EF59	8/-	SP41	3/-
624	9/-	12AU7	6/-	EL32	5/-	SP61	3/-
6A07	4/-	12AX7	7/-	EL84	7/-	U22	7/-
6AM6	4/-	12BH7	7/-	EV61	9/-	UBC41	8/-
6AT6	6/-	12K7	5/-	EV86	9/-	UBC81	9/-
6BA6	7/-	12L6	14/-	EZ40	7/-	UBF80	9/-
6BE6	5/-	12Q7	6/-	EZ80	7/-	UCB81	9/-
6BW6	7/-	26Y5G	9/-	EZ81	7/-	UCL82	10/-
6C4	5/-	35L6	9/-	HABC8010	10/-	UCL83	12/-
6D8	5/-	35Z4	5/-	HVR2A	5/-	UF89	9/-
6G6	4/-	954	2/-	KT33C	8/-	UL41	9/-
6H6	3/-	D4F98	8/-	KT76	8/-	UY41	7/-
6J5	5/-	DF96	8/-	MU14	7/-	UY86	7/-
6J6	5/-	DK96	8/-	PC84	8/-	UJ9	7/-
6J7G	6/-	DL93	8/-	PCF80	8/-	VR150/307	7/-
6K6	5/-	EAB030	8/-	PCF82	8/-	W81	6/-

### NEW ELECTROLYTIC FAMOUS MAKES

TUBULAR	TUBULAR	CAN TYPES	
1/250v.	2/- 50/350v.	5/6 8/600v.	9/-
2/250v.	2/3 100/25v.	2/6 16/600v.	12/-
3/250v.	2/3 200/25v.	2/6 16/450v.	5/-
3/450v.	2/3 500/12v.	3/6 32/250v.	4/-
16/450v.	3/- 1,000/12v.	3/- 47/450v.	6/6
32/450v.	3/9 5,000/6v.	5/- 32/- 32/350	5/-
25/250v.	1/9 8+8/450v.	3/6 32/- 32/450	7/-
25/250v.	2/- 8+16/450v.	3/9 50/- 80/350	6/-
50/250v.	2/- 16+16/450v.	3/9 84/- 120/350v.	11/6
50/50v.	2/- 32+32/350	4/8 100+200/275v.	12/6

TINNED COPPER WIRE 16 to 22 s.w.g. 1 lb. 3/-  
COPPER ENAMEL WIRE 16 to 22 s.w.g. 2/8. 24 to 30 s.w.g. 3/6. 32 to 40 s.w.g. 4/6. D.O.C. 28, 34, 36 s.w.g. 3/6 2 oz.

**CRYSTAL MIKE INSERTS.** High Output  
Miniature size, 1 1/4 in. dia. x 1/2 in. 6/6  
ACOS MIC. 14, insert 1 1/4 in. dia. x 1/2 in. 8/6

**ACOS STICK MIKE 39-1.** 35/-  
T.S.L. DE LUXE STICK MIKE 25/-

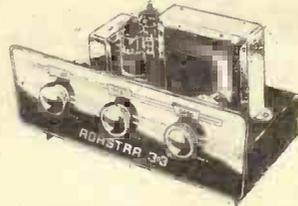
**MORSE KEY 4/6; BUZZER 4/6.**  
**VALVE HOLDERS.** EA50 6d. B12A. CRT. 1/3. Enr. and Amer. 4, 6, 8 and 7 pin 1/-  
**MOULDED Int. Oct. or Mated Oct., 6d.; B7G, B8A, B8G, B9A 9d. B7G with can. 1/6. B9A with can. 1/8. Ceramic EF50, B7G, B9A, Int. Oct. 1/- B7G, B9A cans. 1/- each. Valve base plugs B7G, B9A, 2/3 each.**

### C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having heater Cathode short circuit and for C.R. Tubes with falling emission, full instructions. Mains input, 10/6 ea.  
**TYPE A. LOW LEAKAGE WINDINGS, OPTIONAL 25% and 50% BOOST ON SECONDARY; 2 V. OR V. OR 6.3 V. OR 10.3 V. OR 13.3 V.**  
(State tube voltage required.)

**HEADPHONES.** 4,000 ohms 15/- pair.  
**HEADPHONES.** moving coil 100 ohms 10/- pair.  
**SWITCH** Cleaner Build, squirt spout, 4/6 tin.  
**SPEAKER-FRET.** Gold, Green or Maroon Cloth, 17 x 25 in., 5/-; 25/35 in. 10/- Tygan various colours, 52 in. wide from 10/- ft.; 26 in. wide from 5/- ft. Samples, S.A.E.  
Expanded Metal, Gold, 12 x 12 in., 6/-.

### ADASTRA 3-3 AMPLIFIER 3 Watts



**ADASTRA 3-3 HI-FI AMPLIFIER**  
**READY BUILT, WIRED & TESTED**  
A.C. only, 200-250 V. Valves ECL86 and EZ80. 3 ohms quality output. Mullard tone circuits. Controls: bass boost, treble and volume. Separate engraved front-panel with de luxe finish. Quality mains transformer. Stove enamelled chassis size 6 in. x 5 in. x 3 in. Bargain Price £4/19/6. Details S.A.E.  
\*\* Performs agreeably well. (The GRAMOPHONE)

### MAINS TRANSFORMERS

**200/250 AC Post 2/- each**  
STANDARD 250-0-250, 80 mA. 6.3 v., 3.5 a., tapped 4 v. 4 a., Rectifier 6.3 v. 1 a. tapped 5 v. or 4 v. 2 a. 22/6  
Ditto 350-0-350 28/6  
MINIATURE, 200 v. 20 mA., 6.3 v. 1 a. 10/8  
MIDGET, 220 v. 45 mA. 6.3 v. 2 a. 15/6  
SMALL, 220-0-220 v. 50 mA. 6.3 v. 2 a. 17/6  
STANDARD 250-0-250 65 mA., 4.3 v. 3.5 a. 17/6  
HEATER TRANS., 6.3 v. 1 1/4 a. 7/6  
Ditto tapped sec., 1.4 v. 2, 3, 4, 6.3 v. 1 1/2 amp. 8/6  
HEATER TRANS. 6.3 v. 4 1/2 a. 10/6  
GENERAL PURPOSE LOW VOLTAGE. Outputs 2.4, 5, 6, 8, 10, 12, 15, 18, 24 and 30 v. at 2 a. 22/8  
AUTO TRANS. 150 v. 0, 115 v. 200, 230, 250 v. 22/8  
AUTO TRANS. 500 w. 0, 115, 200, 230, 250 v. 22/8  
PARMEKO MAINS TRANSFORMER. Made for special contract, the ratings can safely be doubled. Guaranteed 2 years. Primary 0-110-210-230-250 v. H.T. 300-0-300 v. 50 mA. LT. 6.3 v. 1.8 a. Weight 6 lb. Price 17/6, post 2/6.  
MULLARD "510" MAINS TRANS. TO SPEC 38/8

**O.P. TRANSFORMERS.** Heavy duty 50 mA., 4/6. Miniature 3V4, etc. 5/9. Small, pentode, 4/6. Multi-ratio, 7/6. Multi-ratio heavy duty push-pull 10 w., 15/6.  
Goodmans heavy duty 10/20 w. 6K push-pull, 30/-  
Estone ultra-linear OTML 10 w., Spec. for "510" 45/-  
10 w. matching transformer, 3, 7, 15 ohms, 12/6.  
**INTERVALVE TRANSFORMERS.** 3:1, 5:1, 9/- each.  
**L.F. CHOKES** 15/10 H., 60/65 mA., 5/-; 10 H. 85 mA., 10/6; 10 H. 120 mA., 12/6; 10 H. 150 mA., 14/-  
**FULL WAVE BRIDGE CHARGER RECTIFIERS.** 2, 6, or 12 v. 1 1/2 a., 8/9; 2 a. 11/3; 4 a. 17/6. Free charger circuit.  
**CHARGER TRANSFORMERS.** Tapped input 200/250 v., for charging at 2, 8 or 12 v., 1 1/2 a., 15/6; 2 a., 17/6; 4 a., 22/6. Ammeter 0 to 5 mA., 9/6.  
**4 AMP. CAR BATTERY CHARGER** with Ammeter, Leads, Fuse, Case, etc., for 6 v. or 12 v., 69/6. Ready built.

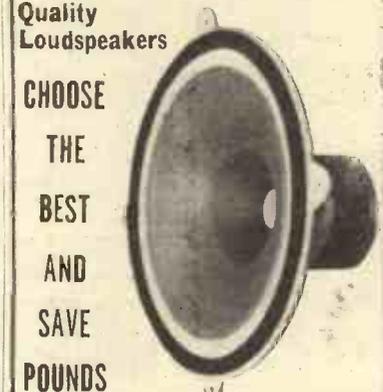
### BOOKS (List S.A.E.)

- "W.W." Radio Valve Data 6/-
- High Fidelity Speaker Enclosures 5/-
- Valve Transistor, CRT Equivs. 9/6
- At a Glance Valve, CRT Equivs. 3/6
- Coil Design and Construction 5/-
- Transistor Sub-Min. Receivers 5/-
- TV Fault Finding 5/-
- Mullard Audio Amplifier Manual 8/6
- Radio Valve Guide, Books 1, 2, 3 or 4, ea 5/-
- Transistor Superhet Receivers 7/6
- Practical Radio-Inside Out 3/6
- Master Colour Code 1/6
- Practical Tape Recording Handbook 5/-
- Coil Design and Construction Manual 5/-
- Radio, TV and Electronics Data Book 3/6
- International Radio Stations List 2/6
- High Fidelity Stereo Gramophone 5/-
- Modern Transistor Circuits for Beginners 7/6
- Principles of Colour TV. (Patchett) 16/-
- Boys' Book of Crystal Sets 7/6
- Stroboscopic Disc 33, 45, 78 r.p.m. 1/-
- Realistic High Fidelity (Hartley) 5/-

CRYSTAL DIODES, G.E.C. 2/-; GEX34, 4/-; O.A.81, 3/-  
CRYSTAL COILS HAX. 3/-; HAXL 3/6; DRE2 4/-; DRE3 2/6;  
CRYSTAL SET BOOKLET 1/- CRYSTAL SET KIT 12/6

**RADIO AND TELEVISION SPARES**  
All leading makes, volume controls, etc., line output transformers, etc., B.V.A. valves (current and obsolete types). Send S.A.E. for quotation.

# BAKERS 'Selhurst' RADIO



Quality Loudspeakers  
**CHOOSE THE BEST AND SAVE POUNDS**  
12in. Stalwart 15w. 45/12000 c.p.s., 3 or 15ohms 90/-  
12in. Stereo, foam suspension, 15 ohms £6/17/6  
12in. Model H.D. 20 w. 40-14,500 c.p.s. £8  
12in. De Luxe foam, 15 w. 25-17,000 c.p.s. £9/10  
12in. Bass 25 w. 20-18,000 c.p.s. £12/12/-  
12in. Ultra Twelve, 20 c.p.s. to 25 kc/s. £17/10/-  
15in. Baker Bass Auditorium, 35 w. Mk. II £18  
Ideal for Bass Guitars.  
Details and Enclosure Plans S.A.E.

**LOUDSPEAKERS.** PM 3 OHM FAMOUS MAKES, 2 1/2 in. 3 in., 4 in., 5 in., 7 in., x 4 in., 15 6 each; 8 in. 17/6; 6 in. 16/6; 10 in. 30/-; 12 in. 30/- (15 ohms 35/-), 10 in. x 6 in. 22/6; E.M.I. 13 1/2 in. 8 in., 35/-; Stentorian Tweeter, T358 5 or 15 1/2 30/-; Crossover CX3000, 30/-; 10 in. HF1012, 87/6; 8 in. HF812 72/6

**TWIN GANG CONDENSERS "0-0."** Transistor 208 pF and 176 pF with trimmers and screen, 10/6 each; 365 pF, miniature, 1 1/2 x 1 1/2 in. 10 in. 500pF standard with trimmers, 9/-; midget, 7/6; midget with trimmers, 9/-; 500 pF slow motion drive, standard or midget, 9/- Small 3 gang 500 pF, 17/6. Single 40" 365 pF, 7/6.  
**SHORT WAVE.** Single 10 pF, 25 pF, 50 pF, 75 pF, 100 pF, 160 pF, 5/6 each. Can be ganged together. Couplers 9d. each.  
**TUNING AND REACTION CONDENSERS.** 100 pF., 300 pF., 500 pF., 3/6 each, solid dielectric.  
**CONDENSERS.** 0.001 mfd., 7 kV. T.C.C. 5/6; ditto 20 kV. 9/6; 0.1 mfd. 7 kV., 9/6; 300 pF. to 500 pF. Micas. 6d. Tubular 500 v. 0.001 to 0.05 9d.; 0.1 1/-; 0.25 1/6; 0.1/350 v. 9d.; 0.5/350 v., 1/9; 0.01 2,000 v., 1/9; 0.1 2,000 v., 3/6.  
**CERAMIC CONDENSERS.** 500 v. 0.3 pF. to 0.01 mfd., 9d. High voltage pulse ceramics, 100 pF., etc., 12 kV., 2/6.  
**SILVER MICA.** 10% to 500 pF., 9d.; 600 to 3,000 pF., 1/-; color tolerance (plus or minus 1 pF.), 2.2 to 47 pF., 1/-; ditto 1% 50 to 515 pF., 1/-; 1,000 to 5,000 pF., 1/6.

**465-470 Kc/s. SIGNAL GENERATOR**  
Price 15/- Uses B.F.O. Unit ZA 30038 ready made with valve 1S5. POCKET SIZE 2 1/2 in. x 4 1/2 in. x 1 in. Only one resistor to change! Full instructions supplied. Battery 8/6 extra. 6v. or 4 1/2 v. Details S.A.E.

**WAVE-CHANGE SWITCHES**  
2 p., 2-way, or 2 p. 6-way, loak spindle ..... 3/6  
3 p. 4-way or 1 p. 12-way, loak spindle ..... 3/6  
4 p. 2-way or 4 p. 3-way long spindle ..... 3/6  
4 p. 4-way 2 water loak spindle ..... 6/6  
Wavechange "4 MAKITS" Waters available; 1 p. 12-way 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 8 p. 2-way. Prices with oleik spindles, etc.  
1 water, 8/6; 2 water, 12/6; 3 water, 16/- Additional valves up to 12, 3/6 each  
**TOGGLE SWITCHES.** s.p., 2/-; d.p., 3/6; d.p.d., 4/-  
Rotary Toggle, s.p., 3/6; d.p., 4/6. Min. Slide D.P. 3/6  
**JACKS.** English open-circuit 2/6, closed-circuit 4/6. Grundig-type 3-pin, 1/3; Grundig Lead, 3/6. Phono Plugs 1/-. Sockets 6d.  
**JACK-PLUGS.** 3/-. Screened 4/-. Grundig 3-pin 3/6.  
**BULGIN NON-REVERSIBLE PLUGS and SOCKETS.** P74 2-pin 4/3; P73 3-pin 4/6; P194 6-pin 6/6.  
P80 3-pin 4/-; Mains selector: Panel with plug, 1/-

**JASON F.M. TUNER COIL SET, 29/-**  
H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s., detector transformer and heater choke. Circuit book using four 6AM6 2/6.

**COMPLETE JASON FMT KIT**  
Jason chassis, calibrated dial, tuning gang, 22/12/-, or complete FMT Kit with 4 valves, 26/5/-

**COMPLETE JASON FMT KIT**  
with New Jason Cabinet, all components, Power Pack and 5 valves £10. Or Less Power Pack 28/5/-

48-HOUR RETURN OF POST MAIL ORDER SERVICE

# RADIO COMPONENT

Our written guarantee with every purchase Buses 133 or 68 pass door. S.R. Stn. Selhurst.

FOR — IMMEDIATE — DESPATCH — PHONE — US — TODAY

Volume Controls

Long spindles. Midge: 5K ohms to 2 Meg. L/S 3/- D.P. 4/6. Stereo L & S 10/6. D.P. 14/6. Linear or Log Tracks.

80 ohm Coax

Semi-air spaced tin. Stranded core. 6d. yd. 40 yds. 17/6; 80 yds. 25/- Fringe Quality. Air spaced. Losses Cut 50% 1/- yd.

ONE AERIAL PLUGS 1/6. Ditto sockets 1/3. TRIPLEXERS Bands L, H, III. COAXIAL PLUGS 1/6. PIN SOCKETS 1/6. LEAD SOCKET 2/-. COAX. OUTPUT BOXES 4/-. BALANCED TWIN FEEDER 6d. yd., 80 or 300 ohms. TWIN SCREENED FEEDER 1/6 yd. 80 ohms. EXTENSION SPKR. CONTROL. 10 ohm 3/-. 25 ohm 6/6. TELESCOPIC CHROME AERIALS. 13in. extending to 43in. 5/6 each. Coax. Adaptor 1/6. RESISTORS. Preferred values. 10 ohms to 10 meg. 1/4 w. 4d.; 1/2 w. 6d.; 1 w. 8d.; 2 w. 1/-. HIGH STABILITY. 1/2 w. 1/2. Preferred values, 10 ohms to 10 meg. Ditto 5%, 10 ohms to 22 meg. 4d. 5 watt 1/3. WIRE-WOUND RESISTORS 1/6. 15 watt 1/6. 10 ohms-10,000 ohms 2/-. 12.5K. to 47 K. 10 w. 3/-

I.F. TRANSFORMERS 7/6 pair. 465 kc/s. Sling Tuning Miniature Can. 2in. x 1in. x 1in. High Q and good band width. Data sheet supplied.

WIRE-WOUND Pots. 3 WATT. Pre-set Min. TV Type. All values 10 ohms to 25K. 3/- each. 30K, 50K, 4/- Carbon 30K to 2 meg. 3/-

TRIMMERS. Compression ceramic 30, 50, 70 pF. 9d. 100 pF, 150 pF, 1/3; 250 pF, 1/6; 600 pF, 750 pF, 1/9; Philips 0 to 10 pF., 3 to 30 pF., 1/- each.

1963 RADIOGRAM CHASSIS



Three Wavebands S.W. 16 m-50 m. M.W. 200 m-500 m. L.W. 800 m-2,000 m. 12-month guarantee. A.C. 200-250 v. 4-way switch. Short-Medium-Long-Gram. Ferrite Aerial. A.V.C. and Negative Feedback. 5 watts, 3 ohm. Chassis 13in. x 7in. high x 5 1/2in. deep. Glass dial size 13in. x 4in. horizontal wording. Two Pilot Lamps. Four Knobs. Walnut or Ivory. Aligned and calibrated. Chassis isolated from mains.

BRAND NEW £8.19.6 Cart. 4/6. Matched Speakers 8in. 17/6; 10in. 25/-; 12in. 30/-.

RADIO SCREWDRIVER, 5in., 6d. Test Prods 2/9 ea. Neosid Trimming tools 1/6. NEON MAINS TESTER SCREWDRIVER, 5/-. SOLDER RADIOGRADE 4d. yd., 1lb. 5/-.

HIGH GAIN TV PRE-AMPLIFIER BAND I B.B.C. Tunable channels 1 to 5. Gain 18 dB. ECC83 valve Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred).

BAND III I.T.A. - same prices. Tunable channels 9 to 13. Gain 17 dB. Set of coils and circuit only 9/6. Band I or III.

PAXOLIN PANELS. 1in. x 10in. x 3in. 2/-. RECTIFIERS. RM1 5/-; RM2 6/-; RM3 8/-; RM4 10/-; RM5 10/-; 14A100 10/-; 14A116 10/-; 83R6 5/-. MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA. 7/6; 250 v. 60 mA. 8/6; 250 v. 85 mA. 9/6; 200 mA. 21/-; 300 mA. 27/6; Full Wave Bridge 250 v. 70 mA. 10/-; 120 mA. 15/-. Silicon 250 v. 450 mA. 10/-. SELENIUM RECT. Populux type. 300 v. 85 mA. 5/-. COILS. Wound "P" type. 3/- each. OSMOR MIDGE "Q" type. adj. dust core, from 4/- each. TELETRON D.W.R. L and Med. T.R.F. with reaction. 4/-; Medium only DR. 3/6. FERRITE ROD AERIALS M.W. 8/9; M. and L. 12/6. FERRITE ROD AERIALS. L and M. for transistor circuits. 10/- each. FERRITE RODS 8in. x 1in. 3/-; 6in. x 1in. 3/-.

QMAX CHASSIS CUTTER

The cutter consists of four parts: a die, a punch, an Allen screw and key. 1in. 14/6 1 1/2in. 18/- 2in. 34/3 1 1/4in. 14/6 1 1/4in. 18/6 2 1/2in. 37/9 1in. 15/6 1 1/2in. 20/- 2in. 44/3 1in. 15/9 1 1/2in. 20/- 1 1/2in. sq. 31/6 1in. 18/- 1 1/2in. 20/6 1 1/2in. sq. 28/- 1 1/2in. 18/- 1 1/2in. 22/6 28/-

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, 4 sides, riveted corners, lattice fixing holes, 2 1/2in. sides, 7in. x 4in. 4/8; 9in. 7in. 5/8; 11in. x 7in. 6/9; 13in. x 9in. 8/6; 14in. x 11in. 10/6; 15in. x 14in. 12/6. ALUMINIUM PANELS. 18 s.w.g. 12in. x 12in. 4/6; 8in. x 9in. 4/-; 12in. x 8in. 3/-; 10in. x 7in. 2/3; 8in. x 6in. 2/-.

H.F. CHOKES 2/6. Osmor QCL 6/9. T.R.F. COILS A/H/F. 7/-; pair BAX 3/-; HAXL 3/6; REPANCO DR2 4/6. DRX1 2/6. Purple Cores 1in. 6d. ALADDIN FORMERS and cores. 1in. 8d. 2in. 10d. 0.3in. FORMERS 5637 or 8 and cans TV1 or 2. 2in. sq. x 2 1/2in. or 3in. sq. x 1 1/2in. 2/- with cores. SLOW MOTION DRIVES. Epicyclic ratio 6-1. 4 3. SOLON IRON. 25 v. 200 v. or 250 v. 24/- 85 w. 29/-. A.N.T.E.X. PRECISION sub-miniature iron. 200 or 240 v. 29/6. Stands for A.N.T.E.X. irons 12/6 extra. Spares in stock for above irons.

EAGLE 4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

Size 3 x 1 1/2 x 3/4 in. Powerful ready built miniature push-pull amplifier with output transformer, 4 transistors. Ideal for use with record players, intercoms. or "BABY ALARM." Complete with full instructions and circuit. PRICE 4/6 9 v. Batt. 2/6. 2 1/2in. SPEAKER 15/- Xtal Mike Insert, 6/6.

MAINS DROPPERS. Midge. With adj. sliders. 0.3A. 1,000 ohms. 5/-; 0.15A. 1,500 ohms. 5/-; 0.2A. 1,200 ohms. 5/-; 0.1A. 2,000 ohms. 5/-.

BARGAIN SINGLE PLAYER KIT 200/250 v. A.C.

£5.15.0 post 5/- WITH 2-STAGE AMPLIFIER 3-WATT 2-VALVES UCL82, UY85, HIGH-FLUX 5in. SPEAKER. 4-SPEED E.M.I. TURNTABLE, 16, 33, 45, 78 R.P.M. CRYSTAL PICK-UP FOR L.P./STD. RECORDS, 7in., 10in., 12in. (less cabinet)

ARDENTE TRANSISTOR TRANSFORMERS D3034, 7.5 CT. 1 Push Pull to 3 ohms for OC72. 9/8 D3034, 1.75-1.1 CT. Push Pull Driver for OC72. 9/8 D3058, 11.5:1 Output to 3 ohms for OC72, etc. 9/8 D167, 18.2:1 Output to 3 ohms for OC72, etc. 12/- D239, 4.5:1 Driver, 1in. x 1in. x 1in. 10/- D240, 8.5:1 Driver, 1in. x 1in. x 1in. 10/- ARDENTE TRANSISTOR VOLUME CONTROLS. VC1345, 5K or 1 meg. with switch dia. 8in. 5/3. VC1760, 5K with switch, dia. 7in., 10/6. DEAF AID EARPIECE Xtal or magnetic, 7/6. SUB-MIN. JACK and PLUG, 3/6 pair. MIKE TRANSFORMER 50L 3 9. P.V.C. CONN. WIRE, single or stranded. 2d. yd. TWIN P.C. FLEX, 2 amp., 4d. yd. SLEEVEING, 1 or 2 mm. 2d.; 4 mm. 3d.; 6 mm., 5d. yd. Bib Cutters 3/6. Neosid Trimming Tools. 1/9. Panel mounting fuse-holders 2/- Fuses 60ma to 5a. 5d.

FERRODYNAMICS AMERICAN "BRAND FIVE" PLASTIC RECORDING TAPE

Double Play 7in. reel, 2,400ft. 42/- Spare Spools 5in. reel, 1,200ft. 25/- 3in. 1/6 4in. 2/- 5in. 2/- Long Play 7in. reel, 1,800ft. 35/- 5in. reel, 1,200ft. 23/6 5in. 2/- 5in. reel, 900ft. 18/6 7in. 2/6 Standard 7in. reel, 1,200ft. 25/- Leader Tape 5in. reel, 900ft. 16/- SplicerTape 3/- 7in. Metal Reels 1/6. "EASYSPLICE" Tape Splicer 5/-.

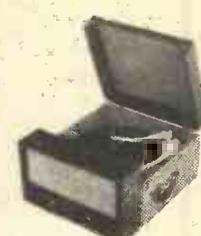
The "INSTANT" Bulk Tape Eraser and Magnetizer Head Demagnetizer



200/250 v. A.C. 35/- Leaflet S.A.E.

BUILD YOUR OWN RECORD PLAYER

AND SAVE POUNDS



Famous Autochange or Single Player units supplied with Brand New 2-tone Portable Cabinets 17 x 15 x 8 1/2in. Strong carrying handle, tilt flush clips and hinges. As used by Famous Make for 20 yrs. models. Ready cut-out motor board 14. 13in. Front baffle with 7 x 4in. high flux loudspeaker and 3 watt 2 valve UY85, UCL82 2-stage amplifier ready built on metal chassis 12 x 3 x 2 1/2in. Quality 3 ohm output transformer, low hum level circuit. Volume and Tone controls, 2-core safety mains lead. All items fit together perfectly. Special instructions enable assembly in 30 minutes. only 5 wires to join! 12 month written guarantee. Available separately or package deals as below:

AUTOCHANGER KITS Complete—as above. B.S.R. Monarch £11/10 0 P.P. 5/- Collaro £11/15 0 P.P. 5/- Garrard £12/5 0 P.P. 5/-

SINGLE PLAYER KITS Complete—as above. Garrard auto stop/start £11/5 0 P.P. 5/- E.M.I. auto stop/start £11/5 0 P.P. 5/-

OR SEPARATELY Cabinet with cut out board £3/2 6 P.P. 3/6 Amplifier with 7 x 4in. speaker £3/17 6 P.P. 3/6

AUTOCHANGERS B.S.R. UA14 £6/5 0 P.P. 3/6 Garrard Autoslim £6/17 6 P.P. 3/6

SINGLE PLAYERS E.M.I. auto stop/start £5/10 0 P.P. 3/6 Garrard SRP10 £5/10 0 P.P. 3/6 E.M.I. (separate pick-up) £2/7 6 P.P. 3/6

TRANSMISSION UNITS Stereo/Mono Garrard 4HF £16/10 0 P.P. 5/- Philips AG1016 £12/5 0 P.P. 5/- Garrard AT6 £10/10 0 P.P. 5/-

BARGAIN B.S.R. Autochange UA12 Stereo/Mono £7/10 0 P.P. 3/6 Replacement sapphire sty'd available from 5/3 Replacement Xtals from 15/- Stereo from 31/6

"6 + 1" TRANSISTOR RADIO

First-class components to make a 6-transistor 2-waveband superbet chassis. Ideal for portable or table radio. All parts including BVA transistors, ferrite aerial, printed circuit, 8 1/2in. x 2 1/2in. but EXCLUDING speaker and cabinet, 35 ohm output. Simple instructions 1/6 (tree with kit). Speakers 35ohm, 7 x 4in. 21/- 5in., 17/6; 3 1/2in., 15/6. £4.5.0

NEW MULLARD TRANSISTORS

OC71 6/-; OC81D 7/6; OC44 8/9; OC171 10/6; OC72 7/6; OC81 7/6; OC45 8/6; AF117 9/6. Sub-miniature Electrolytics (15 v.) 1 mfd. 2 mfd., 4 mfd., 5 mfd., 8 mfd., 16 mfd., 25 mfd., 30 mfd., 50 mfd., 100 mfd., 2/6. Diodes OA81 3/-; GEX34 4/-.

WEYRAD

TRANSISTOR SUPERHET TRANSFORMERS, COILS. PRINTED CIRCUIT and FERRITE ROD AERIAL. Long and Medium Wave Aerial—RA2W with CAR AERIAL COIL. on 6in. rod, 3/4in. diameter, 208pF. tuning 12/6 Oscillator Coil P50/LAC, 178pF tuning 5/4 1st and 2nd I.F. Transformers P50/30C, 470 Kc/s. 3/4in. diameter by 1in. high, ea. 5/7 3rd I.F. P50/30C diode detector 6/- Driver Transformer—LFD74 6/- Printed Circuit—PCAL. Size 2 1/2in. x 8 1/2in. Ready drilled and printed 9/6 Jackson "60" gane 208 + 178pF. with trimmers 10/6 Volume Control 5K D.P. 4/6 35 ohm Speakers, 3 1/2in. 15/6, 5in. 17/6, 7 x 3in. 21/- Wavechange Switch 3/6 Set of 6 Mullard Transistors and diode. 42/6 Constructor's Booklet with full details. 2/- 3 ohm Output transformer OPT1 10/6 Details S.A.E.

B.B.C. 2 TRANSISTOR + DIODE M.W. and L.W. Radio. Kit 22/6; Earpiece 7/6; Battery 2/3. Circuit and Details 6d. Real performance. Ideal beginners, Schools etc.

EXPERTS ANSWER ALL ENQUIRIES OUR ONLY ADDRESS 337 WHITEHORSE ROAD Telephone WEST CROYDON THO 1665 P. & P. charge 1/-, Full List, 1/-, C.O.D. 2/- extra. (Export welcome. Send remittance and extra postage, no C.O.D.)

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Post Orders to R.S.C. (M/C) Ltd., 5 County Arcade, Leeds, 1. Trade Supplied. Personal Shoppers to any of Branches below.

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Only 3 pairs of soldered joints plus mains. **AUDIOTRON HI-FI TAPE RECORDER KIT** Build a high quality recorder in the £70 class for only

**25 1/2** GNS. Carr. 17/6.

Can be assembled in 1 hour

OR DEPOSIT £2.13.9 and 12 monthly payments of 44/- Cash price if settled in 3 months.



INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTION THE AUDIOTRON HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7x4in. LOUDSPEAKER. Reel of Best Quality TAPE. Spare Tape Spools, a Portable Cabinet, size approx. 14 1/2 x 15 x 8 1/2 in., finished in durable and attractive duo tone Polycrome and connection diagram for wiring amplifier to transcription.

FEATURES INCLUDE: ★ 3 SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS. Fast rewind ★ TAPE MEASURING AND CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE. Send S.A.E. for leaflet.

**HI-FI 10 WATT AMPLIFIERS**

BRAND NEW CARTONED MANUFACTURERS' DISCONTINUED £7.19.6 MODEL. A REMARKABLE OPPORTUNITY. Carr. 4/6. Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed, tested and in perfect working order. For 200-250 A.C. mains

**SUPERHET RADIO FEEDER UNIT** Design of a high quality Radio Tuner Unit (especially suitable for use with any of our Amplifiers). Q Triode Heptode F/Changer is used. Pentode I.F. and Double Diode Second Detector delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. i.p.t. depending on Ae. location. Only 250 v. 15 mA. H.T. and L.T. or 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost of £4/15/-. Point-to-point wiring diagrams and instructions 2/6.

**CRYSTAL MICROPHONES.** Hand type 14/9. Hand or Desk R.T.C. 29/9. Acos Mic. 45 29/9. Mic 39 Stick 39/9 BM3 stick with table stand 59/9.

**LINEAR TAPE PRE-AMPLIFIER** Type LP1. Switched negative feedback equalisation. Positions for Record 1 1/2 in, 3 1/2 in., 7 1/2 in. and Playback. EM84 Recording Level Indicator. Designed primarily as the link between Collaro Tape Transcriber and high fidelity amplifier but suitable almost any Tape Deck. 9 GNS. Send S.A.E. for leaflet.

**LINEAR L45 Miniature 4 1/2 W. QUALITY AMPLIFIER.** Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. bass and treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2 1/2 ohms speaker. Three miniature Mullard valves. Size only 6 x 5 x 5 1/2 in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only Deposit 22/- and 5 monthly payments of £5.19.6 Or of 22/- Send S.A.E. for leaflet.

**EXTENSION SPEAKERS.** In handsome, walnut veneered cabinets. All standard 2-3 ohms, 6 1/2 in. 29/9. 8 in. 35/9. **CABY MULTIMETERS.** M1. Sensitivity 2,000 ohms per volt. A.C. and D.C. 54/-, A10. Basic meter, sensitivity 150 microamp. A.C. and D.C. ranges. £4/17/6. B20. Sensitivity up to 10,000 ohms per volt. A.C. and D.C. £6/10/-. TMK500 30,000 ohms per volt. A.C. and D.C. £8/19/6. Send S.A.E. for leaflet.

**STOCKISTS OF ARMSTRONG CHASSIS, GOODMAN'S, W.B. and FANE SPEAKERS, LINEAR, LEAK, VERDIK, ROGERS, and DULCI AMPLIFIERS. CASH OR H.P.**

**THE SKYFOUR T.R.F. RECEIVER**

A design of a 3-valve 200-250 v. A.C. mains L and M. wave T.R.F. receiver with selenium rectifier. It employs valves 6K7, 8F61, 6V6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram, instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including veneered walnut cabinet.

**R.S.C. BATTERY TO MAINS CONVERSION UNITS**

Type BM1. An all-dry battery eliminator. Size 6 1/2 x 4 1/2 x 2 1/2 in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9. Type BM2. Size 8 x 5 1/2 x 2 1/2 in. Supplies 120 v. 90 v. and 60 v. 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions. 49/9 or ready for use 56/6.



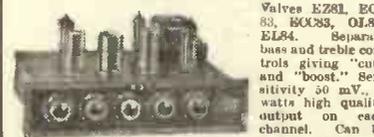
**POWER PACK KITS.** Only 19/11. Fully smoothed H.T. output of 250 v. 60 mA. and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing Choke. Double Electrolytic Condenser. Aluminum Chassis and Circuit.

**DERBY 26 Osmaston Road** New branch opening late JULY

**SENSATIONAL STEREO OFFER**

Complete kit of parts to construct a 3+3 watt good quality stereo amplifier providing realistic reproduction. Suitable all stereo pick-up heads. Ganged vol. and tone controls. Pre-set balance. For 200-250 v. A.C. mains only. Fully isolated chassis. 4 GNS. Or including Stereo Head 19/9 extra. Carr. 4/6.

**R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT**



Valves E28L, EOC 83, 6X4, 6X4, 6X4, 6X4, 6X4. Separate bus and treble controls giving "cut" and "boost." Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch, ganged volume, ganged treble, ganged bass and balance. Outputs for 3 ohms speakers. Point-to-point wiring diagrams and instructions. Illustration. Full wiring details and priced parts list 1/9. Assembled and tested 59/6 extra. Carr. 7/9.

**R.S.C. 3 WATT GRAM AMPLIFIER KIT**

All parts to construct a very compact, highly sensitive amplifier suitable for any type of single or autochange player. Size 12 x 2 1/2 x 2 1/2 in. Chassis is isolated. Mains transformer for 200-250 v. A.C. mains. Output for 2-3 ohm speaker. Volume and tone control with mains switch. ONLY 39/9

**GLSA MINIATURE 3 WATT GRAM AMPLIFIERS.** For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 1 1/2 x 2 1/2 x 2 1/2 in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohms speaker. Guaranteed 12 months. Only 59/6.

**SELENIUM RECTIFIERS**

L.T. Types	H.T. types H.W.
2 1/2 v. 4 a. H.W. .... 1/9	120 v. 40 mA. .... 3/9
6 1/2 v. 1 a. H.W. .... 2/9	250 v. 50 mA. .... 3/11
Following F.W. (Bridge)	250 v. 60 mA. .... 4/11
6 1/2 v. 1 a. .... 3/11	250 v. 80 mA. .... 6/11
6 1/2 v. 2 a. .... 6/11	250 v. 250 mA. .... 11/9
6 1/2 v. 3 a. .... 9/9	Contact cooled
6 1/2 v. 4 a. .... 12/3	250 v. 60 mA. H.W. 5/11
6 1/2 v. 5 a. .... 14/6	250 v. 70 mA. H.W. 7/11
6 1/2 v. 6 a. .... 15/6	250 v. 50 mA. F.W. .... 8/11
6 1/2 v. 10 a. .... 25/9	(Bridge) .... 8/11
6 1/2 v. 15 a. .... 35/8	

**R.C.A. 20-WATT RE-ENTRANT SPEAKERS.** Matching for 3, 15, 200 and 600 ohms only 4 GNS.

**TRANSISTOR SALE** Mullard OC1 3/9, OC45 4/11, OC4 4/11, OC72 4/9, OC81 4/11, OC171 8/9, Ediswan XA101, XB102, XA112, XB113, XB104, XC101A 3/9 ea. Postage 6d. for up to 3 Transistors.

**JASON F.M. TUNER** Type FMT1. All parts including Dial, Escutcheon, Punched Chassis & Valves. Power supply required 180 v. 25 mA. and 6.3 v. 1.5 a. .... £6/19/6 Type FMT2 ..... 8 Gns.

**EX GOVT. SELENIUM RECTIFIERS** 12 v. 15 amp. F.W. (Bridge). Only 19/9

**EX GOVT. SMOOTHING CHOKES** 60 mA. 10 h. 400 ohms 3/11. 100 mA. 10 h. 100 ohms 6/9. 150 mA. 10 h. 100 ohms 10/11. 120 mA. 12 h. 100 ohms 9/9. 200 mA. 5-10 h. 100 ohms 11/9. 250 mA. 5 h. 80 ohms 10/9.

**ACCUMULATORS** 2 v. 16 A.H. New ex Govt. 8 x 4 x 2 in. 6/9 each, 3 for 15/-.

**R.S.C. Battery Chargers & Kits for 200-230-250 v. 50 c/s. A.C. Mains Guaranteed 12 mths.**

**HEAVY DUTY KIT** 6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge), Selenium Rectifier, 0-7 amp. meter. Variable Charge Selector. Fuses, fuse - holders, panels, plugs and circuit. Only 59/9. Post 4/6.

**CHARGER TRANSFORMERS** 200-230-250 v. 50 c/s. 0-9-15 v. 1 a. .... 12/9 0-9-15 v. 2 a. .... 25/9 0-9-15 v. 3 a. .... 16/9 0-9-15 v. 5 a. .... 19/9 0-9-15 v. 6 a. .... 23/9 0-9-15 v. 8 a. .... 28/9

**BATTERY CHARGER KITS** Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case, Fuses, fuse-holders, grommets, panels, battery clips and circuit. Carr. 2/9 extra. 6 v. or 12 v. 1 amp. .... 22/9 As above with ammeter. .... 28/9 6 v. 2 amps. .... 19/9 6 v. or 12 v. 2 amps. .... 25/9 6 v. or 12 v. 2 amps. .... 35/9 (inclusive of ammeter) 6 v. or 12 v. 4 amps., with variable charge rate selector and ammeter ..... 52/9

**CHARGER AMMETERS** 0-1.5 a., 0-3 a., 0-7 a. .... 8/9

**ASSEMBLED CHARGERS**

6-12v. 1a. less meter 27/9 6-12v. 2 amp. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. 49/9 Carr. 3/9. Only 6-12 v. 3 amp. with variable charge rate selector and ammeter, 59/9.

**ASSEMBLED 6 v. or 12 v. 4/5 amps.**

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads 69/9 Carr. 5/- Or Deposit 13/3 and 5 monthly payments of 13/8. As above but for 6 amp. charging. 4 GNS. Carr. 5/- or Deposit 16/- and 5 monthly payments of 15/-.

**D.C. SUPPLY KITS.** Suitable for electric trains. Consists of mains trans. 200-250 v. 50 c.p.s. 12 v. 1 amp. selenium rect. (F.W. Bridge); 2 fuse-holders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, 29/11.

**VALVES:** Full range at really competitive prices.

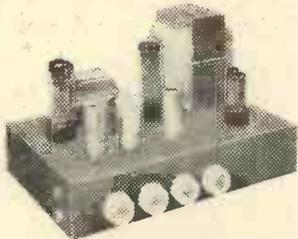
**HEAVY DUTY SELENIUM RECTIFIERS.** 24 v. 20 amp. Full wave (bridge). Brand new. 49/9

**R.S.C. POWER PACKS, 200-250 v. A.C.** Completely enclosed in tinned enamelled case, 8 x 5 1/2 x 2 1/2 in. Output fully smoothed 250 v. 60 mA. and 6.3 v. 2 a. 39/9.

**R.S.C. BABY ALARM or INTERCOMM. UNIT KIT** For 200-250 v. A.C. mains. Includes all parts, diagrams and instructions. High sensitivity. Completely safe. Controllable at either end. Housed in two cabinets of pleasing design 89/6. Carr. 5/- Or assembled and tested 8 gns.

### R.S.C. A10 30 WATT AMPLIFIER

HIGH FIDELITY  
ULTRA LINEAR  
PUSH-PULL  
OUTPUT



SIX VALVES. EP86, EP86 ECC83, 807, 807, GZ34. Tone Control Pre-Amp stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associate vol. control is provided so that two separate inputs such as "mike" and gram, etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20mA and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy to follow wiring diagram.

ONLY Or every built using latest EL34 output valves and with 12 Carr. **11 Gns.** months' guarantee. 14 GNS. TERMS ON ASSEMBLED UNITS. 10/- Protective Cover 10/9. Type 807 output valves with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. (in main loop). CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE. Frequency response  $\pm 3$  D.B. 30-20,000 c/s. Tone Controls  $\pm 12$  D.B. at 50v $\pm$  12 d.b. to  $\pm 6$  D.B. at 12,000 c/s. hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12x9x10in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS, IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

LOUDSPEAKERS. 2 1/2in. to 18in., at keen prices. 12in. 6-8 watt 3 ohms 29/11. 12in. 10 watt 12,000 lines 3 ohms or 15 ohms 59/9. TWEETERS. 4in. R.A. 4.3 ohms 19/11. R.A. 16 ohms 25/9. W.B. 10 ohms 31/9. Fan 15 ohms, Pressure type 43/15/-.

### R.S.C. BASS/20 GUITAR AMPLIFIER

Designed to give powerful amplification of any Bass instrument. Fitted Heavy Duty 15in. 20 watt Loudspeaker with specially constructed voice coil assembly to withstand heaviest loads. Cabinet (size 21 x 24 x 13 1/2in.) is of pleasing appearance and covered in contrasting tones of grey Vynair and Rexine. High Fidelity amplifier unit is fitted so that controls are in top of cabinet. Controls are Bass, Treble, Vol 1, Volume 2, and mains switch. Twin Jack input sockets are provided. Robust construction. Built to highest standards. For 200-250 v. A.C. mains. Incomparable value at only **29 1/2 Gns.** Carr. 17/6. Or Deposit 53/- and 12 monthly payments 53/-.

### R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIERS

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolt input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalization. Hum-level is negligible being 71 D.B. down. 15 D.B. negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 A. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohms speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only **24/15/-** or assembled ready for use 25/- extra, plus 3/6 carriage. Or deposit 22/- and five monthly payments of 22/- for assembled unit.

### R.S.C. TRANSFORMERS Fully Guaranteed. Interleaved & Impregnated.

<b>MAINS TRANSFORMERS.</b> Primaries 200-230 v. 50 c/s.		
250-0-250 v. 60 mA., 6.3 v. 2a., 0-5-6.3 v. 3a. ....	17/11	
250-0-250 v. 100 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	27/11	
300-0-300 v. 100 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	27/11	
400-0-400 v. 130 mA., 6.3 v. 4a., c.t., 6.3 v. 1a. For Mullard 510 Amplifier .....	33/9	
350-0-350 v. 100 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	33/11	
425-0-425 v. 200 mA., 6.3 v. 4a., c.t., 5 v. 3a. ....	55/9	
425-0-425 v. 200 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	59/9	
425-0-425 v. 200 mA., 6.3 v. 5a., 4 v. 3a. ....	69/9	
<b>TOP SHROUDED DROP-THROUGH TYPE</b>		
260-0-260 v. 70 mA., 6.3 v. 2a., 0-5-6.3 v. 2a. ....	17/9	
250-0-250 v. 100 mA., 6.3 v. 3.5 a., 2 1/2 x 2 1/2 in. ....	19/9	
250-0-250 v. 100 mA., 6.3 v. 2a., 6.3 v. 1a. ....	21/9	
350-0-350 v. 80 mA., 6.3 v. 2a., 5 v. 2a. ....	18/11	
250-0-250 v. 100 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	26/9	
300-0-300 v. 100 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	26/9	
300-0-300 v. 130 mA., 6.3 v. 4a., 0-5-6.3 v. 1a. ....	26/9	
suitable for Mullard 510 Amplifier .....	26/9	
350-0-350 v. 100 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	26/9	
350-0-350 v. 150 mA., 6.3 v. 4a., 0-5-6.3 v. 3a. ....	29/9	
425-0-425 v. 200 mA., 6.3 v. 4a., 3 v. 3a. ....	55/9	
<b>MIDGET CLAMPED TYPE, Primaries 200-250 v.</b>		
250-0-250 v. 60 mA., 6.3 v. 2a., 2 1/2 x 2 1/2 in. ....	12/9	
250 v. 60 mA., 6.3 v. 2a., Size 2 1/2 x 2 1/2 in. ....	11/9	
<b>FILAMENT TRANSFORMERS 12 v. 1a. ....</b>		7/9
6.3 v. 1.5 a. ....	5/9	
6.3 v. 3a. ....	7/6	
6.3 v. 3a. ....	8/11	
6.3 v. 3a. ....	17/9	
2 1/2 v. 3a. or 2 1/2 v. 1.5a 17/9		
<b>AUTO (Step Up/Step Down) TRANSFORMERS</b>		
50-80 watts 110-120 v./230-250 v. ....	13/9	
150 watts 110-120 v./200-250 v. ....	27/9	
250 watts 110-120 v./200-250 v. ....	39/9	
<b>W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS.</b>		
WF1012, 10 watt rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance, 24/7/6. Please state whether 3 ohm or 15 ohm required.		

**BASS REFLEX CABINET.** Designed for above speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18x12x10in. Strongly made. Handsome appearance. Ensure superb reproduction for only 23/19/6.

### R.S.C. A11 12-14 WATT AMPLIFIER

HIGH FIDELITY  
PUSH-PULL ULTRA  
LINEAR OUTPUT  
"BUILT-IN"  
PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram, as in A10 High sensitivity. Includes 3 valves: ECC83, ECC82, EL34, E82A. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response  $\pm 3$  D.B. 30-30,000 c/s. 30 negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolt INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12 x 9 x 7in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. Kit is complete to last unit. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 51/6 extra) ONLY **8 Gns.** 10/- If required louvered metal covers with 2 carrying handles can be supplied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 9 monthly payments of 24/9. Send S.A.E. for illustrated leaflet detailing ready-to-assemble Cabinets, Speakers, Microphones, etc. with cash and credit terms.

### R.S.C. BASS-MAJOR 30-WATT GUITAR AMPLIFIER

A Multi-Purpose High Fidelity, High Output Unit for Vocal and instrumentalists Groups. Incorporating two 12in. heavy duty 25-watt high flux (17,000 lines) loudspeakers with 2in. diameter pole pieces (total flux 220,000 lines). Designed for efficiently handling more than full output of amplifier at frequencies down to 25 c.p.s. One speaker has an aluminium speech coil and dual cone to extend frequency range up to 17,000 c.p.s. Heavily made cabinet of convenient size 24 x 21 x 14in. has an exceptionally attractive covering in two contrasting tones of Vynair. For 200-250 v. 50 c.p.s. A.C. mains operation. EMINENTLY SUITABLE FOR BASS GUITAR AND ALL OTHER MUSICAL INSTRUMENTS. Four jack socket inputs and two independent vol. controls for simultaneous connection of up to four instrument pick-ups or microphones. Separate bass and treble controls providing more than adequate "Boost" or "Cut". Level frequency response throughout the audible range. **39 1/2 Gns.** Carr. 17/6 Or DEPOSIT 24/3 and 12 monthly payments of 29/2 Superior to units at twice the cost. Send S.A.E. for illustrated leaflet.

### R.S.C. JUNIOR GUITAR AMPLIFIER.

5-watt high quality output. Separate bass and treble "cut" and "boost" controls. Sensitivity 15 v. Two high impedance inputs. 10in. loudspeaker. Handsome strongly made cabinet (size 14 x 14 x 7in. approx.) finished in attractive and durable polychrome. 200-250 A.C. mains operation. **28/19/6** Carr. 5/9. Send S.A.E. for leaflet. 7/9. Or DEPOSIT 21 and nine monthly payments of 21.

### LINEAR TREMOLO/PRE-AMP. UNIT

Designed for introducing the Tremolo effect to any amplifier fitted with a reservoir power supply point for smoothed H.T. and 6.3 v. A.C. This applies to practically all amplifiers of our manufacture and to those of several other manufacturers. The unit plugs into power supply point and any input socket of amplifier. Controls are Speed (frequency of interruptions), Depth (for heavy or light effect), Volume, and Switch. Three sockets are for 2in. taps and Foot Switch. Only **4 Gns.**

### R.S.C. SENIOR 14 WATT GUITAR AMPLIFIER.

High-fidelity push-pull output. Separate bass and treble "cut" and "boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pick-up can be used at the same time. Two loudspeakers are incorporated, a 12in. high flux 14-watt bass unit and a 6 x 4in. elliptical for treble. Cabinet is well made and finished as Junior Model. Size approx. 18 x 18 x 8in. Or DEPOSIT 37/- and 9 monthly payments **16 Gns.** 37/- Send S.A.E. for leaflet. Carr. 10/-.

### LOUDSPEAKERS IN CABINETS

12in. 10 WATT. Walnut Veneered. Cabinet size 15 x 16 x 8in. approx. High quality 12in. 10 watt 12,000 line Speaker. 3 ohms or 15 ohms. 24/19/6. Carr. 5/-; Or deposit 11/3 and nine monthly payments 11/3.
12in. 20 WATT. High Quality 15,000 line 1/speaker. 15 ohms in Cabinet finished as above. Size 18 x 18 x 8in. 27/19/6. Carr. 8/9 or Deposit 17/9 and 9 monthly payments of 17/9.
15in. 30 WATT Heavy Duty High Flux Speaker. Suitable for BASS GUITAR. Cabinet 24 x 21 x 15in. Heavy construction, covered in attractive Rexine and Vynair in two contrasting tones of grey. Only 19/9 Gns. Or Deposit 37/6 and 12 monthly payments 37/6.
15in. 50 WATT. 14,000 line speaker with 3 in. diameter mesh coil. 15 ohms Impedance. In Substantial Two-tone Rexine and Vynair covered cabinet of pleasing appearance. Acoustically lined. IDEAL FOR BASS GUITAR. Size 30 x 21 x 16in. approx. ONLY 29 Gns. Or Deposit 23/15/- and twelve monthly payments 50/-.

### R.S.C. STANDARD BASS REFLEX CABINET.

For 12in. Loudspeakers, acoustically lined and ported. Size 20 in. x 14in. x 13in. Beautiful walnut veneer finish. Especially recommended for use with Speaker system below, 25/19/6. Set of four legs can be supplied with brass ferrules for 19/6.

**AUDIOTRINE CORNER CONSOLE CABINETS.** Strongly made. Beautiful polished walnut veneered finish. Pleasing design.

**JUNIOR MODEL.** To take up to 8in. speaker. Size approx. 20 x 11 x 8in. Only 49/6.

**STANDARD MODEL.** To take up to 16in. speaker. Size 27 x 15in. 24/11/9.

**SENIOR MODELS.** To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30 x 20 x 15in. (Recommended for use with Audiotriline speaker system). 7 gns.

### OUTPUT TRANSFORMERS

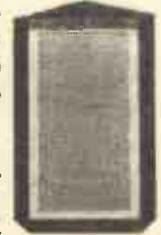
Midget Battery Pentode 66.1 for 354, etc. ....	4/6
Small Pentode 6,000 $\Omega$ to 3 $\Omega$ .....	4/6
Standard Pentode 5,000 $\Omega$ to 3 $\Omega$ .....	5/9
Standard Pentode 7,000 $\Omega$ to 3 $\Omega$ .....	5/9
Push pull 8 watts EL84 to 15 $\Omega$ .....	8/9
Push pull 10-12 watts 6V6 to 3 $\Omega$ or 15 $\Omega$ .....	16/9
Push pull 10-12 watts to match 6V6 to 3-5-8 or 15 .....	17/9
Push pull EL84 to 3 or 15 $\Omega$ 10-12 watts .....	22/9
Push pull Ultra Linear for Mullard 510, etc. ....	29/9
Push pull 15-18 watts, sectionally wound 6L6, KT66, etc. for 3 or 15 $\Omega$ .....	23/9
Push pull 20 watt high-quality sectionally wound, EL34, 6L6, KT66, etc. to 3 or 15 $\Omega$ fully shrouded .....	47/9
<b>MICROPHONE TRANSFORMERS</b>	
120:1 High quality, clamped .....	6/9
120:1 High quality 30 mesh screened .....	8/9
<b>SMOOTHING CHOKES</b>	
250 mA., 5 H., 100 $\Omega$ 11/9	80 mA., 10 H., 350 $\Omega$ 5/6
150 mA., 7-10 H., 250 $\Omega$ 11/9	60mA., 10H., 400 $\Omega$ 4/11
100 mA., 10 H., 200 $\Omega$ 8/9	lamp.0.65PL.T.type 6/6

### AUDIOTRINE HIGH FIDELITY SPEAKER SYSTEMS

Designed to provide a smooth frequency response from 40-30,000 c.p.s. consisting of 12in. 12,000 line 15 ohm speaker. Crossover Unit and Tweeter. Highly recommended for use with any High Fidelity Amplifier. 10 Watt Unit 24/19/6 or Deposit 11/3 and nine monthly payments of 11/3. 15 Watt Unit 27/19/6 or Deposit 17/3 and nine monthly payments of 17/3.

### B.S.R. MONARDECK TAPE DECKS

Speed 3 1/2 in. per sec. As fitted to most leading make Tape Recorders. Brand New 26/19/6. Carr. 5/-. Suitable Portable Cabinets to take Deck and Tape Amplifier 39/9.





We are pleased to announce that all Stern's products are now available from **Clyne Radio Limited**  
 12 SUFFOLK HOUSE, GEORGE STREET, CROYDON Tel: MUN 3250

THE "ADD-A-DECK"

INCORPORATING GARRARD "MAGAZINE" TAPE DECK and the MATCHED MODEL HF/GPP PREAMPLIFIER. Supplied on ONE CHASSIS (as illustrated) READY FOR USE.

PRICE: Including GARRARD MAGAZINE and a 4in. SPOOL DOUBLE PLAY 18 GNS TAPE (Carr. & Ins. 10% extra).

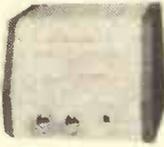
Provides complete tape recording facilities and designed to replay through the pick-up sockets of the standard type of RADIO RECEIVER, or an AMPLIFIER, from which really first-class reproduction is obtained. It consists of a Twin Track Deck connected to the Preamplifier and operates at 3 1/2 in./sec. speed, providing up to 1 hour 10 mins. playing time. Only needs connecting to the mains supply and pick-up sockets. Very simple to operate and easily installed in a cabinet, only four fixing screws being required.



STERN'S INTER-COMM. or BABY ALARM

A small versatile Unit employing the new MULLARD ECL86 valve and designed to provide two (or three) way conversation up to extreme distances. Operates from A.C. mains 200 to 250 volts and as in all our designs only new high-grade and guaranteed components are incorporated. PRICES—MASTER UNIT and ONE EXTENSION KIT OF PARTS **£6.17.6** ASSEMBLED AND TESTED **£8.0.0**

The equipment consists of a MASTER UNIT, size only 8 1/2 in. x 5 1/2 in. x 6 in. and ONE EXTENSION (a second extension may be added at any time). The Master Unit incorporates switching and power supply and with the chassis completely isolated from the mains is operated in absolute safety. Attractively presented in cases covered in quality leatherette.



THE "MONO-GRAM"

A small Amplifier of genuine high quality performance. Incorporates MULLARD ECL86 Valve, separate BASS and TREBLE controls and produces up to 3 wats to undistorted output.

PRICE: KIT OF PARTS **£4.10.0** ASSEMBLED AND TESTED **£6.0.0**

Perfectly suited for Portable Installations for which purpose we offer... PORTABLE CASE £9/10/-, the AMPLIFIER (Kit) and 8 x 5 in. SPEAKER (£1). All for £9. Alternatively with ASSEMBLED AMPLIFIER £10. C. & I. 3/6. The case quoted above will accommodate some 4-speed Single Record Units. A larger model for autochanger is available for extra 10/-. With this Equipment a COMPLETE PORTABLE RECORD PLAYER can be built for £14.



PLESSEY 15in. P.M. LOUDSPEAKER

Ex B.B.C.

A high quality 15in. loudspeaker, handling 20 watts of audio. Suitable for use in public address systems where considerable power is handled, or as a bass reproducer in dual or triple loudspeaker systems where full use can be made of the low fundamental resonance and smooth response.

Impedance	15 ohms at 400c/s.	Total flux	185,000 Maxwells
Dia. of pole piece	2 inches	Bass resonance	25 C.P.S.
Power rating	20 watts	Frequency range	20 C.P.C. to 5 Kc/s
Flux density	12,000 lines	Nett weight	251/oz.

PRICE 12 gns. Carr. & Ins. 10% extra

RECORD PLAYERS

- THE COLLARO "JUNIOR" 4-speed single Player with separate crystal pick-up **£3.10.0**
  - GARRARD Model SRP10 Single Record Player fitted with high-output crystal pick-up **£5.9.1**
  - THE NEW GARRARD "AUTOSLIM" 4-speed Autochanger with crystal pick-up **£6.10.0**
  - GARRARD "AUTOSLIM DE LUXE" 4-speed Autochanger, incorporates transcription Pick-up Arm **£11.8.0**
  - THE COLLARO "C90" 4-speed Autochanger with Studio "O" pick-up **£6.19.6**
  - B.S.R. Model UA14, a 4-speed Mixer Autochanger with crystal pick-up **£16.17.6**
  - The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.F.A.13 pick-up arm and G.C.S. crystal Cartridge **£12.12.0**
  - PHILIPS Model AG1016. A 4-speed Player which can be operated both manually and automatically. Suitable for Mono or Stereo operation....
- Carriage and Insurance on each above 5/- extra.

ARE YOU PLANNING TO INSTALL HI-FI ?

AND UNCERTAIN OF THE TYPE OF EQUIPMENT TO USE—OUR WIDELY EXPERIENCED TECHNICAL STAFF WILL WITH PLEASEURE PUT FORWARD RECOMMENDATIONS—STATE TYPE OF INSTALLATION CONTEMPLATED AND APPROX. PRICE LEVEL. CREDIT SALE TERMS are available on all Equipment over £10.

FULLY DESCRIPTIVE LEAFLETS are readily available—please advise items of interest and enclose S.A.E.

Stereo Amplifiers

MULLARD "10+10" STEREO AMPLIFIER

A HIGH FIDELITY DESIGN PROVIDING UP TO 10 WATTS (per channel) SUPERB REPRODUCTION. FREQUENCY RESPONSE FLAT TO WITHIN 3db from 3 c/s to 80 Kc/s at 50 mW. TOTAL HARMONIC DISTORTION AT 10 WATTS, 0.1%.



PRICE: (a) ASSEMBLED AMP-LIFTER (as illustrated) **£24.0.0** C. & I. 7/6 (b) A complete KIT OF PARTS for **£20.0.0**

Built to the highest technical standards and presented strictly to MULLARD'S Specification. Two specially designed GILSON ULTRA LINEAR OUTPUT TRANSFORMERS with 20% taps are used. We can also supply the assembled MAIN AMPLIFIER only for operation with our DUAL CHANNEL PRE-AMPLIFIER; this provides for a more versatile installation and is essential if a low output Pick-up is to be used. When ordering specify loudspeaker impedance.

(a) THE ASSEMBLED MAIN AMPLIFIER and ASSEMBLED DUAL CHANNEL PRE-AMP. **£34.0.0**

(b) KIT OF PARTS for both Units **£27.0.0**

MULLARD DUAL CHANNEL PRE-AMPLIFIER

A four Valve design for both STEREO-PHONIC and MONOPHONIC operation. Operates equally well with any make of Amplifier requiring input of up to 250 mV.

PRICE: KIT OF PARTS **£12.10.0** ASSEMBLED and TESTED **£15.0.0**



THE "TWIN THREE" STEREO AMPLIFIER

ASSEMBLED AND TESTED for **£9.0.0**

(Carr. & Ins. 7/6 extra) Based on a recent design by MULLARD LTD. is ideally suited for use in PORTABLE RECORD PLAYERS for which purpose we offer a specially designed Case.

It incorporates MULLARD ECL86 Valves, separate BASS and TREBLE CONTROLS and produces up to 3 wats per channel. Frequency response is 40 c/s to 35 Kc/s, size 11 1/2 in. x 8 in. x 5 in. To construct a STEREO PORTABLE RECORD PLAYER we offer—Assembled AMPLIFIER with two ROLA 8 in. x 5 in. LOUDSPEAKERS and PORTABLE CASE for **£16/10/0** (Carr. & Ins. 7/6 extra).



THE "TUDOR" STEREO AMPLIFIER

PRICE ONLY **£15.0.0** (Pkg. & Carr. 7/6)

A self-contained shelf mounting Amplifier designed to provide high quality stereophonic and monophonic reproduction.



Each channel provides a rated output of 6 wats and for monophonic operation approx. 12 wats is produced. Separate BASS and TREBLE CONTROLS. The Cabinet is finished in black crackle. Size 14 x 8 x 4 in. Send for full specifications.

MULLARD FOUR CHANNEL MIXING UNIT

Self-powered Cathode Follower output. Incorporates two Inputs for CRYSTAL MICRO-PHONES, one for CRYSTAL PICK-UPS and a fourth for Radio or Tape.

PRICE: KIT OF PARTS **£8.8.0** ASSEMBLED AND TESTED **£11.10.0** Alternative Model 1/L provides for one input matched for moving coil or ribbon mike **£1 17/- extra.**



HIGH FIDELITY LOUDSPEAKERS BY GOODMANS, WHARFEDALE and W.B. STENTORIAN

8 INCH TYPES		12 INCH TYPES	
GOODMANS "AXIETTE"	£5 5 7	GOODMANS "AXIOM 201"	£10 7 0
W.B. HF816	£5 19 6	GOODMANS "AXIOM 301"	£14 10 0
WHARFEDALE "SUPER 8/RS/DD"	£6 14 2	W.B. Model HFI214 15 wats	£10 5 6
10 inch TYPES		WHARFEDALE "W12/RS"	£10 15 0
GOODMANS "AXIOM 10"	£6 5 11	WHARFEDALE "Super 12/RS/DD"	£17 10 0
W.B. Model HF1016	£7 0 0		
WHARFEDALE "GOLDEN 10/RS/DD"	£7 17 5		

ARMSTRONG RADIOGRAM CHASSIS

FULL RANGE IN STOCK, ALL PRO-VIDE AM and FM RECEPTION. Model STEREO 12 Mk 2. **£40.5.0**



The most complete chassis ever produced, combines AM and FM Tuners, a Stereo Control Unit and two High Fidelity Amplifiers in one compact unit, provide a total of 16 wats for both mono and stereo. Other features include: Inputs for tape recording, play back, pick-ups and stereo radio (should this come about); separate wide range bass and treble controls and balance control. Model STEREO 85 **£29.18.0** Model AF208 **£21.4.0**

Model JUBILEE Mk. 2 **£28.5.0** Model TVB VHF TUNER **£20.8.0**

8 Wats A self-powered tuner of outstanding design.

LEAK and QUAD AMPLIFIERS

LEAK "TL12 PLUS" POWER AMPLIFIER with the "POINT ONE PLUS" PRE-AMPLIFIER... 14 wats rated output **£31.10.0**

LEAK "TL26 PLUS" with the "POINT ONE PLUS" PRE-AMPLIFIER... 28 wats rated output **£37.16.0**

LEAK "STEREO 20" POWER AMPLIFIER with the "VARISLOPE STEREO" PRE-AMPLIFIER... 22 wats (11 wats per channel) **£55.9.0**

QUAD II POWER AMPLIFIER with QUAD II CONTROL UNIT 15 wats output **£42.0.0**



**POSTAL ENQUIRIES and MAIL ORDERS to Dept. W.W. STERN RADIO LTD.**  
 6-12 TUDOR PLACE, TOTTENHAM COURT ROAD LONDON, W.1.  
 TEL. MUSEUM 6128/9.

**DEMONSTRATION and SHOWROOMS at STERN RADIO LTD.**  
 109 FLEET ST., E.C.4.  
 TEL. FLEET ST. 5812/3  
 Open: 9 a.m. to 6 p.m.  
 SAT. Close 1 p.m.

**PREMIER RADIO**  
 23 TOTTENHAM COURT ROAD, LONDON, W.1.  
 TEL. MUSEUM 3451/2  
 Open: 9 a.m. to 6 p.m.  
 THURS. Close 1 p.m.

**"Model HF/G2R" PORTABLE TAPE RECORDER** For Only **22 GNS**  
 (Original Price £33)  
 (Carrriage and Ins. 10/- extra.)



INCORPORATES THE LATEST GARRARD "MAGAZINE" TAPE DECK and MATCHING OFFER DECK and AMPLIFIER. Based on the successful MULLARD TYPE "A" DESIGN and specifically developed to operate the GARRARD DECK. PRICE INCLUDES THE GARRARD TAPE MAGAZINE and 4in. SPOOL OR DOUBLE PLAY TAPE. A Twin Track Recorder operating at 3 1/2 in./sec. providing up to 1 hour 10 mins. playing time. The outstanding features being excellent performance and simplicity of operation.

Incorporates EXT. SPEAKER SOCKET, also operates as independent amplifier (or direct reproduction from P.U. Mike or Radio tuner. Weighs only 22lb. WE ALSO OFFER DECK and AMPLIFIER CONNECTED TESTED, FOR IMMEDIATE OPERATION, 19 GNS. Carrriage and Ins. 10/- ex. INCLUDES SPEAKER

tape magazine and 4in. Spool of Double Play Tape. Comprises a complete tape recorder chassis ready for easy fitting into cabinet. Microphone 25/- extra.

**MODEL CR3/S TAPE RECORDER**



MODEL CR3/S incorporates the HF/TR3 Mk. II Tape Amplifier (described below) and the Collaro "Studio" Twin Track 3-speed Deck operating at 1 1/2 in., 3 1/2 in. and 7 1/2 in. speeds. Complete with microphone and 1,200ft tape.

**KIT OF PARTS £33.8.0**  
**ASSEMBLED & TESTED £43.0.0**

(Carr. & Ins. 15/- extra).

**STEREO TAPE PRE-AMPLIFIER**



Model STP-1. For use with current TRUVOX, BRENNEL or COLLARO "STUDIO" 1/2 and 1/4 track Stereo Decks. Incorporates Ferroxcube Oscillator, 4-speed Equalisation Signal Level Meter and separate Gain Controls. Includes separate Power Unit.

**KIT OF PARTS £22.0.0** **ASSEMBLED AND TESTED £28.0.0**  
 (Carr. & Ins. 8/6 extra)

**MULLARD TYPE "C" TAPE PRE-AMPLIFIER**



Suitable for most 1/4-track Mono Tape Decks. Incorporates Ferroxcube Push-Pull Oscillator and 3-speed equalisation. Includes separate Power Unit. (Carr. & Ins. 7/6 extra).

Kit of parts ..... **£14.0.0**  
 Assembled ..... **£19.10.0**

**MULLARD TAPE AMPLIFIER (Model HF/TR3)**

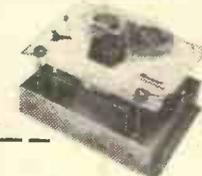
Based on Mullard's Type "A" design and suitable for most 1/4 track Mono Tape Decks. Incorporates Ferroxcube Treble Inductor, Gilsen Output Transformer, and 3-speed equalisation. Includes separate Power Unit.

Kit of parts ..... **£14.0.0**  
 Assembled ..... **£19.0.0** (Carr. & Ins. 7/6 extra)



**STERN'S "ADD-A-DECK"**

A self contained Unit consisting of Garrard Deck and matched Pre-Amplifier on one chassis. Provides full tape recording facilities and replays through Pick-up Sockets of standard Radio receiver or Amplifier. PRICE...includes Spool of Tape **£18.18.0** (Carr. & Ins. 7/6 extra).



**TAPE DECKS and COMPLETE RECORDERS**

By Collaro, Brenell, Truvox, Wearite, Grundig, Ferrograph, Philips and others... Descriptive leaflets readily available.

**COMBINATION TAPE UNITS**

	Kit	Assembled	Assembled with track switch fitted
STP-1 Pre-amp with Collaro Studio Tape Deck .....	£36 0 0	£42 0 0	£44 2 0
STP-1 KIT with Brenell Mk. 5 Series II with Track Switch fitted .....	£64 4 0		
STP-1 with Brenell Mk. 5 Series II 1/4-track Deck .....	£74 15 0		
Type "G" Pre-amp. with Collaro Studio Tape Deck .....	£24 10 0	£30 0 0	£32 2 0
Type "G" Pre-amp. with Brenell Mk. 5 Deck Series II .....	£46 11 0	£53 1 0	£55 3 0
HF/TR3 with Collaro Studio Tape Deck ..	£24 3 0	£29 10 0	£31 12 0
HF/TR3 with Brenell Mk. 5 Series II .....	£46 4 0	£51 11 0	£53 13 0

Send S.A.E. for comprehensive price list. Carr. & Ins. 15/- on above units.

**MULLARD 3-VALVE PRE-AMPLIFIER TONE CONTROL UNIT**

Designed mainly for the STERN/MULLARD range of monophonic Power Amplifiers, but also suitable for any Amplifier requiring an input signal up to 250 mV. Five inputs, including one equalised for replay direct from high impedance tape head, and one for low output magnetic pick-up. Output for tape record. Separate Bass and Treble controls. High Pass Filter 20 to 180 c/s. Low Pass Filter 5 to 9 Kc/s. Power requirements 250 v. at 6 mA., 6.3 v. at 0.8 amps. Totally enclosed case silver hammered. Size 1 1/4 x 4 1/4 x 4 in. Front panel. Polished perspex in choice Black or white.



**KIT OF PARTS £10.0.0** (Carr. & Ins. 5/- extra.) **ASSEMBLED & TESTED £13.13.0**

**MULLARD'S 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT**

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIERS but also perfectly suitable for other makes.



★ Equalisation for the latest R.I.A.A. characteristic.  
 ★ Input for Crystal Pick-ups and variable reluctance magnetic types.  
 ★ Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.  
 ★ Sensitive Microphone Channel. Wide range BASS and TREBLE Controls.

**KIT OF PARTS £6.6.0** (Carr. & Ins. 5/- extra.) **ASSEMBLED AND TESTED £9.10.0**

**MULLARD "5-10" MAIN AMPLIFIER**

For use with MULLARD 2 or 3 valve pre-amplifiers with which an undistorted power output of up to 10 watts is obtained. SPECIFIED COMPONENTS AND MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of PARMEKO or PARTRIDGE Output Transformer. **£10.0.0**



COMPLETE KIT (Parmeko Output trans) **£13.10.0**  
 ASSEMBLED AND TESTED **£13.10.0**  
 ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/8/- extra. (Carr. & Ins. 6/6 extra.)

**COMBINED PRICE REDUCTIONS**

- (a) THE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-valve Pre-Amplifier... **£15.15.0**
  - (b) KIT OF PARTS to (Carr. & Ins. 8/6 extra) build the "5-10" Main Amplifier and 3-Valve Pre-Amplifier ..... **£19.10.0**
  - (a) The "5-10" and the 2-Valve Pre-amplifier both Assembled and Tested ..... **£21.10.0**
  - (b) The "5-10" and the 3-Valve Pre-Amplifier extra. both Assembled and Tested ..... **£25.10.0**
- With PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

**THE MULLARD '510/RC' AMPLIFIER**

The popular complete "5-10" incorporating Passive Control Unit providing up to 10 watts high quality reproduction, with an input of 600 mV. Specified components and new MULLARD VALVES includes PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE Output Transformers. Surplus power available for tuner.



Price: COMPLETE KIT ..... **£12.0.0**  
 ASSEMBLED AND TESTED ..... **£16.0.0** (Carr. & Ins. 7/6 extra.)  
 With PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

**THE MULLARD "33/RC"**

A HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-WATT MULLARD "3-3" DESIGN. (Carr. & Ins. 6/6 extra).

**KIT OF PARTS £8.8.0** **ASSEMBLED AND TESTED £11.10.0**

Complete to the MULLARD specification including PARMEKO OUTPUT TRANSFORMER. 2-tapped inputs for 78 and L.P. records (plus a Radio position). Power to drive a Radio Tuner is also available.

**FULLY GUARANTEED TAPE ... NEW, PERFECT AND BOXED**

3in. Spool 150ft... 4/3	3in. Spool 225ft... 5/6
5in. Spool 600ft... 12/-	5in. Spool 900ft... 16/-
5 1/2in. Spool 850ft... 15/-	6 1/2in. Spool 1,200ft. 18/-
7in. Spool 1,200ft. 19/-	7in. Spool 1,800ft... 27/-
7in. Spool 2,400ft... 47/6	

ALSO IN STOCK: E.M.I., SCOTCHBOY, PHILIPS, GRUNDIG, (BASF) in all sizes from 3in. to 8in. reels.

**Mk. II 'Fidelity' FM TUNING UNIT**

An attractively presented Unit incorporating MULLARD FERREABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

Send for our **NEW PRICE LIST OF ALL BRANDS OF RECORDING TAPE**

**KIT OF PARTS £10.10.0**  
**ASSEMBLED AND TESTED £14.5.0**

# LASKY'S RADIO

## LONDON'S LARGEST STOCKS OF EQUIPMENT & COMPONENTS SPEEDY MAIL ORDER SERVICE



### Transistorised PORTABLE Tape RECORDER The "TRAV-LER"

Dimensions: 10 x 8 x 5in., weight 9lb. Speed 3 1/2 in. per sec. Wow and flutter better than 4 r.m.s. Battery life 50 hours. Amplifier 400 mW. Uses 6 Mullard transistors. Speaker: 3 ohm High-imp., 7 x 4in. Playing time 44 min. using 5in. spools double play tape. Rewind time 2 1/2 min. Neon record level indicator, pause control, loudspeaker switch. Can be run off main power. Socket for external power supply. With Lustraphone LD86 moving coil microphone, 540ft. tape and spool. Brand new and in original maker's cartons. List price £30/9/-.

**LASKY PRICE 15 GNS.**  
Carriage & insurance 17/6.  
A.C. mains unit available 39/6. Post 3/6.

### LARGE SELECTION OF OTHER TRANSISTOR RECORDERS STOCKED

#### THE "CONET"

Fully transistorised 2-speed Battery Tape Recorder. This is a high quality machine incorporating refinements usually found in machines 3 times the price. Capstan drive. 2 speeds, 3 1/2 and 1 1/2 i.p.s. Accessories included Real leather carrying case, Microphone, Telephone adaptor. Personal carphone. Size 9 1/2 x 5 x 3 1/2 in. Takes 3 1/2 in. spools.

**NEW & UNUSED LASKY'S PRICE 19 Gns.**  
P. & P. 7/6. COMPLETE

#### THE "CLARION" PHONOTRIX

With leather case 18 GNS  
Carr. 7/6.

Very latest "PHONOTRIX" with push-pull output. **20 Gns.**  
Carr. 7/6.  
Full details of these Recorders, see previous adverts.

#### COLLARO STUDIO TAPE DECK

Latest model. 3 speed, 3 motors. Take 7in. reels. Fitted with half-track heads. **LASKY'S PRICE £10.10.0.** New and Unused. Carr. and Pack. 7/6.

**COLLARO STUDIO TAPE DECK.** As above but fitted with the latest quarter-track heads. **LASKY'S PRICE £13.19.6.** Carr. and Pack. 7/6.

**MARTIN TAPE RECORDER AMPS.** Designed for use with Collaro Studio Tape Deck. In sub assemblies for immediate installation. 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied, including valves, etc. Monitoring facilities. 3-ohm output, speed equalising, etc. For 200/250 v. A.C. mains.  
**PRICE 1-Track Model £11.11.0. 1-Track Model £12.12.0.** P. & P. 2/6.

Portable carrying case designed to take the Collaro studio tape deck and the Martin tape amplifier. Fitted with 9in. x 5in. speaker.  
Price complete with speaker **£5.5.0.** P. & P. 5/-.

Carriage and Packing free if above 3 items purchased together.

### Hear and compare the very latest HI-FI EQUIPMENT

Visit our spacious showrooms at 33 Tottenham Court Road or 207 Edgware Road, whichever is most convenient. In our Demonstration Studios you can see, examine, hear and compare the very latest products in the realm of high-fidelity reproduction.

- TAPE RECORDERS
- TAPE DECKS
- MICROPHONES
- AMPLIFIERS
- CONTROL UNITS
- AM/FM TUNERS
- RECORD PLAYERS
- AUTOCHANGERS
- TRANSCRIPTION TURNTABLES
- PICK-UPS
- LOUD-SPEAKERS
- SPEAKER SYSTEMS
- CABINETS AND ENCLOSURES
- TRANSISTOR RADIOS.

ARMSTRONG  
BRENELL  
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COLLARO  
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GOLDRING  
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H.M.V.  
JASON  
KORTING  
LEAK  
LENCO  
LINEAR  
LORENZ  
LOWTHER  
LUSTRAPHONE  
ORTOFON  
PAMPHONIC  
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RESLO  
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SIMON  
SOUND  
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TANNOY  
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VORTEXION  
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WHARFEDALE

PROMPT MAIL ORDER SERVICE to all parts of the British Isles; the U.S.A. and overseas. Enquiries invited. We also operate the official purchase tax-free plan for overseas visitors—the PERSONAL EXPORT SCHEME.

We stock a complete range of  
**RADIOGRAM CHASSIS A.M. & F.M.**  
and also TUNERS by  
ARMSTRONG, DULCI, CHAPMAN, Etc.  
Details on request

## RADIOGRAM CHASSIS MAKERS' SURPLUS

Covers Long, Medium and VHF/FM Wavebands. Piano Key selection with gram. position, makes this an ideal chassis for radiogram use.

Valve line-up: EL84; EABC80; EF89; ECH81; ECC85 and E2Z1.  
Volume and Tone controls.  
Full width illuminated glass scale.  
Pick-up sockets and extension loudspeaker sockets fitted.  
Dimensions: 15in. wide, 7in. front to back, 8 1/2 in. high.  
Opening required for scale: 13 1/2 in. x 2 1/2 in.  
Brand New and unused. Fully guaranteed.  
Ready for immediate operation. For 200-250 v. A.C. mains.

**LASKY'S PRICE  
£13.19.6**

Carriage and Packing 12/6 extra.

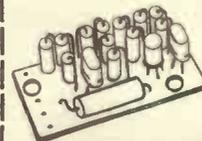
### TELEFUNKEN STEREO HIGH FIDELITY AMPLIFIERS MODEL S82



A complete stereo amplifier of unsurpassed quality, with inputs for radio, tape recorder, F.M. tuner or any other hi-fi source, either monaural or stereo. Output power 5 watts total (2 1/2 watts each channel). With balance control.

**LASKY'S PRICE £5.19.6** Post 7/6.  
Listed at 16 gns. New and unused.

### SUB MINIATURE TRANSISTOR AMPLIFIER

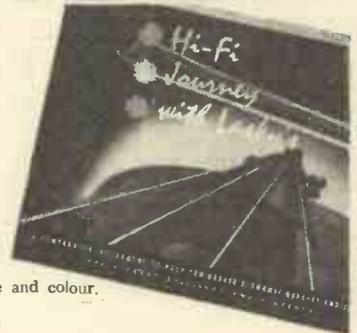


NPN-PNP Transformerless Amplifier.  
The smallest ever available. Size only 2 x 1 x 1 in.  
Rated output 125 mW from 9 v. battery.  
Output impedance 30-60 ohms.  
Frequency range, 100 cycles—25 Kc/s.  
Uses 3 transistors. Single-ended push-pull output.  
Fully assembled on printed circuit with full data and instructions. Ready for immediate use. Thousands of uses. Illustration is half actual size. **29/6** complete. Post 2/6.

**GOODMANS STEREO BOWL LOUDSPEAKERS.** Limited quantity. New & unused. P. & P. 5/-. **LASKY'S PRICE 89/6**

### NOW READY! LATEST EDITION of 100-page HI-FI Catalogue

A superb production illustrating and providing technical data of all the latest equipment. Over 100 large pages. 11 1/2 x 8 1/2 in., in photogravure and colour.



**Price 3/6** Post Free.

Refunded on your first hi-fi purchase of £5 or over from the catalogue.

### SEND FOR OUR LATEST COMPONENTS CATALOGUE

Completely new edition of over 100 pages. 8 1/2 in. x 5 1/2 in., copiously illustrated packed with money-saving bargains! Invaluable for the "ham" or service man. Price 2/-. Post 6d. Our latest 20-page "Bargain Bulletin" included free (separately by post, 6d.).

**SPECIAL PURCHASE!!!** Huge selection of various types of chassis—suitable for Radios—Radiograms AM/FM Tuners, etc. All brand new—Prices from £6—Personal Shoppers only.

## The finest range of Transistor Receivers available for home construction



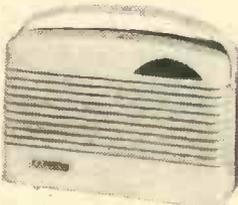
### THE SPRITE

Inclusive price of **79/6** P.P. 3/6 extra

★ Six-Transistor Superhet Miniature Personal Pocket Radio. ★ Long and Medium wavebands. ★ Uses PP3 battery. ★ Ferrite Rod aerial. ★ I.F. Frequency 470 Kc/s. Transistors: 3 x Philco 2007's, 2 x Mullard OC81 M, OC81 DM and OA90 diode. ★ 3 inch speaker. ★ Printed circuit 2½ x 2in. ★ Slow motion Drive. ★ In plastic case, size 4 x 2½ x ¾in.

In order to ensure perfect results, the SPRITE is supplied to you with R.F. and I.F. stages. Driver and Output stages, ready built with all components ready mounted on the printed circuit. To complete assembly you only have to fit the wave-change switch, tuning condenser and drive, volume control, earphone socket and aerial rod, the remaining components all having been pre-fitted at the factory for you. The SPRITE is offered as above, pre-assembled, plus cabinet, speaker and all components for final construction, at the inclusive price of 79/6. Postage and packing 3/6 extra. Data and Instructions separately, 2/6. Refunded if parcel is purchased. Real calf leather case, wrist strap, personal earphone, case for earphone and battery 12/6 the lot extra.

*Make no mistake—this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.*



### BUILD THE ★ ★ ★ ★ ★ ★ ★ REALISTIC "SEVEN"

Fully tunable long and medium wavebands. Uses 7 Mullard Transistors; OC44, 20C45's, OC71, OC81D and 20C81's, plus Crystal Diode OA70.

#### STAR features

★ 7 Transistor Superhet. ★ 350 Milliwatt output into 4-inch flux speaker. ★ All components mounted on a single printed circuit board, size 5½in. x 5½in., in one complete assembly. ★ External socket for car aerial. ★ I.F. frequency 470 kc/s. ★ Ferrite rod internal aerial. ★ Operates from PP9 or similar battery. ★ Full comprehensive data supplied with each Receiver. ★ At all coils and I.F.s, etc., fully wound ready for immediate assembly. An outstanding Receiver. Lasky's Price for the complete parcel including Transistors, Cabinet Speaker, etc., and Full Construction **£5.19.6**

All components available separately P. & P. 4/6

Data and instructions separately 2/6, refunded if you purchase the parcel.

★ A 6-transistor plus 2-diode superhet receiver using the latest circuitry. ★ Three Mullard AF117 alloy diffused transistors are used with OA79 and OA91 diodes, followed by OC81D and two OC81's in push-pull. ★ I.F. frequency 470 Kc/s. ★ Covers the full medium and long wavebands. ★ Sockets provided for personal earpiece or tape recorder, and car radio aerial. ★ Large internal ferrite rod aerial gives high sensitivity. ★ Uses four 1.5 v. pen torch batteries. ★ All components mounted on a single printed circuit. Simple stage by stage instructions. ★ Cabinet size 6½ x 4 x 1½in. With carrying handle. ★ All coils and I.F.'s ready wound.

### THE STROVER '6'

ALL COMPONENTS AVAILABLE SEPARATELY. Data and instructions separately 2/6. Refunded if you purchase the parcel. CAN BE BUILT FOR **£5.7.6**



Post and packing 4/- extra. Batteries 1/4 extra.

#### FULLY GUARANTEED TAPE AT RECORD NEW LOW PRICES

Famous make, P.V.C. base on latest type plastic spools. New, perfect, boxed, guaranteed.  
1,200ft. on 7in. spool ..... 15 0  
1,800ft. on 7in. spool ..... 19 6  
1,200ft. on 5½in. spool ..... 17 6  
850ft. on 5½in. spool ..... 11 6  
600ft. on 5in. spool ..... 11 3  
2,250ft. on 3in. spool ..... 4 11  
2,250ft. D.P. on 7in. spool 32 6  
All other makes, types and sizes of tape in stock including E.M.I. and Scotch.



**MINIATURE EARPIECES** for Transistor Radios. Transparent ear-insert with 3ft. cord, sub-min. Jack and socket. Fully guaranteed Post free. CR.5. Crystal, high imp., 5/-.  
MR.4. Magnetic, low imp., 6/6. Post free.

**SPECIAL OFFER/** Verdict "Quality Ten" Hi-Fi amplifier and pre-amplifier. Listed at £21. LASKY'S PRICE £14/19/6. Post & Pkg. 7/6. VERDICK MK. III with "High-Gain" Pre-Amplifier 15/- gnx. P. & P. 7/6. VERDICK MK. V amp. and pre-amp. 15/- gns. P. & P. 7/6.

#### BUILD YOURSELF A TRANSTOR RECORD PLAYER

★ **AMPLIFIER.** 300 milliwatts p.p. output using two OC71 and two OC72. Fully assembled 3x2x2in., 39/6. Knobs 3/6 extra. Post 2/6.  
★ **SPEAKER.** 30 ohms, 5in. Round matched to amplifier, 25/- Post 2/-.  
★ **3-SPEED PLAYER.** 6 volt, complete with pick-up, t.o. crystal cartridge and two sapphire styli, 69/6. Post 2/6.

**AGOS CRYSTAL STICK MIKE.** Type MI C.39/1 complete with Cable. List £5/5/-. LASKY'S PRICE 32 6. Post free.

Crystal Hand or Table Mike, 15/- Post free.

**LAPEL TYPE MP110.** High imp. xtal mic. 1½in. dia. x ½in. thick, 15/-, post 1/-.

**TYPE NP100.** Tie clip mic, 1x½x½in. High imp. xtal, 22/6, post 1/-.

**LUSTRAPHONE MOVING COIL** pencil mic. LPVH59. Freq. response 50 to 12,000 c/s. All impedances available. Listed 8 gns. LASKY'S PRICE £4/19/6.

# LASKY'S RADIO

## CRYSTAL PICK-UP CARTRIDGES

LOWEST PRICES EVER!

Some are less than half list price.

**CRYSTAL PICK-UP CARTRIDGES ALL COMPLETE WITH STYLI, L.P. AND STANDARD (AND STEREO WHERE SHOWN). FULLY GUARANTEED, STANDARD FITTING, WILL FIT MOST P.U. ARMS AND HEADS. Postage 1/- extra each.**

**MONO Type C.T.1.** By well-known manuf. With 2 sapphire styli ..... 9 6  
Garrard Ceramic G.C.E.4 ..... 15 0  
Garrard Magnetic T.O.M.2 ..... 15 0  
Acos GP.59 ..... 14 0  
Acos GP.05/3 ..... 15 0  
Acos GP.05/1 ..... 17 0  
Acos GP.07/1 ..... 14 0

**STEREO Acostereo 73/1;** with 2 sapphires 25 0  
Acostereo 73/2, with Diamond LP/ Stereo and sapphire Std. .... 29 6  
Collaro type C Turnover, with 2 sapphires ..... 19 11  
Collet S.C.I. Turnover, with 2 sapphires 19 11  
Collet S.C.I. Turnover, with Diamond LP/Stereo and sapphire Std. .... 25 0  
Ronette Stereo O.V. turnover, with 2 sapphires ..... 25 0  
Ronette Stereo type 105 and 106 with 2 sapphires ..... 35 6  
Ronette Stereo type 105 and 106 with Diamond LP/Stereo and sapphire Std. 39 6

#### AGOS STYLUS PRESSURE GAUGE

New and boxed. Listed at 12/6.

LASKY'S PRICE 4/6.

Plus 1/6 post.

#### TV CAMERAS

Transistorised, closed circuit cameras, complete with lens, new and unused and in perfect condition. For use on 200/250 volt A.C. Works with any 405 Line TV Receiver. LASKY'S PRICE Complete 79 GNS.

#### TRANSFILTERS by BRUSH. CRYSTAL Co.

Available from stock.

TO—O1B 465 kc/s. ± 2 kc/s.  
TO—O1D 470 kc/s. ± 2 kc/s.  
TO—O2B 465 kc/s. ± 1 kc/s.  
TO—O2D 470 kc/s. ± 1 kc/s.

**6/6**  
EACH  
P. & P. 6d.

#### MULTI TEST METERS

All new & unused & complete with test leads  
TAYLOR 127A ..... £10 10 0  
TAYLOR 88D ..... £23 10 0  
AVO Model 8 ..... £24 0 0  
AVO Minor ..... £9 10 0  
Model P1 ..... £22 14 0  
Model P3 ..... £4 9 6  
Model AN20 ..... £4 19 6  
JENNEN 220s ..... £5 9 6  
JENNEN T.P.5.H ..... £5 19 6  
JEMCO MT 316 ..... £5 19 6  
Model EP.10K ..... £5 19 6  
Model AN 27 ..... £7 19 6  
JENNEN 500 ..... £8 19 6  
JEMCO MT955 ..... £10 19 6  
Model T.E.13 ..... £1 19 6

Full details of all the above meters sent FREE on request. P. & P. 5/-.

**TV TURRET TUNERS.** Famous British make 38 Mc/s. I.F. with a few coils. Uses PCC84 and PCF80 valves. Less valves LASKY'S PRICE 5/-, P. & P. 2/- (No data or circuit available).

**NEWMATIC CAR RADIO.** Valve transistor Model 12 VOLT. Relieves the tension of long journeys. With all fittings. NEW and GUARANTEED. 13/- GNS. P. & P. 5/-.

# LASKY'S RADIO

## 4-SPEED AUTO-CHANGERS



- B.S.R. Type UAS**  
 £5 19 6  
**B.S.R. Type UA14/UA20** ..... £6 9 6  
**COLLARO Studio C60** wired for stereo with monaural p.p. .... £6 19 6  
**MAGNAVOX-COLLARO** latest model, 4 speed Stereo Auto changer. Fitted diamond stylus and record dust cleaning attachment. Mono ..... £6 19 6  
 Stereo ..... £7 19 6  
**GARRARD**  
 Model 209 Mono ..... £7 19 6  
 Model 209 Stereo ..... £8 19 6  
 Auto-Slim Mono Plug-in-head ..... £7 9 0  
 Auto-Slim De Luxe Mono ..... £11 9 0  
 Auto-Slim De Luxe Stereo ..... £12 5 0  
 Lab. Model "A" Mono ..... £19 14 0  
 Lab. Model "A" Stereo ..... £20 10 0  
 Postage on all above 5/-.

- SINGLE PLAYERS**  
 Auto start and stop. With pick-up and crystal cartridge.  
**GARRARD T.A. MK II MONO** ..... £7 17 3  
**GARRARD SRP10**, latest model, single player with G.C.S. .... £5 9 11  
**E.M.I.** 4-speed, wired for STEREO, fitted mono cartridge ..... £5 5 0  
 As above, STEREO ..... £0 6 0  
 Post on all above 5/-.  
**COLLARO JUNIOR** 4-speed motor and pick-up 69/6. 6 volt battery version, 4-speed with pick-up 69/6.  
**B.S.R. TU9**, non-auto. Turntable with pick-up, 59/6.

## TESLA "Sonet" DUOTAPE Recorder

Continental manufactured. 2-speed Tape Recorder with 1½ and 3½ i.p.s. Twin Track Recording to International standards.  
 • Takes 5½ in. spools. • Fast forward and fast re-wind.  
 • Record level indicator. • Inputs for Microphone, Radio and Pick-up. • For use on 110 and 200/250 volts, 50 c.p.s. mains. • Digital position indicator. • In attractive wood case with metal top cover. Fitted with storage compartments and carrying handle. Size 13in. x 10in. x 7in. • High quality record-replay amplifier with internal loudspeaker provides immediate high quality reproduction. • Socket for external speaker.  
 • Tone control.  
 Supplied with reel of tape, empty spool, microphone and a selection of inter-connecting leads, etc., with canvas waterproof cover. Brand new and unused.  
**LASKY'S PRICE 24 Gns.** Carr. and Ins. 10/6.

## BRAUN Model PC4L 4-SPEED STEREO RECORD PLAYER UNIT.

Incorporates a number of refinements including hydraulic pick-up lift; heavy die-cast metal turntable with rubber mat, and retractable adaptor for large hole 45 r.p.m. records: multi-mains voltage, etc. Lightweight pick-up arm fitted with an Elac type KST102 stereo cartridge, also suitable for L.P. and 78 r.p.m. mono records. Auto-stop mechanism fitted.  
 Unit plate size only 12x8in. Depth below unit plate, 3in. Height above top of unit plate, 1½in.  
 Motor has voltage tappings for use on 110, 160 and 200-250 v. 50 c.p.s. A.C. mains. Hydraulic pick-up lift incorporated, of a fool-proof design, together with a set down position indicator. Speeds, 16, 33½, 45 and 78 r.p.m.. 6ft. of mains lead fitted and 3ft. of multi-way cable for pick-up connection also fitted.  
 Brand new and unused. Fully guaranteed.  
**LASKY'S PRICE £12.9.6** P & P. 5/-.

**CELLULOSE WADDING.** For lining the interior of loudspeaker enclosures. Width 36in. Any length cut to nearest 6in.  
**LASKY'S PRICE 2/11** per sq. yard and pro-rata. P. & P. extra.

★ **LARGEST and most COMPREHENSIVE STOCKS of all COMPONENTS, TEST GEAR, etc., and FINEST VALUES IN GREAT BRITAIN**

### BY FAMOUS BRITISH MANUFACTURER

## STEREO AMPLIFIER

Self-contained integrated stereo amplifier, including combined control unit pre-amplifier. Designed to provide high quality stereo and mono reproduction with a rated output of 6 watts per channel stereo 12 watts mono. Input sockets are provided for the direct connection of most types of tuners and pick-ups, plus tape heads and high quality microphones including moving coil and ribbon. Separate output for feeding a tape recorder available on each channel. Facilities include inputs for 3½, 5 m/v; tape 4 m/v.—equalised for CCR; R.I.A.A. 4.3 m/v; flat 260 m/v; radio tuner 100 m/v. Overall response 60 cycles—20,000 cycles. Controls fitted are bass, treble, balance, volume, phase reverse, stereo sense, and selector Outputs 4, 8 and 16 ohms. Mains voltage 105-240 v. A.C. Attractively styled in free-standing metal case, finished in silver and black. Size: 14x8x4 inches. Suitable for use with any good quality tuner, speaker system, record player, etc. Will form the basis of a high fidelity stereo system. Brand New and Unused in maker's original cartons.



**LASKY'S PRICE £15**  
 Carriage & Packing 7/6

### BY FAMOUS BRITISH MANUFACTURER

## AM/FM RADIO TUNER



**LASKY'S PRICE £16.19.6**  
 Carriage and packing 7/6.

A self-powered tuner covering full VHF Medium and Long wave bands. Excellent quality provides perfect reception, can be used with any good quality amplifier, but especially suitable for the Tudor amplifier described above. Latest type tuning indicator fitted. Multiplex output socket fitted. Separate tuning of AM and FM. Fully variable gain control. For use on A.C. mains 105-240 v. Attractively styled in free-standing metal case finished in silver and black. Size 14x8x4in.

- "LINEAR" AMPLIFIERS**  
 "Diatonic" 10-14 watt ..... 12 Gns.  
 "Concord" 80-watt ..... 16 Gns.  
 L45, 4-5 watt ..... £5 19 6  
 LT45 Tape Deck Amp. .... 12 Gns.  
 L10 10-watt with pre-amp. .... 15 Gns.  
 L50 50-watt ..... 22 Gns.  
 L5/5 Amplifier and Pre-amp. .... 12 Gns.  
 LPI Tape Pre-amp. .... 9 Gns.

- HI-FI TAPE RECORDER HEADS**  
 High impedance Record/Play. Low impedance erase. **Lasky's Price 29/6**  
 Upper or lower track. Post free  
 State track required when ordering. Per pair

**MARRIOTT "K" Type** ¼ track heads, Record/play and erase. **4 GNS. pair.**  
 ¼ Track heads record/play and erase 59/6 pair.

- TRANSCRIPTION MOTORS**  
 GARRARD 4HF, stereo or mono, £16 19 6  
 GARRARD 301 ..... £20 12 0  
 GARRARD 301 (Strobe) ..... £22 0 0  
 GARRARD A with GC8 ..... £19 14 0  
 GARRARD A with GSC10 ..... £20 10 0  
 PHILIPS AG1016 ..... £12 12 0  
 Carr. and Ins. 5/- Also Lenco, Connoisseur, etc.

- P.M. SPEAKERS**  

3in.	4in.	5in.	6½in.	8in.	10in.	12in.
17/6	19/6	10/6	16/-	18/6	25/-	27/6
7x4	9x6	10x9	10x9½	10x6	10x7	
12/6	22/6	25/-		25/-	26/-	

## ELECTRIC MOTORS



Brand new tape recorder motors. Single phase, fully shrouded. 200-250 v. A.C. 8 x ½ in. spindle with detachable pulley, fitted switch. Suitable for tape decks, record players and many other uses.  
**P. & P. 3/6. 14/11**

## DISTLER MINIATURE MOTORS

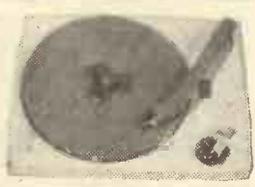
6 volt battery operated. **7/11**  
**P. & P. 2/6.**

**20,000 VALVES IN STOCK AT NEW LOW PRICES**  
 Brand new surplus and imported, also full stocks of B.V.A. valves. List post free.

**SUB-MIN COMPONENTS**  
 As used in the smallest Japanese pocket transistor radios. Coils, loudspeakers, I.F. transformers, Ganged Condensers, etc., in stock at lowest prices. Also all T.S.L. transistorised Miniature Units.  
**TRANSISTORS**  
 All Brand New and Guaranteed  
 GET.S11 2/6; GET.S5 2/6; GET.S6 2/6;  
 GET.873A 3/6; GET.874P 3/6; OC44 7/6;  
 OC45 6/6; OC70 6/6; OC71 6/6; OC72 8/-;  
 OC73 16/-; OC75 8/-; OC76 8/-; OC81D 6/6;  
 OC28 19/6; OC81 (matched) 6/6, pair 13/-.  
**SPECIAL PRICES FOR QUANTITIES.**

## STAAR KINDER RECORD PLAYER

45 r.p.m., 6 v. Battery operated. Complete with pick-up fitted crystal cartridge. Size only 7½ x 6in. Fitted auto. stop and start. New and perfect. **LASKY'S PRICE 49/6.** P. & P. 2/6.  
**2 speed model for 33½ and 45 r.p.m. 79/6.** P. & P. 2/6.  
**ONE WATT FULLY TRANSISTORISED AMPLIFIER**  
 Can be used with Staar Kinder to make a fully portable record player. Incorporates two GET 114 and two power transistors, in push-pull output. Fully built. Complete with tone and volume controls, on printed circuit. Size 2½ x 2½ x 1½ in. Uses 9 v. PP11 or similar battery. Complete with 3in. P.M. speaker. **LASKY'S PRICE 49/6.** P. 2/-.



**HEADPHONES**  
 High impedance. 14/6 per pair.  
 A.K.G. Model K.50 Stereo headphones, superb quality moving coil headphones. Low impedance 27/10/- per pair including ear pads.

**RE-GUNNED C.R. TUBES (full range stocked).**  
 We shall be pleased to quote on request.

**33 TOTTENHAM COURT ROAD, W.1 | 207 EDGWARE ROAD, W.2.**

2 mins. Oxford Street. Nearest Station, Goodge Street. MUSEum 2605 Few yards from Praed Street. PADDington 3271/2  
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# LOOK FELLAS — THEY'VE DONE IT AGAIN!

## CLOSED-CIRCUIT TRANSISTOR T.V. CAMERA KITS

(COMPLETE WITH VIDICON TUBE)

To Assemble in ONE HOUR!

Kit comprises:—

4 PRE-ASSEMBLED 'PLUG-IN' PRINTED CIRCUIT BOARDS, SMART ALLOY CASE, POWER UNIT & VIDICON TUBE.

Only a few wires to solder — and — Hey presto, your own Television Camera!

Look at the features:—

- ★ Standard 405 line, R.F. Output, operates on your own T.V. Just plug into the Aerial socket at the back of your set.
- ★ Camera tunable over Channels 1 to 5. Distance between Camera and T.V. can be up to several hundred yards.
- ★ Several Monitor sets can be used off one Camera.
- ★ Camera uses normal 16 mm. Cine type lenses. 'C' mount. (Lens not supplied). Standard lin. Vidicon Tube fitting. Mains power pack supplied, 210-240 volts A.C.
- ★ No other separate units, controls on camera.
- ★ Miniature size, being ideally suitable for observation in the awkwardest of spots. Excellent picture quality comparable with normal broadcast.
- ★ Full Circuitry with each kit.



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POST & INSURANCE 28/-.

50% postage refunded on acknowledgement of goods.

# YES

COMPLETE WITH VIDICON

FELLAS—the price is still correct & HURRY—the last batch went straight out

★ FACTORY ASSEMBLED SETS £49.10.0



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### HIRE PURCHASE!!

H.P. terms are willingly quoted on any item value £5 and over. Illustrated leaflets available on full range of ARMSTRONG chassis and most branded manufacturers' items of interest to readers of this publication.

## JASON Complete range available. The following are selected examples only.

**FMT1 Tuner.** 4 valve with ratio detector plus matched pair germanium diodes. External power supply required. All required components £6/15/-. P. & P. 2/6.

**FMT2 Tuner.** The modern shelf mounting version of the FMT1 complete with honeycomb case and complete with built-in power supply. All required components £8/19/6. P. & P. 4/-.

**FMT3 Tuner.** 7 valve tuner, with Foster Seeley discriminator. For fringe areas, complete with power supply. All required components £10/19/6. P. & P. 4/-.

**"MERCURY 2" Tuner.** 5 valves with special turret for switching channels to operate on 3 F.M. stations: Home, Third and Light, and TV channels as required. Foster Seeley discriminator. Less power unit. All required components £10/10/-. P. & P. 2/6.

**JTV2 Tuner.** Switched tuner covering B.B.C. F.M. and B.B.C. TV and ITV. Turret tuner with built-in Foster Seeley discriminator. All required components £13/19/6. P. & P. 4/-.

Instruction books and itemised price lists available separately as follows: FMT1, FMT2, FMT3, 2/6 each. MERCURY 2, JTV2, 3/6 each.

### VISIT OUR FULLY EQUIPPED HI-FI SHOWROOM AT TOTTENHAM COURT ROAD FOR DEMONSTRATIONS OF THE LATEST HI-FIDELITY EQUIPMENT BY ALL LEADING MANUFACTURERS—

i.e., Leak, Quad, Armstrong, Dulci, Ferrorograph, Relectograph, Tandberg, Vorticon, Tannoy, Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco, B.T.H., Pamphonic, Simon, Brenell, Collaro, Telefunken, Fi-Cord, Autoba, Philips, etc. etc. A full range of high quality cabinets to suit all purposes is on show. Enquire about our interesting part-exchange scheme for personal cellars. H.P. available.

★HI-FI DEMONSTRATION ROOM NOW OPEN at MANCHESTER★ DEMONSTRATION FACILITIES also available AT CROYDON

## DE LUXE 4 BAND COMMUNICATION RECEIVER RX-60

NEW Imported 4 Band Communication Receiver. Model RX-60. Completely built and ready to go. Not a kit. High sensitivity Superheterodyne receiver covering 550 Kc/s.—1,600 Kc/s., 1.6 Mc/s.—4.4 Mc/s., 4.4 Mc/s.—11 Mc/s., 11 Mc/s.—30 Mc/s.

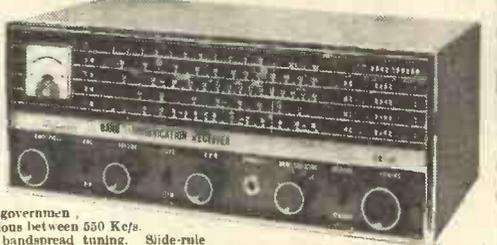
Covers all amateur, government, aircraft and broadcast stations between 550 Kc/s. and 30 Mc/s. Electrical bandspread tuning. Side-rule type tuning dial giving accurate logging of stations. Internal ferrite rod aerial for medium waveband reception, and a 59in. 10-section chromium plated telescopic whip aerial for the short-wave bands. Sockets for optional outdoor aerial. Internal high flux, monitor loudspeaker. Latest modern miniature B7G base valves. High Q coils and I.F. transformers. Bendphone socket (may also be used for external loudspeaker). Automatic noise limiter (ANL) for reduction of external interference. Beat frequency oscillator (BFO) for reception of CW (morse) signals. Receive/Stand-by switch. Signal strength meter calibrated in "8" units and reads to 89+10db. 220/240 volt A.C. mains, 50-60 cycle operation.

Handsomely styled cabinet with grey crackle finish and handsome front panel, with chrome and satin chrome fittings. Measures 13 1/2in. x 8 1/2in. x 5 1/2in. (high) and weighs only 11 1/2 lb. A comprehensive instruction manual is supplied. An ideal receiver for the radio amateur and short wave listeners of all ages.

Come and hear this wonderful receiver at any of our many branches.

**PRICE ONLY £34 POST FREE. H.P. TERMS AVAILABLE**

Send stamp for copy of our interesting little book-let "What is High Fidelity?" and Suggestion List of Budget Hi-Fi Systems.



## THE OUTSTANDING TAPE RECORDER BUY! THE STEELMAN TRANSITAPE FROM U.S.A.

Fully portable, all transistor 2-speed! Tape Recorder. Carry it like a Camera and capture the sound of any event when it happens, where it happens. Big set fidelity. For business or pleasure.

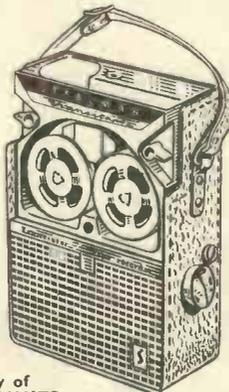
- ★ Fully transistorized. 7 Transistors—2 diodes. ★ 2 standard speeds, 3 1/2 for music, 1 1/2 for voice. ★ Over 1 hour on a single reel of tape. ★ Recording level indicator.
- ★ Precision made. Jewelled and Oilite bearings require no lubrication. ★ Illuminated overload and battery life indicators ensure uniform crystal performance. ★ Heavy duty 4in. speaker. ★ Sensitive crystal microphone. ★ Compact size 9 1/2 x 9 1/2 x 2 1/2 in. ★ Wt. under 9 1/2 lbs. less batteries.
- ★ Many other refinements.

Supplied complete with free set of Mallory Mercury Long Life Batteries complete with tape and microphone in solid leather case with shoulder strap. Illustrated instruction manual. In manufacturers' cartons. Fully guaranteed.

**ORIGINAL LIST PRICE 55 GNS. (less batteries) OUR PRICE 24 GNS.** Plus 7/6 pky., carr. and ins. Limited supply. Buy now!! H.P. available. (including batteries)

## STILL AVAILABLE! Small quantity of A.C. MAINS UNITS

List Price 9 gns. OUR PRICE 5 gns. Enquiries also invited for other accessories



## THE "AIR KING"

Our highly successful six-transistor luxury portable with the "SLIM Line" look.

To build yourself, with printed circuit chassis for reliability and simplicity in construction. May be used as Car Radio, with full MEDIUM wave and LONG wave coverage.

### LOOK AT THESE FEATURES:

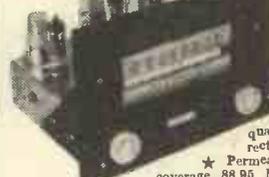
- ★ 500 milliwatt output to high flux 7 x 3 1/2 in. high fidelity loudspeaker.
- ★ Six selected MULLARD TRANSISTORS in latest supersensitive circuit plus germanium diode. ★ Compact size only 9 1/2 x 8 1/2 x 6 1/2 in. high. ★ Attractive three-tone cabinet, black, dark grey and silver grey with gilt control knobs and all gilt fittings. ★ Coax. socket for car aerial. ★ Brand new guaranteed components. ★ Push-pull output. ★ Automatic volume control.
- ★ Long-life battery. ★ Super-sensitive internal Ferrite rod aerial. Special inclusive price for all required components.

Alignment service available. Full assembly details and individually priced parts list, all of which are available separately, price 1/6 post free.

**ONLY £7.19.6** Plus P. & P. 4/-.

★ Nothing more to buy. Cabinet included.

## OUR NEW Mk.V F.M. TUNER UNIT TO BUILD YOURSELF!



Combines quality with simplicity of construction (only specially selected top-grade components are used). The refinements provided, and the performance achieved are equal to many commercial models at twice the price.

- ★ Self-powered using a good quality mains transformer and valve rectifier. ★ Guaranteed non-drift.
- ★ Permeability tuning. ★ Frequency coverage 88.95 Mc/s. ★ Fully drilled chassis.
- ★ F.M. Tuning Head by famous maker. ★ OAB1 Magic-eye tuning indicator. ★ Two I.F. Stages and Discriminator. ★ Attractive maroon and gold glass dial.
- ★ Valves used: EC885, two EF90's, E280 (rectifier) and magic eye. ★ Attractive metal front panel as illustrated, finished in a choice of black crackle, glossy hammer green, or glossy hammer grey enamel. ★ Everything supplied down to the last nut and bolt. All parts sold separately.

Special inclusive price for all components, full assembly instructions, circuit diagram, etc. Plus 5/- P.P. Optional extra: Attractive metal cabinet in grey, black or green to match front panel already supplied. 17/6. P. & P. 2/6. Full assembly instructions, etc., available separately if req. at 1/6 Post Free.

## The "HIGHWAYMAN"

OUR QUALITY CAR RADIO TO BUILD YOURSELF AT AN ECONOMICAL PRICE

- Look at these features:
- ★ Attractive styling. ★ Push-pull output.
- ★ Three latest MULLARD transistors plus valve types EB883 and EOB83.
- ★ No Buzz, high output and sensitivity.
- ★ Printed circuit (newest type).
- ★ 7 x 4 in. high flux p.m. speaker and baffle.
- ★ Medium and Long Waves.
- ★ Push button for fingertip control.
- ★ Extremely low battery consumption (less than 1 amp).
- ★ Easy to fit any make car. (Positive earth only.)
- ★ 12-volt operation.
- ★ Compact size, measures only 7 x 7 x 2 1/2 in. deep.
- ★ Easy assembly, supplied with dial and drive already mounted.



All parts available separately but if purchased at one time, the whole will be supplied at a special inclusive price of **ONLY £10.19.6** Plus 4/- P. & P. Individually priced parts list and comprehensive instruction booklet 2/6 post free. (Deducted from cost if complete parcel purchased later.)

**TAPE RECORDER CONSTRUCTORS**  
**LATEST COLLARO STUDIO TAPE TRANSCRIBER.** Latest type incorporating Record, Interlock, Lever, Button, 3 motors, 3 speeds, 1½, 3½, 7½ i.p.s., takes 7in. spools. Push-button controls. **NEW LOW PRICE OF £10/10/- ONLY!** plus 7/6 P. & P. Usual H.P. Facilities.

**NEW! TAPE RECORDER AMPLIFIER TYPE 8311-V.** Sub-assembled — anyone can build. Printed Circuit, all components mounted and dip soldered. Already tested. Each lead cut to length. All that is required to complete with tape recorder is for a few components to be mounted in the cabinet and the free end of the leads soldered to terminals which are clearly marked, everything supplied, all you need is solder iron, pliers and screwdriver. Valve line-up: EF86, ECC83, 2 x EL84, EZ81 and EM34 magic eye. Monitoring facilities, output socket for feeding to high quality amplifier can be used as "straight" amplifier for record reproduction. **EQUALISING ON TWO SPEEDS. OUTSTANDING VALUE AT £11/11/- plus 2/6 P. & P.** including all necessary instructions. **ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE.** Suitable for above amplifier and Collaro Studio deck. Fitted with 9in. x 5in. High Flux P.M. speaker for high quality reproduction. Inclusive price £5/5/- plus 5/- P. & P. Full list of competitively priced mics. and stands on request. The above 3 items purchased at one time, **SUPPLIED CARRIAGE PAID.**



**NOW AVAILABLE!** **FOUR-TRACK STUDIO DECK AS ABOVE.** FITTED WITH HI-FI FOUR-TRACK HEADS. PRICE £13/19/6 plus 7/6 P. & P. Four track heads supplied separately, complete with mounting bracket for Studio Deck at 9/1/6 pair, plus 2/6 P. & P.

**TAPE RECORDER AMPLIFIER 8311-4V.** Exactly as 8311-V but four-track, suitable for hi-fi four-track heads. Price £12/12/- plus P. & P.

**N.B.—**Four-track deck and amplifier fit the above case, without any modification whatsoever.

**PRE-AMPLIFIER KIT TYPE 8312-CP.** Complete high quality pre-amplifier kit for use with Collaro Studio Deck. Price £8/8/- plus 2/6 P. & P.

**TELEPHONE PICK-UP COIL.** Designed to feed into the microphone input of either a tape recorder or any high gain amplifier. Easily attached to telephone by rubber suction attachment. The coil is electrostatically shielded to minimise hum pick-up. When positioned on telephone this model is more than adequate for fully modulated tape recording. Brand new complete with 5ft. cable shielded. **ONLY 14/-.** Post free.

**TAPE! TAPE!**

**FOR THE FIRST TIME IN THIS COUNTRY—CANADA'S HI-FI MAGNETIC RECORDING TAPE — MADE BY "BEL CLEER" OF CANADA!**

Following sizes available—others to follow. **BRAND NEW—NOT SUB-STANDARD.** High grade acetate base. Attractively boxed, fitted leaders, fully guaranteed. 5in. 600ft., 12/6; 5in. 900ft., 15/-; 5½in. 1,200ft., 18/6; 7in. 1,200ft. 18/6; 7in. 1,800ft., 25/- P. & P. 6d. per spool, 3 or more post free (bona fide trade enquiries invited).



**PLASTIC SPOOL CONTAINERS** for spool sizes 5in. 1/6; 5½in. 2/-; 7in. 2/3.

**PLASTIC TAPE SPOOLS.** Best quality. 3in. 1/3; 4in., 2/-; 5in., 2/-; 5½in., 2/3; 7in., 2/6. Any single item plus 6d. P. & P. Orders over £1, post free.

**THE NEW R.C. TRANSISTOR TAPE TUNER**

May be used with most Tape Recorders. Full medium wave coverage, ferrite rod aerial sensitivity control. Attractive case, size only 3½in. x 2½in. x 1½in. deep. Carded components for easy identification. Solder, wiring wire, PP3 battery and step by step instructions supplied. **SPECIAL INCLUSIVE PRICE FOR ALL COMPONENTS, inc. battery 27/6. P. & P. 2/6.**

**ANOTHER CHASSIS SPECIAL**

Latest printed circuit. **THREE WAVE.** Long, Medium and Short. Extremely sensitive, ferrite rod aerial. 4 watts output. Valve line up. ECL82, EZ80, EBF89 and ECH81. Tape and gram inputs. Tone control. Attractive dial (size 12½in. x 4½in.) in maroon with gold lettering. Overall chassis size 12½in. x 4½in. x 7½in. high. A.C. 200/250 volts. Fully guaranteed. **SPECIAL PRICE £9.19.6** Plus 5/- P. & P. H.P. available.

**Another Unrepeatable CHASSIS BARGAIN**

A six-valve waveband AM/FM Superhet Radiogram chassis for 200/240 A.C. mains. Brand new, manufacturer's surplus. Covering:— 1,200-2,000 metres L.W. 200-550 metres M.W. 6-19 MCS S.W. 87-100 MCS VHF.

Internal Ferrite rod aerial for long and medium wave. Permeability tuner unit on VHF. Piano keyboard style push buttons for waveband and gram selection. Other controls: Volume-Tone on-off Tuning. Valves: ECC85, ECH81, EF89, EAB80, EL84, EZ80. Audio output: 4 watts. Chassis: 15½in. x 7in. x 7½in. high. Dial aperture: 13½in. x 4in. Attractive dial printed in gold on dark brown background. An ideal chassis, especially recommended for use with any of the latest autochanger units. Wonderful tone and dynamic range. Come and hear it at any of our branches. **PRICE COMPLETE £15/15/-** tax paid, plus 7/6 P. & P. H.P. available.

**AN ALL BRITISH PRECISION TEST METER**

(To build yourself)  
 Designed for Test bench and produced for us by one of Britain's leading technical training organisations this instrument covers the following nineteen basic ranges: D.C. Voltage 0-2.5, 0-10, 0-50, 0-100, 0-500, 0-1000. (All ranges 5000 ohms per volt.) A.C. Voltage 0-10, 0-50, 0-100, 0-500, 0-1000. (All ranges 5000 ohms per volt.) D.C. Current 0-200 microamps. 0-10 m/a., 0-100 m/a., 0-250 m/a., 0-500 m/a., A.C. current, 0-200 microamps. Resistance, 0-200,000 ohms. (Easily extendible to 2 megohms.) Accuracy, 3% of F.S.D. on D.C. ranges, 4½% on A.C. ranges, any frequency between 15-20,000 C.P.S. (Sine wave) 5% on resistance range. Positive Range selection by means of plug and socket. Easily constructed, full instructions being given with each assembly. All necessary components offered at the **ABSURDLY LOW PRICE OF 59/6, P. & P. 2/6.** Strictly limited quantity!!

**THE SINCLAIR SLIMLINE**

A new 2 TRANSISTOR printed circuit pocket radio. Completely portable—the smallest ever—only 2½in. x 1½in. x ¾in. Uses Micro Alloy Transistors and with built-in ferrite aerial will receive all stations on M.W.—B.B.C., 208, etc. Easy to assemble—no alignment problems. All required components, including earpiece **ONLY 49/6, P. & P. 1/6.** All parts sold separately.

**HI-FI SPEAKERS**  
**15in. BASS SPEAKER.** As used by B.B.C. British made. 20 watts. Flux density 12,000 Gauss, 185,000 Maxwells, 15 ohm speech coil, 20 cycles to 5 kc/s. This is a once only purchase, and the quantity is strictly limited. **12 gns. ONLY,** plus 7/6 P. & P.

**12in. Co-axial Speaker.** British manufacture. 15 watts, 15 ohms speech coil, Flux density 12,000 Gauss, 160,000 Maxwells. Foam rubber surround. A special price of **£6/12/6 ONLY,** plus 5/- P. & P.

**12in. BAKERS SELHURST LOUDSPEAKER.** 15 ohms, 15 watt 30-14,000 c.p.s. Brand new **£4/10/-, P. & P. 3/6.**

**12in. RICHARD ALLAN P.M. LOUDSPEAKER.** 3 ohm speech coil. Brand new. **ONLY 32/6** plus 2/6 P. & P.

**12in. RICHARD ALLAN P.M. LOUDSPEAKER.** 3 ohm speech coil. Double cone, full frequency. Brand new. **ONLY 39/6, P. & P. 2/6.**



**MULTI METER MODEL TK.50**

Size 5in. x 3½in. x 1½in. 1,000 ohms per volt. D.C. current: 1-250 m/a. D.C. and A.C. volts: 10, 250, 500 and 1,000 v. Resistance: 0-10K, 0-100K. Complete with test prods, battery and full instructions. Outstanding buy at **57/6,** plus 2/6 P.&P.



**MODEL TK20A**

Size 3½ x 2½ x 1½in. Meter size 2½ x 1½in. Sensitivity 1,000 o.p.v. on both A.C. and D.C.! A.C. and D.C. volts 0/15, 0/150, 0/1000 volts. D.C. current 0/150 mA. Resistance 0/100K. Complete with test prods, battery and full instructions. **OUTSTANDING VALUE AT 42/-** Plus 1/6 P. & P.



**MODEL 500 30,000 OHMS PER VOLT MULTI METER!**

9 range D.C. voltage to 1 kV. 7 ranges A.C. voltage to 1 kV. 5 ranges D.C. current to 12 amp. 3 ranges resistance to 60 meg. Incorporates internal buzzer for audible warning of direct shorts and blocking condensers for A.F. output. Capacity—20 -56. Measurements 3½ x 6½ x 2½in. Outstanding value at **£8/19/6.** H.P. available. **SOLID LEATHER CARRYING CASE** for Model 500. Price 30/- only.



**20,000 OHMS PER VOLT!!**

**MODEL 200H. Volt-ohm-Milliammeter. RANGES:**  
 A.C. VOLTAGE: 10, 50, 100, 500 and 1,000 volts (10,000 ohms per volt).  
 D.C. VOLTAGE: 5-25, 50, 250, 500 and 2.5k. (20,000 ohms per volt).  
 D.C. CURRENT: 0-50 micro-amps., 0-2.5 m/a., 0-250 m/a.  
 RESISTANCE: 0-6k., 0-6 meg. (300 ohms and 30k. at centre scale).  
 CAPACITANCE: 10pf. to .001 mfd., .001 mfd. to .1 mfd.  
 DECIBELS: —20 to +22 db.  
 A fully guaranteed pocket size meter, complete edge pointer, top quality, supplied complete with test prods and full operating instructions at **£5.5.0** Post free.

**CLYNE RADIO LTD.**

18 Tottenham Court Road, London, W.1.  
 162 Holloway Road, London, N.7.  
 9 Camberwell Church St., S.E.5.  
 12, Suffolk House, George St., Croydon.  
 10 Withy Grove, Manchester, 4.

THE COMPONENT SPECIALISTS  
 ALSO SEE OPPOSITE PAGE

**TELEFUNKEN HI-FI STEREO AMPLIFIER MODEL S.82 WITH BALANCE CONTROL NOW ONLY £5/19/6**

Carr. 7/-

110/250 v. A.C. input 5 watt undistorted, output (10 w. nominal). Size 9 x 9 x 2in. Weight 9 lb. Complete with spec. and instructions.



**6 TRANSISTOR AND DIODE SUPERHET**

A first class 2 waveband transistor superhet. Printed circuit panel (size 8½ x 2½in.) 3 pre-aligned I.F. transformers. High gain Ferrite rod aerial. First-grade transistors. Car-aerial winding. Push-pull output. All parts supplied with simple instructions. Set of parts if purchased at one time ONLY £4/5/- P. & P. 2/6. All parts sold separately.



**35 OHM SPEAKERS**

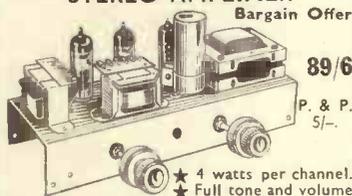
Suitable for use with above: 2in. Goodmans. Ideal replacement for many pocket portables, 8/6; 2½in. 10/6; 3½in. 12/6; 5in. 17/6; 7 x 4 21/- P. & P. 1/6 per speaker. PORTABLE CABINET Size approx. 9½ x 6½ x 3½in. Suitable for above using 3½in. speaker 25/- P. & P. 2/-

**COIL AND TRANSFORMER SET FOR TRANSISTOR SUPERHET**

3 I.F. transformers, one oscillator coil, one driver transformer and wound Ferrite aerial (med., long and aerial coupling). 28/6 complete, post 1/- 6 transistor printed circuit, board to match, 8/6, post 9d. Circuit diagram 1/6 extra.

**STEREO AMPLIFIER**

Bargain Offer



89/6 P. & P. 5/-

4 watts per channel. Full tone and volume controls. Absolutely complete. Suitable Pair of Speakers. 8 x 5in. 3 ohm. 21/- the pair. P. & P. 3/-

**RECORDING TAPE**

P.V.C. base, full frequency L.P. tape. 7in. 1,800ft. (normally 50/-). 27/6; 5½in. 1,200ft. (normally 35/-), 18/9. 5in. 900ft. (normally 28/-), 15/- P. & P. 1/- per spool. Ideal for 2- or 4-track recorders.

**HARVERSON'S F.M. TUNER MARK I**

F.M. tuning head by famous maker. Guaranteed non-drift. Permeability tuning. Frequency coverage 88-100 Mc/s. OAB1 balanced diode output. Two I.F. stages and discriminator. Attractive maroon and gold dial (7 x 3in. glass). Self powered, using a good quality mains transformer and valve rectifier. Valves used ECC85, two EF80s and E280 (rectifier). Fully drilled chassis. Size of completed tuner 8 x 6 x 5½in. All parts sold separately. Set of parts if purchased at one time. £5/19/6 plus 8/6 P.P. and ins. Circuit diagram and illustrations 1/6 post free. Mark II Version, as above, but complete with magic eye, front panel and brackets. £6/12/6. P. & P. 8/6. Mark III Version, as Mark I but with output stage (ECL82) and tone control. £7/7/- P. & P. 8/6.

**HANDSOME METAL CABINET**

In choice of grey, black or green. To fit Mark I, 25/- P. & P. 2/6. To fit Mark II, 17/6. P. & P. 2/6.

**SPECIAL OFFER!**

**GORLÉ F.M. TUNER HEADS**

10.7 Mc/s. I.F. 15/- plus 1/9 P. & P. (ECC85 valve 8/6 extra).

**F.M. TUNER HEAD**



A permeability tuned tuner head by a famous maker, supplied without valve (ECC85) and drum and spindle, 18/6, plus 1/9 P. & P. Valve 8/6 extra. Drum and spindle 3/6 extra.

**SPECIAL PURCHASE!**

**TURRET TUNERS**

By famous maker. Complete with PCC84 and PCF80 valves. 34-38 Mc/s. I.F. Biscuits, for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. 25/- each. P. & P. 2/6.

**FURTHER HUGE PURCHASE enables us to offer the**

**E.M.I. 4-speed Player and P.U.**

FOR ONLY 67/6 P. & P. 4/6



Heavy 8½in. metal turntable. Low flutter performance 200-250 v. shaded motor with tap at 45 v. for amplifier valve filament if required. Turn-over LP/78 head.

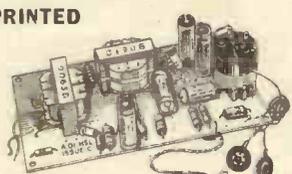
**4-SPEED PLAYER UNIT BARGAINS**

Single Players. B.S.R. TU/12, £3/10/- Carr. 3/6. Auto Changers. B.S.R. UA14, £6/2/6. Latest B.S.R. UA16, £7/2/6. Carr. 5/- on each. Latest Garrard "Auto-Slim," £6/17/6 Carr. 5/-

**SPEAKER AND CABINET FABRICS** Oatmeal fabric for speaker or cabinet or red rexine for cabinet. 54in. wide, 13/6 per yd. length (minimum order). P. & P. 1/6.

**HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1**

★ Peak output in excess of 1½ watts. ★ All standard British components. ★ Built on printed circuit panel, size 6 x 3in. ★ Generous size Driver and Output Transformers. ★ Output transformer tapped for 3 ohm and 15 ohm speakers. ★ Transistors (GET 114 or S1 Mullard OC81D and matched pair of OC81 o/p). ★ 9 volt operation. ★ Everything supplied, wire, battery clips, solder, etc. ★ Comprehensive easy to follow instructions and circuit diagram 1/6 (free with kit). All parts sold separately.



**SPECIAL PRICE 45/- P. & P. 2/6.**

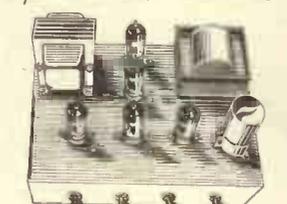
**TRANSISTORS**

GET15 (Matched-Pair) 15/-  
OC71 ..... 5/- PXA101 ..... 6/6  
OC72 ..... 6/- XA103 ..... 6/6  
OC76 ..... 6/- V15/10p ..... 12/6  
Set of Mullard 6 transistors OC44, 2-OC45, OC81D, Matched pair OC81, 25/- All Post Free.

**SPECIAL OFFER! CAR RADIO AERIALS**

by well known maker Originally listed 32/6 OUR PRICE 22/- P. & P. 2/- Wing mounting, heavily chromed, 3-section telescopic, open 43½", closed 17". Simple one hole fitting. Complete with coax lead and plug.

**10/14 W. HI-FI AMP. KIT**



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer (to match 3-15Ω speaker) and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and E280 rectifier. ONLY £6/19/6. P. & P. 6/6. All parts sold separately. Simple instruction booklet 1/6. (Free with parts.)

**AMPLIFIER ON PRINTED CIRCUIT BOARD**

Two valve. UY85, UL84 with O.P. trans., use with 80 volt tap off motor, 39/6. P.P. 2/6 on above. Dropper res. for filaments if required 2/6.

**B.S.R. AUTO UNITS**

160 v. Suitable for use with above. (Slightly soiled) £4/4/- P. & P. 5/-

**LARGE CABINET**

Suitable for above B.S.R. Auto Unit and amps. Complete with 3 ohm speaker. £3/9/6. Carr. 5/- Superior Cabinet. Similar to above to take 8 x 5in. speaker, with motor board, will accommodate BSR UA14 or UA16. £3/9/6. Carr. 5/6. Speaker 15/- extra. P. & P. 1/6 extra.

**3 OHM LOUDSPEAKERS**

2½in. 12/6; 5in. 12/6; 6½in. 15/-; 8in. 21/-; 10in. 25/-; 12in. 27/6  
E.M.I. 2½in. tweeter ..... 10/6  
Goodmans 5in. tweeter ..... 10/6  
8 x 5in by famous maker ..... 10/6  
E.M.I. 10 x 6in. ceramic magnet 25/-  
E.M.I. 13½in. x 8½in. high flux 32/6  
Rola Celestion approx. 9in. x 6in., middle register speaker ..... 10/6  
Also 15 ohm, 12in. 30/-  
P. & P. up to 6in. 1/6; over 6in. 2/6 per speaker. ALL BRAND NEW.

**B.S.R. MONARDECK**

(Single speed) 3½in. per sec., simple control, uses 5½in. spools, £6/15/-  
**COLLARO STUDIO DECK** £10/10/- plus 5/6 carr. and ins. on both (Tapes extra on both).

**RECORD PLAYER AMP.**

2 valve (E280, ECL82), A.C. mains, 3 watts output, ready built, tested and complete with valves and output transformer. Size 7in. w. x 2½in. d. x 5½in. h. 55/- P. & P. 3/- Suitable Speakers, 6in. 15/-, P. & P. 1/6, or 10in. x 6in. 25/-, P. & P. 2/6.

**QUALITY RECORD PLAYER AMPLIFIER**

A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs ECC83, EL84, E280 valves. Bass, treble and volume controls and op. transformer matched for 3 ohm speaker. Price 69/6. P. & P. 3/6. DITTO. Mounted on board with output transformer and 6½in speaker. Complete at 89/6. P. & P. 4/6.

**SPECIAL BARGAINS!**

**TWO GANG .0005 TUNING CONDENSER.** Gearing precision reduction drive. Size 2½ x 2 x 1½in. Brand new and unused, 3/6 each. P. & P. 1/-

**MAINS TRANSFORMERS.** Tapped Primary, ½ wave or Bridge Rectifier. Secondary 250 v. at 75 mA. 6.3 volts at 2 amps. 10/6. P. & P. 3/-

**MAINS TRANSFORMER.** Impregnated and fully shrouded. Size 4½ x 3½ x 2½in. Weight 6lb. Tapped primary 205, 225, 245 v. Electrostatic screen. Output 360-0-360 v. at 120 mA. D.C. plus 1050 v. half wave at 3 mA. D.C., 6.3 v. at 3.5 amps, centre tapped 5 v. at 2½ amps, and 6.3 v. at 6 amps. PRICE ONLY 21/- P. & P. 5/-

**CARBON MIKE INSERTS.** Brand new 2½in. dia. 3/6. P. & P. 9d.

**ELECTROSTATIC H.F. TWEETERS.** Type L.S.H. 75. Size 3 x 3in., 2/6 each, plus 9d. P. & P.

**ACOS CRYSTAL MIKES.** High impedance for desk or hand use. High sensitivity, 18/6. P. & P. 1/6.

**TSL CRYSTAL STICK MIKES.** (Listed at 45/-) Our Price 18/6. P. & P. 1/6.

**TRANSISTOR DRIVER and O/P TRANSFORMERS.** (Tapped 3 ohm and 15 ohm o/p) plus 4 suitable Transistors giving approx. 1 watt o/p. 30/- P. & P. 2/-

**3 PUSH-BUTTON TRANSISTOR SWITCH D.P. — D.T.** Each switch 5/6 plus 1/- P. & P.

**HARVERSON SURPLUS CO. LTD.**

170 HIGH ST., MERTON, S.W.19 CHERRYWOOD 3985/6  
Open all day Saturday. Early closing Wed., 1 p.m.  
A few minutes from South Wimbledon Tube Station. (S.A.E. all enquiries.)  
Please Note: P. & P. charges quoted apply to U.K. only. P. & P. on overseas orders charged extra. (PLEASE WRITE CLEARLY.)

**UNIVERSAL AVOMETERS**



Guaranteed perfect working order. Supplied complete with leads, batteries and instructions.  
**Model "D,"** 34 range... £8 19 6  
**Model "7,"** 50 range... £11 0 0  
 Registered Post 5/- extra.

**MICROAMMETERS**

0-500 microamps. 2½ in. circular flush panel mounting. Dials engraved, 0-15, 0-600 volts. **BRAND NEW. BOXED. 15/- P.P. 1/6.**

**7.5 K.V.A. AUTO TRANSFORMERS**

0-115-230 volts. Brand new boxed. £15. Carriage 10/-.

**230/250 VOLT A.C. MOTORS**  
 4½ x 3 in. dia., 90 watts, 5,000 r.p.m., ½ in. spindle. 22/6. P.P. 1/6.

**1 K.V.A. ISOLATION TRANSFORMERS**

230 v. Pri.: 230 v. Sec. Boxed, £5 each. Carriage 10/-.

**VARIAC TRANSFORMERS**

24 amp., 230 volt primary, 185 to 250 volt output, £12/10/-. Carriage 10/-.

**TELEPHONES TYPE "H"**

Sound powered, generator bell ringing, 2 line connection. Fully tested, £4/19/6 pair. Carr. 5/-.

**3000 WATT AUTO TRANSFORMERS**

0-115-230 volts, step-up or step-down. Brand new boxed ex-U.S.A., £7/10/- each. Carr. 10/-.

**PANEL METERS**

100µA	2½" F.M.	D.C.	42/6
100µA	3½" F.M.	D.C.	62/6
1 mA.	2½" F.M.	D.C.	25/-
2 mA.	2½" F.M.	D.C.	15/6
30 mA.	2½" F.M.	D.C.	12/6
30/0/30 mA.	2½" F.M.	D.C.	9/6
350 mA.	2½" F.M.	D.C.	10/6
15 amp.	3½" F.M.	D.C.	39/6
5/0/5 amp.	3½" F.M.	D.C.	25/-
300 v.	2½" Proj.	A.C.	19/6
300 v.	2½" F.M.	A.C.	25/-
500 v.	2½" F.M.	A.C.	25/-
120v.	3½" F.M.	D.C.	32/6

Postage extra.

**FIELD TELEPHONES TYPE "F"**

Suitable for many applications. Generator bell ringing, 2 line connection. With batteries and wooden carrying case, fully tested, £4/19/6 per pair. Carr. 5/-.

**SUB-STANDARD D.C. AMMETERS**

9 ranges, 150 mA., 1.5A., 3A., 7.5A., 15A., 30A., 60A., 300A., and 450A. Housed in teak portable case, 8 in. mirror scale. Supplied brand new with all shunts and leather carrying case, £15 each. P.P. 10/-.

**P.C.R.2 RECEIVERS**

800-2,000 metres, 190-550 metres 6-22 Mc/s. output for phones or 3Ω speaker. As new £5/19/6. Carr. 10/6. PCR3 as PCR2 but covers 190/550 meters, 2-7 Mc/s, 7-22 Mc/s, including top band. As new £8/8/-, Carr. 10/6. All above models can be supplied with internal power unit to operate on 200/250 v. A.C. at 39/6 extra or alternatively plug-in external power units are 35/-.

**AVO WIDE RANGE SIGNAL GENERATOR**

Frequency coverage 50 kc/s to 80 Mc/s in six turret operated ranges. For use on standard A.C. mains. Packed in original transit cases with accessories. Supplied in as new condition, fully checked before despatch, £15. Carriage 10/-.

**NATIONAL H.R.O. RECEIVERS**

**SENIOR MODEL.** Supplied complete with full set of 9 coils covering 50 kc/s. to 30 Mc/s. Each receiver thoroughly checked and available as follows:  
**TABLE MODEL.** As new condition £25.  
**TABLE MODEL.** Extremely good used condition, £19/19/-.  
**RACK MODEL.** Extremely good used condition, £18/18/-, Carriage £1 extra.

200/250 volt A.C. power packs for above receiver, also sold separately, 59/6. Carr. 5/-.

**PRECISION COMBINATION VOLTMETER/AMMETER FOR A.C. AND D.C.**

Two separate instruments housed in polished wood case, 6 in. scales with knife edge pointers.

Ranges:  
 Volts A.C. and D.C. 160-300-600 v.  
 Amps. A.C. and D.C. 25-50-150-200 A.

Supplied complete with all current shunts, leads and leather carrying case. Manufactured by Elliott Bros. Supplied brand new, £9/19/6 each. Carriage 7/6.

**HALLICRAFTER S36 V.H.F. RECEIVERS**

F.M./A.M. 27-143 Mc/s. 110 volt A.C. (transformer supplied for 230 v. A.C.) Improved version of S-27. Tested before despatch. Brand new boxed with instruction manual. **£40** each Carr. £2

**MINE DETECTOR No. 4A**

Will detect all types of metal. Fully portable. Complete equipment supplied tested with instructions, 39/6. Carriage 10/6. Battery 8/6 extra.

**COLLARO STUDIO TAPE TRANSCRIBER**

Brand new 1962 model. 3 speeds, 3 motors, digital counter, etc. With latest Bradmatic heads and interlock button. Supplied with spare spool, instructions, fixings, 10 gns. each. Carr. paid.

**FABULOUS TAPE OFFER**

Famous American Brand Tapes. Brand new, fully guaranteed. 5 in.—600ft., 10/6. 5 in.—900ft., 13/6. 5 in.—1200ft., 17/-, 7 in.—1200ft., 13/6, 7 in.—1800ft., 18/6, 7 in.—2400ft., 27/6. P. & P. extra. S.A.E. for full tape list.

**COSSOR 1035 DOUBLE BEAM OSCILLOSCOPES**

Offered in guaranteed perfect condition, £45 each, carr. £1. A vast selection of other scopes available by Erskine, Mullard, E.M.I., Solartron, etc.

**HEAVY DUTY POWER PACKS**

Input 200/250 volts A.C., three H.T. outputs, 2 x 400 volt 175 mA., 350 volt 225 mA., all fully smoothed. 2 x 6.3 volt 5 amp., 6.3 volt 4 amp., 12 volt 5 amp. Supplied in perfect condition, £5/10/- each. Carr. 30/-.

**PRECISION A.C. AND D.C. VOLTMETERS**

Two ranges, 160 and 320 volts, 8 in. mirror scale with knife edge pointer. Housed in polished wooden case. Ideal for Schools, Labs., etc. Supplied brand new, £5/19/6 each. P/P 3/6.

**MARCONI STANDARD SIGNAL GENERATORS TF-144G**

Frequency 85 kc/s. to 25 Mc/s., calibrated output 1µV. to 1 volt. Operation 200/250 volts A.C. Supplied in guaranteed perfect condition, with mains lead and dummy aerial, £25. Carr. 30/-.

**CAMBRIDGE UNIPIVOT GALVONOMETERS**

Centre reading 50 microamps. Supplied complete with leather carrying case, perfect condition, £4/19/6. P/P 3/6.

Hours of Business: 3 LISLE STREET, 9 a.m.—6 p.m. Half Day Saturday  
 34 LISLE STREET, 9 a.m.—6 p.m. Half Day Thursday

**MARCONI CR100/8 RECEIVERS BRAND NEW**

Packed in original transit cases and complete with handbook/manual. 60 Kc/s to 30 Mc/s. 200/250 volt A.C. operation. Tested before despatch.

**£35** Carriage £2.

A few CR.100 receivers available in good used condition, £21.

**MINI FLUX—HI-FI TAPE HEADS**

Set of 3, record, play back, erase. Only 29/6 a set. P. & P. 9d.

**L.T. METAL RECTIFIERS**

All full wave, bridge connected. Brand new, guaranteed.

12/18v. 1.5A. 3/9	24/36v. 4A. 22/6
12/18v. 2.5A 6/3	24/36v. 6A. 27/6
12/18v. 4A. 8/3	24/36v. 15A. 45/-
12/18v. 6A. 12/3	36/48v. 2A. 19/6
12/18v. 10A. 22/6	36/48v. 4A. 29/6
12/18v. 15A. 37/6	36/48v. 6A. 32/6
24/36v. 1A. 7/3	48/60v. 2A. 21/-
24/36v. 2A. 13/6	48/60v. 10A. 82/6

Please add postage.

**L.T. TRANSFORMERS**

All primaries tapped 200/250 volts. 1 Battery Charging. 3.5, 9 or 17 volt, 1 amp., 9/9. Ditto 2 amp., 14/3. Ditto 4 amp., 16/6. 9 or 17 volt, 6 amp., 26/-.

2 Model Type 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt, 2 amp. 18/6. Ditto 4 amp., 30/- Ditto 5 amp., 37/6. Add postage.

**MINIATURE MODEL ACCUMULATORS**

Lead Acid. BRAND NEW. 2v. 1.5 A.H., 4 x 1½ x 1 in., 2lb., 5/6. P.P. 1/3. 12v. 0.75 A.H., 4 x 3 x 1½ in. 2lb., 15/6. P.P. 1/6.

**R.C.A. PLATE TRANSFORMERS**

Pri. 200/250 v. sec., 2,000.0-2,000 v. 500 mA., tapped 1,500 v. New. Boxed, £6/10/-. Carriage 15/-.

**DUMONT KI051PI DOUBLE BEAM C.R.T.**

Twin Gun. Brand new, boxed, 59/6. P.P. 3/6. 1.2 Ohm 12 Amp. RHEOSTAT Geared slider type, new boxed, 15/6 each. P.P. 3/6.

**MARCONI TF-885 VIDEO OSCILLATORS**

25 c/s-5 Mc/s. Supplied in guaranteed as new condition, £90 each.

**H.R.O. DIALS**

Brand new, 27/6. P.P. 2/6.

**MINIATURE PANEL METERS**

For 1½ in. dia. panel hole.  
 0.50µA 39/6 0-300 v. D.C. 27/6  
 0-500µA 32/6 "5" meter 35/-  
 0-1 mA 27/6 "VU" meter 42/6  
 0-5 mA. 27/6 Post paid.

**CONSTANT VOLTAGE TRANSFORMERS**

95/130 v input 115v. output 500 watts. Can be used in series for 230 volt £4 each. Carriage 10/-.

**WESTON MICROAMMETERS MOVING COIL RELAYS**

Brand NEW, Boxed, fully guaranteed, 42/6 each. P. & P. 2/-.

Send S.A.E. For Bargain Lists

**GW. SMITH & CO. (RADIO) LIMITED**  
 Phone: GERRARD 8204/9155  
 Cables: SMITHEX LESQUARE  
 3-34 LISLE STREET, LONDON, W.C.2

# Samson's

(ELECTRONICS LTD)

LONDON'S LARGEST SUPPLIERS OF  
ELECTRONIC EQUIPMENT  
9 & 10 CHAPEL STREET,  
LONDON, N.W.1.  
Tel. PAD 7851      AMB 5125



## HEAVY DUTY L.T. TRANSFORMERS

All primaries 220-240 volts. Terminal block connections.

No.	Secondary Tapped	Price	Carr.
1	25, 30, 35 v., 40 a.	£11 9 6	10/-
2	25, 30, 35 v., 20 a.	£6 19 6	7/6
3	25, 30, 35 v., 10 a.	£4 15 0	5/-
4	25, 30, 35 v., 2 a.	£1 17 6	3/6
5	10, 17, 18 v., 10 a.	£2 17 6	4/-
6	24 volts, 30 amps.	£7 15 0	7/6
7	20 volts, 30 amps.	£6 15 0	7/6
8	50 volts, 15 amps.	£6 19 6	7/6
9	30 v., 40 v., 50 v., 5 a.	£4 15 0	5/-
10	24, 36, 48 v., 8 a.	£4 19 6	5/-
11	17, 18, 20 v., 20 a.	£4 19 6	5/-
12	6, 12 v., 20 a.	£3 12 6	5/-
13	20 volts, 20 amps.	£4 15 0	7/6
14	30, 32, 34, 36 v., 5 a.	£2 17 6	4/-
15	6, 12 v., 10 a.	£2 2 6	4/-
16	12 volts., 5 amps	£1 9 6	3/-
17	24 volts, 10 amps.	£3 5 0	4/-
18	24 volts, 5 amps.	£1 19 6	3/6
19	48, 56, 60 v., 1 a.	£1 9 6	3/6
20	12, 24, 30, 48 v., 2 a.	£2 5 0	3/6
21	6.3 volts, 15 amps.	£1 17 6	3/6
22	6.3 v. 5 a. and 6.3 v. 1 a.	15 0	3/6
23	12, 24 v., 1 a.	15 0	2/6
24	9, 15 v., 2 a.	17 6	2/6
25	6, 9, 15 v., 4 a.	£1 5 0	3/6
26	12, 18 v., 10 a.	£2 12 7	4/-
27	12, 18 v., 20 a.	£3 19 6	5/-
28	10, 18, 20 v., 9 a.	£3 9 6	5/-
29	10.5 v. 7 a. and 6.6 v. 7 a.	£1 15 0	5/-
30	12 v. 1/2 a. and 12 v. 1/4 a.	15 0	3/-

**MULTI TAPPED TRANSFORMERS**  
Pri. 200, 230, 250 volts. Sec. T 3, 4, 5, 6, 8, 9, 12, 12, 15, 18, 20, 24, 30 volts, 5 amps. 45/-, p.p. 4/- 4 amp. 39/6, p.p. 3/- 2 amp., p.p. 3/-.

**AUTO TRANSFORMERS**  
240-110 volts 2 kVA. Completely enclosed in metal case with carrying handle. Fitted with 2 two-pin American sockets or terminal blocks. Size 10 x 8 x 6in. Supplied brand new and guaranteed. £8/15/- Carr. 7/6. 1,000 watts £4/15/- Carr. 4/- 500 watts £3/10/- Carr. 4/- 300 watts £2/7/6 Carr. 3/-.

**HEAVY DUTY L.T. TRANSFORMER**  
Pri. 240 v. Sec. tapped 4, 6, 11 volts. 200, amps. £9/10/0. Carr. 10/-.

**A.M. HEAVY DUTY AUTO STEP-UP OR STEP-DOWN TRANSFORMERS.**  
Designed for the Air Ministry for mains boosting or operating 110 v. equipment. 10KVA. Tapped 250, 240, 230, 220, 120, 115, 110, 105 volts. Completely enclosed in metal case. Size 27 x 17 x 14in. Weight approx. 3 cwt. £29/10/0. 5KVA. Tapped as above. Size 23 x 14 x 11in. Weight approx. 2 cwt. £19/10/0. 2.5KVA. Tapped as above. Size 15 x 8 x 8in. Weight approx. 75 lb. £10/19/6. All transformers supplied new and guaranteed and offered at a fraction of maker's price. Carr. extra.

**STEP DOWN TRANSFORMERS**  
Pri. tapped 220-230-240-250 v. Sec. tapped 100-110 volts, 200 watts double wound. 52/6. Carr. 5/-.

**A.M. ISOLATION TRANSFORMERS**  
Pri. tapped 100-200-220-240 v. Sec. 225 volts. Very conservatively rated at 1.1 amps, double wound. £3/15/- Carr. 7/6.

**TEDDINGTON THERMOSTATS TYPE I.T.** Range 25-105°C. Length 6in., 22/6, p.p. 2/6. Supplied new and guaranteed.

**ROTOTHERM THERMOMETERS.** 50-250 deg. C. Immersion type. 3 1/2in. dia. Dial length of tube 13 1/2in. Complete with flange nut, 37/6, plus 3/6.



## AMERICAN HIGH VOLTAGE CAPACITORS

1 MFD. 20,000 V. WKG. Tropically rated. Size H. 1 1/2in. plus insulated terminals. 5in. W. 13in., D. 4in.  
Supplied brand new in maker's packing case at a fraction of original price. £7/10/0. Carr. 7/6.

### OTHER TYPES AVAILABLE

T.C.C. 1 mfd. 7,500 v. wkg. at 70°C. 50/-, carr. 7/6. 0.5 mfd., 15,000 v. wkg. at 60°C. 79/6, carr. 7/6. 0.001 mfd. 15,000 v. wkg. 45/-, carr. 5/- 1.5 mfd., 4,000 wkg. 12/6, p.p. 2/6. 1 mfd., 2,500 v. wkg. at 60°C. 15/-, p.p. 2/- 0.5 mfd., 7,500 v. wkg. at 71°C. 25/-, p.p. 2/6. 4 mfd., 1,500 v. wkg. at 71°C. 10/6, p.p. 2/- 4 mfd., 1,000 v. wkg. at 60°C. 7/6, p.p. 2/- 10 mfd., 450 v. wkg. at 140°F. 8/6, p.p. 2/- 8 mfd., 600 v. wkg. at 71°C., p.p. 7/6. 2 mfd., 200 v. wkg. at 71°C. 2/6, p.p. 1/6. 1 mfd., 500 v. wkg. at 60°C. 2/-, p.p. 1/-.

**DUBILIER.** 4 mfd., 3,000 v. wkg. at 71°C. 25/-, p.p. 3/- 2 mfd. 2,500 v. wkg. at 71°C. 17/6, p.p. 2/6. 1 mfd., 5,000 v. wkg. at 71°C. 25/-, p.p. 3/- 0.5 mfd., 5,000 v. wkg. at 71°C. 15/-, p.p. 3/- 0.25 mfd., 7,500 v. wkg. at 71°C. 17/6, p.p. 3/- 0.25 mfd., 5,000 v. wkg. at 71°C. 12/6, p.p. 2/6. 0.1 mfd., 5,000 v. wkg. 10/6, p.p. 2/6. 8 mfd., 900 v. wkg. at 71°C. 8/6, p.p. 2/- 0.5 mfd., 10,000, 37/6, carr. 3/6.

**AMERICAN.** All tropically rated. 16 mfd., 400 v. wkg., 8/6, p.p. 2/- 10 mfd., 300 v. wkg. 5/6, p.p. 2/- 8 mfd., 500 v. wkg. 7/6, p.p. 2/- 3 mfd., 1,000 v. wkg. 7/6, p.p. 2/- 0.15+0.15 mfd., 8,000 v. wkg. 10/6, p.p. 1/6. 0.1 mfd., 7,000 v. wkg. 8/6, p.p. 1/6. 0.2 mfd., 5,000 v. wkg. 7/6, p.p. 1/6. 8 mfd., 1,500 v. wkg. 17/6, p.p. 2/6. 10 mfd. 600 v. wkg., 8/6, p.p. 2/- 2 mfd. 5,000 v. wkg., £3, carr. 4/-.

### A.C. RATED CAPACITORS

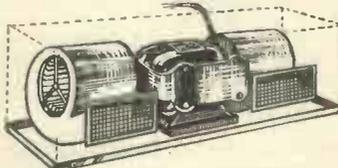
30 mfd., 440 v. wkg. A.C. 35/-, p.p. 2/6. 5 mfd., 400 v. wkg. A.C. 10/6, p.p. 2/- 5 mfd., 220 v. wkg. A.C. 7/6, p.p. 2/- 25 mfd. 440 v. A.C. 22/6, p.p. 2/6. 15 mfd. 660 v. A.C. 17/6, p.p. 3/6. 4 mfd. 650 v. A.C. 15/-, p.p. 2/6. 68 mfd., 440 v. r.m.s. 45/-, p.p. 5/- 10 mfd. 660 v. 15/-, p.p. 2/- 13.5 mfd. 750 v. 30/-, p.p. 4/- 16 mfd. 650 v. 18/6, p.p. 2/6.

**DUBILIER CAPACITORS.** Tubular electrolytics. 16+16 mfd., 500 v. wkg. Brand new. 24/- Per dozen. p.p. 2/6.

### SPECIAL OFFER

**E.A.C. LTD. A.C. 0-300 VOLTMETERS.** 6 inch flush mounting, iron case protected, panel hole 6 1/2in. Supplied brand new in sealed cartons at a fraction of maker's price. £3/15/- Carr. 4/-.

### TWIN TURBO BLOWERS



A.C. 200-240 volts 1/8 h.p. motor, 2,850 r.p.m. Manufactured by famous manufacturers for computer equipment in perfect condition. Completely enclosed, size 24 x 8 x 8 in. £7/19/6, Carr. 7/6.

**SPECIAL OFFER. LATEST HIGH CAPACITY TUBULAR ELECTRO-LYTICS.** By famous makers. 8,000 mfd., 65 v. wkg. 25/- 3,300 mfd. 110 v. wkg. 22/6. 2,000 mfd. 115 v. wkg. 17/6. 1,500 mfd. 100 v. wkg. 15/- 500 mfd. 400 v. wkg. 12/6. 500 mfd. 200 v. wkg. 10/6. 400 mfd. 300 v. wkg. 10/6. P.p. 2/- each Supplied New and Guaranteed.

### S.T.C. L.T. UNIT TYPE 7B

A.C. input 200-250 v. D.C. output 36 volts 50 amps. Built into heavy metal case. Size 40 x 20 x 13in. £32/10/0. Ex warehouse.

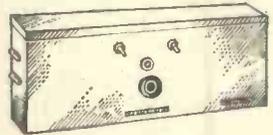
### WESTINGHOUSE "WESTAT" CONSTANT POTENTIAL POWER UNIT.

A.C. input 200-250 v. D.C. output 12.9 volts. 46.5 amps. Stabilised and smoothed, built into heavy metal case. Size 21 x 19 x 17in. £35. Ex warehouse.

### I.B.M. D.C. SUPPLY UNIT

A.C. input 220-250 v. D.C. output 75 volts, 2 1/2 amps. £3/15/- Carr. 5/-.

### L.T. SUPPLY UNIT TYPE S.E.I.



A.C. input 200-240 v. D.C. Output tapped to give 12 or 24 volts 8 amps. continuous rating. Fitted with panel fuse. Mains on/off switch and D.C. output socket. Built in strong metal case. Size 15 x 6 x 6in. An ideal general purpose L.T. supply unit for operating relays. Contactors, battery charging, etc. £9/19/6, carr. 7/6.

### L.T. SUPPLY UNIT TYPE S.E.2

A.C. input 200-240 v. D.C. output 50 volts 5 amps. Built in metal case size 15 x 6 x 6in. Fitted with on/off switch, panel fuse, and output socket. £9/19/6, carr. 7/6.

### LOW VOLTAGE VARIACS

We have a large selection of these transformers, example 0-30 v., 0-60 v., 0-100 v. at various amperages, let us know your requirements.

**L.T. CHOKES.** Designed to smooth 12-24 v. D.C. at 5 amps., 25/-, p.p. 3/-. Larger types available.

### AMERICAN TELEPHONE CABLE

Similar to single D3 field cable. 2 mile drums. Supplied unused and perfect £5/10/0. Carr. 10/-.

### GRESSALL HEAVY DUTY RHEOSTATS

26 ohms 4 amps. 6 in. dia., carbon track. Panel mounting. Length of spindle 1 1/2 in., 3in. dia. BRAND NEW 45/- Carr. 4/-.

### HIGH GRADE M.C. D.C. VOLTMETERS

180-280 volts 5 1/2 x 2in. Rectangular dial. Set in wall mounting case, size 8 x 6 1/2 x 3 1/2in. with lamp fitting to illuminate dial. Supplied brand new at a fraction of maker's price, 37/6, p.p. 3/6.

### UNIT SUPPRESSOR TYPE. A2276B.

Containing E. Edgcumbe A.C. 0-300 v. 50 cy., 4 1/2 meters 2 mfd. 350 v. A.C. wkg. capacitor. Smoothing choke. Size of unit 10 x 11 x 7in., 59/6, carr. 7/6.

### BRAND NEW W.D. TELEPHONE CABLE

Twin DB, one mile drums. £7/10/0, carr. 15/- Twin Canadian P.V.C. D3, 500 yard drums. 59/6, carr. 7/6. British D3 single 1 mile drums. 59/6, carr. 7/6. 1/3 mile drums, 25/-, carr. 5/- P.V.C. Telephone Cable, 6 steel, 1 copper strands, 800 yard coils, 35/-, p.p. 5/- P.V.C. Commando Tele Cable, 1,000 yard drums, 9/11, p.p. 4/-.

### CROMPTON PARKINSON A.C. VOLTMETERS.

90-180 v. M.I. 50 cycles. 4 1/2in. scale. Flange mounting. Supplied new and guaranteed at a fraction of maker's price. 27/6, p.p. 4/.

### MINIATURE ALKALINE CELLS.

1.2 volts. 3 A.H. Size 3 x 2 1/2 x 1/2in. Unused and guaranteed. 6 for 18/6, p.p. 3/- 12 for 35/-, p.p. 4/-.

### STC FW BRIDGE RECTIFIERS.

Max. A.C. input 90 volts. D.C. output 8 1/2 amps. 7 1/2in. sq. plates. Brand new £7/10/0. Carr. 5/-.

**100,000 O.P.V. MULTI-TESTER**

MODEL 370-N  
**£14.14.0**

Incorporates 9.5  $\mu$ A. basic meter, scale size 4 x 2 1/2 in. Ranges D.C. volts, 8 ranges 100 mV. to 5 kv. D.C. amps., 7 ranges, 10  $\mu$ A. to 10 A. A.C. volts, 6 ranges 2.5 v. to 1 kv. Ohms 5 ranges 0-50 megohms and 5 ranges 40 ohms to 400 K ohms. Overall size 7 x 5 x 2 1/2 in.

**30,000 o.p.v. MULTI-TESTER MODEL 500.** Ranges D.C. volts 0-1,000 v. A.C. volts 0-1,000 v. (15,000 o.p.v.). D.C. current 0.05-500 mA., 0-12 a. Resistance 0-60 megohms. Decibels +20 to -50 dB. Sizes 3 1/2 in. x 6 1/2 in. x 2 1/2 in. **ONLY £8/17/6.** Both above supplied complete with instruction manual, test leads and batteries.



**COSSOR 1035 DOUBLE BEAM OSCILLOSCOPE**

A fine instrument in perfect condition and in good working order, £40. Carr. 30/-. Also 1049 at £45. Carr. 30/-.

**EVERSHED & VIGNOLES Series II. 500 v. Megger** with leather case, used but in good condition, £18/18/-.

**EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER** (low reading ohm meter), 2 ranges 0-3, 0-80 ohm. Complete with leather case and test leads. As new, £8/6/-. Ditto, 0-500, 100-5,000 ohms, £8.

**EVERSHED & VIGNOLES. Wec Megger 500 v.**, with leather carrying case, good working order £12/19/6.

**BRIDGE MEGGERS.** Evershed and Vignoles Series 2, 500 v. Accurate working order, perfect condition, fully tested. Complete with leather case, £40.

**LEATHER CASES for Wec Meggers, 10/- each.**

**AVO MODEL 7**  
Good working order, 10 gns. Post 5/-.

**CRYSTAL CALIBRATOR No. 10.** (Battery powered 1.4 v. valves). Frequency range 1.5 to 10 Mc/s. (nominal) but can actually be used up to 30 Mc/s. Weight 5 lb. Size 7 x 7 1/4 x 4 in. Complete with full working instructions, circuit diagram, carrying haversack, connecting leads and spare valves. **ONLY £4/17/6.**

**OUTSTANDING BUYS IN QUALITY MULTI-METERS**

Model Y.3, 2,000 ohms per volt. Sub-miniature in size and convenient in use. Ranges: D.C. volts, 6, 30, 150, 600. A.C. volts, 6, 30, 150, 600. D.C. amps, 150 mA. Ohms, 0-100 K ohms. Size 3 1/2 x 2 1/4 x 1 1/2 in. **PRICE 39/6. P. & P. 2/-.**  
Model Y.P.60, 3,300 ohms per volt. Pocket size suitable for general use. Ranges: D.C. volts, 6, 12, 60, 300, 1,200. A.C. volts, 6, 12, 60, 300, 1,200. D.C. amps., 300  $\mu$ A, 3 mA, 300 mA. Ohms, 0-30 K ohms, 0-3 M ohms. DB, -20 to +18 dB, 0 to +24 dB. Size, 4 1/2 x 3 1/4 x 1 1/2 in. **PRICE £2/6. P. & P. 2/-.**  
Model 100L, 4,000 ohms per volt. Miniature tester with high sensitivity of 150  $\mu$ A. Ranges: D.C. and A.C. volts, 10, 50, 250, 500, 1,000. D.C. amps, 250  $\mu$ A, 50 mA, 500 mA. Ohms, 0-10 K ohms, 0-1 M ohms. DB -20 to +22 dB, +20 to +38 dB. Capacity, 0.05  $\mu$ F, 1  $\mu$ F, 250  $\mu$ F, 0.2  $\mu$ F. **PRICE 59/6. P. & P. 2/-.**  
All complete with test leads, battery, instructions and fully guaranteed.



**FIRST QUALITY TAPE**  
FACTORY FRESH

**LOWEST EVER PRICES**

5in.	Std.	600ft.	8/6
7in.	Std.	1,200ft.	12/8
5in.	L.P.	900ft.	10/-
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7in.	L.P.	1,800ft.	15/-
4in.	D.P.	600ft.	9/-
4in., 5in., 5 1/2 in.	5in.	D.P.	1,200ft.
2/-	each.	7in.	D.P.
8 1/4 in.	5/-	7in.	D.P.

**SPARE SPOOLS.** 4in. D.P. 600ft. 9/-  
4in., 5in., 5 1/2 in. 5in. D.P. 1,200ft. 15/-  
2/- each. 7in. 5 1/2 in. D.P. 1,800ft. 22/6  
2/8; 8 1/4 in. 5/- 7in. D.P. 2,400ft. 25/-

**"GEE'S" SUPER QUALITY MESSAGE TAPES.** 3in. Std. 150ft. 3/9. 3in. L.P. 240ft. 5/- 3in. D.P. 400ft. 10/-. On brightly coloured spools in neat plastic cassettes. Ideal for gifts or messages.  
**"GEE'S" ACCESSORY KIT**  
1 "BIB" Splicer, 1 Splicing Tape, 3 Leader Tapes (3 colours), 10 Retaining Clips. Packed in plastic container. **PRICE 32/6.** While stocks last.  
**THE "INSTANT" BULK TAPE ERASER**  
A complete reel of magnetic tape can be effectively erased of all traces of recorded matter within a few seconds leaving tape as new. Operates on A.C. 200/250 v. Today's price 35/-.  
**FEW ONLY AT 27/6. P. & P. 2/6.**

**EXCLUSIVE TO GEES**  
**American "Shamrock" Tapes**  
7 inch L.P. 1800 ft.

Professional quality, attractively boxed. Guaranteed brand new.

**SPECIAL INTRODUCTORY 15/6**  
**PRICE OFFER**  
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Where not stated, please add P. & P. 2/- per order. (Orders over £3 post free.) Many other types available including "SCOTCH," "EMI," "BASF," "Synchrolape," etc. Send S.A.E. for our huge money-saving literature on Tapes and Accessories.

**FERRANTI SILICON DIODE. ZR21, 50 v.** at 8 amps. Brand new 15/-.  
**WESTINGHOUSE 36EHT240 PENCIL RECTIFIER.** 12 1/2 in. long x 1/2 in. dia. 6.7KVA at 5 mA. 15/-.  
**MULLARD OC16T POWER TRANSISTOR.** 10/12 watt in push/pull 15/- ea. New & boxed.

**'POWERSTAT' VARIABLE TRANSFORMERS**

Input 230 volts. 50/60 cycles. Output 0-200 volts at 9 amps. Fully shrouded. For bench or panel mounting. A robust job of outstanding quality and performance. Brand new and guaranteed. £15. Carr. 7/6. Made in U.S.A.  
**AUTO TRANSFORMERS.** Step up, step down. 110/115, 220/230 v. Full shrouded, terminal block connectors. 150 w. 32/6; 300 w. 47/6; 500 w. 67/6; 750 w. 77/6; 1,000 w. 90/-; 1,750 w. 175/-.  
**CARRIAGE 5/-** on each type.  
**RCA PLATE TRANSFORMERS 190 to 250 v.** primary 50-60 cycles. Secondary 1,500-0-1,500 v. or 2,000-0-2,000 v. at 500 milliamperes. Brand new and boxed £8/10/-. Carriage extra.  
**L.T. TRANSFORMERS.** Tapped. Primary 200/250 v. 50 cycles. Secondary, 0-12-18-24-30-36 v. at 0/8 amps. 65/-. Ditto 10/12 amps. 85/-. Carr. 5/- each.

**G.P.O. STANDARD 19in. HEAVY DUTY EQUIPMENT RACKS**

5ft. 6in. Angle Uprights, £4/10/-. Carr. 15/-.  
6ft. Channel Upright, £6. Carr. 20/-.  
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All with Heavy Duty Base.

**NEW AND UNUSED ACCUMULATORS**

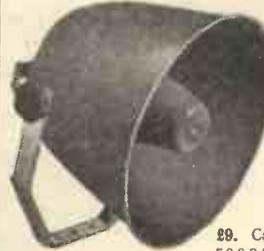
12 v. 25 A.H. Size 10 x 10 x 4 1/2 in. 45/- Carr. 8/6.  
6 v. 40 A.H. Metal box with hinged lid and carrying handle, 39/6. Carr. 7/6.  
6 v. 75 A.H. Ideal for starting or storage, 59/3. Carr. 8/6.  
6 v. 20 A.H., comprises three 2 v. celluloid cased cells in wooden case. Overall size 5 x 5 x 7 1/2 in. 17/6. P. & P. 1/-.

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**RE-ENTRANT LOUD HAILERS** (Ex-Govt.) Heavy duty 20 watts. all-metal, 15 ohms. Dia. 15in. length 15in. (approx.). Brand new and boxed. £9. Carr. 10/-.

**W.B. STENTORIAN 12in. heavy duty 15 ohm Speaker.** Handling capacity 15-20 w. Listed £10/5/-. **OUR PRICE £5/15/-.** P. & P. 5/-.  
**AR. 88 Original 8in. P.M. SPEAKERS.** Black crackle metal cases. Brand new in original cartons. Few only. 23/10/-. Carr. 3/6.

**12 VOLT D.C. AMPLIFIER** (Ardent). 15 watt push-pull output Mike and gram. inputs, tapped output transformer.



Brand new, maker's cartons, £12/10/-. Carr. 10/6. (Original hand mike for above 30/-).  
**HEAVY DUTY PRESSURE UNIT.** Special quality. 15 ohm, 20 watts P.M. 1 1/2 in. dia. Screw top, 79/6. Carr. 4/-.

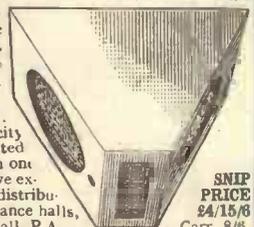
**15 WATT TRANSISTOR POWER AMPLIFIER.**

A new transistor Audio Frequency Amplifier of new modern design incorporating a number of additional practical features. Operates on 12 volts. Power output 15 watts. Output impedance 25, 15, or 3.75 ohms. Inputs for mike and gram. Frequency response 100 c/s to 10 kc/s. Incorporates on/off switch, volume control, tone control, pilot lamp. Complete in pale green hammer finish metal case, size 6 x 3 1/4 x 5 1/2 in. Weight 4 1/2 lbs. Made in England. Brand new and fully guaranteed. All parts replaceable. **ONLY £21.**

**TELEPHONE CABLE.** One mile drums. Single. For in or outdoor use. Ideal for P.A. systems. Brand new, £3/10/-. Carr. 10/-.

**6 inch P.M. HEAVY DUTY SPEAKERS.** Complete with line trans. in all steel blue-grey double gridded circular cabinet. 30/- P. & P. 3/-.

**W.B. Stentorian Dual Purpose Speaker System.**



Incorporates 2 x 8" 3 ohm speakers and 100 volt line transformer. Handling capacity 10 watts. Mounted back to back in one cabinet they give excellent sound distribution. Ideal for dance halls, factories, and all P.A. systems. **LIMITED QUANTITY ONLY.**  
**TRUVOX/TANNOY LOUD HAILERS.** With 180 ohm line transformer and condenser. Impedance 7 1/2 ohms, handling capacity 8 watts. Complete in slope-front wooden case, 30/- Carr. 5/-.

**MICROPHONE FLOOR STAND (Telescopic).** HEAVY 9in. dome, chromium base, chromium stand with screw top. Extends to approx. 6ft. 55/- Carr. 5/-.

**SOUND POWER OPERATED HEAD AND BREAST SETS.** Brand new. (Ex-Admiralty.) Make a perfect intercom. by connecting two sets together. Will operate up to 1/2 mile, no batteries required. Original maker's boxes, 17/6 each. P. & P. 4/-. Two for 35/- P. & P. 4/-.

**ROTARY CONVERTERS. ALL BRAND NEW** 24 v. D.C. input 230 v. A.C. output 50 cycles at 100 watts. Brand new £6/10/-. Carr. 10/-.

24 v. D.C. input 230 v. A.C. output 50 cycles at 100 watts. Capable of 25% over actual rating. Smoothed, filtered, regulated and fused. Housed in strong metal case with A.C. output voltmeter. Ex-Admiralty and made to highest specification. Complete in original sealed crates, £10. Carr. 15/-.  
240 v. D.C. input 115 v. A.C. output 50/60 cycles at 500 watts. With starter, New and unused, £22. Carr. £1.

# PROOPS Walk-around Store

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### ELECTRONIC TACHOMETER £4.10

Carriage 3/6.

Specially made for Proops to a unique design giving greater accuracy than ever before! Uses a brand new transistor circuit operating on induction principles that does not require connection to contact breaker or interfere in any way with the engine ignition system. Can be fitted in minutes without special skill, and is supplied with a universal mounting bracket that ensures ready installation to any car where dashboard space is not available. Transistor unit utilizes printed circuit board technique and top grade components, and is entirely contained within a magnificent aircraft quality instrument with 3-inch circular dial and huge 270 deg. scale that gives really accurate, instant check readings to within 1% of engine speed up to 8,000 r.p.m. Provides a first class, dependable instrument that pays for itself quickly in essential tuning facility, economical motoring, precise gear changing, and that extra feature that earns its place in any car. Present supplies are for 4-cylinder, 4-stroke, 12v positive earth systems only. Complete with mounting bracket and fitting instructions.



### EXTRA QUALITY SELECTED VALVES

Unique opportunity to acquire extra-quality valves, selected to meet the requirements of most rigid specifications, at bedrock prices. Many are latest types, and all have been removed from absolutely unused, very recent pattern American airborne radar equipment. Each valve is guaranteed by us to be in perfect working order. Types available: 2J42 (Magnetron with magnet) £7/10/-, 2K25 Klystron £3/10/-, 1B35A 15/-, KU42 (6130) £1, 5654 (6AK5W) 7/6, 5726 (6AL5W) 5/-, 5663 10/-, 6AF6 2/6, 6AL5 2/-, 6AG5 2/6, 12AK7 4/6, 6AH6 8/6, 12AT7 3/6, 2C51 10/-, 5670 8/6, 2D21 5/-, 2D21W 8/6, 6J4 7/6, 6AK5 4/-, B2-WX 15/-, 6J6 2/6, 12AX7 7/-, 12AX7W 10/-, 6X4 4/-, 6X4W 6/-, 6AQ5 6/-, OAZ 5/-.

Add 1/- post and packing for single valve, 2/6 for quantities. Quantity and export enquiries invited.

### SYNCHRO CONTROL TRANSFORMER



Signal Aysynn type A by Smiths. Rotor 26 v. 400 c/s., single phase. Stator 11.8 v., 400 c/s. 3-phase. Size overall 2 1/2 in. x 1 1/2 in. dia. with 3/4 in. dia. x 1/4 in. long plain shaft drive. Fitted with short connecting lead and six-pin miniature Jones plug and supplied complete with calibration chart. Unused.

£4.10.0 Post free.

### ETCH YOUR OWN PRINTED CIRCUIT KITS 21/- Post free.

Each contains over 60 sq. in. of laminated board and sufficient chemicals to make dozens of printed circuits, plus comprehensive instruction book giving advice and examples on translating theoretical circuits into layouts ready for etching. High quality materials—completely safe to handle—carefully prepared to ensure fine definition and uniform results without laboratory control.

### COPPER LAMINATE BOARD

Ready cut panels in convenient sizes of high-quality, single sided copper laminated board at a fraction of the usual prices. Sizes available: 6 x 3 in., 3 for 5/-; 7 x 4, 2 for 5/-; 8 x 5 4/- each; 9 x 6, 5/-; 10 x 8, 6/-.

Add 1/- for postage and packing.

### HIGH VALUE RESISTORS 5 for 10/- Post paid.

Glass encapsulated 125, 1,000 or 10,000 megohms. To errance 10%. One of each value plus any chosen two.

### LOW PRESSURE DIFFERENTIAL TRANSDUCER

Inductance type I.T.I.-29 by a well known British manufacturer. Sandwich construction with high-duty plastic housings, and metal dividing plate and bellows seal communicating with cylindrical inductance unit at rear of housing. Max. Neg. Differential: 64 mH. ±0.3. Max. Pos. Differential: 11 mH. ±20% of overall. Intended for input of 5 volts across coil and 133 kc/s. Three types available: 1: ±1 p.s.i. 2: ±5 p.s.i. 3: ±6 p.s.i. Size overall: 2 in. diam. x 1 1/4 in. deep.

£2.10.0 Post free.

### POST FREE BARGAINS!

- MAIN SUPPRESSOR in die-cast sealed case, two for 6/6.
- MAINS OVERLOAD cut out switch pre-set at 13 a. but adjustable. Instant reset, two for 6/-.
- APN1 Transducer Unit, 8/6.
- IN70 Crystal diode, four for 5/-.
- PIEZO CRYSTAL complete element with ribbon contact leads, ten for 12/6.
- EDISWAN XA101 TRANSISTOR (equivalent Mullard OC45) two for 6/-.

### VIBRATION PICK-UP

Crystal type, contact pick-up originally designed for vibration measurement in gas turbines and missile systems. Size overall: 1 in. long x 1/2 in. diam. plus 1/4 in. long x O.B.A. threaded bolt end. Consists of silvered crystal wafer and spring-loaded mass housed in a machined, chrome plated capsule with domed cover. Makes a first class electronic stethoscope in conjunction with a transistor amplifier and earpiece.

25/- Post free.

### SIX-DIGIT RESET COUNTER



Made in Germany for a famous British manufacturer. Superbly constructed and supplied complete with plug-in mounting cradle. Functionally styled grey plastic case has white figures on black background in six window display, and pushbutton reset. Max. speed 1,500 c.p.m. For 24 volts D.C. operation.

£3 Post free.

### MULTI-PIN PLUG & SOCKET



Modern, miniature, 15-contact type with gold-plated pins and contact sleeves moulded into low-loss plastic bases. Socket can be recessed into chassis; plug is complete with light alloy screening.

7/6 Postage & packing 1/-

Similar to above, 7-pin plug and socket complete with plug holder clamp, 3/6, postage & packing 1/-.

### MICRO-MINIATURE

### TRANSISTOR AMPLIFIERS

Brilliantly constructed with incredibly minute yet robust components and providing ideal packaged units for probes, electronic stethoscopes, signal tracers, listening devices, telephone amplifiers, etc. Each has an overall gain of about 40 db, and a substantially flat response over the range 500-3,000 c/s. Each type can be operated from a tiny Mallory cell size only 1/4 in. diam. x 1/4 in. thick.

TYPE 2. Three transistor completely encapsulated, rectangular pattern, size 1/2 x 1/2 x 1/4 in. thick. Input impedance 300-350 ohms. Output impedance 100 ohms.

30/- Post & packing 1/-

TYPE 3. Three-transistor type mounted on open circuit board and complete with built-in miniature volume control. Size: 2 in. long x 1/2 in. wide (tapering to 1/4 in.) x 1/4 in. thick. Input and output impedance 2,000 ohms.

30/- Post & packing 1/-

TYPE 4. Three transistor type mounted on open circuit board and complete with built-in miniature volume control. Size: 1 1/2 x 1 1/2 x 1/4 in. high. Input impedance 2,500 ohms. Output impedance 600 ohms.

20/- Post & packing 1/-

Each type supplied complete with wiring diagram.

### MINIATURE DYNAMIC MICROPHONES

Low impedance. Totally enclosed in metal case, size only 1/2 x 1/2 x 1/4 in.

4/- Post & packing 1/-



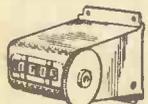
### 6V. 40 AH BATTERIES £1

Carriage 5/-.

Unused, modern soft separator Lead Acid units, each contained in metal carrying case. Size approx 9 in. x 4 in. x 9 in. high.

### RESETTABLE MAGNETIC COUNTERS

Brand new, 0-9999 small reset counters by Veeder-Root. Mechanism constructed on diecast frame and totally enclosed by a one-piece aluminium cover. For pedestal or panel mounting. Max. speed: 250 c.p.m. Consumption 4-5 watts at rated voltage. Reset by knurled knob at side. Size overall: 1 1/2 x 2 1/2 wide x 2 1/2 in. high. Can be supplied for 200/250 volts A.C. mains operation, or for 12 or 24 volts D.C. Brackets for panel mounting 2/6 extra. State voltage required.



£3 Post free.

### COLD CATHODE TRIGGER TUBES

Sub-miniature cold cathode valve developed by Ericsson primarily for computer work. Anode-cathode running voltage of 95 to 140 at 4.5 mA., and at 290 anode volts require a trigger current of only 250 microamps to cause the anode to take over the discharge. Typical ionization time: 90 microseconds. Will withstand up to 310 volts with zero trigger voltage without self-igniting. Complete with full performance data in original packs of 100 at the special price of

£5.5.0

Minimum quantity supplied: 6 for 10/-, post paid. Post-paid.

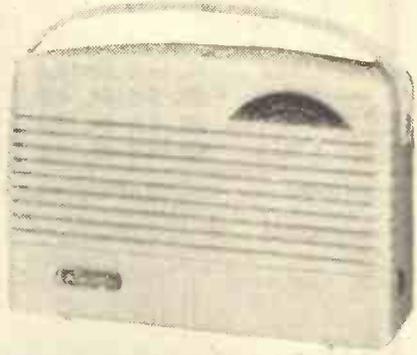
# LOOK! 'THE REALISTIC 7'

## FULLY TRANSISTORIZED PORTABLE RECEIVER CAN NOW BE BUILT FOR EVEN LESS

This super set—made to the highest professional standards—is now available to the home constructor. Comprises 7 Mullard Transistors OC44, 2 OC45's, OC71, OC81D, and 2 OC81's, plus OA70 Crystal Diode. Delivers 350 milliwatt output to 4in. high flux speaker—1F Frequency 470 kc/s.—fully tunable over medium and long wavebands. All components mounted on single printed circuit board, size 5½ x 3½ in. Attractive two-tone plastic cabinet with carrying handle—size 7 x 10 x 3½ in. with easy to read dial and socket for car aerial; choice of Red/Grey, Blue/Grey or all Grey Complete with full instructions. All parts sold separately.

**WIRECOMP'S PRICE £5.19.6** P.P.9 Battery—3/9 Extra.

P. & P. 4/6 extra. (Circuit diagram 2/6, free if all parts bought.)



### FANTASTIC PRICE REDUCTIONS!

#### THE 'VISCOUNT' SELF-POWERED TUNER



A Hi-Fi tuner of outstanding quality, gives full coverage of VHF/FM LONG and MEDIUM wavebands. Multiplex outlet socket for stereo and separate tuning controls for FM and AM bands. Operates well with any amplifier. Matching sport styled finish to the "Baron" amplifier in black crackle with aluminum front panel and controls.

**WIRECOMP'S PRICE NOW ONLY £16.19.6**

#### THE 'BARON' STEREO AMPLIFIER

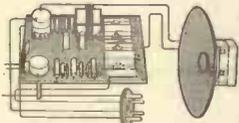


A high quality integrated stereo amplifier with combined pre-amplifier. Stereo output 6 watts per channel; 12 watts Mono. Inputs provided for tuners, pick-ups, tape decks and microphones. Separate tape output available on each channel. Overall response 60-20,000 cycles. Outputs: 4, 8 and 16 ohms. Power requirements 105-240 v. A.C. Controls include: bass, treble, balance, volume, phase reverse, input selector. Styled as the above Tuner. Size of both units 14 x 9 x 4 1/2 in. Excellent basis for a high quality Stereo or Mono system.

**WIRECOMP'S BARGAIN PRICE £15**  
Add 10/- Carriage and Insurance on Each Unit.

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**COMPLETE WITH 3in. MOVING COIL SPEAKER 49/6**  
P. & P. 2/-.



1 watt fully transistorised Amplifier. Incorporates 2 power Transistors and 3 G.E.T. 114 Transistors in push/pull—complete with separate tone and volume controls on 2½ x 4½ in. printed circuit board. Operates from Free Ready P.P. 11 Battery. Suitable for use with the Staar Kinder Players. See below.

#### THE STAAR "KINDER" 45 R.P.M.

9 v. Battery Operated Single Player Complete with P.U.

The ideal deck for your transistorised portable Record Player, complete with Cartridge and Stylus. Size 7½ x 6 in., depth below motor 2½ in. Attractive two-tone grey finish. Ideally suited for use with the above Transistor Amplifier.

**£2.9.6** P. & P. Two speed Model 33 2/6. & 45 r.p.m. 79/6.

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A six transistor super-hit Miniature Pocket Radio of Commercial Quality. Fully tunable over Long and Medium wavebands. Uses printed circuit and high sensitivity internal ferrite rod aerial. 1.F. frequency 470 Kc/s. Transistors: 3-Philco 2067s, 2-Mullard OC81M, OC81DM and OA90 diode. 3 inch speaker. Works on single 213 battery. Supplied with the complete RF and IF stages, Driver and Output stages, ready built and mounted on the printed circuit; for final assembly you have only to fit the wave-change switch, tuning condenser and drive, volume control, earphone socket and aerial rod. In very attractive plastic case, size 4x2½x1½ in.

**COMPLETE AS ABOVE 79/6** All parts sold separately.

Real Calf Leather Case, wrist strap and Personal Earphone with case and battery 12/6 extra.

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This superhet receiver uses the very latest circuitry, 6 transistors and two diodes and is fully tunable over both medium and long wavebands. First stage uses three Mullard AF.117 alloy diffused transistor with OA.79 and OA.91 diodes. output—OC81D and two OC.81's in push-pull 1.F. frequency 470 Kc/s. Large internal ferrite rod aerial gives excellent reception over all ranges. 3 inch high flux speaker has a maximum output of 330mW. Operates on four 1.5 v. pen torch batteries. All components are mounted on a single printed circuit board. Attractive plastic case with carrying handle—fitted sockets for personal earpieces, tape recorder and car aerial. Size 6½ x 4 x 1½ in.

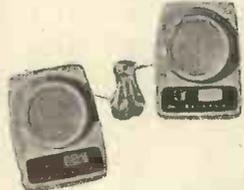
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Made by well-known manufacturer Spec. 2 - E 1, 8 4 1-EZ80 and 1-EC83 Push-pull output. Separate Bass and Treble controls on panel with extended lead. P. & P. 3/6.

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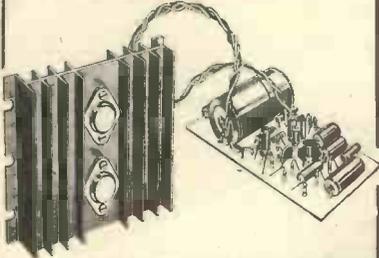
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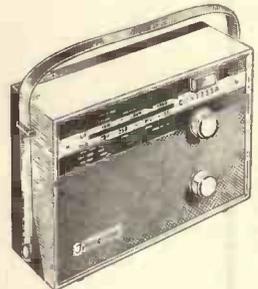
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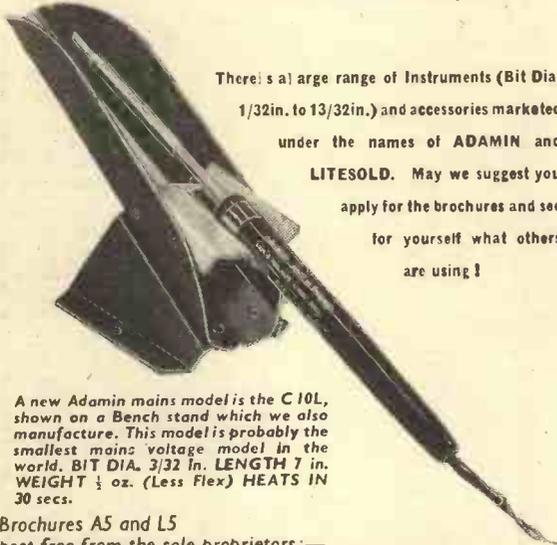
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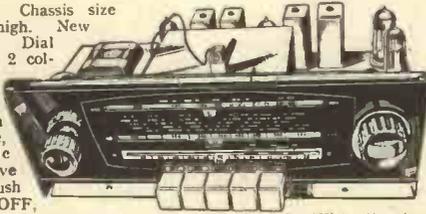
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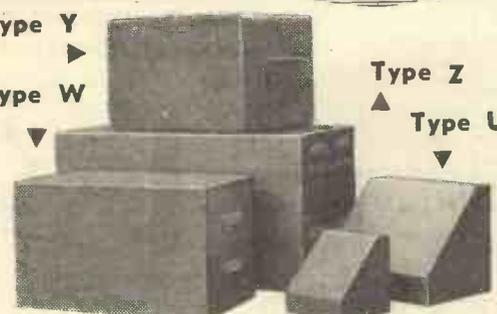
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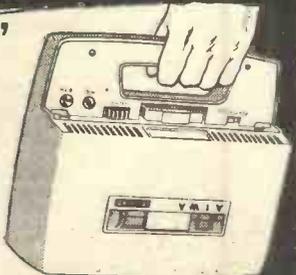
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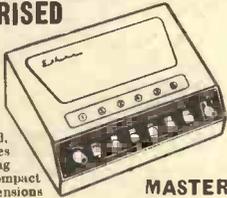
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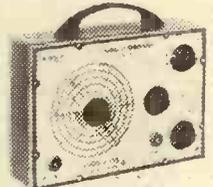
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# ADVANCED DESIGNS FOR TRANSISTOR ENTHUSIASTS

## SINCLAIR "SLIMLINE" MICRO-RADIO RECEIVER

★  $2\frac{3}{4}'' \times 1\frac{5}{8}'' \times \frac{5}{8}''$   
★ BUILT IN A COUPLE OF HOURS

By using our remarkable new range of Micro-Alloy Transistors ("MATS") we have been able to produce a radio receiver of unprecedented small size and high sensitivity, combined with incredibly good quality. These are some of the features which make the "Slimline" completely unique.

- 1. SIZE**—a mere  $2\frac{3}{4} \times 1\frac{5}{8} \times \frac{5}{8}$  in.—small enough to be concealed in one hand.
- 2. RANGE**—Using only its internal ferrite rod aerial, the set will receive a large number of stations on the medium band including Home, Light, Third, Luxembourg and dozens of Continental transmissions.
- 3. HOUSING**—The receiver is built into an elegant royal blue case with calibrated dial and gold trim.
- 4. SPECIAL EARPIECE**—The special high-impedance earpiece provided gives superb linear reproduction at sufficient volume for use even in cars and trains.
- 5. COMPONENTS**—All components are brand new, with Micro-Alloy Transistors used throughout.
- 6.** A thoughtfully designed printed-circuit board is supplied on which all the components are mounted.
- 7. INSTRUCTIONS**—These are so clearly presented that an absolute beginner is assured of complete success, yet the brilliant performance will more than satisfy the expert.



PERFECT FOR HOLIDAYS

RECEIVES HOME, LIGHT, THIRD AND COUNTLESS EUROPEAN STATIONS WITH FANTASTIC EASE AND QUALITY.



Total cost of all parts including special earpiece, royal blue and gold plastic case and instructions.

FULL SERVICE FACILITIES AVAILABLE

THOUSANDS OF THESE SETS HAVE ALREADY BEEN SOLD. THE TESTIMONIALS BELOW ARE TYPICAL OF THE MANY WE ARE ALWAYS RECEIVING

- "Most ingenious. I find myself using it for serious listening more and more." J.A., Wakefield.
- "Would never have thought such performance possible from such a tiny set." F.G.M., Lewes.
- "Very cleverly thought-out design, and a most useful companion wherever I go." T.B., London, N.B.

## MAT TRANSISTORS FOR A.F., I.F., R.F., AND V.H.F.



Gold-plated leads ensure perfect contact

These amazing new Micro-Alloy Transistors take transistor performance into entirely new fields of design development. With far greater gain for less power consumption, two 'MATS' can do the work of three ordinary types, thereby effecting savings in space, components and cost. All are carefully tested before despatch.

For full description, send for our book "22 TESTED CIRCUITS USING MICRO-ALLOY TRANSISTORS" price 5/9 inc. postage.  
MAT 100 7/9 each    MAT 101 8/6 each  
MAT 120

## SINCLAIR MICRO AMPLIFIER OUTPERFORMS AMPLIFIERS 20 TIMES AS LARGE

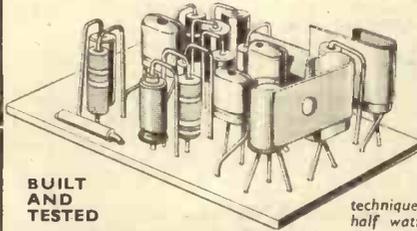


- SMALLER THAN A THREEPENNY PIECE
- **POWER GAIN** 60dB (1,000,000 times).
  - **POWER CONSUMPTION.** From 0.4 mA. at 1.3 V. to 1 mA. at 9V.
  - **POWER OUTPUT**—sufficient for any earpiece or even a loudspeaker.
  - **WITH DETAILED INSTRUCTIONS, APPLICATIONS DATA AND CIRCUITRY.**

Fascinating possibilities are opened up by building this fantastically small, powerful amplifier. With a frequency response extending from 30 to 50,000 c/s  $\pm 1$  dB., it becomes a valuable tool in the hands of the keen experimenter as well as providing an excellent sub-miniature hi-fi amplifier with an output suitable for any earpiece or even loudspeaker. With MAT Transistors, brand new micro-miniature quality components and micro-printed circuitry.

FREE APPLICATIONS DATA showing use with pick-ups, microphones, hi-fi stereo headphones and in micro-radios, transmitters, etc.

## SINCLAIR 5-TRANSISTOR COMBINED PRE-AMP & HALF-WATT POWER AMPLIFIER



80dB POWER GAIN  
0.5mV SENSITIVITY RESPONSE  
50-20,000 c/s  $\pm 3$ dB  
 $2\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{2}''$

This radically new amplifier embodies the latest circuitry techniques to produce a perfectly clean half watt of audio power even from very low output sources such as low-impedance tape recorder heads, pick-ups and microphones. Each amplifier is supplied ready built and unconditionally guaranteed.

BUILT AND TESTED

IDEAL FOR PICK-UPS, TAPE-HEADS, RADIO, MICROPHONES, ETC.

FREE with every amplifier, circuits showing how to use it with low and high impedance pick-ups, microphones, tape-heads, in various radio circuits, transmitter circuits, in guitar amplifier, as a mono or stereo hi-fi system, inter-com., etc.

59/6 POST FREE

UNCONDITIONALLY GUARANTEED FOR 12 MONTHS

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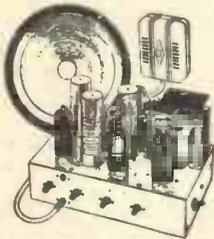
# More BIG BARGAINS from R. & T.V!

## B.S.R. MONARCH

### UA 14 WITH FUL-FI HEAD

4-speed, plays 10 records, 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position: colour, brown. Dimensions: 12½ x 10½in. Space required above baseboard 4in., below baseboard 2½in. Fitted with Ful-Fi turnover crystal head, £5/19/6. P. & P. 6/6.  
**B.S.R. UA16**, similar to the above, £6/12/6. P. & P. 6/6.  
**B.S.R. GU7**, 4-speed, single-player, complete with pick-up on in-plate with automatic switch. £3/19/6. P. & P. 5/6.

### 4-VALVE AMPLIFIER IDEAL FOR SMALL HALLS



High power—high quality 200/250 v. A.C. 2 inputs, mike and gram, bass and treble lifts. For use with Standard/L.P. records. Two would be suitable for stereophonic. Ideal P.A. system, £3/19/6. P. & P. 8/-.  
**CRYSTAL MIKE** to suit, 15/-.  
**P. & P. 2/-**. 8in. x 5in. P.M. **SPEAKER** to suit, 12/6. P. & P. 2/-.

**POCKET MULTI-METER**. Size 3½ x 2½ x 1½in. Meter size 2½ x 1½in. Sensitivity 1,000 O.P.V. on both A.C. and D.C. A.C. and D.C. volts 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100KΩ. Complete with test prods, battery and full instructions, 35/-. Plus 1/6 P. & P.

### STAAR 45 9v. BATTERY RECORD PLAYER

**COMPLETE WITH PICK-UP AND DECK**  
 For a completely portable record player. Head is protected by a plastic dome with a brush which cleans the stylus as it rises into playing position. 45 r.p.m. Automatic on/off switch, governed 9 v. motor. Attractive 2-tone grey finish. £2/9/6. P. & P. 2/6.

**PRESS-BUTTON COIL PACK**. Medium and 2 shorts. Complete with twin-gang tuning condenser and ferrite rod aerial. 19/6, plus 2/6 P. & P. Circuit diagram 2/6, FREE with pack.

## SPECIAL OFFER! OBTAINABLE ONLY FROM R. & T.V. THE "Elegant Seven"

### COMBINED PORTABLE & CAR RADIO THE RADIO WITH THE "STAR" FEATURES

- ★ 7-transistor superhet. Output 350 mW.
- ★ Two-tone grey wooden cabinet, fitted handle with silver coloured fittings. Size 12½in. x 8½in. x 3½in.
- ★ Horizontal tuning scale, size 11½in. x 2½in., in silver with black lettering.
- ★ All stations clearly marked.
- ★ Ferrite-rod internal aerial.
- ★ IF 470 kc/s.
- ★ Operated from PP9 battery.
- ★ Fully comprehensive instructions and point-to-point wiring diagram.
- ★ Printed circuit board, back-printed with all component values.
- ★ Fully tunable over medium and long waveband.
- ★ Car-aerial socket.
- ★ Full after-sale service.

### RADIO AND T.V. COMPONENTS (ACTON) LTD.

21A, ACTON HIGH ST., LONDON, W.3. ● Goods not despatched outside U.K. All enquiries S.A.E. Terms C.W.O.

### SIGNAL GENERATOR



Covering 100 Kc/s-100 Mc/s. on fundamental and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6½in. x 5½in., grey hammer finish. Incorporating three miniature valves and metal rectifier. A.C. mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.  
 Or 30/- deposit and 6 monthly payments of 21/6. Post and Packing 6/6 extra.

£7/5/0

### LINE E.H.T. TRANSFORMER

With built-in line and width control. 14 kv. Scan Coil, 90in. deflection, on ferrite yokes. Frame O.P. transformer 500 pf., 18 kv. smoothing condenser. Can be used for 14in., 17in., or 21in. tubes. Complete with circuit diagram, 29/6. Plus 5/- P. & P.

### MAINS TRANSFORMERS

ALL WITH TAPPED PRIMARIES 200/250 VOLTS.

250-0-250v. 60 mA., 6.3 v. 1.5 amp., 6.3 v. 1 amp.	11/6
250-0-250v. 80 mA., 6.3 v. 1.5 amp., 6.3 v. 1 amp.	15/-
250-0-250v. 50 mA., 6.3 v. 2 amp.	9/6
250-0-250 v. 250 mA., 6.3 v. 5 amp.	19/6
350-0-350 v. 250 mA., 6.3 v. 8 amp., 6.3 v. 2 amp., 5 v. 2 amp., 4 v. 7 amp.	22/6
Heater Transformer 6.3 v. ct. 3 amp.	7/6

Postage and packing on all the above transformers 4/-.

**A.M./F.M. PERMEABILITY TUNER FOR ALL TRANSISTOR OPERATION**. Size 2½ x 2½in. approx. By famous manufacturer. A.M.-I.F. 470 kc/s., F.M.-I.F. 10.7 mc/s. A.M. coverage from 1,620 kc/s.-525 kc/s. F.M. coverage 108 Mc/s.-88 Mc/s. Circuit diagram 2/6, FREE with Tuner, 25/-, plus 1/- P. & P.

**INDOOR AERIAL** for I.T.V./B.B.C./F.M. Complete with standard co-axial plug. Heavy chrome extending dipoles—7ft. fully extended. Plugs straight into T.V. or V.H.F. Tuner. Fully directional, 10/6. P. & P. 1/6.

### TRANSISTORISED AMPLIFIER

**CAN BE USED WITH THE STAAR 45**  
 Output 1 watt. Can be used with the STAAR 45 record player. Size 4½ x 2½in., printed circuit. Tone and volume control. 4 transistors. Push/pull output. Complete with 3in. moving coil speaker. BUILT AND TESTED 49/6. P. & P. 2/-.



**ONLY £5.9.6 PLUS 5/6 POSTAGE AND PACKING**

# CRYSTALS & COMPONENTS LTD

TEL: TEM. 1189 Dept. W.W.11 2, 4, EARLHAM ST., W.C.2.

Near Cambridge Circus. A few minutes' walk from Leicester Square or Tottenham Court Road Underground Stations.  
HOURS OF BUSINESS: 9 to 6. Saturdays 9 to 1. OPEN ALL DAY THURSDAY

## TYPE 68 TRANS/RECEIVER

3 to 5.2 Mc/s. Portable station with range up to 10 miles under good conditions. In very good condition, complete with valves, hand mike and aerial rods. 70/- plus 8/6 carriage and packing. Require 150 v. H.T. 3 volts L.T. and 9 v. G.B.

## B.C. 221 FREQUENCY METERS

Every one tested and working in perfect order. Exterior slightly soiled, from £12/10/-. Packing and carr. 17/6.

## CRYSTALS !!!

LARGE RANGE OF 10X, 10XJ, FT243, FT241 CRYSTALS ALWAYS IN STOCK. Send stamped addressed envelope for free comprehensive list.

## VIBRATOR POWER SUPPLY UNIT

6 volts D.C. input 230 volts 100 mA A.C. output and 6 v. L.T. out. Fully smoothed, with OZ4 rectifier valve. Brand new in steel case with pilot light, on/off switch and Slydlok fuse on front panel. Measures 8½ x 6 x 5½in. 39/6, plus 6/6 P.&P.

## AR 88 L.F. RECEIVERS

75-550 Kc/s and 1.5 to 30 Mc/s. 110/240 v. A.C. input. In as new condition and fully tested £30. Carriage and packing 25/-.

## E.H.T. TRANSFORMERS

E.H.T.1. Input 200/250 volts 50 C/s. Output 2kV. 10 M/A 4v. 1A.0-2.4V. 1.5A. 22/6 p.p. 5/-  
E.H.T.2. Input 200/250 volts 50 C/s. Output 2.5 kV. 10M/A 6.3v. 3A. 2v. 1.5A. 3.5 kV. D.C.Wkg. 22/6 p.p. 5/-  
E.H.T.4. Input 200/250 volts 50 C/s. Output 2,000 v. 15 M/A. 4 v. 1.5 A. 0-2.4v. 2A. 29/6. p.p. 5/-.

## TF 144 G STANDARD SIGNAL GENERATOR

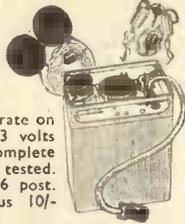
85 Kc/s to 25 Mc/s fully serviced and in perfect condition £36 post paid.

## SILICON RECTIFIERS

Westinghouse 1,000 P.I.V. 500 M/A. 9/- each. 800 P.I.V. 500 M/A 7/6 each. 400 P.I.V. 200 M/A 3/6 each.

## TYPE 38 WALKIE TALKIES

Brand new. Operating on 7.4 to 9 Mc/s Trans/Receivers. Complete with headphones, throat microphone, junction box and aerial rods. Operate on 150 volts H.T. and 3 volts L.T. dry batteries. Complete less batteries and not tested. 42/6 per set plus 6/6 post. Or £4 per pair plus 10/- post and packing.

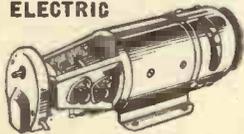


## A GEARED ELECTRIC MOTOR FOR ONLY

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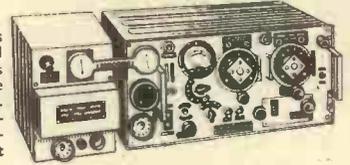
P. & P. 2/6.

Due to bulk purchase we are able to offer these 24 v. Rotary Convertors at this fantastic price. Easily modified for mains operation (full simple conversion details supplied). Complete with 400 to 1 reduction gearbox.



## WIRELESS SET No. 19

Complete with original power supply unit for 12 volts input. Transmitter/Receiver covering 2.8 Mc/s and V.H.F. 240 Mc/s. 6 valve superhet receiver and 6 valves in Transmitter. Using I.F. of 465 Kc/s. For voice and C.W. In good condition not tested. £4/17/6. Plus £1 packing and carriage. Microphone and head-set for this set 17/6 plus 2/6 P. & P. 19 Set Variometers 17/6 plus 2/6 post. Control box for 19 Set 10/- plus 2/- P. & P.



## TEST SET 193A

For testing quartz crystals of ¼in. and ½in. pin spacing and B7G based crystals. 240V and 80V A.C. input including 0-100 micro amps, 3½in. scale meter, indicator light and variable control. 19in. rack mounting but completely enclosed. AS NEW £4/15/- carr. paid.

## ON VIEW IN OUR SHOP FOR CALLERS ONLY, VERY LARGE RANGE OF TESTGEAR

Including, signal generators, decade resistance boxes, Pen recording Voltmeters and thermometers, Electronic Tuning Forks, etc.

## L.T. TRANSFORMERS

Pri. 240 volts. Output 6.3 volts 5 amps 8/6, post 2/6. Pri. 240 volts. Output 17 volts 1 amp., 9/6, post 2/-.

## H.T. TRANSFORMERS

Type (350/120) Tapped 200/250 v. input 350/0/350 v. 120 m/A 6.3 v. 3½ amp. 5 v. at 2 amps., 16/6. P.&P. 3/6. Type 5K Pri. 200/250 v. Output 350/0/350 v. 350 M/A 5 v. 3 amps. Tapped 4 v. 2 v. 2 amps. 10 Kv ins., 20 v. 1 amp. 7.5 v. 1 amp. 5 kV. 5 m/A. Price 25/- P.&P. 6/-.

## ASSORTED PACKETS OF 100 BRAND NEW RESISTORS

Including miniature and high stab. 12/6 POST PAID. All useful values.

## CONDENSERS 100 ASSORTED

Including mica, ceramic, metal tubular, etc. 15/- post free.

## SPECIAL H.D.

50 volts 10 amps transformers 250 volts input. Brand new and boxed. Conservatively rated. 55/- each. Carriage 7/6.

## SPECIAL OFFER

OF 6in. METRO-VIC TEST METERS ALL AT ONE PRICE 25/- FOR CALLERS ONLY INCLUDING 0/20/50 M/A, 0/100 M/A, 0/15 M/A, 0/500 Microamps, 0/50 M/A, 0/300 v. D.C., 0/30 volts D.C. 0/50 volts, 0/100 volts, 0/5 Kv., 0/500 volts, and many others. All in perfect condition (surface mounting).

## VARIABLE AIR-SPACED CONDENSERS

150 pfd with ¼in. spindle .....	4/6 each
75+75 pfd with ¼in. spindle .....	4/6 each
100 pfd with ¼in. spindle .....	2/6 each
100 pfd pre-set .....	2/- each
50 pfd pre-set .....	1/6 each
4 gang H.R.O. variable 390 pfd. ....	12/6 each

## MOTORS 200 v.-230 v. 50 c.

Shaded pole. Made by Hoover for washing machines. Brand new 30/- each P. & P. 7/6 also 115 v. A.C. 22/6 each. P. & P. 7/6.

## DECCA X.M.5 L.P. PICK-UP HEADS

Brand New 8/6. P. & P. 1/-.

## TERMS OF BUSINESS

CASH WITH ORDER. Handling charge of 1/6 on all orders under 20/- where P.P. is not otherwise stated.

## RI09 RECEIVER

1.8-3.9 Mc/s and 3.9-8.5 Mc/s. For audio or phone operation, loudspeaker, complete with Vibrator pack for 6V D.C. input. Fully valued, untested but in good clean condition. 65/- plus p.p. 10/-.

## MICA CAPACITOR

In cast metal and ceramic .0002 Mfd. 6000V working. 2/6 plus 1/6 P. & P. each.

## FIELD STRENGTH METERS 100-150 Mc/s

Contains 0-1 mA meter, 155 valve, chrome telescopic aerial, etc. New condition in black crackle case. Operates on 1.5 v. and 90 v. batteries. Dimensions: 7 x 7 x 7in. 45/- P. & P. 2/9.

## 20-0-20 AMMETER

2in. flush mounting. D.C. Brand new 11/6 each, post 1/6.

## WOBBULATOR FREQUENCY MULTIPLIER

Band 1. Channels 1-13 with 50 micro/ammeter and 0-80 dB attenuator. £9. P. & P. 10/-.

## DOUGLAS AUTO TRANSFORMERS

Auto 115-200-230-250 v. 300 w. 45/-, P.&P. 5/-  
Auto 110-120-200-240 v. 75 w. 16/-, P.&P. 3/6  
Auto 115-200-230-250 v. 500 w. 76/6, P.&P. 5/-  
Auto 115-200-220-240 v. 1 kW. 119/-, P.&P. 6/6

## SPECIAL OFFER—TYPE 46 SETS

From 3.6-4.3 Mc/s. Complete with valves, crystals and coil box but having had the original send/receive switch removed. Without other accessories. This set is supplied with a substitute switch and full instructions and diagram for wiring in. At 18/6 each or 35/- per pair. P. & P. 5/6.

# VALVES

Brand new, individually packed and guaranteed

AC/HL 4/6	DF92 3-	EF36 3/8	G1/371K	PCL83 9/-	TT11 3/-	1LH4 4/-	6AM5 2/6	6LD20 5/9	12SA7 7/-	225DD 9/-	C.R.
AC/PEN 6/-	DF96 7/-	EF39 4/-		PCL84 8/-	TT15 30/-	1N43 4/-	6AM6 4/-	6N7G 5/9	12BC7 4/-	307A 5/6	5/6
AC/PEN 5/-	DK92 7/-	EF41 8/-	G50J2G 5/-	PCL86 10/-	TR31 60/-	1N70 4/-	6AQ5 7/-	6N7 6/-	12BG7 3/-	350B 8/-	ACR8 20/-
AB8 5/-	DL92 5/-	EF54 3/8	H63 7/-	PEN25 4/6	T2020 20/-	1R4 5/6	6AQ5W 9/-	6Q7G 8/-	12BH7 3/-	357A 70/-	CV95 15/-
ABP3 3/6	DL93 3/-	EF55 7/8	HF300	PEN26 4/6	T220 16/-	1R5 6/-	6A86 4/-	6R7 6/-	12BJ7 5/-	368A 5/-	CV150 60/-
ABP4 3/6	DL94 6/-	EF70 4/-		PEN46 6/-	U12 8/-	1R4 5/6	6A86W 9/-	68C7 5/6	12BK7 3/6	393A 15/-	CV1596
AR12 2/6	DL96 7/-	EF71 7/6	HK54 220/-	PEN220A	U15 6/6	1T4 3/-	6AT6 5/-	68C7GT 8/-	328K7GT	705A 16/-	(09J) 55/-
AR21 7/6	DL19 15/-	EF72 5/-	HL2K 2/6	PL36 9/-	U25 10/6	2A3 5/-	6AX4 3/-	68F6GT 5/6	12SL7GT	716B 60/-	E4103/5/4
AR24 3/6	DL148 2/6	EF73 5/-	HL23 6/6	PL38 9/-	U26 11/6	2A5 6/-	6B4G 8/-	68H7 3/-	5/9	801 6/-	E4504/6/16
AR24 4/-	E1232 9/-	EF74 4/-	HL23D16/-	PL31 8/6	U27 8/6	2A6 7/-	6B7 5/-	68J7GT 5/6	12BN7GT	803 22/6	30/-
ARTP1 6/-	E1956 5/6	EF80 5/6	HL41 4/-	PL32 8/6	U301 20/-	2C26 3/-	6B8G 2/6	68J7GT 5/6	12BR7 5/6	805 30/-	VCR97 28/-
ATP4 2/3	E1416 30/-	EF85 6/-	HR8 15/-	PL33 9/3	UBC40 7/-	2C34 2/6	6B8E 6/3	68K7 6/6	12D4 2/4	809 30/-	VCR138
AT7 5/6	E1624 12/6	EF86 7/-	KVR2 3/6	PL34 7/3	UBC41 7/-	2C43 2/6	6BR7 12/-	68L7GT 6/6	13L7 7/-	813 55/-	30/-
AU7 5/6	E2134 18/6	EF89 6/-	K3A 10/-	PL35 9/-	UBP80 8/-	2C46 30/-	6BW6 9/-	68M7 4/6	16D2 6/-	816 40/-	VCR138A
AZ91 7/-	E80F 25/-	EF91 2/8	KT32 9/6	PL36 9/-	UBP89 7/6	2C51 12/-	6C4 2/6	68N7 6/-	18G9 10/-	829A 80/-	25/-
BS4 10/-	EAS0 1/6	EF92 3/-	KT33C 4/-	PL37 8/6	UCB42 7/6	2D21 5/-	6C5G 4/-	68P7 2/6	19H6 9/-	829B 40/-	3FP7 25/-
BS84 47/6	EA76 7/-	EF96 5/6	KT44 5/6	PL38 8/3	UCB43 7/6	2D21W 8/6	6C5GT 6/-	6U4GT 9/6	19G11 6/-	830B 4/-	5CP1 25/-
BT19 25/-	EAC80 6/3	EF183 9/-	KT63 4/6	PL39 9/3	UCB44 7/6	2D21W 8/6	6C6G 3/-	6V6G 4/-	20A2 17/6	832 15/-	5FP7 45/-
BT35 25/6	EAC91 3/6	EF184 9/-	KT66 12/6	PL39 9/3	UCB45 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	837 9/-	5FP7A 25/-
BT45 15/6	EAF42 8/6	BL32 3/9	KT67 15/6	PL39 9/3	UCB46 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	7BP7 200/-
BT9B 20/6	EB34 1/8	EL34 13/6	KT76 8/6	PL39 9/3	UCB47 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	12DP7A
BT98 35/-	EB91 3/-	EL35 5/6	KTW81 5/6	PL39 9/3	UCB48 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	Photo Tubes
CB35 2/6	EB93 6/6	EL41 9/-	KTW82 6/6	PL39 9/3	UCB49 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	CMG8 9/-
CIC 6/6	EB94 7/6	EL42 8/6	KTW83 6/6	PL39 9/3	UCB50 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	OS16 12/6
CL33 3/6	EB95 5/6	EL42 8/6	KTW83 6/6	PL39 9/3	UCB51 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	931A 55/-
CV71 3/6	EBF80 7/6	EL44 6/3	LP2 10/-	PL39 9/3	UCB52 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	697C 350/-
CV77 6/-	EBF89 7/6	EL45 9/-	M8100 9/6	PL39 9/3	UCB53 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	Special Valves
CV102 1/6	EC35 12/6	EL51 4/6	M8142 12/-	PL39 9/3	UCB54 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	4063 8/-
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D1 1/6	EC85 8/6	EY91 3/6	OB3 7/6	PL39 9/3	UCB62 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	KR83 70/-
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D77 4/6	ECF80 7/6	EZ41 6/6	OD3 6/6	PL39 9/3	UCB64 7/6	2X2 3/-	6C8G 3/-	6V6M 8/-	20B4 17/6	843 5/-	1B94 25/6
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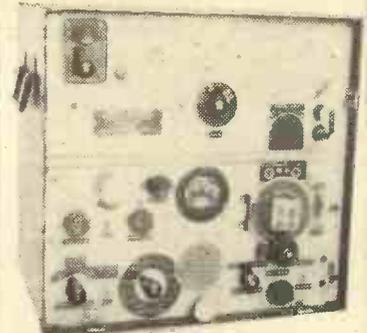
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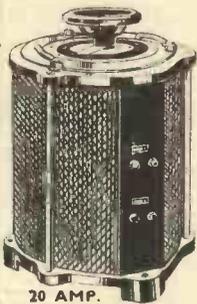
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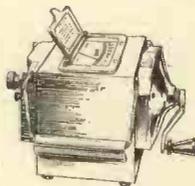
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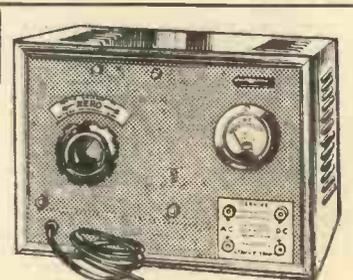
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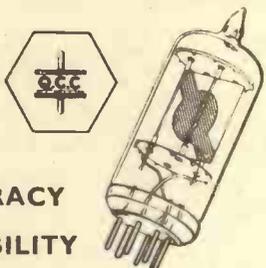
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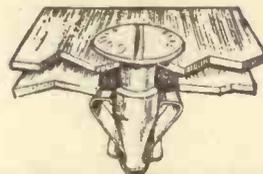
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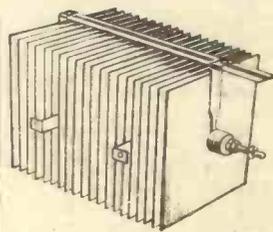
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2½	7,000	35	8/6	4	7,000	35	11/-	5	10,000	3	11/6
2½	7,000	50	8/6	4	9,500	35	11/6	5	6,000	25	10/6
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3½	7,000	35	8/6	5	6,000	3	8/-	5	9,500	35	11/6
3½	9,500	50	10/6	5	6,000	5	8/-	5	10,000	25	12/-
4	5,000	3	7/6	5	7,000	3	8/6	6½	7,000	3	11/-
4	6,000	3	8/-	5	7,000	5	8/6	6½	7,000	5	11/-
4	7,000	3	8/6	5	7,500	3	9/-	6½	8,500	3	11/6
4	9,500	5	9/6	5	8,500	3	9/6	6½	8,500	3	11/6
4	6,000	25	10/6	5	8,500	5	9/6	8	7,000	3	12/-
4	7,000	25	11/6	5	9,500	3	10/6				

Elliptical Size in Ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in Ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in Ins.	Gauss in Lines	Impedance in Ohms	Price
5x3	6,000	3	7/6	7x4	7,000	3	10/-	8x2½	6,000	6	8/6
5x3	7,000	3	8/-	7x4	7,000	5	10/-	8x2½	6,000	30	9/6
5x3	9,000	3	8/6	7x4	8,500	3	10/6	8x2½	8,500	5	9/6
5x3	9,000	4	8/6	7x4	9,500	3	11/-	8x2½	9,500	3	10/-
5x3	9,000	5	8/6	7x4	9,500	4	11/-	8x2½	9,500	4	10/-
5x3	6,000	25	9/6	7x4	9,500	5	11/-	8x2½	9,500	5	10/-
5x3	7,000	25	10/-	7x4	9,500	30	11/6	8x2½	10,000	5	10/6
5x3	9,000	25	11/-	7x4	9,500	50	11/6	8x5	6,000	3	8/6
5x3	9,000	35	11/-	7x4	9,500	15	12/6	8x5	7,000	3	9/-
6x4	6,000	3	8/6	7x4	10,000	15	12/6	8x5	8,500	3	9/6
6x4	7,000	3	9/-	7x4	9,500	3	13/6	8x5	8,500	3	9/6
6x4	8,500	3	9/6		(with match. trans.)			8x5	9,500	3	10/-
6x4	9,500	3	10/-	8x2½	6,000	3	8/6	8x5	9,500	15	13/6
6x4	9,500	5	10/-	8x2½	7,000	3	9/-	8x5	9,500	15	14/6
7x3½	9,500	3	10/6	8x2½	7,000	5	9/-				

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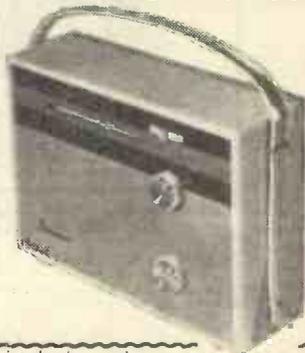
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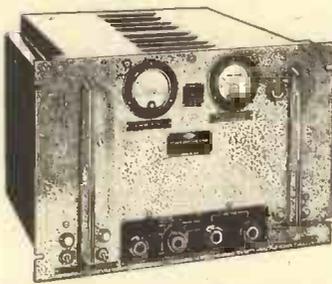
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Ranges: 1  $\mu$ H to 100H in 7 decades; 1pF to 100pF in 7 decades, 1 $\Omega$  to 100 M $\Omega$  in 8 decades; circuit magnification factor .1 to 100. Test frequency 1 kc/s and 10 kc/s. Measurements accuracy approx.  $\pm 10\%$  for R, L and C and  $\pm 10\%$  for "Q." Mains operation. Fully overhauled and guaranteed. £80 0 0

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Consists of a 5mA Cirsecula Moving Coil Aircraft Indicator with 3in. scale and kit of parts. Very simple modification. The Indicator is energised from the O.B. connection on the Distributor. Complete Kit with instructions. 45/- Indicator Only with instructions. 25/- P.P. 5/-

### KLYSTRON POWER SUPPLY UNITS Type 698

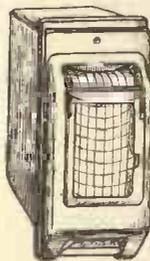


Fully regulated and stabilized rack mounted (19in.) mains operated power unit providing the following facilities:

- Cathode volts -1.0 kV. to -2.4 kV.
- Grid volt 0 to -220 v.
- Reflector volts 0 to -500 v.
- Cathode current 180mA. max.
- L.T. supplies 4.0 v. to 1.4 A.

INTERNAL GRID OR REFLECTOR MODULATION: Square wave: 2.4 kc/s., 70 v. peak-to-peak. Sawtooth: 150-600 c/s.; 0 to 30 v. peak. PRICE, fully overhauled and guaranteed, £65. Packing and carriage £2.

### ELLIOTT FLUSH MOUNTED RECORDING MILLIAMMETERS TYPE 230



Range: 1 mA. direct-to-movement, D.C., and 11 MA. A.C. through internal rectifier. Curvilinear trace. 3 $\frac{1}{2}$ in. wide strip-chart. Two-speed electric chart drive (230 v. A.C.) at 1 in. and 6in. per hour. Two limit contacts provided for high and/or low current alarm.

PRICE, fully overhauled and guaranteed, complete with two charts .. £37 10 0 Packing and carriage 15/-

### MARCONI TF934 DEVIATION TEST SET



Fundamental frequency range 2.5-100 Mc/s. basic; range can be extended to 500 Mc/s. by using harmonics. Deviation range 0-5, 0-25 and 0-75 kc/s. in the modulation range of 50 c/s. to 15 kc/s. Sensitivity better than 55mV. Power supplies 100-150 and 200-250V. A.C. Price fully overhauled and guaranteed. £85 0 0

### AMPHENOL TYPE "AN" SCREWED-ON CONNECTOR PAIRS

Ref.		
128-38,	1 $\frac{1}{2}$ in. dia., 2-20 amp. pins, 500V.	5/-
148-3P,	2 $\frac{1}{2}$ in. dia., 5-20 amp. pins, 200V.	6/-
18-38,	1 $\frac{1}{2}$ in. dia., 2-40 amp. pins, 900V.	7/-
18-4P,	1 $\frac{1}{2}$ in. dia., 4-20 amp. pins, 900V.	7/6
20-7P,	1 $\frac{1}{2}$ in. dia., 6-20 amp. pins, 500V.	8/-
20-16S,	1 $\frac{1}{2}$ in. dia., 7-40 amp. pins, 500V.	8/6
22-58,	1 $\frac{1}{2}$ in. dia., 5-40 amp. +1-20 amp. pin, 900V.	10/-
24-198,	1 $\frac{1}{2}$ in. dia., 12-20 amp. pins, 900V.	10/-
28-17P,	1 $\frac{1}{2}$ in. dia., 15-20 amp. pins, 500V.	12/-
32-13S,	1 $\frac{1}{2}$ in. dia., 6-40 amp. +18-20 amp. pins, 900V.	15/-

NOTES:—Letter "S" following Type No. denotes wall mounted socket and cable mounted plug. Letter "P" means wall mounted plug and cable mounted socket. Size is insert diameter. Voltage figures are working A.C. r.m.s. volts. Please add 1/- per pair for packing and postage.

### MARCONI TF888 PORTABLE RECEIVER TESTER

Self-contained mains operated instrument for determination of performance figures of radio receivers. The instrument consists of: (a) Signal generator covering a range of 70 kc/s. to 70 Mc/s. in 8 bands calibrated within  $\pm 2\%$  and providing calibrated output of 1  $\mu$ V. to 10 mV. and unattenuated output of approx. 500 mV.; (b) Crystal oscillator providing check points at 500 kc/s. and 5 Mc/s.; (c) 1,000 c/s. A.F. oscillator for use either as A.F. tone source up to 12 V. output or as an R.F. Modulator; (d) A.F. output power meter providing 3 ranges of 10mW., 100 mW. and 1 W. into 3-33-150 and 600 $\Omega$ . PRICE, in good condition and guaranteed. £30 0 0

### MARCONI TELEVISION SWEEP GENERATOR TF923

Mains operated instrument providing 6 pre-set frequencies normally centred at 44-50-55-60-65-90 Mc/s. and 4 pre-set frequencies of 120-133-189-195 Mc/s., variable I.F. of 8.5 to 18.5 Mc/s. and 25-35 Mc/s. and variable video frequency of 0 to 10 Mc/s. Frequency sweep 8-10 Mc/s. Output 1 V. approx. Oscilloscope time base output of approx. 2 V. PRICE in good condition and guaranteed. £20 0 0

### POWER UNITS TYPE W8356A

This is a Navy version of Type 3 Power Unit. 19in. rack mounting. Input 230 V. Fully smoothed H.T. output can be adjusted from 360 to 270 V. at 80 mA. by means of primary taps. L.T. output 6.3 V. A.C. at 4 amps. A.C. voltmeter monitors A.C. mains input and with key switch depressed, H.T. output. PRICE, second-hand, in good condition £3 10 0. P.P. 15/-

### TRANSFORMERS—BRAND NEW

PLATE TRANSFORMERS: Input 210-230V, Output 1600-1500-0-1500-1600V. at 350mA. .... 80/- P.P. 10/-  
H.T. TRANSFORMERS: Input 200-250V—  
Parmeko P2838 screened, 0-4-6.3V. at 4A., 0-4-5V. at 3A., 2x 0-4-6.3V. at 3A. 450-400-0-400-450V. at 180mA. 45/- P.P. 7/6  
Gardner 6079S screened, 2x 0-4-6.3V. at 4A., 0-4-5V. at 3A., 0-4-5-6.3V. at 3A., 300-300-0-300-350V. at 200mA., 40/- P.P. 7/6

### BATTERY CHARGER TRANSFORMERS

Input 200-250 v.  
MT3/AT, 0-12-15-20-24-30 v. 2 amps. .... 25/6  
MT10/AT, 24 v. at 5 amps. .... 38/6  
MT21/AT, 0-12-15-20-24-30 v. 4 amps. .... 38/-  
Packing and postage 8/-

### POST OFFICE TYPE 3000 RELAYS BRAND NEW

500 $\Omega$ coil, 2M+2 C.O.	12/6
2x 500 $\Omega$ coil, 2M heavy duty	12/6
2,000 $\Omega$ coil, 1M	10/-
2,000 $\Omega$ coil, 2B	10/6
2,000 $\Omega$ coil, 4 C.O.	12/6
6,000 $\Omega$ coil, 2M+2B. break before make	13/-
6,000 $\Omega$ coil, 1M+1B	10/6
6,500 $\Omega$ coil, 1M	11/6
6,500 $\Omega$ coil, 2B+4M	13/6
8,800 $\Omega$ coil, 2M+1B	12/6

### Removed from equipment—unused

200 $\Omega$ coil, 2 C.O. +1 C.O. (M before B)	6/6
200+400 $\Omega$ coil, 1 M+1B	6/6
1,000 $\Omega$ coil, 1B	5/6
1,000 $\Omega$ coil, 2M+4 C.O. (M before B)	7/-
10,000 $\Omega$ coil, 2 C.O.	6/6

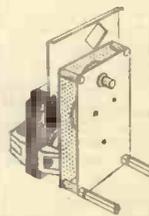
### P.P. 9d. per relay.

### HEAVY DUTY RELAYS

Type 332A-1 enclosed relay with removable bakelite cover. 160  $\Omega$  coil. One change-over contact 25 amps. capacity. Operating voltage 24 v. 10/- P.P. 1/6.

### "ELECTRON" OUTDOOR ROD AERIAL

3 strong tubular light alloy sections 3ft. long each on an insulated aerial base fitted with wall mounting bracket. Complete with down lead. PRICE, brand new, P.P. 6/- 15/-



### 230V. A.C. MOTOR

Approx. 8 watts 5 minute. Integral with 4-stage reduction gearbox giving an output shaft speed of approx. 7.5 r.p.m. with a torque of 1 ft.-lb. Shaft diameter 1/4in. Overall dimensions 2 $\frac{1}{2}$  x 3 $\frac{1}{2}$  x 3 $\frac{1}{2}$ in. Will operate continuously at 180V.

PRICE. £12/6 P.P. 2/6.



## R.E.C. BARGAINS

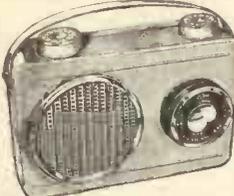
**HIGH FIDELITY MINIATURE HEAD- PHONES** on slim band. Resistance 150 ohms approx. Transformer free for high impedance circuits. 12/6, post 1/6.  
**MINIATURE PUSH PULL TRANSFORMERS** for transistor radios 8/6 per pair. P. & P. 9d.  
**FERRITE ROD AERIALS** 4" x 1/8" medium wave only 3/6 each. P. & P. 9d.

### Portable Transistor Sets

Backed by Super After Sales Service

#### ROAMER SIX

★ 8 stages—6 transistors and 2 Diodes.



Listen to stations half a world away with this 6 wave band portable. Tunable on Medium and Long waves, Travler band and two Short waves. Sensitive ferrite rod aerial and telescopic

aerial for short waves. Top grade transistors, 3 inch speaker, handsome case with gilt fittings. Size 6 1/2 in. x 4 1/2 in. x 1 1/2 in.

Total cost of all parts **NOW £4.19.6** P. & P. 3/6.  
*Parts price list and easy build plans 3/-.*

#### ROAMER SEVEN Mk. III

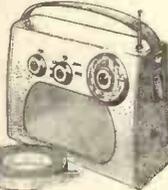
**5 WAVE BAND PORTABLE OR CAR RADIO. AMAZING PERFORMANCE & SPECIFICATION.**

★ 8 Stages—7 transistors and 2 diodes.

Covers Medium and Long Waves, Travler Band and two Short Waves to approx. 17 metres.

Push Pull output for room filling volume from rich toned heavy duty 5 in. speaker, Ferrite rod aerial for M. & L. waves and telescopic aerial for S. Waves. Air-spaced ganged tuning condenser ensures wonderful station selection. Stimulated hide case with gilt trim and shoulder and hand straps. Size 9 in. x 7 in. x 4 in. approx. The perfect portable and the ideal car radio. (Uses PP9 Battery available anywhere.)

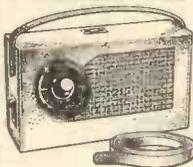
*Parts price list and easy build plans 3/-.*



P. & P. 5/6  
**NOW £5.19.6d.**

#### MELODY SIX

**NEW !!**



★ 8 stages—6 transistors and 2 diodes. Our latest completely portable transistor radio covering medium and long waves. Incorporates pre-tagged circuit board, 5 in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change

slide switch, sensitive 6 in. ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208, and many Continental stations. Handsome leather look pocket size case, only 6 1/2 in. x 3 1/2 in. x 1 1/2 in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

Total cost of all parts **£4.9.6** P. & P. 3/6.

*Parts price list and easy build plans 2/-.*

#### TRANSONA FIVE

★ 7 Stages—5 Transistors and 2 diodes. Covers Medium and Long Waves and Travler Bands, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed around super-sensitive Ferrite Rod Aerial and fine tone full size 3 inch moving coil speaker, built into attractive case in grey plastic with red grille. Size 6 1/2 in. x 4 1/2 in. x 1 1/2 in. approx.

(Uses 1289 battery available anywhere) **NOW 42/6**

Total cost of all parts **ONLY 3/-** P. & P. 3/6.

*Parts price list and easy build plans 2/-.* "Agreeably surprised with T.E. reception—Luxembourg as loud as local. Your easy build diagrams helped a lot... my first attempt."—H. S., Penzance, Oornwall (Poor reception area.)

All components used in our receivers may be purchased separately if desired. Parts price lists and easy to build plans supplied free with sets of parts or available separately at prices stated.

OVERSEAS POST 10/-

**Radio Exchange**  
 27, HARPUR STREET, BEDFORD  
 Phone 2367 • 10-1 Sats.

# NEWS

from Partridge

MEMO . . .

To Electronic Engineers

## YOU KNOW . . .

If you are engaged in the electronic or allied professions, that Partridge manufacture the best Output Transformers. In fact for 30 years the name of Partridge has been synonymous with high-fidelity.

## DO YOU ALSO KNOW . . .

that Partridge have a large technical staff available to design and manufacture any type of transformer to suit your particular electronic circuit? These can be designed especially to meet your own electrical requirements and to incorporate your specified fixing and mounting style. Partridge transformers can employ C-Core or laminated construction, open or hermetically sealed assemblies. Government type approval Certificate No. 1295.

Over 5,000 standard specifications are available for quick delivery. Prototype produced in 7 days from receipt of telephone call.

Write now for free copies of Partridge general data sheets; these provide fullest details from which to compile your specifications.

Send for details of the newest releases in the Partridge C-Core range for Hi-Fi equipment.



Partridge Transformers Ltd.,  
 ROEBUCK ROAD CHESINGTON SURREY  
 Telephone: Lower Hook 4253

## CABINETS AT SENSIBLE PRICES FROM £5.7.6d!

You can be sure of meeting the exact cabinet you require when you examine the most extensive range in the country at Lewis Radio, here are just two examples:



THE BRAHMS  
 Price 26 gns.

This new elegant Brahm's cabinet is available in medium walnut and medium mahogany, with 9 in. legs and will take any tape deck, turntable, tuner and pre-amplifier, the largest stereo amplifier plus record and tape storage.



THE LOWBOY  
 Price 24 gns.

This rigidly constructed Hi-Fi cabinet will accommodate even the largest Hi-Fi units—available in walnut or stripey sapele mahogany—size 53 in. long by 20 1/2 in. deep by 26 in. high including 12 in. legs.

### TWO NEW LEWIS CATALOGUES

Designed to assist your choice of cabinet and equipment.

The new Lewis Radio Cabinet Catalogue—the most comprehensive ever prepared. The unique 64-page equipment catalogue. **ONLY 3/6.**

Please send your two new catalogues. Enclosed is P.O. for 3/6 which will be credited against any purchase I make.

NAME AND ADDRESS

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W.8

CAPITALS PLEASE

## LEWIS radio

100 CHASE SIDE, SOUTHGATE, LONDON, N.14  
 Telephone: Palmers Green 3733/9666

# CLASSIFIED ADVERTISEMENTS

Rate 9/- for 2 lines or less and 4/6 for every additional one or part thereof, average lines 8 words. Box Numbers 2 words plus 1/-. (Address replies: Box 0000 o/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day September 1963 issue, Wednesday, August 14th. No responsibility accepted for errors.

## SITUATIONS VACANT

**A**N overseas career.

**WITH INTERNATIONAL Aeradio, Limited.**  
TO meet the requirements of constant growth and expansion we invite applications from technicians and engineers for an overseas career in North, West and East Africa, the Mediterranean area, the Caribbean, the Arabian Gulf and the Far East. If you have recently completed service in a trade such as Ground Wireless Fitter in the R.A.F. or Radio Electrical Artificer in the Royal Navy or have other experience in the maintenance of HF and VHF communications, RTT and navigational aids, we should be interested to hear from you. Successful candidates would normally spend six weeks at our Radio Training School, Southall, Middlesex, before proceeding overseas, but in some cases staff with suitable qualifications and experience may be offered immediate posting. Overseas staff receive a tax-free salary with married and child allowances if appropriate and accommodation, bachelor or married, is provided free; other benefits include generous U.K. leave and membership of an excellent pension and life assurance scheme.

WRITTEN applications, please, to Personnel Officer, 40, Park Street, W.1. 10084

**E**LECTRICAL engineers.

MEN with O.N.C. or equivalent experience required for test room on a variety of instruments and equipment for H.M. Services; suit radio technicians with experience on ground radio and radar equipment; staff position; salary in line with qualifications and experience; holiday arrangements honoured; super-annuation scheme; company station transport.  
—Apply in writing to Personnel Officer, Peto Scott Electrical Instruments, Ltd., Weybridge. 10086

**C**LOSED circuit TV testers.

WE invite applications from test engineers, preferably with previous industrial experience on television equipment; interesting work on TV cameras, camera control units and a variety of monitors, including transistor equipment. **SUCCESSFUL** applicants will be offered positions on the company's permanent staff; salary in line with qualifications and experience; holiday arrangements will be honoured; super-annuation scheme; company station transport.  
—Apply in writing to Personnel Officer, Peto Scott Electrical Instruments, Ltd., Weybridge. 10085

**U**NIVERSITY OF EAST ANGLIA.

**SCHOOL** of Chemical Sciences.  
APPLICATIONS are invited for the following appointment to the technical staff of the School at a starting salary appropriate to qualifications and experience on the scale £540 to £745.

**TECHNICIAN** (Electronics) to work on the design and development of light electronic circuits for teaching and research, and to carry out routine maintenance and repairs of electronic instruments used in physical methods. Applicants should have a good theoretical background to C. & G. standard.

APPLICATIONS, in writing, giving full details of age, qualifications and experience, should be sent to the Dean of the School of Chemical Sciences, Earlham Hall, Norwich. NOR. 05G. 12460

**R**ADIO & Television Service Engineers

**ADDITIONAL** engineers required. Experienced and to C & G. standards. Permanent pensionable positions.—G. A. Colbourne, Limited, 10 Southgate, Chichester. 12466

**A**SSISTANT SUPERINTENDENT OF POLICE (RADIO).  
REQUIRED by the Sierra Leone Government on contract for 2 tours of 15-18 months in first instance. Salary according to age and experience in scale (including Inducement Pay) rising to £1,666 a year.

GRATUITY at rate of 15% of total salary drawn. Outhy Allowance £60. Children's allowances. Free passages. Liberal leave on full salary.

CANDIDATES, under 45 years of age, should possess C. & G. Final Certificate in Telecommunications or equivalent. They should be proficient in Morse and have wide experience of installation and maintenance of low power H.F. communication equipment and fixed and mobile H.F. equipment.

APPLY to Crown Agents, 4 Millbank, London, S.W.1, for further particulars, stating age, name, brief details of qualifications and experience and quoting reference M2/51991/WF. 12427

## ELECTRONIC ENGINEERS AND ELECTRO-MECHANICAL TECHNICIANS

Expansion of our business has created openings in the maintenance of computers and their associated equipments. Vacancies exist at various levels and applications are invited from men with any of the following backgrounds:—

- (1) Qualified men with a degree of H.N.C. in Electrical Engineering or Physics.
- (2) Engineers with experience of electronic circuitry and pulse techniques.
- (3) Men who have served a mechanical engineering apprenticeship and have experience of maintaining light electro-mechanical equipments.
- (4) Young men with a mechanical aptitude and a knowledge of D.C. theory.

Full training will be given and our training scheme provides the means whereby men of ability can advance to more senior positions. Good starting salaries will be paid and further increases will be awarded quickly whenever individual merit warrants recognition.

Write giving details of career to date to:—

The Personnel Manager (Code 650),  
**ENGLISH ELECTRIC—LEO COMPUTERS LTD.**  
Hartree House, Queensbury, London, W.2.

## TEST ENGINEERS

Continued expansion of our Test and Calibration Department has created new opportunities for work involving electronic techniques from d.c. to microwave. The Company attaches great importance to this part of its activity and these are real career opportunities which will be of interest to graduate engineers and holders of H.N.C.

Vacancies also exist for less well qualified applicants who have experience in trouble-shooting electronic circuits. Facilities for part time studies will be available in approved cases.

Apply:

Technical Manager

**HEWLETT - PACKARD LIMITED**  
DALLAS ROAD, BEDFORD

## Opportunities in COLOUR TELEVISION DEVELOPMENT ENGINEERS

- To work on the development of colour monitors and colour equipment. Experience of transistor techniques desirable.
- To work on the design of U.H.F. aerials for both transmitting and receiving equipments.
- To work on the design of radio and intermediate frequency amplifiers and mixers.

Preference will be given to people with a good engineering degree or equivalent qualification plus experience in the fields mentioned.

All applicants should write giving fullest details of qualifications, experience, age and other personal details to:—



Personnel Manager,  
**G.E.C. (ELECTRONICS) LTD.**,  
North Wembley Works,  
East Lane, Wembley, Middlesex.

### CITY AND GUILDS OF LONDON INSTITUTE.

**ADMINISTRATIVE Officer.** APPLICATIONS are invited from men graduates or equivalent within the age range 25-35 for a pensionable post as administrative officer at the Institute's Head Office.

THE post is concerned with the administration of the Institute's examinations in the electrical and electronics industrial fields.

APPLICANTS should have a genuine interest in the advancement of technical education and previous experience in educational administration and committee work will be an advantage. Preference will be given to those who have been engaged in the electrical, electronics or telecommunication industries, and who are familiar with technical terms.

SALARY will be on a scale within the range £750 to £1,450 according to qualifications and experience. There are opportunities for advancement to higher scales and appointments.

APPLICANTS should send particulars of qualifications and experience as soon as possible to:

SECRETARY (TO) City and Guilds of London Institute, 76, Portland Place, London, W.1. [2468]

YOUNG development engineer required for expanding TV rental and distribution chain. —Box 5168. [0181]

### HAMMERSMITH HOSPITAL AND POST-GRADUATE MEDICAL SCHOOL.

DU Cane Road, London, W.12.  
**ELECTRONICS TECHNICIAN** wanted in leading Medical Physics Department carrying out both research and clinical work, to construct new circuits and maintain existing equipment. Salary scale £630-£785 plus £25/40 London Allowance. Detailed applications, naming two referees, to Secretary, Board of Governors, Hammersmith Hospital, Du Cane Road, London, W.12. within 7 days. [2465]

### NORTHAMPTON College of Advanced-Technology, St. John Street, London, E.C.1.

DEPARTMENT of Electrical Engineering.  
JUNIOR Laboratory Technicians.

CANDIDATES should have (a) 4 approved G.C.E. subjects at "O" Level or (b) have obtained or pursuing the O.N.C. course in Electrical Engineering. Junior Technicians normally receive a five-year integrated course of education and training in all branches of electrical engineering. This includes workshop processes and experience in the undergraduate teaching and special project laboratories, and where appropriate research laboratories. Concurrently with training, each Junior Technician receives part-time day release to study for the H.N.C. or possibly H.N.D. After training the Technician would be qualified to work as Senior Technician in College, Industrial, Government and Research Association, research and development laboratories.

APPLICATIONS to Head of Department for details, salary and conditions. [2453]

## TECHNICAL WRITER

A writer is required who would prepare instruction and service manuals for Electronic Measuring Instruments. The Technical Standard is at least to H.N.C. level and some experience in writing is essential. Applications to Personnel Manager giving full details of experience, age and qualifications.

### WAYNE KERR

The Wayne Kerr Engineering Co. Chessington, Surrey.

# ARE YOU

an  
Electronic Test Engineer?

at present earning  
£900 to £1300 OR looking ahead to  
a salary of this order?

if your answers are  
YES!—read on:

We are a leading manufacturer of Electronic capital equipment and increasing production means a sharply rising demand for Production Test Staff. Ideally you should have an H.N.C. plus two or three years test experience in electronics, although there are junior openings for those with O.N.C. or equivalent. All these posts offer a good career structure in a stable organisation.

Why not write, in complete confidence, for more details and at the same time let us have a brief résumé of your own background, including current salary. All replies will be acknowledged.

Write Box 5221.

**G.E.C.****COVENTRY**

G.E.C. (Telecommunications) Ltd are manufacturers of transmission systems in the VHF and micro-wave bands, and electronic and electro-mechanical telephone exchanges. We are going through a stage of considerable expansion and will be requiring the following staff from time to time over the next 12 months:—

**TEST DEPARTMENT**

For the junior vacancies we would like to see evidence of progress in ONC or in City and Guilds telecommunications subjects. Men who have been working on electronic or telecommunications equipment in the Services are particularly welcome. For the senior vacancies some years' experience on electronic or electro-mechanical equipment preferably combined with formal qualifications are desirable. Starting salaries are in the bracket £13/6/- to £18 a week.

**CONTRACT ENGINEERS**

Would be particularly attractive to men who have had wide experience of the installation and commissioning of complex telecommunications systems and who are now seeking more static employment. Starting salary not less than £1,000 a year.

**INSTALLATION**

Testers and installers for the installation and commissioning of transmission equipment both in the U.K. and overseas.

**ELECTRONIC DESIGN ENGINEERS**

The production of prototype manufacturing instructions from laboratory schematic sketches. A formal qualification together with a mechanical as well as an electronic bent and draughting experience are required. Starting salaries are in the bracket £15-£17 a week.

*Apply, with full details of age, education and experience to:—*

**GENERAL ELECTRIC CO., LTD.**

Telephone Works, Copsewood, Coventry.

**THORN-AEI****APPLICATIONS LABORATORY**

Vacancies exist in the Sections responsible for the following:—

**COLOUR RECEIVER CIRCUIT DEVELOPMENT (ref. A105)****T.V. TUNER DESIGN (ref. A106)**

Senior Engineers are required with good academic qualifications. Previous experience in their respective fields is essential.

**SEMICONDUCTOR CHARACTERISATION AND PERFORMANCE (ref. A107)**

A Physicist or Engineer with good academic qualifications, and preferably, experience in semiconductor performance measurement

**DOMESTIC ENTERTAINMENT EQUIPMENT (ref. A108)**

This position will entail investigation of problems in connection with the application of valves, cathode ray tubes and semiconductors in domestic entertainment equipment. The applicant should be a qualified engineer or physicist who already is quite familiar with circuitry normally encountered in domestic television and radio. A knowledge of tape-recorder circuitry would be an advantage.

The conditions of employment are excellent. Contributory Pension Fund, Canteen, Social Club and Welfare facilities available. Generous starting salary commensurate with age, experience, qualifications, etc.

Written applications giving full details of education, training, experience, qualifications (with dates) and present salary, will be treated in strict confidence and must be addressed to:—

The Personnel Manager, THORN-AEI RADIO VALVES & TUBES LTD.

Millmarsh Lane, Brimsdown, Enfield, Middlesex.



# ROLLS-ROYCE

## ADVANCED RESEARCH LABORATORY

An experimental assistant is required to join a small group carrying out basic research in hypersonic gas dynamics. The work involves the use of a variety of techniques, such as microsecond electronics and high speed photography, for the study of shock and detonation waves.

A general knowledge of experimental procedure, acquired by a few years work in a physics laboratory, is desirable, and the minimum qualifications required are an O.N.C. or equivalent.

Applications should be addressed to the—

Employment Manager, Rolls-Royce Limited, P.O. Box 31, Derby.

### GOVERNMENT COMMUNICATIONS HEADQUARTERS

**RESEARCH & DEVELOPMENT CRAFTSMEN**  
RADIO MECHANICS for the maintenance and installation of radio communication receivers and equipment.

**TELEPRINTER MECHANICS** for the maintenance of teleprinter and cypher machines and associated telegraph equipment.

**COMPUTER MECHANICS** for the maintenance of computer peripheral equipment including magnetic tape handlers, paper tape equipment and electric typewriters.

**WIRESMEN** for prototype sub-assembly layout, wiring and testing of radio and computer type chassis.

**BASIC PAY** £10/4/2 per week plus merit pay in the range of 10/- to 100/- per week. Merit pay will be assessed at interview based on ability and the necessary basic qualifications. Opportunities for eventual permanent and pensionable posts. Five-day 42-hour net week.

Good working conditions.

Apply in writing to:  
Recruitment Officer (RDC/S), G.C.H.Q. "A"  
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LONDON hi-fi dealer seeks experienced male order organiser, part-timer considered.— [0139] Box 5192.

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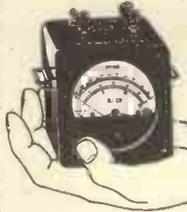
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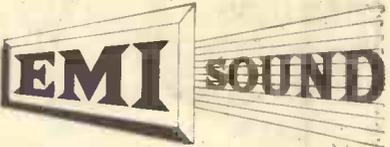
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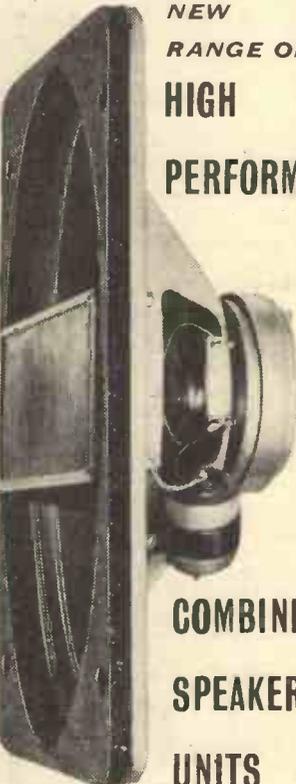
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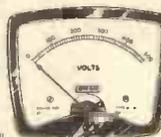
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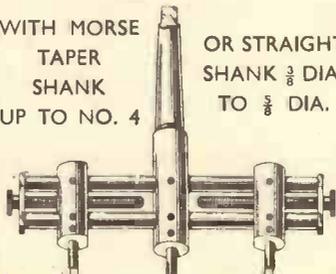
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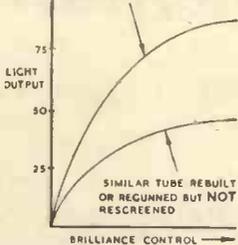
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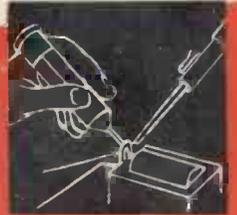
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