

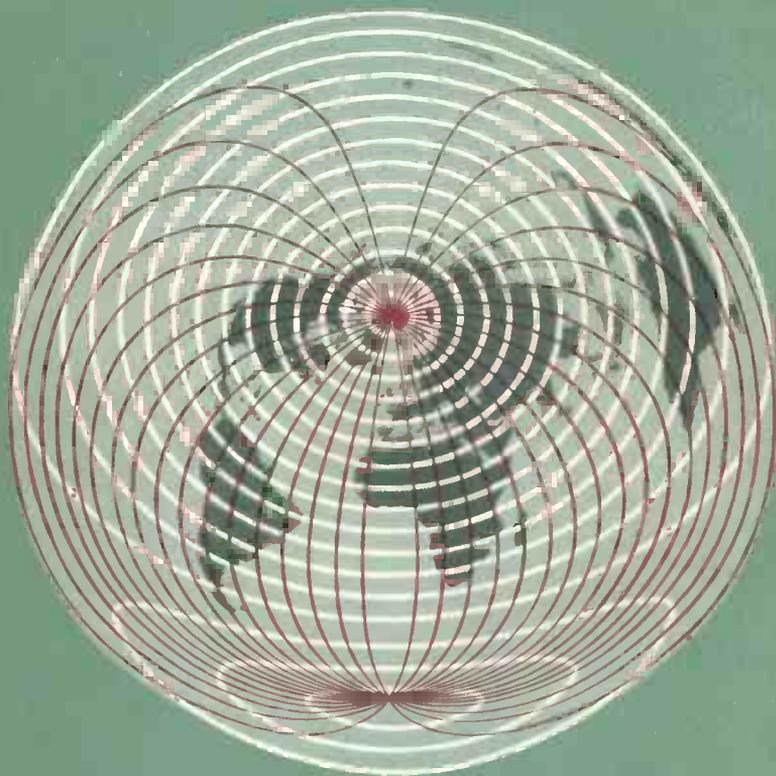
NOVEMBER 1960

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Wireless World

ELECTRONICS

Radio • Television



FIFTIETH YEAR OF PUBLICATION

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Wireless World

ELECTRONICS, RADIO, TELEVISION

NOVEMBER 1960

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VOLUME 66 No 11.

PRICE: TWO SHILLINGS

FIFTIETH YEAR

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PUBLISHED MONTHLY (4th Monday of preceding month) by ILIFFE & SONS, LTD., Dorset House, Stamford Street, London, S.E.1. Telephone: Waterloo 3333 (65 lines). Telegrams: "Ethaworld, Sedist, London." Annual Subscriptions. Home and Overseas, £1 15s. 0d. Canada and U.S.A., \$5.00. Second-class mail privileges authorised at New York, N.Y. BRANCH OFFICES: BIRMINGHAM: King Edward House, New Street, 2. Telephone: Midland 7191. COVENTRY: 8-10, Corporation Street. Telephone: Coventry 25210. GLASGOW: 62, Buchanan Street, C.1. Telephone: Central 1265-6. MANCHESTER: 260, Deansgate, 3. Telephone: Blackfriars 4412. NEW YORK OFFICE: U.S.A.: 111, Broadway, 6. Telephone: Digby 9-1197.

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Electronic Air Traffic Control

FEW more challenging tasks have been presented to electronics than that of freeing the bottleneck which threatens to restrict further expansion of air transport, namely, the saturation of airways and existing traffic control procedures by the ever-increasing numbers and speeds of jet and turbo-prop aircraft now entering service.

Expansion of air transport to its present volume has depended as much on radio and electronics as on aircraft design. Navigational aids, and instrument approach systems, have gone far in solving the problems of night and bad-weather flying. Today the world's airlines run traffic schedules comparable in complexity with those of the railways, but with at least three significant differences—the time scale, the fact that movement is in three instead of two dimensions and that, unlike trains or road vehicles, aircraft awaiting the signal to land consume large quantities of fuel.

The existing system of traffic control is founded on flight progress strips which are based on pilots' reports of positions and estimated times of arrival at successive reporting points. These are displayed on the controller's progress board and are continuously "up-dated" by him. From an inspection of these data he anticipates possible future "conflictions" and issues flight instructions (clearances) to maintain an orderly flow of traffic with safe spacing based on a knowledge of possible errors of navigation and of time delays in communication. Under present conditions the "error volume" per aircraft is large and is the reason why, particularly on the North Atlantic routes, at certain times of the day, no more aircraft can at present be put into the airspace. More people want to fly and airlines have already ordered more high-speed jets, but the time is not far distant, if it has not arrived already, when air traffic control will have to say that it cannot accept any further extension of schedules. This is a world problem, for an airport must accept foreign aircraft as well as dispatch its own traffic at times which will be acceptable at other centres.

The solution of the problem rests on greater precision in navigation and on greater speed of communication, both of which can be provided by electronic methods. Excellent surveys of the possibilities and of present achievements have been given recently.* These envisage in the first instance the

automatic reporting, by facsimile methods or in digital codes, of navigational information from hyperbolic or Doppler flight logs with transmission times of the order of milliseconds and the automatic preparation of accurate and up-to-date progress strips for the controller. Subsequently there is the possibility of processing this data in three-dimensional Cartesian co-ordinates, of computing the future positions of aircraft and giving automatic warning of conflictions. There is the alternative possibility of deriving flight data from radar displays, of presenting the controller with a synthesized display giving only essential information which might include, instead of the familiar phosphor persistence "tails," vectors pointing in the opposite direction and showing the future positions of all aircraft in the area. Large-scale projects to test these and other possible methods, including not only the detection but the resolution of conflicts, are already in progress by the Federal Aviation Agency at Indianapolis, by N.V. Hollandse Signaalapparaten at Schiphol in Holland and by the Ministry of Aviation at the Oceanic Control Centre at Prestwick.

The Guild of Air Traffic Control Officers at their Third Convention last month in Bournemouth discussed all these projects and welcomed the promised aids in the knowledge that while they could relieve them of tedious routine "book-keeping" they would not in the foreseeable future compete with the experience and flexibility of the human controller in dealing with an emergency. These aids could take out of his hands the monitoring of normal flights and allow him to give his undivided attention to the small percentage of situations calling for the exercise of his store of knowledge and experience—as yet unrivalled by the capacity of any computer.

Considerable sums of money are being spent on the development and testing of electronic navigational and control systems of different kinds, but it will be some time before technical assessments can be completed and operational procedures modified to admit these extensions of human faculties. But it is to be hoped that decisions will not become bogged down in too many committees, and that those elements of a future co-ordinated world system which have for their object the simplification and reduction of the information presented to the controller, may be quickly adopted and, where desirable, standardized.

* See, for example, papers in the "Symposium on Data Handling and Display Systems for Air Traffic Control," Vol. 107, Part B, Proc. I.E.E., and "Air Traffic Control" by C. D. Colchester. (Marconi's W/T Co. Ltd. Price 17s 6d.)

Microwave Aerial Measurements

AUTOMATIC APPARATUS FOR PLOTTING PHASE AND AMPLITUDE DISTRIBUTION

By C. M. CADE*, M.Brit.I.R.E., M.A.I.E.E., S.M.I.R.E., and A. T. ELLIOTT*, A.M.Brit.I.R.E.

ONE of the most frustrating factors in the design of any aerial system is the time involved in the measurement of polar diagrams, where on external sites the vagaries of the weather can cause considerable delays. Measurement of the amplitude and phase distribution of the near field radiation pattern is a convenient method of obtaining experimental



Fig. 1. Five-foot slotted X-band array for a marine radar equipment.

data on the performance of the aerial, and has the great advantage that these tests can be carried out in the laboratory. Having obtained the desired characteristics, the polar diagram measurements need only be carried out as a final check. This method was used for the development of the X-band slotted array shown in Fig. 1.

Most systems in use for phase distribution measurements are based upon similar principles. The aerial under test is energized from a low-power source and a sample of the radiated power is picked up on a small receiving aerial and then compared with a reference signal coming directly from the same source. If the receiving aerial is moved over the aperture, the two signals will either add or cancel, and a pattern similar to Fig. 2 can be produced. Each null point represents a phase change of $\pi/2$ radians. If a phase shifter is then provided for varying the phase of one signal relative to the other, so that a maximum signal is always maintained, then

the phase shifter will indicate directly the phase of the radiation.

However, these simple systems are subject to many inaccuracies. The sampling aerial has to convey its signal either by coaxial cable, flexible waveguide or rigid waveguide incorporating several rotating joints. These moving parts can all cause random phase variations. Other errors can be introduced due to the laborious nature of the measurements, and also by the fact that the pick-up aerial is of large physical size and introduces considerable distortion into the field under measurement.

In the automatic phase plotter developed by the authors, instead of a sampling aerial being used, an isolated half-wave dipole is mounted in the field of the aerial under test and reflects a part of the radiated signal back into the aerial. A general view of the apparatus is given in Fig. 3. The dipole aerial is of such small dimensions that it introduces negligible distortion into the micro-wave field. This is the method first described by Cullen and Parr.[†] By the use of suitable directional feeds, the reflected sample is compared in phase with the source, and the resultant signal is detected on a crystal. In order to discriminate between reflections from the dipole and unwanted spurious reflections, the dipole is arranged to rotate so that the required signal is modulated at twice the dipole rotational frequency, and can therefore easily be separated from spurious reflected signals. The required separation is obtained by feeding the signal into a high-Q selective amplifier tuned to the modulation frequency. This arrangement has the further advantage that suitable selection of dipole rotational speed and selective amplifier frequency results in the rejection of noise and mains hum interference.

In order to maintain a constant-phase signal at the crystal the height of the rotating dipole above the aerial undergoing test is automatically adjusted by a velodyne servo motor (Fig. 4). The aerial to be tested is energized by a klystron and is mounted beside a railway track. A trolley moves along the track, carrying the rotating dipole over the aerial aperture, and the dipole movement is plotted by an

*Radar Research Dept., Kelvin & Hughes Ltd.
[†]Cullen, A. L. and Parr, J. C. *Proc. I.E.E.* 102, Part B. No. 6, November 1955. "A New Perturbation Method for Measuring Microwave Fields in Free Space."



Fig. 2. Oscilloscope recording of phase and amplitude response of five-foot array.

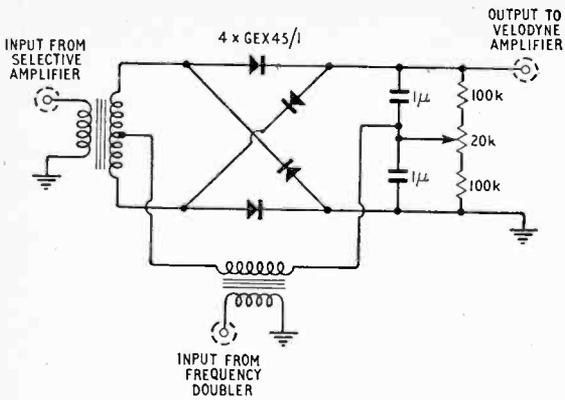


Fig. 7. Phase-sensitive detector.

passing through a null point, and hence the phase-sensitive detector operates as a discriminator, controlling the velodyne amplifier. The dipole height is automatically adjusted and zero discriminator output maintained. Since the power distribution of a linear array varies by some 30 dB along the length, it is important to ensure that the system has an adequate dynamic range, and suitable a.g.c. circuits are essential. It is found in practice that a complex amplified automatic gain control system is required, for even small variations in signal strength will affect the loop gain and response of the servo system.

Selective Amplifier Requirements.—To obtain adequate rejection of mains hum and its harmonics, it is necessary for the selective amplifier response to be some 30 dB down at 100 c/s and 150 c/s. A parallel-T feedback amplifier is suitable, the bandwidth being 2 c/s. The circuit diagram is shown in Fig. 8. With this narrow bandwidth, the amplifier

build-up time is appreciable, and limits the velocity of the trolley carrying the rotating dipole. The build-up time of a frequency selective circuit is given by:—

$$T = \frac{1}{\Delta f \pi} \text{ seconds} \quad \dots \quad (1)$$

where Δf is the bandwidth. The build-up time of the amplifier employed is 160 milliseconds.

It may be shown that the trolley velocity is limited to:—

$$V \leq \frac{l}{2\phi T \times 100} \text{ cm/second} \quad \dots \quad (2)$$

where l = test aerial length.

ϕ = total phase change along aerial.

In the case of the slotted array under test, these parameters were

$l = 150$ cm.

$\phi = 8\pi$ radians (at a frequency of 9,500 Mc/s).

Inserting these figures in the formula gives a maximum velocity of approximately 0.2 cm/second.

Mechanical Tolerances.—The height of the rotating dipole must be known accurately, since any error in the recording of its height produces an inaccuracy in the phase plot.

If Δh is a random change in height of the dipole, then the change in phase of the signal will be

$$\phi_h = 2\pi \times \frac{2\Delta h}{\lambda_0} \text{ radians} \quad \dots \quad (3)$$

where λ_0 = free space wavelength.

This formula can be re-written to obtain the error for each thousandth of an inch variation in the dipole height, in which case:

$$\phi_h = \frac{1.83}{\lambda_0} \text{ degrees/thou.} \quad \dots \quad (4)$$

Thus, $\phi_h = 0.6$ degrees/thou. for $\lambda_0 = 3.2$ cm. If we assume that the closest economically practicable tolerance for a fifteen-foot long railway is $\pm 1/64$ inch,

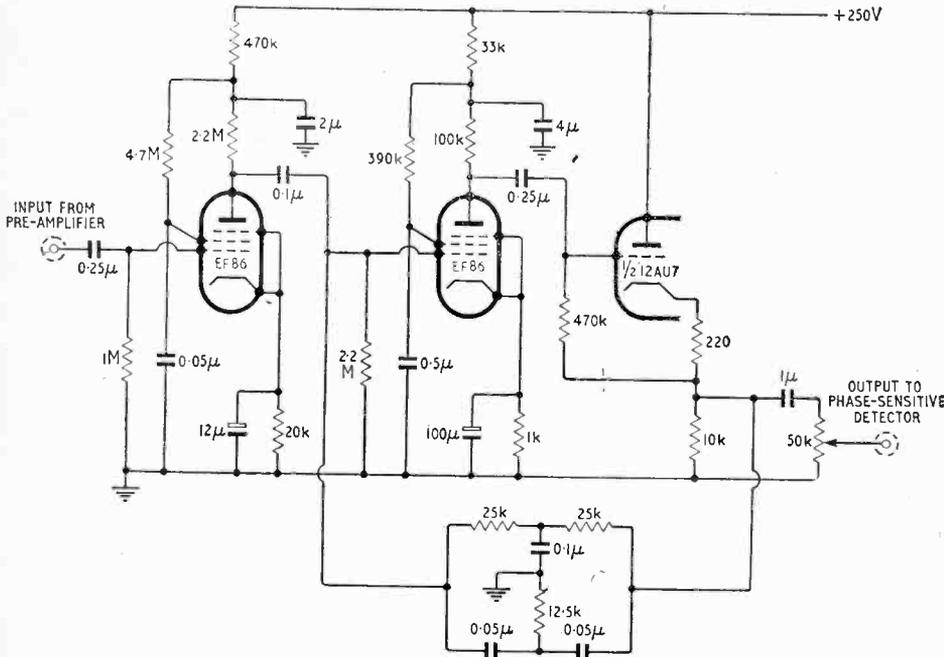


Fig. 8. 126-c/s selective amplifier.

the phase error in the system will be approximately ± 10 degrees.

Klystron Ripple.—Consideration must be given to the effect of power-pack ripple on the klystron performance. If the ripple is excessive the signal may be swamped with hum. Also, the phase of the klystron oscillation could change sufficiently during the time taken by a signal to travel to the end of the aerial and return, and an error would occur in the recorded phase angle.

Assuming the maximum test aerial length to be fifteen feet, then the return path from the aerial to the crystal mixer would be some 10 metres. If the velocity of propagation in the waveguide is 200×10^6 metres/second, then the delay time becomes $1/20 \mu\text{sec}$.

It may be shown that the change in phase of the klystron oscillation during this delay time is:

$$\theta_r = \frac{2\pi \cdot xV}{W_r} \sin \frac{W_r T_d}{2} \text{ radians} \dots \dots (5)$$

where θ_r = phase angle,
 W_r = ripple frequency,
 x = klystron reflector characteristic, cycles/volt,
 V = peak-to-peak voltage of klystron reflector ripple,
and T_d = delay time.

Assuming full-wave rectification, and a 50 c/s supply, $W_r = 200$.

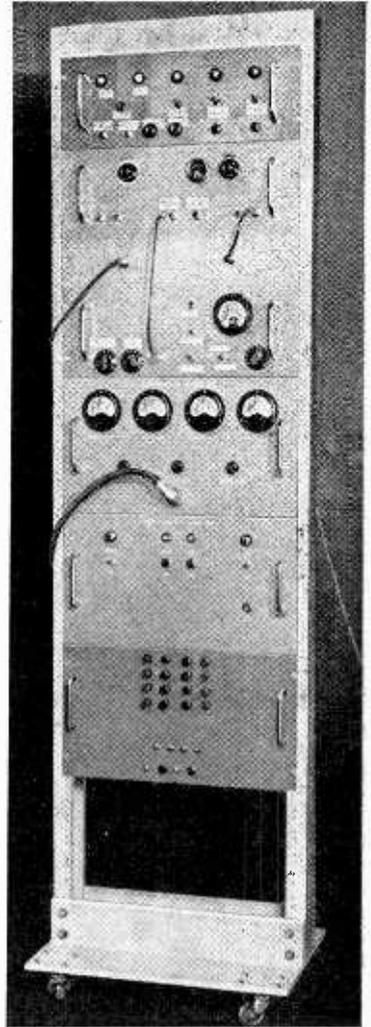
If the maximum error is not to exceed 1° , or $\frac{2\pi}{360}$ radians, then:

$$V \gtrsim \frac{10^6}{9x} \text{ volts}$$

The klystron in use is a CV.129, the reflector characteristic being approximately 2.5×10^5 cycles/volt. Therefore, $V \gtrsim 500$ millivolts peak-to-peak. This ripple voltage corresponds to a frequency deviation of about 125 kc/s, and the ripple from a stabilized power supply can be controlled well within this limit. The recording of a complete phase plot may take as long as fifteen minutes, and it is important that the klystron does not drift more than 125 kc/s during this period. Thus a highly stable power supply, and some form of cavity stabilization is required for the klystron. The Kelvin-Hughes High Voltage Power Unit, which is stable to one part in 10^6 has been found very suitable. The two units comprising this power supply can be seen in Fig. 9.

Recording System.—The recorder, which is shown in Fig. 5, consists of a long carriage arranged to move slowly across a piece of graph paper at a speed proportional to the dipole trolley speed. The carriage is driven by a synchronous motor operating from the same supply as the trolley motor. Mounted on the carriage is a pen which can be moved transversely across the carriage by the rotation of a screwed rod, the turning of the rod being directly related to the vertical movement of the rotating dipole. Geared to the velodyne motor, which raises or lowers the dipole, is an "M" type "step-by-step" transmitter (see Fig. 4) which is connected to an "M" type receiver motor, which turns the screwed rod. Thus the position of the pen is directly proportional to the position of the rotating dipole and

Fig. 9. Rack-mounted equipment. The units are (from top to bottom):—Railway control unit, selective amplifier, phase sensitive detector, velodyne amplifier, the two units of the klystron power supply, and finally the main power supplies.



a graph is drawn of the contours of constant phase of the aerial under test.

Conclusions.—The equipment has been used successfully for phase plots of various types of X-band aerial. A limitation of the present system is that the pen movement can only follow contours of constant phase, and to obtain a plot of actual phase requires conversion from wavelength into phase angle. A direct plot of phase angle could be obtained by incorporating a variable speed gear in the "M" motor drive. A different ratio would be required to be set for each frequency, and then by choosing a suitable graph paper scale, degrees or radians would be indicated directly.

CORRECTION

On page 443 of our September 1960 issue, in referring to the "Lifeguard" products of Cathode Ray Tubes, Ltd., Factory Centre, Kings Norton, Birmingham 30, we inadvertently used a contraction which may have caused confusion with the firm of C.R.T. Ltd., Royston Road, Baldock, Herts, which has for some time now been engaged in the business of reconditioning cathode ray tubes.

We wish to express regret to both firms for any embarrassment which this may have caused.



Paris Radio Show: BROADCASTING AND ELECTRONICS

THIS year's exhibition, organized jointly by the Fédération National des Industries Electronique (F.N.I.E.) and the Radiodiffusion-Télévision Française (R.T.F.) was notable for the addition of a large section devoted to professional electronics and a considerable expansion of the facilities for the public presentation of live television and sound broadcasts. The F.N.I.E. has happily amalgamated the divergent interests of the manufacturers of domestic and professional equipment, and, in consequence, the exhibition presented a comprehensive view of the radio and electronics industry in France.

Television. The main hall, occupied by the domestic receiver manufacturers, seemed poorly lit by Earls Court standards and on a dull morning it was a little difficult to see what was on view in the recesses of some of the stands; but the logic of subdued ambient lighting became at once obvious when the day's television programme started. Judgment of picture quality could be made under conditions much nearer those of the home than is generally possible at Earls Court. The French 819-line standard presents no barrier to the current trend towards larger screens, and France definitely leads the race in this direction. Sales of 21-in sets are already on the point of overtaking those of 17-in, and large-screen (écran géant) receivers of 70-cm (27½-in) diagonal were offered by at least five firms. The tubes call for high e.h.t. supplies and some of these pictures were a little pale by comparison with adjacent 17-in and 21-in tubes, but no criticism could be levelled on the score of liness. Three firms were showing sets with photo-cell automatic control of contrast.

A mains/battery receiver for use in cars and boats with 12-volt power supplies (shown by Télé-portable) was equipped with a 9-in tube, but the smallest television sets in the show made use of 1½-in tubes

and were to be seen, faithfully reproducing the day's programmes, in a doll's house on the stand of Sonneclair. We have an idea that there was a good deal of auxiliary equipment out of sight in the cellars of this house!

Channel switching on most receivers includes a position for the proposed French "second chain" of television stations on u.h.f. Receivers with provision for the reception of one or both 625-line standards (Belgium and Luxembourg) in addition to the French national 819 lines are readily available, though most of the lower priced sets are for the French standard only. The question of price seems to be the first one asked by prospective customers at the Salon when they have been attracted to a receiver by the appearance of its cabinet, and discussion to the point of sale often continues without any sign of any picture on the screen. Good picture quality seems to be taken for granted by the French public—a remarkable tribute to the general technical competence of the receiver manufacturers and to the quality of the R.T.F. transmissions.

Styling in cabinet designs was in general conservative, though three or four of the larger firms showed a tendency to follow the slim rectilinear trends seen this year in other countries. There is no sign of the general adoption of plastic front-covers and most sets, even some portables, are fitted with heavy plate-glass implosion guards, detachable from the front for ease of cleaning.

Special programmes originating from the exhibition were radiated by R.T.F., from small glass-fronted studios and from the adjacent Palais des Sports (6,000 seats). One of the most popular was the "Jeu du Transistor" in which young enthusiasts were invited to assemble transistor receivers from kits of parts; the first to make his set work was allowed to keep it.

Of special interest in the R.T.F. technical exhibit was the latest mobile TV reporting link, used for the first time this year in following the Tour de France cycle race. A miniature TV camera unit (C.S.F.) and microwave link (492Mc/s, 400mW) was installed in a saloon car with sunshine roof. Its signals were transmitted vertically and picked up by a following helicopter and re-transmitted on 650Mc/s with a power of 5W and with, of course, much greater effective height. In this way fading troubles were eliminated and the number of relay points considerably reduced.

Sound. The emphasis in sound broadcasting this year was on *haute fidélité*. The coverage of f.m. stations in Band II has been considerably increased in France and a separate programme "France 4" now transmits high-quality music daily from 9.30 a.m. to midnight. There are also regular stereophonic broadcasts using two transmitters on Thursdays, Saturdays and Sundays. Even more interesting is an occasional stereophonic transmission on a single radio channel (90.35 Mc/s) from the Eiffel Tower using an experimental system developed by R.T.F. In this one audio channel is frequency modulated on the main carrier and the other amplitude modulated on a 70-kc/s sub-carrier. We were able to hear one of these experimental transmissions in a listening room at the High Fidelity Centre of the R.T.F. in the exhibition and the results were excellent, apart from a slightly higher background hiss than one has become accustomed to expect from a single-channel f.m. transmission.

As in most national radio shows there was a certain uniformity of cabinet styling, in conformity with the prevailing fashions. The small portables tend to be bright and colourful but here and there the quality of mouldings could be better. One point of design which commended itself and was seen in the majority of small radio sets was the push-button waverange selection with miniature stops no bigger than those used in an accordion.

Record players (électrophones) were offered in wide variety by a large number of small firms, and competition was keen. Stereo versions were common and in the better makes the practice was to provide two valises, one for the turntable and amplifier and the other dividing into two similar loudspeaker units with adequate baffle area.

Communications and Electronics. The French have always shown a marked flair for microwave techniques and they have established a considerable export business in microwave links (*faisceaux hertziens*). They also use them widely in their internal communications and in Africa, where developments in the Sahara have called for considerable extension of the services.

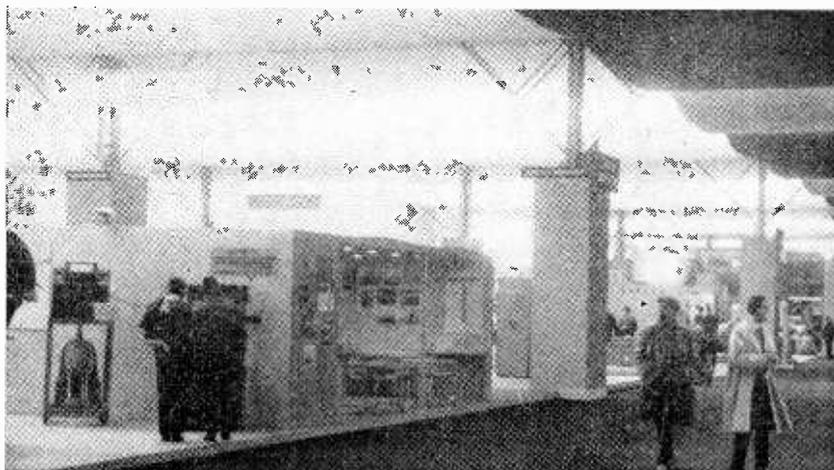
Equipment used in the new inter-continental television link between metropolitan France and Algeria was on show. This operates on 4kMc/s with 0.5kW into high-gain 6-metre reflectors which are shortly to be enlarged to 9 metres (e.r.p. 35MW). The total distance is 630km from Fontfrède to Algiers with one relay station at 4,500 ft in Majorca.

A replica of one of the new air traffic control desks now in use at Orly Airport was shown with a "live" radar display transmitted continuously by microwave repeater from Orly to the exhibition.

The organization of the electronics section in this its first year was excellent. Many firms had collaborated to display the whole range of the subject in its many aspects, and the group exhibits dealing with communications, national defence, nuclear energy, civil aviation, navigation, railways and automation were designed primarily to educate the public to a realization of the social and economic importance of electronics in France at the present time. Research and development as well as equipment already in production were shown, and one had the feeling that the representatives of the commercial firms and organizations contributing to the exhibits were as ready to explain the possibilities of electronics in general as to supply details of their own lines in particular.

The recruitment and training of personnel for the electronics industry is being pursued vigorously in France as in other countries, and the F.N.I.E. provided a special stand ("Formation Professionnelle") to give information on courses of instruction and the qualifications available to young people entering the industry. In addition to the normal engineering degrees from universities there are now the Certificate d'Aptitude Professionnelle (C.A.P.) awarded to apprentices who have also followed approved courses of study outside working hours, and the Brevet d'Enseignement Industriel (B.E.I.) for a somewhat longer course at a technical college. Various endorsements are possible for specialists in receiver alignment and fault finding, and for draughtsmen. Further study leads to the Brevet Professionnelle (B.P.) or Brevet de Technicien (B.R.) and the right to use the title "Agent Technique".

Electronics exhibits of Government departments and leading firms were grouped to demonstrate the contribution they make to the public service and industrial expansion.



COLOUR TELEVISION STANDARDS

Co-channel Interference and the Colour Sub-Carrier

By R. D. A. MAURICE*, Ing. Dr., A.M.I.E.E.

It is suggested that the half line-frequency offset commonly used or suggested for the N.T.S.C.-type colour sub-carrier is inferior to third line-frequency precision best offset from the point of view of interference from the colour sub-carrier in the luminance channels of colour and monochrome receivers. A diminution in extinction viewing distance of between 12% and 65% can be obtained by changing the offset of the colour sub-carrier from half line-frequency to third line-frequency, and the improvement in decibels can be given as between 4 and 9. Specifically it is suggested that the proposed colour sub-carrier frequency for the 625-line system be changed from 4,429,687.5 c/s to 4,430,800 c/s and that the number of lines per picture be changed from 625 to 627.

IT is well known¹ that for precision-offset working between television transmissions, the optimum results are not achieved when the unwanted carrier frequency differs from the wanted carrier frequency by exactly half or an odd multiple of half the line-scan frequency. Better results can be obtained when the difference between the unwanted carrier frequency and the frequency of the nearest line-harmonic sideband of the wanted signal is an odd multiple of the picture frequency. Such a relationship does not result in an invariant, odd or even, relation between the unwanted carrier and the picture frequency of the wanted signal, because odd line harmonics of the wanted signal have frequencies which are odd multiples of wanted picture frequency whilst even line harmonic frequencies are even multiples of picture frequency.

Using Hopf's¹ formulae, we have for the precision-

offset best frequencies for an unwanted carrier

$$f_u = mf_L \pm (2n + 1)f_p \dots \dots \dots (1)$$

where f_u = frequency of unwanted carrier
 f_L = line-scan frequency of wanted signal
 f_p = picture frequency of wanted signal
 m and n are integers, including zero
 and $|f_u - mf_L| < f_L/2$

Now in all television systems (using interlacing) we have

$$f_L = (2q + 1)f_p \dots \dots \dots (2)$$

where q is integer

$$\text{so } f_u/f_p = m(2q + 1) \pm (2n + 1) \dots \dots (3)$$

and this ratio is odd when m is even and vice versa.

The above discussion refers to an unmodulated unwanted carrier, but it is not thought that the presence of unwanted modulation will affect to a material extent the proposals which follow.

In a colour transmission of N.T.S.C. type, the chrominance signal may be regarded, from the point of view of the luminance signal, as an unwanted carrier and it would, therefore, seem advisable to use a precision-offset best frequency for it. The present use of half line-scan frequency is, therefore, deprecated and following Hopf's¹ Figure 18, it would seem that a frequency differing from a line harmonic by about $\pm f_L/3$ would be optimum. Thus, letting the colour sub-carrier frequency be

$$f_{sc} = f_u$$

$$\text{we may write } f_{sc} = m f_L \pm (2n + 1) f_p \dots (4)$$

$$\text{where } (2n + 1) f_p \simeq f_L/3 \dots \dots (5)$$

But from equation (2)

$$(2n + 1) f_p \simeq (2q + 1) f_p/3$$

$$\text{so } (2n + 1)/(2q + 1) \simeq 1/3 \dots \dots (6)$$

The following table shows some suggested frequencies for colour sub-carriers for several television systems. The master oscillator frequency which controls the line- and field-scan frequencies must be derived from the sub-carrier frequency and the

* Research Dept., Engineering Division, B.B.C.

¹ Hopf, H., "Experiments on the Operation of Television Transmitters with Precision Offset Carrier Frequencies," *Rundfunktechnische Mitteilungen*, December, 1958.

PROPOSED FIGURES: EQUATIONS (4), (5), (6) and (7)

System		$2q + 1$	f_L (kc/s)	m	$2n + 1$	$\frac{2n + 1}{2q + 1}$	f_{sc} (kc/s)	f_{sc}/f_M
Lines/ picture	Fields/ second							
405	50	405	10.125	262	+ 135	+ 1/3	2656.125	787/6
525	59.940052	525	15.734264	227	+ 175	+ 1/3	3576.9226	341/3
625	50	625	15.625	283	+ 207	$+\frac{1}{3 + 4/207}$	4427.050*	425/3**
627	50	627	15.675	283	- 209	- 1/3	4430.800	424/3

* $(283 + 1/3) f_L - 33\frac{1}{3}$ c/s.

** Actually $f_M = 3(f_{sc} + 33\frac{1}{3} \text{ c/s})/425$

division ratios which are shown in the table are obtained by noting that the master oscillator frequency, f_M , is

$$f_M = 2f_L$$

and the division ratio results immediately:

$$f_{sc}/f_M = [m + (2n + 1)/(2q + 1)]/2 \quad (7)$$

It will be seen from the table that the suggested new colour sub-carrier frequencies do not differ greatly from those either in use at the moment or agreed internationally for prospective use. Except for the 625-line, 50-field system there is no difficulty in obtaining the master oscillator frequency from the sub-carrier frequency; division by large prime numbers such as 787 presents no difficulties in the present state of the art. The 625-line system is unfortunate in that 3 is not a factor of 625, or $2q + 1$, in general terms. This lack is the cause of the quantity $4/207$ which appears in the denominator of $(2n + 1)/(2q + 1)$ for the 625-line system and this term, in turn, is the cause of the need to add $33\frac{1}{3}$ c/s to the sub-carrier frequency before dividing by 425 and multiplying by 3 to obtain f_M , as shown in the footnote(**) to the table. The inclusion of a separate source of frequency for supplying the $33\frac{1}{3}$ c/s is undesirable and complicates the frequency-generating equipment required to obtain the master oscillator frequency from a crystal-controlled sub-carrier source.

It is, therefore, suggested that European agreement be obtained for a change in both the proposed 625-line sub-carrier frequency and in the number of lines per picture, thus:

Sub-carrier frequency from 4,429,687.5 c/s to 4,430,800 c/s, an increase of 1,112 $\frac{1}{2}$ c/s

Number of lines per picture from 625 to 627 $\frac{1}{2}$

The master oscillator frequency would then be obtained from the colour sub-carrier frequency by division by 424 followed by multiplication by 3.

It has been shown experimentally that this change improves markedly the compatibility of the colour television system, and it allows the future use of precision best offset between television transmissions with the least complexity of waveform-generating and feed-back type carrier-locking equipment, should precision offset be desired in the u.h.f. bands. The only disadvantage of using $1/3$ rd line offset instead of $1/2$ line offset for the colour sub-carrier is the very slight increase in susceptibility to "side-locking" in colour receivers. It is thought that this will, however, be negligible.

The beat pattern between sound and chrominance carriers will be reduced in like manner to the colour sub-carrier and it is not necessary to make any

§This change was suggested by Mr. G. F. Newell.

PRESENT FIGURES: $f_{sc} = (r + 1/2)f_L$		
r	f_{sc} (kc/s)	f_{sc}/f_M
262	2657.8125	525/4
227	3579.545	455/4
283	4429.6875	567/4
283	4443.8625	567/4

changes in existing relationships which may have been established between wanted sound and wanted vision carriers in certain colour television systems.

It should be pointed out, perhaps, that the suggested change from 625 to 627 lines is not essential to the use of precision-offset best frequencies for colour sub-carriers or other interfering signals, but it does render the equipment required to achieve $1/3$ rd line offsetting simpler and more reliable. The table shows the appropriate sub-carrier frequency for the 625-line system, should international agreement to change it to 627 lines be difficult to achieve.

Experimental Confirmation

An experiment was set up using equipment which had been in use for extensive co-channel interference tests. Two levels of unmodulated interfering carrier at about $2\frac{1}{2}$ Mc/s were used in a 405-line, 50 field closed-circuit monochrome video test using a 21-in monitor. Reference to the table shows that exactly $1/3$ rd line-frequency offset is satisfactory for the 405-line system,

$$[(2n + 1)/(2q + 1) = 1/3]$$

The $2\frac{1}{2}$ Mc/s carrier was meant to represent a colour sub-carrier and the two levels of interference used corresponded with (i) the ratio of chrominance to luminance during transmission of fully saturated red at maximum brightness and (ii) maximum chrominance signal with reference to peak white. The two levels of interference, although differing quantitatively in appearance, gave the same subjective improvement when the frequency of the simulated sub-carrier was changed from the half line-frequency offset to the one-third line-frequency offset. The results will, therefore, be presented without further reference to the ratio of chrominance to luminance.

Although several observers were present during the tests, only the writer recorded his opinions. These took two forms: the improvement ratio in decibels and the viewing-distance improvement as a ratio of interference extinction distance. The form of the interference was also dual in the sense that there was the well-known dot pattern and, with a particular slide showing a girl holding a fan with fine tracery on it, there was severe flickering (with the sub-carrier in the half line-frequency condition) which was representative of the monochrome compatible equivalent of cross-colour. An interesting feature of interference resulting from an unwanted signal at a precision best offset is the absence of pattern movement or dot crawl which is so evident at the half line-frequency offset.

For the *dot-pattern* interference the ratio of extinction viewing distances was

$$\frac{1}{3}\text{rd line} = 12\frac{1}{2}\text{ft.}$$

$$\frac{1}{2}\text{ line} = 14\frac{1}{2}\text{ft.}$$

or 12% improvement.

The improvement in the $1/3$ rd line-frequency condition measured in decibels was between 4 and 5 dB.

For the *flickering cross-colour* type of interference the ratio of extinction viewing distances was

$$\frac{1}{3}\text{rd line} = 12\frac{1}{2}\text{ft.}$$

$$\frac{1}{2}\text{ line} = 21\text{ft.}$$

or 65% improvement.

The improvement in the $1/3$ rd line-frequency condition measured in decibels was 9 dB.

The author wishes to thank the Director of Engineering of the B.B.C. for kind permission to publish this paper.

Elements of Electronic Circuits

19.—GATES AND COINCIDENCE CIRCUITS

By J. M. PETERS, B.Sc. (Eng.), A.M.I.E.E., A.M.Brit.I.R.E.

A COINCIDENCE circuit delivers an output when one or more independent inputs coincide or occur at the same time. This is a general term for describing the class of circuit and consequently covers cases where the output bears little resemblance to any of the inputs. For instance, the amplitude and/or shape of the output waveform may not necessarily be the same as the input waveforms.

A gate circuit is a particular class of coincidence circuit where it is essential that the output waveform should closely resemble the input waveform. When the gate is "open" it is required to pass the input with the minimum of distortion; when it is "shut" there should be no output.

Gate circuits can be further sub-divided. Two important classifications are "and" gates and "or" gates, the significance of the terms being appreciated if the symbols in Fig. 1 are examined. Fig 1 (a) illustrates in diagram form a circuit which has, for example, two inputs and one output. When signals are present simultaneously at both inputs then an output signal is delivered.

The numeral 2 is written inside the circle to

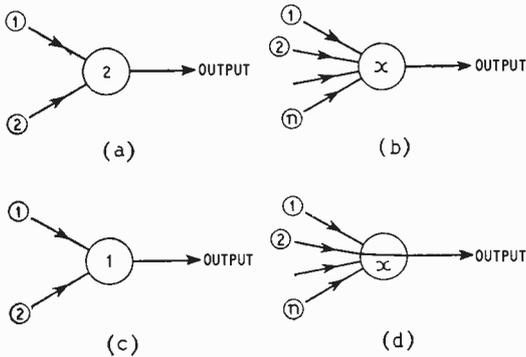


Fig. 1

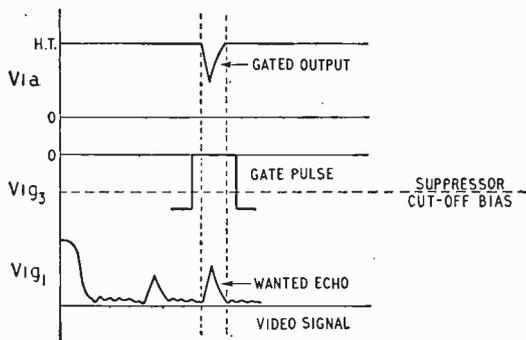


Fig. 2

denote the fact: this circuit is called an "and" gate. A more general symbol sometimes encountered is that in Fig. 1(b) which represents a circuit with n input sources but which only delivers an output when x (in number) sources are supplying inputs. It follows therefore if $x=n$ the circuit is an "and" gate. Fig. 1(c) represents a circuit again having two inputs, but in this case it is only necessary for one input signal to be present for an output signal to be delivered. As with the previous symbol, the numeral 1 is written inside the circle to denote the fact. This circuit is called an "or" gate. The general symbol for an "or" gate is shown in Fig. 1 (d). Here $x=1$ and the line is carried through the symbol to denote the preservation of the characteristics of the input waveform.

Practical Forms

Now let us examine the form and use of some coincidence and gate circuits. One of the widely used gate circuits involves a multi-electrode valve, the control electrodes of which are biased to prevent anode current flowing. The positive inputs are applied to the control electrodes, which in a pentode are control grid and suppressor grid, and when both signals are present simultaneously anode current flows. When used as a true gate circuit as opposed to a coincidence circuit, a positive gate or square wave pulse applied to the suppressor grid "turns the valve on" for the duration of the pulse. Provided that the valve is biased just below grid cut off, the gate pulse will introduce very little distortion. The output therefore closely resembles the input signal, which is a necessary requirement of a gate circuit.

Radar receivers often include gate circuits of this type to select a particular target echo from a number of target echoes or background clutter. The output from the timebase generator is fed to a gate pulse generator which produces a short positive pulse as the c.r.t. spot passes the range marker. The duration of the pulse is a little longer than the received echo and is applied to the suppressor grid of the pentode gate valve (see Fig. 2). The video signal comprising ground return, wanted and unwanted echoes, is applied to the control grid of the pentode. Although the control grid is taken above cut-off by the video signal, no anode current flows until the positive-going gate pulse arrives at the suppressor grid and raises it above suppressor cut-off. The positive pulse coincides with the wanted echo which therefore causes a negative-going voltage pulse to be produced at the anode; thus the wanted echo is allowed through the gate and the other echoes, etc., are rejected. Fig. 3 shows the gate circuit in which V1 is the gate valve. The diode clamp V2 is inserted to prevent the gate pulse from driving

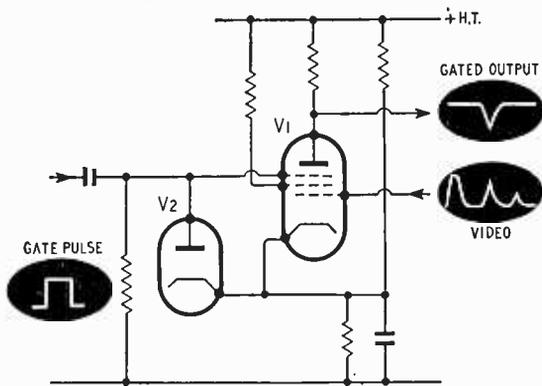


Fig. 3

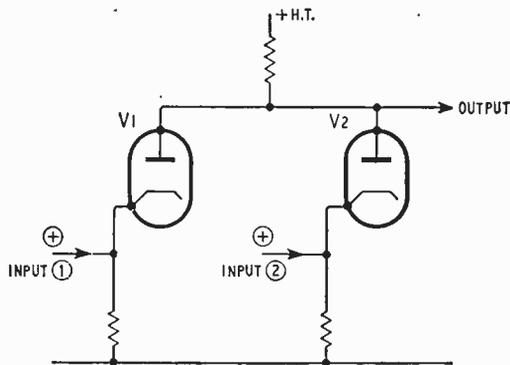


Fig. 4

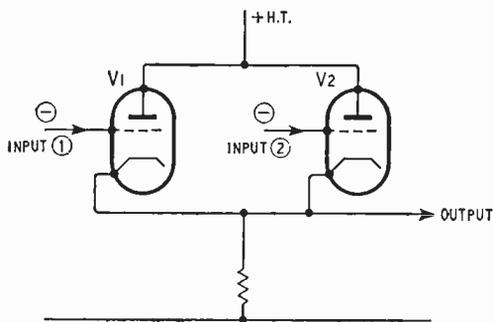


Fig. 5

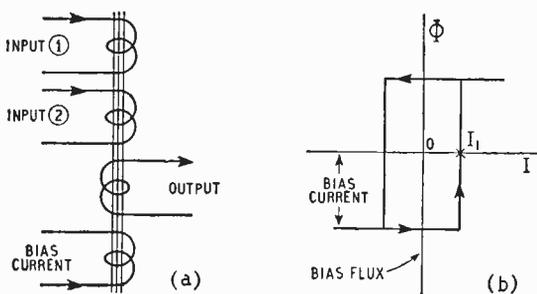


Fig. 6

the suppressor grid positive with respect to the cathode.

Another example of an "and" gate is shown in Fig. 4. Crystal diodes may be used here in preference to valves. The application of a positive signal, Input 1, to the cathode of V1 cuts off the current flowing in V1. Although this causes the current in the second valve to double, the result is a negligible increase in output voltage. When Input 2 is in coincidence, however, the output is greatly increased. An alternative version of this circuit may be encountered in which the diodes and the supply voltage are reversed. The input signals would then be negative-going.

When describing the action of the long-tailed pair or cathode inversion circuit (No. 5 of this series, p. 911, Sept. 1959), it was shown that the common cathode voltage always tended to follow the more positive grid. This configuration can also be used as a coincidence circuit (Fig. 5). Suppose we apply negative signals to both grids, the voltage at the common cathode can only swing negative if both input signals are present simultaneously. Alternatively, a gate pulse can be applied to one of the grids thus transforming it into a gate circuit.

Current-operated Gates

In all the above examples we have considered the gate as an acceptor or rejector of voltage signals or pulses. We must not overlook the fact that current gates are also widely used. One type of current gate involves the use of a magnetic core with a rectangular hysteresis loop. The several positive inputs are applied to a number of windings on the core upon which is wound the output coil (Fig. 6(a)). The core is "biased" by a reverse-polarity current flowing through one of the windings. The bias produces an opposite flux which is only overcome when the sum of the currents in the other windings exceed a value shown as I_1 in Fig. 6 (b). The gate is now open and a current is induced in the output coil.

RADIO HOBBIES SHOW

List of Exhibitors

THIS year's International Radio Hobbies Exhibition, sponsored by the Radio Society of Great Britain, opens at the Royal Horticultural Society's Old Hall, Westminster, London, on November 23rd for four days. As will be seen from the appended list, exhibitors include manufacturers and suppliers of equipment for the amateur fraternity, publishers and amateur organizations, as well as the Armed Forces. A feature of the exhibition, which will be open daily from 11 to 9 (admission 2s) is the display of typical transmitting rooms, some with home constructed equipment and others with commercial gear.

As already announced, Brian Rix, the well-known actor who is also a radio amateur (G2DQU), will open the Show.

A.E.I. (Woolwich)
Avo
Bridge Electronics
British Amateur TV Club
Data Publications
Daystrom
Electronic Technology
Electroniques (Felixstowe)
Enthoven Solders
Jason Motor & Electronic Co.
K.W. Electronics
London U.H.F. Group
Minimitter

Mullard
R.S.G.B.
Royal Air Force
Royal Naval Reserve
Royal Signals T.A.
Scott, James, & Co.
Short Wave Magazine
Sound Vision Service
Taylor Electrical Instruments
Tiger Radio
Webbs Radio
Wireless World
Withers Electronics

WORLD OF WIRELESS

Mobile Radio

THE Fourth Report of the Mobile Radio Committee set up by the P.M.G. is concerned with recommendations for reducing to 25kc/s the channel spacing in the mobile radio "high" band (165 to 173.05Mc/s). The Committee's Third Report, issued in March, 1959, proposed a similar reduction of channel spacing in the "low" band (71.5 to 88Mc/s).

The situation in the high band is, however, rather complex, for the reduction of channels from 100 to 50kc/s in accordance with the Committee's Second Report of July, 1956, has not yet been completed.

The Committee has revised the distribution of channels amongst the various categories of users, and a diagram showing the new allocation is included in the Report.

The changeover to the narrower channels begins on January 1st. Thereafter, all new land-mobile systems in the high band will have to use equipment meeting the 25-kc/s specification. With few exceptions, the 25-kc/s standard will also apply to replacements of equipment for existing services.

Pilkington Committee

THE Committee on Broadcasting, set up under the chairmanship of Sir Harry Pilkington, has invited any person or organization desirous of submitting evidence or making representations to the committee to communicate with the secretary not later than November 30th. The committee, which originally had an office in the G.P.O. Headquarters, is now at Cornwall House, Waterloo Road, London, S.E.1, to which address communications should be sent. The committee's terms of reference are:—

"To consider the future of the broadcasting services in the United Kingdom, the dissemination by wire of broadcasting and other programmes and the possibility of television for public showing; to advise on the services which should in future be provided in the United Kingdom by the B.B.C. and the I.T.A.; to recommend whether additional services should be provided by any other organization; and to proposed what financial and other conditions should apply to the conduct of all these services."

"Marconi House"

THESE words have been removed from the well-known building in the Strand, London, which now forms part of the new English Electric House built on the adjacent site of the old Gaiety Theatre. For such an historic building to lose its identity is indeed regrettable. It is, of course, realized that the Marconi companies are now part of the English Electric Group and, too, that there is a plaque on the outside wall of the building recording that the first station of the British Broadcasting Company operated within the building, but even so, it has lost its identity—at least for future generations.

The change of title will not involve the movement of the various departments of the Marconi companies occupying offices in the building.

B.B.C. Report

IT is difficult to give extracts from the 175-page Report of the B.B.C. for 1959/60* without giving undue prominence to what may be a comparatively insignificant part of the whole. However, here are some facts and figures.

V.H.F. Coverage.—About 97% of the population are within range of the v.h.f. sound broadcasting service but only an estimated 20% of the households have v.h.f. sets.

A Third TV Service?—Some 750,000 people are still without a television service. The B.B.C. suggests that instead of utilizing the "uncommitted channels in Band III" to provide a third television service for those already with a choice of two, "a better use would be to strengthen the coverage of the existing television services." Nevertheless "it remains the B.B.C.'s objective to provide the public with a planned choice between two different television programmes as soon as possible." The Report reiterates that "if the Government so decided the B.B.C. would be ready to start a service of colour television in Bands I or III."

Revenue.—The gross revenue from broadcast receiving licences for 1959/60, excluding the £1 excise duty, was £36,209,680. The Post Office deducted £2,394,060, the Treasury retained £2,529,467, leaving the B.B.C. £31,286,153. The B.B.C. also received a grant-in-aid of £6,679,000 for its External Services.

Expenditure.—Of the £11.9M revenue expenditure on the Sound Services, £2.77M was for engineering. Revenue expenditure for television was £15.8M (engineering £5M) and for External Services £6.4M (engineering £1.6M).

* Cmd 1174, H.M.S.O., 9s.

Student Apprentices

THE student apprenticeship scheme inaugurated by the Post Office last January drew over 1,000 enquiries, which resulted in some 600 applications for consideration for the 20 places. Two hundred of the applicants—between the ages of 17½ and 20—were eventually interviewed.

The scheme provides for a year's training in telecommunications engineering, and three years at a University, all fees and subsistence being paid under the award. The successful candidates are:—

M. Elliott (Kings School, Canterbury); T. R. Marsh (Leeds Grammar S.); A. D. King (George Watson S., Edinburgh); A. E. Fantom (Stockport Grammar S.); A. Wright (Ilkeston Grammar S., Derby); D. G. Leyton (St. Julians High S., Newport, Mon.); M. J. Colles (Canford S., Wimborne, Dorset); A. Thomas (Stretford Grammar S., Manchester); J. S. H. Ross (Dame Allens S., Newcastle); B. Ray (Slough Grammar S.); N. A. Cumpsty (Haberdashers Askes S., London); D. J. C. de Mesquita (Owens S., London); M. Crabtree (King Edward VI S., Stourbridge); T. G. Simmonds (Exmouth Grammar S.); J. C. Berry (Bolton S.); T. F. Smith (St. Albans S., Herts.); J. A. Beattie (Devonport High S., Plymouth); M. R. Miller (Watford Grammar S.); N. J. E. Reynolds (Queen Elizabeth S., Barnet); D. W. McLachlan (Wrekin College, Wellington, Salop).

Ultra Scholarships.—Ultra Electronics, Ltd., have awarded three two-year research scholarships instead of the one originally announced last March, because it was found difficult to select only one from the large number of applications received from graduates of a very high calibre. The recipients are: D. E. Hirst, of Barkingside, Essex, who obtained 1st class honours in engineering at Kings College, University of London, where he will undertake research on microscopic measurements by electronic/optical means; W. P. Williams, of Meols, Cheshire, who graduated with 1st class honours in engineering at Nottingham University and will carry out research on computer systems using ternary devices at the University; and D. A. Green, of Leeds, Yorks., who obtained 2nd class honours at University College, University of London, will carry out research on electronic means of producing synthetic speech in the Department of Anatomy. The company also awarded a sandwich scholarship to R. A. Greenbaum, of Hendon, London. He has been accepted in the Electrical Engineering Department of Sheffield University as from Autumn, 1961, and has joined Ultra Electronics for 12 months' practical work.

Institute of Navigation.—This year's gold medal of the Institute of Navigation is awarded to Captain F. J. Wylie, R.N., director of the Radio Advisory Service of the Chamber of Shipping and Liverpool Steam Ship Owners' Association, for "his outstanding contributions, made over a number of years, to the art of radar-assisted navigation at sea". Capt. Wylie was president of the Institute for 1958/59. The Institute's bronze medal is awarded to W. J. Charnley, of the Blind Landing Experimental Unit of R.A.E., for his paper "Blind landing". G. E. Beck, of Marconi's, who contributed an article on airborne Doppler navigation in our May, 1957 issue, has been elected a Fellow of the Institute. The annual report of the Institute records that the membership increased during 1959/60 by 129 to 1,883.

R.T.E.B.—Of the 642 candidates who sat for the television servicing examination held by the Radio Trades Examination Board earlier this year, 298 qualified for the certificate, 248 failed and 96 have to re-take the practical test next year. The total number of candidates was 179 more than last year. Only the written part of the sound radio servicing examination was taken in May. Of the 1,715 entrants, 1,253 were successful. These, together with 330 candidates who were "referred" in last year's practical test, sat for the practical examination in October.

Brookman's Park's New Transmitter.—The B.B.C. has ordered from Marconi's a new 50-kW medium-wave transmitter to replace the existing Light Programme transmitter at Brookman's Park installed 31 years ago.

"**Modulation and Modulators**" is the latest colour filmstrip introduced by the Mullard Educational Service. The first part of the 30-frame strip deals with the various types of modulation and the second with practical methods of achieving them. It is available from the distributors, Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens, London, S.W.1, price 25s, including comprehensive teaching notes.

Careers.—A booklet "Careers in the Scientific Industry" has been issued by the Scientific Instrument Manufacturers' Association, which gives, in addition to background information on the industry, a geographical directory of 170 member firms of the association.

"**Piezoelectric Voltage Transformers**".—On page 513 of the October issue, the voltmeter input capacitance (last paragraph of left-hand column) should, of course, be 10 pF (not μ F). Similarly, the transformer output capacitance is 40 pF (not μ F).

Faraday Lecture.—The subject of the 1960/61 Faraday Lecture of the I.E.E. is "Transistors and all that" which will be given by L. J. Davies, director in charge of research and education of A.F.I. (Rugby). The lecture will be delivered first at Rugby (on November 16th) and then at a number of provincial centres before being given at the Central Hall, Westminster, London, on February 16th. Tickets, obtainable free, are needed for each meeting. Those for the London meeting can be obtained from the I.E.E., Savoy Place, W.C.2.

Weather Ships.—The nine weather ships in the north Atlantic supplied and maintained by 18 countries whose airlines fly across the Atlantic, made radio contact with 51,577 aircraft and 14,791 ships during 1959. They also provided 45,980 radar fixes for transatlantic aircraft and 3,396 d.f. bearings. These figures are given in the report of the International Civil Aviation Organization on the ocean stations network.

N.E. England is to have its own electronic engineering exhibition next year. Organized by the North East Industrial Development Association, it will be held in Newcastle from February 28th to March 2nd. Over 20 companies and colleges have already taken space.

A.E.R.E. Harwell.—A solid-state physics division has been formed at the Atomic Energy Research Establishment, Harwell. Its initial term of reference will be: to carry out basic research leading to greater knowledge and understanding of the structure and behaviour of solids. Dr. W. M. Lomer, at present head of the theoretical physics division, has been appointed head of the new division.

International Symposium.—"Electromagnetics and fluid dynamics of gaseous plasma" is the subject of the 11th international symposium organized by the Polytechnic Institute of Brooklyn, which will be held in New York City from April 4th to 6th next year.

Television licences in the U.K. increased during September by 63,422, bringing the total to 10,880,470. Sound-only licences totalled 4,296,246, including 456,292 for sets fitted in cars.

School Television.—The number of schools registered with the U.K. School Broadcasting Councils for school television programmes is now 2,287.

Can You Help?—A reader in Mauritius requires a circuit diagram of the Hartley-Turner 20-W amplifier. Information addressed to A. Domaingue, care of the Editor, will be forwarded.

CLUB NEWS

Cleckheaton.—"Receivers for f.m." is the title of the talk to be given by F. L. Allen (G3CJD) to members of the Spen Valley Amateur Radio Society on November 23rd. Meetings are held on alternate Wednesdays at 7.30 at the Labour Rooms.

Halifax.—At the November 1st meeting of the Halifax and District Amateur Radio Society C. B. C. Hill (G3LGS) will speak on single sideband operation. The club meets on alternate Tuesdays at 7.30 at the Sportsman Inn, Ogden.

Mitcham and District Radio Society is to have a lecture-demonstration by Collins Radio Co. on November 18th. Meetings are held at 8.0 at "The Cannons," Madeira Road.

Reading.—Ampex are providing a lecture-demonstration of their video tape recording equipment for the Calcot Radio Society on November 25th at 7.45 at St. Birinus Church Hall, Calcot.

South Kensington.—A. F. Wilkins, an early member of Sir Robert Watson-Watt's radar team, is to give a talk entitled "The beginnings of radar" at the meeting of the Civil Service Radio Society at 5.30 on November 1st. Visitors are welcome, but should contact G. C. Voller at the Science Museum (Tel.: Kensington 6371).

Personalities

H. Stanesby, C.G.I.A., M.I.E.E., the new Deputy Director of Research at the Post Office, has been staff engineer in the radio planning and provision branch of the Engineering Department since 1952. He joined the Radio Laboratories at Dollis Hill as a youth-in-training in 1924 and in 1951 was made responsible for the direction of the laboratories. He was intimately concerned with the development of the first long-wave transatlantic radio-telephone system. He later played an important part, especially in the design of quartz crystal filters, in developing coaxial cable systems for multi-channel telephony. Mr. Stanesby, who is 54, was chairman of the Radio and Telecommunications Section of the I.E.E. in 1955/56.



H. Stanesby.



Dr. T. W. Straker.

Dr. T. W. Straker, chief of the projects co-ordination group of Marconi's Research Division, has been appointed manager of the company's Radar Division. A New Zealander, he took his B.Sc. (and later, in 1938, his M.Sc.) at Canterbury University College, where he was engaged on researches on the absorption of h.f. radio waves in the ionosphere. After war service he returned to New Zealand as assistant lecturer in physics at Canterbury University. A year later, in 1946, he came to this country to study at the Cavendish Laboratory, his particular subject being research in the ionospheric propagation of low-frequency radio waves. He took his Ph.D. in 1950 and that year joined the Defence Research Board of Canada. In 1954 he was appointed Defence Research Liaison Officer, Canadian Joint Staff in London. Dr. Straker joined Marconi's in 1957.

Among the dozen or so special promotions of "research workers of exceptional merit" in the Scientific Civil Service are: **R. Benjamin** (A.S.E.) and **Dr. L. Essen** (N.P.L.), who became Deputy Chief Scientific Officers, and **W. R. Piggott** (D.S.I.R.) who is appointed Senior Principal Scientific Officer. Mr. Benjamin, who is 37, joined the Admiralty Signal Establishment in 1944. His particular fields of research have been in pulse techniques and more recently in automation and computation as applied to data processing and weapon control in naval warfare. He has played a major part in the latest naval 3-D air defence system. Dr. Essen is well known for his work on precise frequency standards and more recently for introducing the caesium atomic beam resonator as a standard of time. Mr. Piggott, who joined the D.S.I.R. in 1939, has made an intensive study of the absorption of radio waves by the ionosphere. His studies of the upper atmosphere have also influenced the design of aerials to take the best advantage of the ionosphere for long-distance communications.

Air Commodore A. T. Monks, C.B., M.I.E.E., Controller of Telecommunications at H.Q., Signals Command, R.A.F., for the past five years, has been appointed Senior Air Staff Officer, Technical Training Command, with the acting rank of Air Vice-Marshal. Air Commodore Monks, who is 52, joined the R.A.F. as an aircraft apprentice in 1924 and became a signals specialist in 1940. Among the appointments he has held since the war are those of Deputy Director of Telecommunications, and Deputy Director of Signals (Ground) at the Air Ministry, C.O. of Nos. 4 and 1 Radio Schools and Chief Signals Officer at H.Q., Allied Air Forces Northern Europe.

George A. Smith, until recently general manager of the Telecommunications Division of the Plessey Company, has been appointed commercial executive of the company's Electronic and Equipment Group. This group includes the telecommunications, electronics and domestic equipment divisions and Hagan Controls Ltd., employing in all over 4,000 people. Before joining Plessey in 1957, Mr. Smith was for ten years with the telecommunications division of Pye Ltd.

In consequence of the recent acquisition of the Telephone Manufacturing Company by Pye, three directors of the Pye Group have been appointed to the board of Temco. They are **R. M. A. Jones** (vice-chairman), **Sir Ben Barnett** and **J. R. Brinkley**.

Horace Freeman, who has been associated with radio publicity since the early 1920's and was for very many years advertisement manager of the R.S.G.B. publications, has resigned from the National Publicity Company, with which his own agency was merged in 1951. Mr. Freeman was closely associated with the staging of the first all-British wireless exhibition in London in 1922 and was manager of many of the amateur radio shows sponsored by the R.S.G.B.

Hedley J. C. Gower, A.M.I.E.E., has been appointed chief engineer of Border Television Ltd., the I.T.A. programme contractors for the Scottish / English border area. The station is at Caldbeck, near Carlisle. He commenced his career with E.M.I. and then joined the B.B.C. After war service he returned to the B.B.C. where he stayed until going to Granada Television in 1955 as head of O.Bs. He is 43.



H. J. C. Gower.

OUR AUTHORS

David S. Wilde, B.Sc., A.M.I.E.E., Grad.Inst.P., who writes in this issue on digital computers, is a senior project engineer with E.M.I. Electronics, Wells, Somerset, where for the past three years he has been working on digital data processing equipment. After nearly three years in the Royal Navy as a radar mechanic, he went to Manchester University where he graduated in physics in 1951. On leaving the University he joined the computer group of Ferranti, and three years later went to the electronics laboratory of A. V. Roe and Co., where he stayed until 1957 when he joined E.M.I.

C. Maxwell Cade, who with A. T. Elliott, describes an automatic microwave aerial plotter in this issue, has been with Kelvin and Hughes since 1954 and is now deputy head of the Radar Department. He originally studied medicine at Guy's Hospital Medical School.

taking the 1st M.B. in 1940. He was invalided out of the R.A.F. in 1942 after two years' service and joined the M.O. Valve Company as a technical supervisor. From 1951 to 1954 he served as an experimental officer in the Royal Naval Scientific Service at the Services Electronics Research Laboratory, Harlow, Essex. In 1959 Mr. Cade received the Navigation Prize of the Royal Aeronautical Society for a paper on radio astronomy and navigation and this year was a recipient of one of the R.I.C./E.E.A. technical writing premiums. He is 42.



C. M. Cade.



A. T. Elliott.

A. T. Elliott, co-author of the article on p. 530, has been with Kelvin and Hughes since 1947 except for two years' National Service when he was an instructor in radar techniques at the R.A.F. Radio School, Yatesbury. He rejoined the company as a radar development engineer and since 1956 has been a senior engineer leading a development group concerned with microwave and infra-red devices.

F. R. B. Jones, the first part of whose article on nodal analysis appears on p. 556, is a civilian lecturer at the R.E.M.E. Training Centre, Arborfield, Berks. During the war he specialized in radio and radar in the Army and was at one time Brigade Radio Officer and at the time of his demobilization was Telecommunications officer in 7 Base Workshop, Alexandria. From 1945 until 1952, when he went to Arborfield, he was a teacher.

J. P. Hawker, who contributes the article on amateur radio developments in this issue, obtained his first transmitting licence (2BUH later G3VA) in 1936 when he was 14. He edited the latest edition of the R.S.G.B. "Guide to Amateur Radio."

OBITUARY

Sir George Barnes, M.A., D.C.L., who died at the age of 56 on September 22nd, was for 21 years with the B.B.C., which he left in 1956 to become principal of the University College of North Staffordshire. Sir George was the first Head of the Third Programme. For the last six years of his service with the Corporation he was Director of Television. Since 1958 Sir George had been president of the Television Society.

Sir Arthur Fleming, C.B.E. Director of Research and Education of Metropolitan-Vickers for many years before assuming a similar position with the parent company, Associated Electrical Industries, from which he retired a few years ago, died on September 14th, aged 79. Sir Arthur joined Metrovick in 1902.

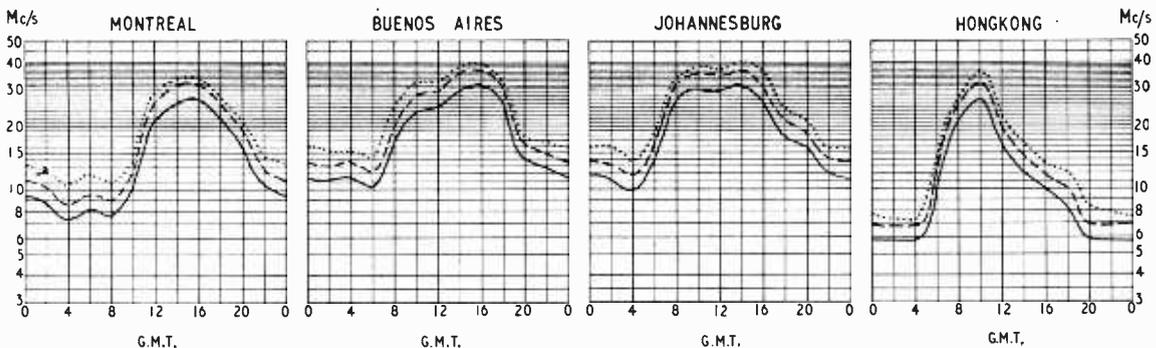
W. J. Chalk, B.A., who was in charge of the Frequency Allocations Section of the B.B.C.'s Engineering Information Department, died suddenly on September 24th, aged 61. He served throughout the war in Royal Signals, holding a number of staff appointments as Radio Planning Officer in Europe and the Middle and Far East. He was a member of the Allied Control Commission in Germany. Mr. Chalk joined the B.B.C. in 1951 and represented the Corporation on a number of national and international technical committees concerned with frequency allocation and radio interference problems.

George E. Turnbull, a director of W.N.A. (Wireless Navigational Aids) Ltd., who died on September 17th, had been associated with the radio industry since 1902 when he joined the Marconi Company. In 1924 he became director of the International Marine Sounding Device Soc. Ame., of Brussels.

E. T. W. Barnes, manager of manufacturing, A.E.I. Electronic Apparatus Division, New Parks, Leicester, died on September 19th. He was 54. He joined Metropolitan-Vickers, now A.E.I. (Manchester), in 1930 as a college apprentice and was at one time superintendent of the company's Radio Department.

SHORT-WAVE CONDITIONS

Prediction for November



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

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

- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME
- PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY
- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

News from Industry

A.T.V.—The group profit of Associated Television, Ltd., programme contractors for the I.T.A. London and Midland stations, for the year ended on April 30th, was £5,388,330 as compared with £5,316,493 in the previous year. Taxation took £2,711,820 as against £2,715,076. Muzak, Ltd., suppliers of recorded background music, are a subsidiary of the group, which also has a 50% holding in Pye Records and an interest in British Relay Wireless and Television, Ltd.

Sobell-McMichael.—A record trading profit of £1,325,735 is recorded by Michael Sobell, the chairman of Radio and Allied (Holdings) Ltd., in his statement for the year ended last April. The profit after taxation was £655,107. Reference is made in the report to the company's acquisition in April of Masteradio Ltd.

E.M.I.'s group profit for the year ended in June (before taxation) was £5,348,000 compared with £4,909,000 the year before. U.K. and overseas taxation absorbed £2,714,000 (£2,534,000) which after small adjustments left a group net profit of £2,413,000 (£2,232,000).

Multisignals Ltd., formed jointly by Thorn Electrical Industries, E. K. Cole, Ultra and Anglia Television to promote wired television installations, announce that the Granada group has become a 20% shareholder. Multisignals operates in association with the Radio and Television Retailers' Association.

Ampex.—The name of the company marketing Ampex magnetic recording equipment in the U.K. has been changed from Redwood City Engineering Ltd. to Ampex (Great Britain) Ltd. Its offices are in Reading, Berks, adjacent to those of Ampex Electronics Ltd., the British manufacturing company. Both companies are subsidiaries of Ampex International, S.A., of Fribourg, Switzerland. Excluding the U.S.A. where there are 484 video tape recorders in use, the U.K. has the second largest total—46. Canada has 49 and Japan 35.

Hughes International (U.K.) Ltd., the recently formed associates of the Hughes group of America, are now producing semiconductors at their new factory at Glenrothes, Fife. Initially the staff is 80 but it is planned to be increased to 350 by the end of next year. The general manager is David Simpson, for some time research engineer in Marconi's radar division and more recently general manager of Microcell Ltd. George D. Scott, until recently with Ferranti, is chief engineer, and William J. Symes, formerly a transistor development engineer with Associated Transistors Ltd., is assistant chief engineer.

Emidicta.—A further supply of Emidicta telephone answering machines, making nearly 100 in all, has been ordered by the Post Office from E.M.I. Sales and Service. They are used for the various telephone information services—TIM, WEA and ASK—provided by the G.P.O.

Pye TVT, Ltd., equipped Eastern Nigeria's first television station which was opened on Nigeria's Independence Day, October 1st. The station, situated at Enugu, also incorporates a commercial sound broadcasting transmitter.

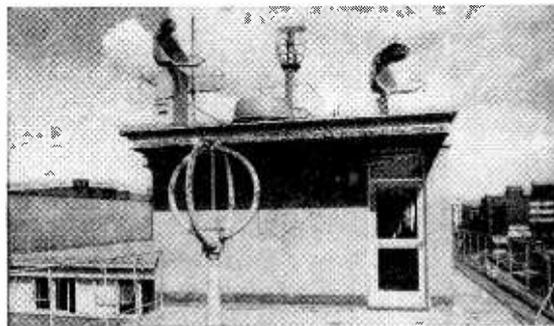
KABI, the trade name of Precision Components (Barnet) Ltd., of Potters Bar, Middx., is incorporated in the company's new title which is KABI (Electrical and Plastics) Ltd.

Radio and Television Trust, which was until last year a subsidiary of Crompton Parkinson Ltd., records a consolidated profit for the nine months ended last March of £118,060. This figure includes £25,742 in respect of three months' profits of British Communications Corporation, which was taken over by the company in January. The net profit after taxation for the nine months is £65,816 compared with £71,533 for the previous 15 months. Airmec, Ltd., of High Wycombe, is also a subsidiary of the company.

S.T.C. provided the complete cable system, including 530 nautical miles of submarine cable, 29 submerged repeaters, submerged equalizers and terminal equipment, for the first direct U.K.-Sweden telephone cable link inaugurated on October 11th. It employs a single cable for both directions of transmission. The repeaters provide for 60 two-way circuits of 4kc/s spacing.

Decca have announced the receipt of the 10,000th order for their marine radar—eleven years after they entered the marine radar market. The installation of 10,000 sets represents sales valued at some £18M, of which £11M worth has been exported.

Magnavox equipment, including record players, radio gramophones and later tape recorders and television sets, is once again being marketed in the U.K. Magnavox Electronics Ltd., of 129, Mount Street, London, W.1, has been formed to handle the equipment which initially is being manufactured by sub-contractors in this country. The directors are Denis Fitzgerald (marketing and sales) and Donald Fisher (production).



Scanners, d.f. loops and communications aerials surmount the new Marconi House, Hull. Below is a view of the test and repair sections of this Marconi Marine service depot.



Principles of

Digital Computers

By D. S. WILDE,
B.Sc., A.M.I.E.E., Grad.Inst.P.

I.—BASIC REQUIREMENTS OF A COMPUTING MACHINE

THE history of digital computation is very well covered in many books and it is sufficient to highlight only a limited number of developments which have had an appreciable effect on the evolution of calculating machines.

The first mechanical aid to computation was the abacus or counting frame. It is believed to have been in use for centuries in the Far East before its introduction to Europe about 1,000 years ago. Its origins are obscure but it is in use at present, particularly in Japan, where skilled operators can beat equally-skilled operators at desk machines to the correct answers.

In 1642 Pascal invented the first calculating machine, which performed simple addition. It was widely demonstrated but never exploited. In 1673 a second machine was designed by Leibnitz with a mechanism, based on the stepped wheel, which allowed multiplication to be performed. This machine was also widely demonstrated and again was never developed. The technological advances of the industrial revolution made the production of small mechanical parts realizable and Pascal's and Leibnitz's machines have "reappeared" in the modern desk calculators of to-day.

The desk machine is a mechanical aid to computation and the intervention of a human being is essential at every step of its operation. It was Charles Babbage^{1, 2} who realized that human intervention could be dispensed with and that a machine could be constructed which would automatically perform an entire computation—even printing out the answers. Initially, of course, the machine had to be provided with the input numbers and the sequence of manipulations that must be performed on them to yield the final answers.

Babbage's Fundamental Discoveries

Babbage's interest in computers was aroused as a result of the extensive work going on in the preparation of navigational and mathematical tables. The work involved in calculating these tables was prodigious and monotonous, and errors were frequent and occasionally disastrous. Babbage's first machine was conceived with this sort of application in mind but he was very soon intrigued by the possibilities of a far more ambitious machine on which almost any type of problem could be dealt with. This machine was never built, although some parts of it exist. Failure to build the machine does not detract from the significance of the ideas and principles established by Babbage. There are at least three points of fundamental importance on which Babbage showed remarkable foresight:—

(1) The human factor is prone to error when do-

ing repetitive and monotonous work; it must therefore be dispensed with as far as possible. Babbage showed that a machine was realizable which could automatically complete a full computation, if it was given a programme of instructions to follow and a set of numbers with which to deal. Even the final answers should be printed automatically, thus removing human error in copying.

(2) The numbers and instructions must be presented to the machine in a physical form which it can recognize and manipulate. The numbers in Babbage's proposed machine were stored on gear wheels and the instructions were punched on cards similar to those used on a Jacquard loom card. Babbage decided that if a set of holes punched on a card could control the machinery which wove extraordinarily complex textile patterns, it could equally well control a calculating machine. He thus arrived at the Hollerith card which is to-day an extremely important input-output medium for digital computers, even though not used in quite the same way as Babbage used the Jacquard card.

(3) It is obvious that the machine must be able to perform all the typical arithmetical operations of addition, subtraction, multiplication and division; it is not so obvious, but quite as important, that the machine must have a "decision" facility to enable it to take one of (generally) two lines of action. This point will be taken up later.

More Recent Theory and Practice

No one immediately after Babbage followed up his pioneering work, though its importance was realized by some of his contemporaries and the succeeding years were notable for the development of desk machines and the invention of the Hollerith card with its application to accounting machines. Dr. L. J. Comrie of the Nautical Almanac Office did, however, exploit punched-card machinery in quite striking fashion for the production of astronomical tables, and his work had an appreciable stimulus on digital computing. Important theoretical work was done by Dr. A. M. Turing of the N.P.L., but it was not until the 1939-45 war that practical automatic computers were built.

Babbage's computer was purely mechanical. Had it been completed it would have been a prodigious feat of engineering, extremely expensive, and slow in operation. Electromechanical techniques were exploited for a short time in early machines and a significant and often overlooked example of a very successful computing system (whatever the punter may think) is the Racecourse Totalisator. The Harvard Mk. I computer was the first full-scale computer to be built using electromechanical devices.

The first all-electronic machine was the ENIAC (Electronic Numerical Integrator and Calculator) which used 18,000 valves. I.B.M. built a second enormous machine (the Selective Sequence Electronic Calculator) and both this and the ENIAC performed a large volume of useful calculation. If they did nothing else they did show that automatic machines were extraordinarily useful scientific and technical tools and that their potentialities were enormous.

In 1947 and 1949 Prof. J. von Neumann and his team of co-workers at the Institute of Advanced Study, Princeton, published reports of theoretical studies into the logical design of digital computers. The immediate consequences of this work were the construction of the EDSAC (Electronic Delayed Storage Automatic Computer) at Cambridge, the Manchester University machine, the ACE (Automatic Calculating Engine) at the N.P.L. and the EDVAC (Electronic Discrete Variable Automatic Computer) in the United States. Since then the pace of development has been steadily increasing.

Von Neumann's contributions to digital computing were extremely far reaching, although they do not probably appear so in retrospect and when stated baldly. Essentially they were as follows:—

(1) The recognition that the binary scale of numbers is the best to use in a digital computer.

(2) The fact that a number in the machine may be used in two quite distinct ways. It can be used purely as a number or as a code representation of an instruction. The mathematical manipulations of instructions (in number form) can be used to modify existing instructions and give great economy and flexibility.

Thus we have from Babbage and von Neumann the essential principles of all modern automatic digital computers. The rest of this article will be devoted to describing a very simple computer utilizing these principles and indicating how the component parts are realized in practical terms.

Manual and Machine Computation

Fig. 1 shows a block diagram of how a mathematician obtains solutions to a set of his equations using a desk machine and an operator to manipulate it. The equations may be extremely complicated in form and they will be broken down into a set of operational instructions (the programme), together with a list of numbers for substitution. The programme is obeyed by the operator, step by step, until the final answers are produced. The preparation of the programme is generally an extremely involved process for the mathematical equations must be transformed into operations which the machine can perform. It seems rather obvious to point out that one cannot require a differentiation operation to be performed if there is no such facility on the machine. This transformation process—numerical analysis—is an extremely important part of digital computing and its techniques are very highly developed.

But to return to the desk machine and its operator, it is apparent that the latter need only be an automaton capable of obeying instructions. The desk machine operator need not use any original thoughts at all but is required only to have the ability to obey a set of simple instructions.

In Fig. 2 the various sections of Fig. 1 are re-

placed schematically by sections of an elementary computer. The list of numbers and instructions are replaced by stores. The operator is replaced by the control unit and the desk machine is now the arithmetic unit. The computer will consist of a collection of electrical devices and there must be a translation between mathematician's language (written symbols on paper) and machine language (electrical pulses). This is provided by the input and output equipment and is extra to the original analogy in Fig. 1. Information is fed into the

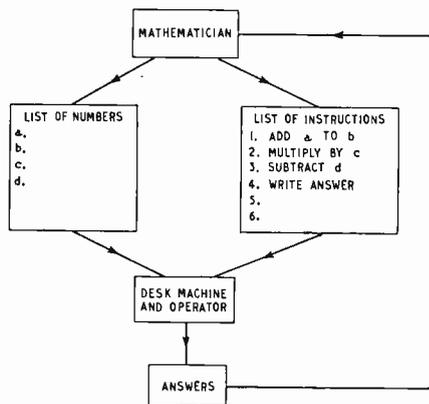


Fig. 1. Block diagram of how a mathematician solves a set of equations by using a desk machine and an operator to manipulate it.

machine using punched cards, punched tape or magnetic tape. At the conclusion of a programme, answers may be printed out or punched in coded form on cards or tape, or possibly stored on magnetic tape to be used in a later programme. However, input and output is quite a subject in itself, so its details will be ignored and its existence will be assumed to provide information to the computer in the appropriate form.

We are accustomed to dealing with numbers in the decimal system (radix 10), but even so the Anglo-Saxons are taught to deal with the most frightening variations in radix (five and a half yards are one rod, pole, or perch; fourteen pounds are one stone, and so on). This at least should show that there is nothing sacred about 10 and in fact the sole convenience of 10 as a radix for arithmetical purposes lies in it being the number of digits on a man's hands. Other radices have been tried and other number systems. The Roman system is an example of the most unwieldy. Whatever virtues 10 may have as a base for numbers it is quite unsuitable for digital computers⁴. Von Neumann advocated the scale of two and almost all large computers are binary machines in some form or other. There are various reasons for this:—

(1) In an electronic computer many of the elements are two-state devices: valves are conducting or non-conducting, relays are open or closed, capacitors are charged positively or negatively, magnetic components can have fields set up in opposite directions, and so on.

(2) It can be shown quite easily that a computer using the scale of two is almost the most economical that can be built in practice. (Actually

on theoretical grounds radix e is the most economical and radix 3 is slightly better than radix 2.)

(3) Binary arithmetic can be very easily reduced to logical (or Boolean) operations. The basic logical operations are easily realized by elementary electronic circuits—this will be shown later.

Binary arithmetic itself presents no difficulties, as long as one can count up to two, and the rules are quite unchanged.

In our use of the decimal notation the symbols 4306 really mean $4 \times 10^3 + 3 \times 10^2 + 0 \times 10^1 + 6 \times 10^0$. Correspondingly in binary notation the symbols 10101 really mean $1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$ which, in decimals, is equal to 21.

Addition and subtraction in binary are quite easy; a carry is developed for each pair of ones added, thus

$$\begin{array}{r} 101 \\ + 11 \\ \hline 1000 \end{array}$$

Subtracting the same pair of numbers

$$\begin{array}{r} 101 \\ - 11 \\ \hline 010 \end{array}$$

Binary multiplication has the useful quality that the multiplicand is merely repeated whenever a 1 occurs in the multiplier. It undergoes no change save for a shift in position. This has considerable circuit advantages. The final product is arrived at by addition of the partial products formed by this shifting process.

$$\begin{array}{r} 101 \\ 101 \\ \hline 101 \\ 000 \\ 101 \\ \hline 11001 \end{array}$$

Negative binary numbers are generally recognized by a sign digit. This is a 1 in the most significant position. For example 1111 represents -1 and is interpreted as $-1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$. This is analogous to subtracting 1 from 0 in decimal notation and arriving at 999, etc.

There are four arithmetical operations: addition, subtraction, multiplication and division. In fact only subtraction is fundamental. If one can perform subtraction then addition follows since $(a+b) = (a - (-b))$. Multiplication can be reduced to continual addition and division is continued subtraction. The only really essential arithmetical component of a computer is therefore a subtracter. Continued subtractions or additions would consume a heavily disproportionate amount of time and consequently full-size computers have built-in adders, complementers (for subtraction) and multipliers; some have dividers, and the provision of these units is generally based on some compromise.

The information given to the computer (instructions and numbers) is passed to it by the input equipment and it must be stored until needed for use. The store must have a binary property, it must be compact and have the highest possible binary-digit capacity per unit-volume. Moreover, it should

have the property of immediate access, i.e. any required number or instruction must be available at the instant it is needed by the programme. Other desirable properties are that the store should be able to retain information when the power supplies are switched off, and that the process of reading the information from the store does not destroy it.

Storage devices have been (and are) the part of the computer which have received the most attention and development. Modern developments are exploring extremes of physical phenomena and the prospects are quite fascinating. It is beyond the scope of this article to venture into these realms, but most computers have had their form dictated to a very large measure by the nature of their storage, and it is interesting to recount some of the early forms of storage.

The first successful store (used in EDSAC and ACE) was the mercury delay line. This takes the form of a long tube filled with mercury and fitted with a quartz crystal at each end. Electrical pulses are applied to the transmitting crystal and are turned into longitudinal acoustic pulses which travel with the speed of sound to the receiving crystal where re-conversion to electrical pulses takes place. The emergent electrical pulses are amplified, shaped and reapplied to the transmitter crystal so that a re-circulating store is realized.

Other stores using acoustic delays set up torsional or longitudinal vibrations in a nickel rod or wire by magnetostrictive means. There are a lot of snags with such a store. For example, once a particular group of pulses has left the transmitter it is completely inaccessible until it has reached the receiver. Temperature stability must be maintained and tubes

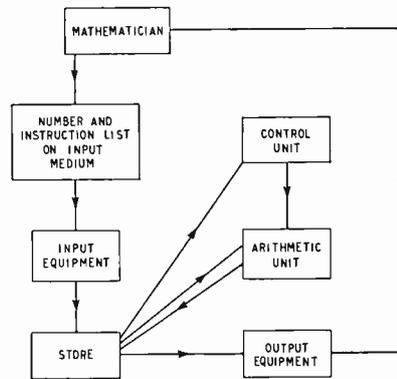


Fig. 2. In this figure the various sections of Fig. 1 have been replaced schematically by sections of an elementary computer.

full of mercury are awkward to handle as well as being bulky. Moreover, loss of power supply loses the information stored.

A store developed by Professor F. C. Williams and Dr. T. Kilburn of Manchester University used a pattern of charged spots on the screen of a cathode-ray tube to give an electrostatic store^{6, 7}. This store had the advantage of immediate access since the timebase of a cathode-ray tube can be moved to any selected position instantaneously. It was not a permanent store since, obviously, loss of power supplies meant loss of stored information, nor did

it retain the information on read-out, although this failing was quite ingeniously overcome to all practical purposes.

A third type of storage which is almost universal in present computers is the ferrite core store. The principle is based on the magnetic properties of small ferrite rings. The flux in the ring can be induced in either one of two directions, storing a binary 1 or 0. An excellent description of a ferrite core store has appeared in a past issue of *Wireless World*⁵, so it will suffice to remark that ferrite stores have properties of immediate access and permanence. They are a compact form of store but essentially have "destructive" read-out. Despite many ventures into other forms of storage the ferrite core store still holds the field quite firmly and will probably continue to do so for several years in improved forms.

The three types of storage do not possess a very high storage capacity in terms of digits per cubic inch, and the cost in pence per digit is high. These reasons have been responsible for the provision of "backing-up" stores purely to supply information to the other stores faster than input machinery could during the actual operation of a programme. These stores have nearly always been magnetic drums consisting of a rotating cylinder coated with a magnetic oxide or nickel plated. The recording and replay is precisely that employed on digital recording on magnetic tape (out of contact) and typically over half a million digits can be stored on such a drum as opposed to only 13,000 in a complete c.r.t. electrostatic store.

Magnetic tape is being used increasingly for backing-up storage (it is the sole medium for this type of storage on the EMIDEC 2400 machine) whilst an American computer uses magnetically coated discs selected on the "jukebox" principle.

(To be concluded)

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⁴ "Tens or Twos", Cathode Ray, *Wireless World*, Sept. 1951.

⁵ "Computer Storage Systems", B. Z. de Ferranti, *Wireless World*, Aug. 1954.

⁶ "A Storage System for Binary Digital Computing Machines", Williams and Kilburn, *Proc.I.E.E.*, vol. 96, Part III, p. 81 (1949).

⁷ "Cathode-Ray Tube Storage", L. S. Allard, *Wireless World*, Feb. 1953.

⁸ "Magnetic Matrix Stores", W. A. Cole, *Wireless World*, June, 1959.

ELECTRONIC CONTROL OF ROAD VEHICLES

IN a lecture given at the U.K. Road Research Laboratory, Langley, Bucks., L. E. Flory of the R.C.A. Laboratories in America described some of the work done on electronic control of road vehicles on the other side of the Atlantic. The ultimate aim is the removal of the human element as a cause of accidents on the roads.

Electronics can be employed to warn a driver of the state of traffic ahead, particularly in conditions of poor visibility and, if necessary, take over complete control

of a vehicle if the driver fails to take appropriate action in time.

Two of the basic requirements described were guidance of vehicles along a "lane" on the highway and warning of the presence of a vehicle ahead. The former was effected on an experimental section of road by burying a cable along the centre of the traffic lane, feeding into it a h.f. signal and equipping the car with pick-up "aerials" on near and off sides. When the signals picked up by the two aerials are equal the vehicle is centred over the cable, while with unequal signals the "error" can be made to illuminate an appropriate deviation light, or, if servo control of steering were employed, could automatically bring the vehicle back over the guide cable. Of course suitable equipment must be fitted in all vehicles, but by the use of transistors this need not be bulky. Where two or more traffic lanes exist each can be fed with an identifying signal.

Telephonic information can be superimposed on the guidance signal giving drivers warning of approach to bends, cross-roads or any information contributing to highway safety.

For the prevention of collision with vehicles ahead travelling in the same direction loops of wire about the size of a car and spaced a few feet apart, were embedded in the roadway. The mass of metal in any vehicle passing over a loop alters its inductance and this change can be detected by electronic equipment located alongside the roadway. Electrical voltages can be generated whenever a car passes over a buried loop and these voltages fed back to preceding loops in the system, thus giving warning to following drivers with suitably equipped cars of vehicles ahead. The actual distance of the vehicle ahead can be conveyed by attenuating the signal fed to each preceding loop.

It will not overstress the imagination to visualize complete automatic control of road vehicles by extension of such systems as those briefly described here.

Industrial Groups

THE second family to be dealt with in our survey of industrial groups is that of which Jules Thorn is patriarch. Thorn Electrical Industries, which made a net group profit in 1959-1960 of £1.5M, recently acquired the Brimar cathode-ray tube and valve section of Standard Telephones & Cables and have formed a new company, Brimar Electronics Ltd., which brings the group's total to 35. Trade names of domestic sound and television equipment produced in the group's 19 establishments in this country include Ferguson, Champion, Avantic, Philco, "His Master's Voice" and "Marconiphone." Sets bearing the last two names, which are respectively the trade marks of the Gramophone Company and the Marconiphone Company, are manufactured by the Thorn group under an agreement with E.M.I.

The Thorn group had its foundation in the small company which Jules Thorn started in 1928 to manufacture and market electrical equipment. In the following list of companies within the group, those in the world of wireless head the list.

Thorn Electrical Industries Ltd.	H. Herrmann Ltd.
Beam-Echo Ltd.	Industria Lampade Elettriche S.A.
British Radio Corporation Ltd.	Lamp Presscaps Ltd.
Champion Electric Corporation	Manifold Machinery Co. Ltd.
(C.R.V.T.C. Ltd.).	F. H. Marshall & Co. Ltd.
Ferguson Radio Corporation Ltd.	Newhaven Cabinet Works Ltd.
Nash & Thompson Ltd.	Smart & Brown (Engineers) Ltd.
Philco (Great Britain) Ltd.	Talent European Co. Ltd.
Philco (Overseas) Ltd.	Talent Furniture Ltd.
Sylvania-Thorn Colour Television Laboratories Ltd.	Thorn Electrical Industries (Australia) Pty. Ltd.
African Lamps Pty. Ltd.	Thorn Electrical Industries (New Zealand) Ltd.
Atlas-Licht G.m.b.H. (Germany).	Thorn Electrical Industries (South Africa) Pty. Ltd.
Atlas Lighting Ltd.	Thorn Elektro Industrie A.G.
Austin Clarke (London) Ltd.	Tricity Cookers Ltd.
Ekco-Ensign Electric Ltd.	Tricity Electric Ltd.
Elgar Research Laboratories Ltd.	Tricity Finance Corporation Ltd.
Ensign Lamps (Australia) Pty.	Tricity Property Co. Ltd.
Evansville Cabinet Co. Ltd.	
George Forrest & Son Ltd.	

AMATEUR RADIO PROGRESS

By
J. P. HAWKER*

A REVIEW OF MODERN TECHNIQUES

ALMOST ten years ago, in these columns, the writer described some of the technical trends in post-war British amateur transmitting stations. With the marking off of yet another decade in the long story of this interesting hobby (amateur transmitting licences have been officially issued in the United Kingdom for more than 50 years) a fresh survey of some modern amateur practices and trends of development may be of interest.

Amateur Activity.—During the early 1950s, amateur radio activities showed some slight tendency to decline from the high immediate post-war peak. This was partly because of the general deterioration in high-frequency propagation conditions associated with the sunspot minimum of 1954 but mainly, it is felt, because of the difficulties experienced in the prevention of interference to television reception in the immediate vicinity of the transmitter. By the mid-fifties, however, a good deal had been learnt by amateur designers about the practical reduction of harmonic radiation, while the gradual change to higher intermediate frequencies for television receivers made it simpler to avoid causing interference by i.f. break-through of strong signals. With modern transmitter technique it is usually possible—although not always easy—to avoid causing any interference, at least in areas where there is a reasonable television signal. Modern anti-television interference technique is less concerned with preventing the harmonics from being generated than with keeping them from being radiated outside the transmitter: in h.f. practice this is done primarily by enclosing all r.f. equip-

ment in adequate screening cabinets, filtering all leads emerging from the cabinet by decoupling them to chassis, and by including a low-pass filter designed to attenuate sharply all signals above 30Mc/s in the r.f. output line (see Fig. 1).

As sunspot numbers increased from 1955 onwards, so did amateur activity. There are now in the United Kingdom some 8,500 amateur "sound" licences, plus some 850 authorizations for working "mobile" from cars and over 90 licences for television transmission. This compares with some 7,500 licences in force ten years earlier. The increase, though substantial, is less spectacular than in the United States where there are today over 200,000 radio amateurs, roughly double the figure ten years ago and an increase of 285% during the post-war period. This difference in growth rates may be partly due to the introduction in the "States" of two new classes of amateur licence: the "technician" licence, restricted to v.h.f., and the "novice" licence which provides restricted operating privileges for 12 months. Neither of these categories require the passing of the Morse test which, in the United States, is at 13 words per minute. In addition there are now more than 70,000 authorizations for the U.S. 29-Mc/s "Citizens' Band."

In the United Kingdom more realistic licence conditions were introduced in 1954 and subsequently the probationary year of "telegraphy only" with a maximum of 25 watts input (compared with the normal British limit of 150 watts) was abolished. No official steps have been taken to encourage new recruits (apart from the continuous efforts of such organizations as the Radio Society of Great Britain) and it is very noticeable how many more teenagers there are among American amateurs. In one respect there has been a tightening up of British licensing procedure: no exceptions are now granted from the

* Amateur transmitting station G3VA

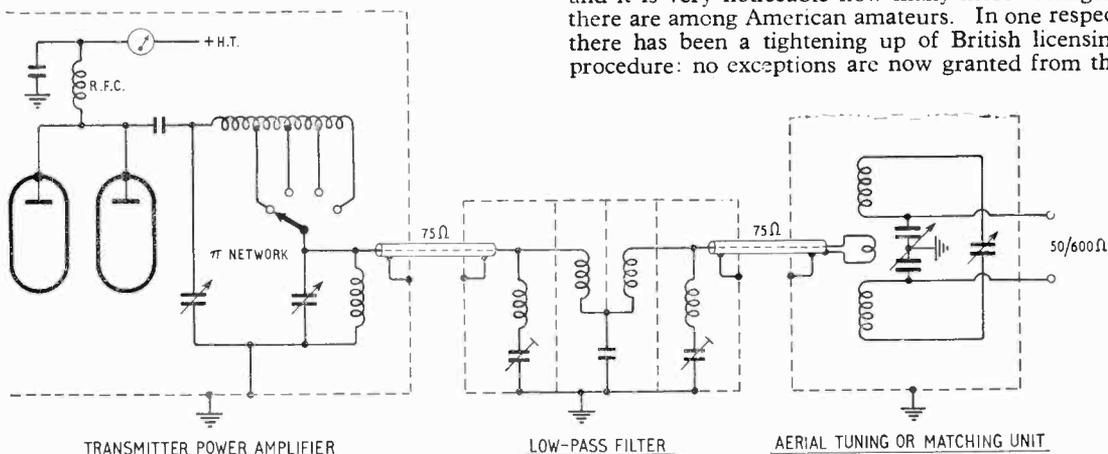


Fig. 1. Typical anti-TVI (television interference) precautions to prevent the radiation of transmitter harmonics. Harmonic signals are reduced first by the pi-network output circuit, then by the low-pass filter, and finally by the aerial tuning unit.

radio amateurs examination or, except for television, the G.P.O.-conducted Morse test.

"Table-top" Transmitters.—A notable feature of amateur transmitter construction has been the general reduction in size: the six-foot G.P.O. racks, popular at one time, are giving way to compact band-switched transmitters in which the entire equipment—including the r.f. oscillator, frequency multipliers and power amplifier, a.f. amplifier and modulator; and all power supplies—is often squeezed into one fairly substantial instrument-type cabinet. Apart from the saving in space, the main benefit bestowed by this form of construction is that the screening needed to prevent harmonic radiation is more easily applied to a single cabinet than to a number of separate units and their interconnecting cables. This trend has been encouraged by the appearance on the market of a number of factory-built transmitters and kits based on this system; it has been made possible by the availability of miniature valves and components suitable for the early stages of the transmitter and modulator.

The modern amateur transmitter normally com-

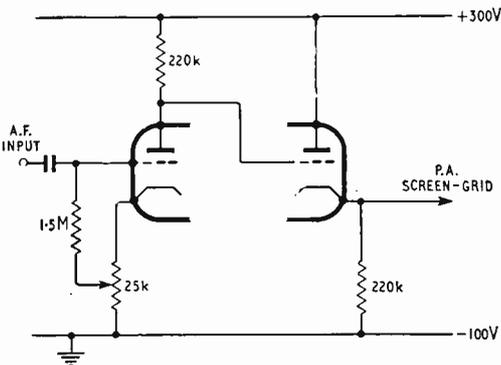


Fig. 2. Basic series gate modulator for use with tetrode power amplifier.

prises a variable-frequency oscillator, designed mainly with the requirements of frequency stability in mind and operating in the lowest frequency band for which the transmitter is intended (usually 3.5 Mc/s), followed by bandswitched frequency-multiplying stages providing outputs on 7, 14, 21 and 28Mc/s to a class-C power amplifier. This final amplifier often uses an 807 or the newer 6146 (QV06-20) valve, or two of these in parallel. Alternatively, a single 813 may be used, although it seems likely that gradually this type will be largely superseded by the recent G.E.C. type TT21 or TT22 (r.f. versions of the KT88), as these can be operated at up to the full 150-watts input with relatively low h.t. and with a more economical heater supply. The vast majority of amateur transmitters now use a pi-network to match the valve output impedance to a low-impedance coaxial output line; this provides some 30dB of harmonic suppression provided that it "sees" a purely resistive low-impedance load.

A 150-watt transmitter requires some 75-watts of a.f. output for high-level amplitude modulation, and this is often obtained from a push-pull modulator using such valves as 807, EL34, KT88 or TT21. Alternative a.m. systems requiring much less a.f. power, but of less efficiency, are also fairly popular,

especially where the transmitter is mainly intended for telegraphy operation. One new form of screen-grid modulation which has attracted attention recently is the "series-gate" system.² The basic circuit is shown in Fig. 2.

Suppressed Carrier Transmission.—A major talking point among radio amateurs recently has been the growing interest in suppressed-carrier modes of telephony transmission. Although under 10% of active amateurs has so far gone over to single-sideband (s.s.b., A3a), it is now generally recognized that, especially for long distance work, or where only restricted power is available (for example in mobile work), substantial benefits are bestowed by its more efficient use of "talk power." An s.s.b. "system benefit" of 9dB is sometimes claimed in comparison with conventional amplitude modulation, though this figure assumes that full advantage is taken at the receiver of the narrower bandwidth and does not take into account the slightly lower efficiency of a linear r.f. amplifier. Apart from the power gain, s.s.b. allows many more stations to operate without mutual interference in a given band of frequencies, minimizes heterodyne interference and makes it easier to operate with full voice break-in (VOX) systems. The elimination of the high-power modulator provides an economic advantage above a certain power level, though below this conventional a.m. scores financially on the grounds of simplicity.

Two main methods of s.s.b. generation are used by amateur transmitters—the filter and the phasing systems—though there is interest in other arrangements such as "the third method."³

Amateur Filter Systems.—Fig. 3 shows the basic arrangement of a popular filter system, though there are many variations in use. A crystal-controlled oscillator on about 465kc/s is fed, together with a low-level a.f. signal, to a balanced-modulator stage using valves or crystal diodes. A typical balanced modulator comprises a pair of similar valves with r.f. applied to the signal grids in parallel and a.f. injected in push-pull to the cathodes or screen-grids, the anodes being connected in push-pull (alternatively the modulator may have grids in push-pull and anodes in parallel). When correctly balanced, the carrier frequency is suppressed but both sets of sidebands appear in the output. The output from the balanced modulator is then passed through a tuned filter of sufficiently high selectivity to accept one set of sidebands but reject the other: such selectivity cannot normally be attained at frequencies of this order with normal inductors. In practice either quartz-crystal networks or mechanical filters are used: these filters resemble those described later in connection with receivers but often using up to six or eight crystals.

In a few factory-built designs crystal networks have been used at much higher frequencies (up to about 5Mc/s) but relatively few amateur constructors have used this technique.

After the signal has passed through the filter it emerges as s.s.b. but must be converted to the required amateur band and amplified. Since it is impossible to pass the s.s.b. signal through a non-linear amplifier, such as a class-C frequency multiplier, without introducing extreme distortion, frequency conversion is carried out in one or more mixer stages. The use of a mixer stage also makes it possible to vary the output frequency to facilitate

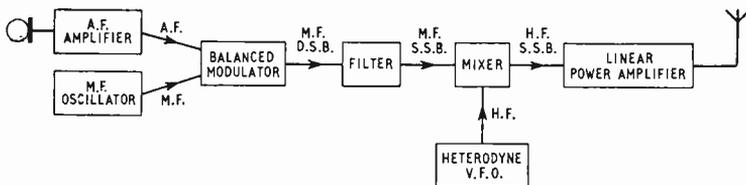


Fig. 3. Block outline of the "filter" type s.s.b. transmitter. To facilitate band switching more than one frequency conversion stage may be incorporated.

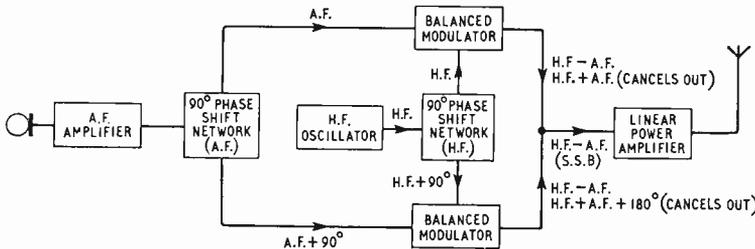


Fig. 4. The "phasing" method of s.s.b. generation applied directly to an h.f. signal. A frequency conversion stage is often incorporated to permit band changing.

changing transmitter frequency, provided that a high-stability heterodyning variable-frequency oscillator is used. Linear power amplification is usually by means of a class-B stage or a grounded-grid amplifier and calls for greater voltage regulation of the power supplies than for an A3 transmitter.

The Phasing Method.—An advantage of the phasing system of s.s.b. generation for amateur transmitters is that it functions at a much higher frequency, thus reducing the problems of frequency conversion; on the other hand, the final degree of sideband suppression is often less than with a well designed filter. This ingenious system depends upon the use of 90° phase-shift networks for both r.f. and a.f. signals: while the production of two r.f. signals 90° out of phase is not difficult, the design of a simple resistance-capacitance network which will shift by 90° a wide range of audio frequencies needs close-tolerance resistors and capacitors of unusual values. This calls for some careful checking of junk-box components before it becomes possible to obtain complete networks. A.F. and r.f. signals at low level are passed through the phase-shift networks and the outputs fed to a balanced modulator. A second balanced modulator is fed with the original signals. When the outputs from these two balanced modulators are combined it is found that both the carrier and the upper sidebands have been suppressed (see Fig. 4).

Double-sideband Transmissions.—Recently an alternative, and usually much simpler, suppressed-carrier system has enjoyed some support, particularly in the United States where it has been ably promoted by J. P. Costas (W2CRR). This is double-sideband (d.s.b.) suppressed carrier with the carrier suppressed by means of a balanced modulator (usually but not always the final amplifier stage) as shown in Fig. 5, but with no attempt made to suppress either set of sidebands. According to

classical radio theory, this system requires the re-insertion of the carrier at the receiver not only at exact frequency (as in s.s.b. reception) but also in the correct phase—this would present serious difficulties. In practice, however, if the signals are received on a receiver having a bandwidth equal to that of one set of sidebands (about 3kc/s), the second set of sidebands will be automatically filtered out in i.f. stages; the signal may then be dealt with as though it were an s.s.b. emission. Suppressed-carrier double-sideband signals are thus fully "compatible" with s.s.b. transmissions, though it must be admitted that d.s.b. is not always regarded with favour by s.s.b. adherents. It does not conserve frequency space to the same extent as s.s.b. and the power gain is not great unless a special detection system is employed; on the other hand, it offers the advantage

that an existing A3 transmitter can often be adapted very easily for suppressed-carrier d.s.b.

"Transceivers."—Since many of the requirements of a filter-type s.s.b. transmitter coincide with those of a good communications receiver (a highly selective filter, very stable variable-frequency oscillator, etc.) a number of factory-built "transceivers" have appeared in which many of the circuits are employed for both transmission and reception. One extremely compact equipment of this type (Collins KWM-2) intended for either fixed or mobile operation provides two-way operation on all amateur bands from 3.5 to 28Mc/s with 150 watts peak envelope power, yet it measures only $7\frac{1}{2} \times 14\frac{1}{2} \times 13\frac{1}{2}$ in and weighs about 18 lb.

Communications Receivers.—The availability from "surplus" disposals of such high grade receivers as the American AR88, HRO, SX28, "Super-pro," BC312 and BC348 and the British B28 (Marconi CR100) tended for some years to inhibit the design and construction of receivers by amateurs. Recently, however, the position has begun to change, though home-built receivers are still very much in the minority. War-time designs are seldom capable of giving optimum performance on s.s.b. signals (for which they were never intended) or of providing

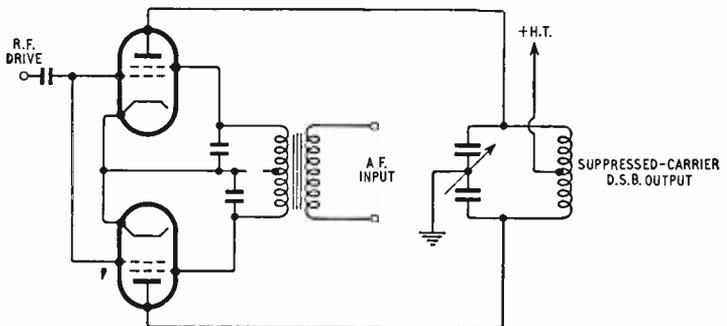


Fig. 5. Screen-grid balanced modulator for d.s.b. transmission. In this circuit the grids are in parallel, while the screen-grids and anodes are in push-pull.

maximum usable sensitivity on the 21- and 28-Mc/s bands. Many amateurs have carried out fairly drastic modifications to these good but out-dated receivers: for example, rebuilding the front-ends to fit modern low-noise valves or fitting a half-lattice crystal filter to improve selectivity. Others, in steadily increasing numbers, are starting afresh and tackling the complete construction of receivers capable of providing the very slow tuning rates, the high stability and good "skirt" selectivity (response at 60dB down) needed for good s.s.b. performance. A receiver which is satisfactory on s.s.b. signals will usually be equally effective for telegraphy and A3 telephony. An experienced constructor is at present able to build a high-performance receiver at appreciably lower cost than he would have to pay for an equivalent factory-built set.

Tuning and Stability.—Whereas, even on a highly-selective receiver, an a.m. (A3) signal can usually be mistaken by several kilocycles per second before distortion becomes severe and a telegraphy (A1) signal will remain audible over a minimum of several hundred cycles per second, the missing carrier of an s.s.b. or d.s.b. (suppressed-carrier) transmission must be re-inserted with an accuracy of the order of about 25c/s if distortion is to be avoided. Unless a separate carrier-insertion v.f.o. is used, the receiver's h.f. oscillator, second oscillator (in a double-conversion superhet) or beat-frequency oscillator (the last-mentioned being used for carrier re-insertion) must be readily tunable to this degree of accuracy. Furthermore, should any of these oscil-

lators drift, the transmission will soon become very distorted or unintelligible.

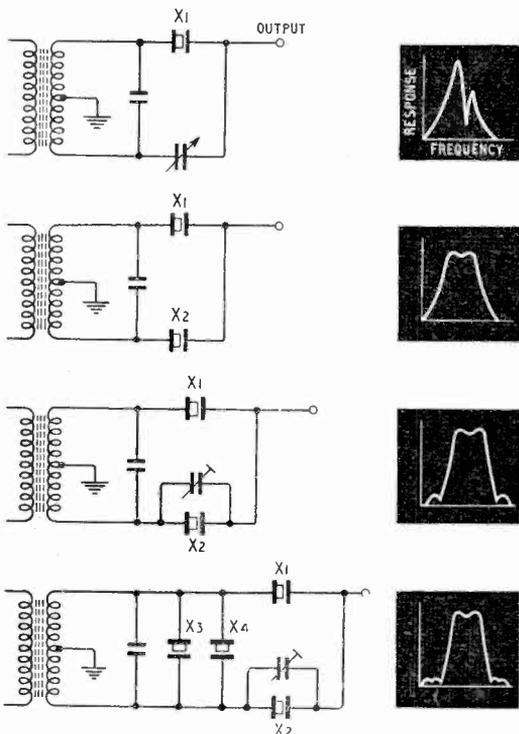
Although many older receivers can be used fairly effectively for s.s.b. reception by using the b.f.o. control for fine carrier insertion adjustment, it is now often considered desirable that an operator should be able to tune in an s.s.b. signal directly with the normal tuning control. This calls for a degree of bandspreading found in very few of the older general-coverage receivers: for example even the highly-regarded AR88 receiver has a tuning rate of some 125kc/s per turn of the tuning knob at 14Mc/s. The ideal tuning rate for s.s.b. depends upon such factors as the amount of mechanical backlash in the tuning system and the size and style of the tuning knob, but it would be generally agreed that a frequency shift of about 5kc/s, or even less, per revolution greatly simplifies the tuning of s.s.b. (and telegraphy) signals: the addition of a small handle to the tuning knob is then often required to reduce the time taken to tune from one end of an amateur band to the other!

Crystal-controlled H.F. Oscillator.—One result of the need for a low tuning rate and high stability has been the growing popularity of a tunable first i.f. used in conjunction with a crystal-controlled h.f. oscillator; each band—or segment of a wide band such as 28Mc/s—is selected by switching in a different crystal. In effect the "front end" for each band may be regarded as a broad-band, low-noise fixed tuned converter feeding a single-band (the first i.f.) tunable receiver: for home construction the receiver may in fact be built in this form, with each converter on a detachable sub-assembly. This arrangement allows, in the complete absence of any switching at h.f., accurate calibration and a fixed tuning rate on all bands.

Selectable-sideband Reception.—It is advantageous, in order to dodge adjacent-channel interference, to be able to select at will, without adjusting the main tuning control, the set of sidebands to which a highly-selective receiver is tuned. This applies equally to the reception of conventional a.m., d.s.b. and (with the co-operation of the transmitting station) s.s.b. emissions. One method of achieving this, applicable to a conventional type of double-conversion receiver, is to make it possible to vary the second oscillator, which would normally be fixed tuned, over about 5kc/s, allowing the pass band of the receiver to be readily shifted from one side of an a.m. signal to the other. Another, and increasingly popular, method is to provide a choice of two crystals for controlling the second oscillator, spaced twice the second i.f. apart. For example, if the first i.f. is 2,000kc/s and the second 470kc/s, then the crystals would be about 2,470kc/s and 1,530kc/s respectively. With the oscillator tuned below the signal at the mixer grid, the output will be inverted, thus automatically reversing the sideband to which the receiver is tuned. This system can be applied alternatively to any other fixed-tuned oscillator, including the beat-frequency oscillator although in the latter case it cannot be used on A3 signals.

I.F. Selectivity.—Most amateurs would consider that the optimum "nose" (-6dB) bandwidths would be of the order of 300c/s for telegraphy, 3kc/s for s.s.b. and d.s.b. and 3-6kc/s for a.m. telephony. Razor-sharp telegraphy selectivity of the order found
(Continued on page 553)

Fig. 6. Half-lattice crystal networks for s.s.b. receivers; indicating the improvement in skirt response when the crystals are correctly balanced or when extra crystals are used to reduce "humps." Typical crystal frequencies would be: X1 = 464.8kc/s; X2 = 466.7kc/s; X3 = 463 kc/s; X4 = 468.5kc/s



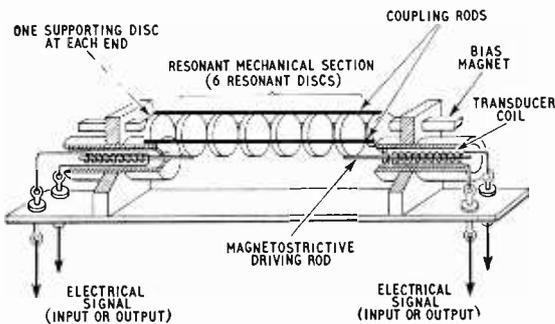


Fig. 7. The Collins mechanical filter. I.F. signals are converted into mechanical vibrations by a magnetostrictive transducer and passed along a series of resonant discs—equivalent to series resonant electrical circuits of very high Q (about 5,000), and finally re-converted to i.f. signals by a second magnetostrictive transducer. Bandwidth of the filter is governed by the number of resonant discs and design of the coupling rods.

in some large commercial point-to-point receivers could lead to difficulty in holding some transmissions—particularly those from remote areas where poor voltage regulation tends to produce drifting signals. The “skirt” (-60dB) bandwidths should ideally be as close to the -6dB figures as possible, but in practice will seldom be less than about three times the bandwidth. As the problems of producing economically i.f. characteristics to these specifications are overcome, the secondary problem of blocking and cross-modulation by extremely strong signals outside the pass band tends to become more prominent.

Recent trends in achieving good i.f. selectivity may be summarized as follows: (1) low second (or third) i.f. of the order of $50\text{--}100\text{kc/s}$ in double- and triple-conversion designs; (2) two or more quartz crystals in half-lattice filter or the equivalent mechanical filter; (3) ferrite pot-cored inductors to improve Q ; (4) Q -multiplier to sharpen the i.f. response, or to provide a tunable rejection notch.

The low second (or third) i.f. remains generally popular though it is noticeably absent in some of the highest-grade, factory-built receivers. One reason for this is that selectivity attained in a relatively late stage in a receiver tends to increase susceptibility to blocking and cross-modulation. One recent design⁴ for home construction while using a 50-kc/s second i.f. to obtain its selectivity, included two cascaded half-lattice crystal filters at its first i.f. of 4.5Mc/s to reduce blocking.

Although the half-lattice, band-pass crystal filter was developed in the “thirties,” it is only in recent years that it has really come into favour with home constructors. One reason may be that experience gained in the construction of such filters for s.s.b. transmitters has often been utilized later to improve the receiver, and the habit has spread along the amateur grapevine. The other reason (equally important) is the continued availability at a reasonable cost of surplus Type FT241 quartz crystals with suitable channel spacings. Fig. 6 shows some typical filter networks using up to four crystals.

Mechanical Filters.—The development by the American Collins Radio Company of mechanical filters (Fig. 7) has given the amateur receiver designer a new and very convenient way of obtaining a band-

pass characteristic at frequencies between about 60kc/s and 600kc/s of almost any desired bandwidth with a response curve having a sensibly flat top and very steep sides. A mechanical filter can thus provide in a compact unit smaller than the average i.f. transformer, a robust filter with the characteristics of a multiple-crystal network. Such filters, however, add appreciably to the cost of a receiver and the amateur can usually construct crystal networks at lower cost—though he will be fortunate if he can obtain such carefully controlled characteristics.

Ferrite Pot Cores.—I.F. inductors of higher Q than is possible with conventional i.f. transformers can be obtained by the use of ferrite pot cores. The use of pot cores to provide a highly-selective band-pass i.f. response is described elsewhere.⁵ A simpler arrangement which has been used in a number of recent American receivers and which can readily be adapted to provide variable-i.f. selectivity is the bottom-coupled i.f. transformer comprising two pot-cored inductors in separate screening compartments, all coupling being provided by the inductor C (Fig. 8).

Q -Multipliers.—The apparent Q of a tuned circuit can be increased by applying positive feedback up to the point of oscillation: this was a well-known characteristic of the reaction control on old t.r.f. receivers. Recently, this fact has been made use of in a number of devices, generally known as Q -multipliers. Usually a valve or transistor circuit at the i.f. is advanced near the threshold of oscillation and coupled to an early i.f. stage of the receiver. It has the effect of placing a high- Q circuit in parallel with the i.f. transformer. By the provision of negative feedback from a second valve stage, it is possible to

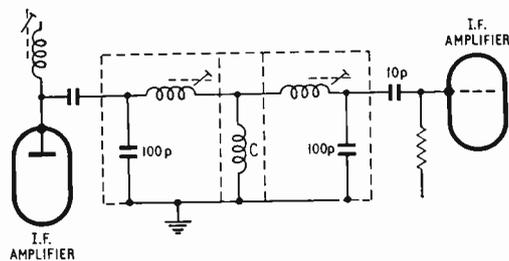


Fig. 8. Ferrite pot-cores used in a high- Q bottom-coupled i.f. transformer. Selectivity is determined by the value of C which can be altered to provide switched degrees of selectivity.

convert the sharp “accept” characteristic of a Q -multiplier to that of a “reject” notch, similar to that provided by the phasing control of a single-crystal filter.

While the Q -multiplier is often added to relatively simple communications receivers to sharpen the response curve⁶, the rejection notch is also quite widely used in high-performance receivers to reduce heterodyne interference from carriers operating at frequencies within the pass-band of the receiver. Fig. 9 shows the Q -multiplication effect applied to a bridged-T filter to provide an extremely sharp and deep rejection notch, as used in a well-known American receiver.

Product Detectors.—Although there is still some difference of opinion⁷ as to the value, in practice, of “product detectors,” these are often included in amateur receivers for use on s.s.b., d.s.b. and tele-

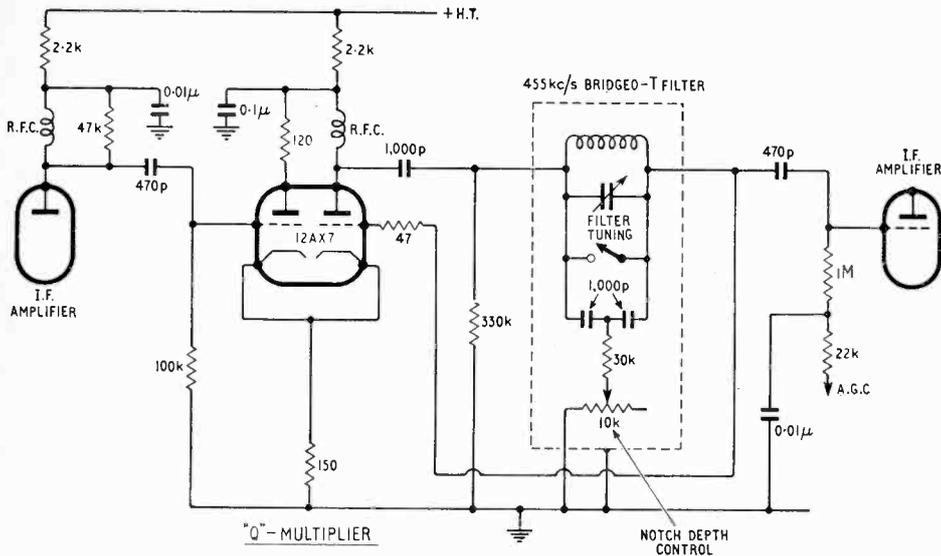


Fig. 9. The rejection notch of a bridged-T filter can be increased by Q-multiplication. The filter inductor should be of high Q construction.

graphy signals, a diode detector being switched into circuit for A3 telephony signals. In the product detector two input signals are fed to what is basically a mixer stage: (1) the incoming signal at i.f.; and (2) the signal from the carrier-insertion or beat-frequency oscillator. The difference in frequency, after filtering out the original signals, is fed directly to the a.f. stages. Fig. 10 shows a typical circuit, using a double-triode valve, though an alternative arrangement using a 6BE6 mixer valve is also fairly widely used. The product detector reduces intermodulation distortion at low-signal levels but the claims that it facilitates s.s.b. tuning and reduces interference from a.m. stations have been challenged.

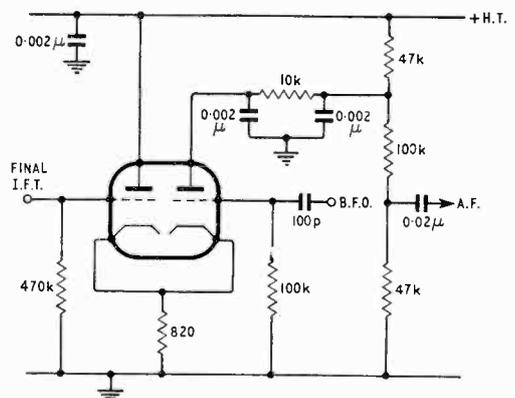
Aerials.—Although the traditional dipoles, end-fed "long-wires" and "Zepps" remain popular, many amateurs now use beam aerials either fixed or rotating for long-distance work on the 14-, 21- and 28-Mc/s bands, providing power gains of up to 10dB. The most popular arrays are adaptations from the well-known Yagi array or its folded form generally known as the cubical quad. In recent years main interest has been in the development of arrays which will function effectively on a number of different bands without the need for separate structures and transmission lines. This is usually done by the insertion of tuned traps or stubs in the aerial elements so that they will appear to the feeder as electrical dipoles on a number of different frequencies. Because a conventional horizontal polarized Yagi on say 14Mc/s is too large for many amateur locations, considerable progress has also been made in the use of loading coils, stubs or helical winding of elements to reduce their overall size without affecting too much the efficiency of the array. A multi-band array used in conjunction with a fully band-switched transmitter and receiver enables an amateur operator to change his frequency band almost without pause.

Electronic T-R Switches.—For many years it has been amateur practice to use the same aerial for transmission and reception, in order to derive maximum benefit from its directional properties. This has involved the use of a change-over switch or relay, making it difficult to operate with "listening

through" (break-in) facilities and requiring some care with high power to avoid the risk of burning out the aerial input coil in the receiver. A useful family of devices, known as electronic T-R switches, has been developed to allow a single aerial to remain permanently connected to both transmitter and receiver. A low-impedance aerial feeder is taken in the usual way to the transmitter with a parallel connection to the receiver via a protective valve switch which stops any appreciable r.f. power from reaching the receiver input circuits. The switch usually comprises a sharp cut-off valve arranged so that when any r.f. power from the transmitter is applied to its untuned input circuit, grid current flows through a grid-bias resistor, thus applying bias and reducing the anode current practically to zero (Fig. 11). While the transmitter is off the valve functions as a low-level amplifier passing incoming signals to the receiver.

Mobile Operation.—A fast growing branch of amateur radio is the operation of telephony transmitters installed in cars. Some operate on all amateur bands between 1.8 and 28Mc/s, and there is also a good deal of 144-Mc/s equipment in use.

Fig. 10. One form of product detector commonly used for s.s.b. and telegraphy reception.



It is in this type of equipment that amateurs are turning gradually to transistors, primarily for a.f. amplification and modulation, but also for power conversion. Two a.f. power transistors in a push-pull inverter (Fig. 12) can provide h.t. supplies for say a 25-watt transmitter at very high efficiency and with no battery drain except when the transmitter is actually working.

Popular aerials for mobile work include inductively-loaded whip aerials on the h.f. bands and the omni-directional "halo" on 144Mc/s. The halo is a simple half-wave dipole bent round to form a circle with the ends of the element joined by insulating material: on 144Mc/s this results in a circle of about 12in diameter and enables a mechanically rigid aerial to be mounted on the roof of a car.

V.H.F. Activities.—A substantial minority of radio amateurs has always concerned itself with the investigation of v.h.f. and u.h.f. propagation and equipment. The results have not been without interest. In recent years two-way amateur contacts have been made on 144Mc/s and 220Mc/s (and one-way transmission on 420Mc/s) over the 2,540-mile path between California and Hawaii. The European 144Mc/s record is held by G5NF and I1KDB for a contact between Farnham, Surrey, and Naples, Italy; a distance of 1,084 miles. On 420Mc/s a world record was gained in 1959 by a two-way contact between G3KEQ (Sanderstead) and SM6ANR (Gothenburg, Sweden). As a special concession, certain British amateurs have been permitted to use powers up to 1kW on 144Mc/s and this has resulted in a fairly regular schedule being maintained between G2NY (near Preston, Lancs) and the Dutch Government experimental station PE1PL, a distance of 300 miles. In the microwave region, two Swiss amateurs have worked nearly 140 miles on 10,000 Mc/s, although Americans hold the record on this band with a contact over more than 185 miles.

In November, 1956, as a result of talks between the Radio Society of Great Britain and the Post Office, permission was granted—at first on a restricted basis—for the use by amateurs of the band 70.2-70.4Mc/s. This provides for the first time since the loss of the old five-metre band in 1949 a v.h.f. band on which sporadic E propagation can be expected occasionally. Although not an international allocation, the band is now available to amateurs in several countries and contacts exceeding 1,000 miles have been made.

The usual receiving set-up for long-distance v.h.f. work is to use a broad-band converter, with low-noise r.f. stage (cascode, balanced, neutralized twin-triode, grounded-grid or disc-seal) and crystal-controlled oscillator/multiplier in conjunction with an h.f. communications receiver.⁶ Multi-element stacked arrays, with up to about 48 elements, are used at the more elaborate stations.

V.H.F. enthusiasts took part in organized observations throughout the I.G.Y., carrying out a programme of auroral and tropospheric studies and the tracking of earth satellites. Meteor scatter communication has attracted amateur interest in the United States and Europe. On 1296Mc/s, two-way working over 2,700 miles has been achieved in the U.S. by means of "moon bounce" using 18ft and 8ft parabolic reflectors, parametric amplifiers and 1 kW klystron transmitters.

In a letter to *Wireless World* published in 1919, Marconi—in pleading for a removal of war-time

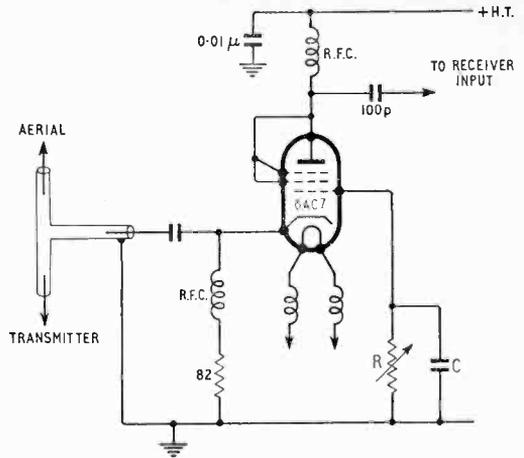


Fig. 11. An electronic T-R switch obviates the need for a transmitter/receiver aerial change-over relay, thus facilitating "break-in" operation. Values for R and C determine the recovery time of the switch and typical values are $C = 0.01\mu F$ and R about $2M\Omega$.

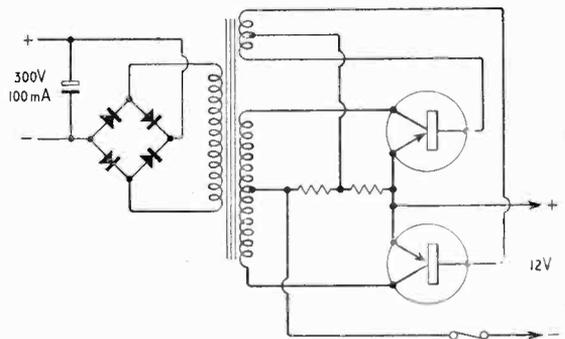


Fig. 12. Transistor d.c. converters can provide h.t. for mobile equipment at very high efficiency and with no battery drain during "stand-by" periods. Working at 1-2kc/s two junction-power transistors can readily supply some 30W or more in a push-pull circuit.

restrictions—wrote that "a body of independent and often enthusiastic amateurs constitutes a valuable asset towards the further development of wireless telegraphy." More than 40 years later, who would question the continued relevance of this accurate forecast?

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NODAL ANALYSIS

By F. R. B. JONES*, A.M.BrIt. I.R.E.

I.—COMPARISON WITH MESH ANALYSIS

NODAL analysis is a straightforward method of solving network problems which does not require a high standard of mathematics or electrical theory. It is complementary to mesh analysis, which we all learn as a matter of course, and its great beauty is that it is particularly suited to solving networks which contain valves and transistors. Very often, in such a case, it will yield a solution with fewer unknowns and equations, which means less work and hence less chance of error.

Scope of Network Analysis.—Before explaining nodal analysis it may be useful to the new student if some indication is given of the scope of network analysis. It is a vast and complicated subject where many of the branches call for quite a high degree of mathematical ability. This is because there are quite a number of different types of network, each of which may be excited in several different ways. (By excitation we mean the force which energises the network; it could be a steady value, supplied by a battery, a sinusoidal waveform from, say, the mains, a continuous sawtooth waveform, or even an impulse.)

With regard to networks, they may be linear or non-linear. If the former, they obey Ohm's Law within their working limits; if the latter, they don't—there may be a metal rectifier present which, when you double the voltage, does not double the current. This latter type is difficult to solve mathematically and often an approximation is made, using a series.

Again, networks may be bilateral or unilateral. A bilateral network will pass energy equally well in

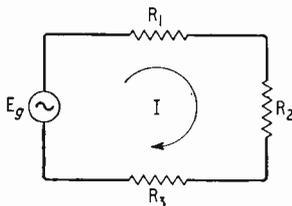


Fig. 1. Simple single-mesh network.

both directions. A unilateral network, however, will pass energy in one direction only (there may be a valve in it).

Whatever the type of network, it will have two modes of behaviour: the first known as the steady state, the second as the transient or force-free condition. The steady state is the behaviour (i.e. current flow) in the network with the driving voltage applied, after allowing the necessary time for the current to settle down to its "steady state". This is the normal working condition and the one we are generally more interested in.

The transient state exists immediately after switching on or off, it commonly lasts for only a fraction of a second, so that in most cases it may be

neglected; there are times, however, when it assumes great importance.

Now we are going to confine ourselves to the study of linear networks working in the steady state: this ensures that we will not meet a current squared or cubed in our equations, which would entail the solution of a set of simultaneous quadratic or cubic equations.

In the same cunning manner we will restrict our studies to sinusoidal generators, the reason being that when a sinusoidal voltage is applied to an inductor

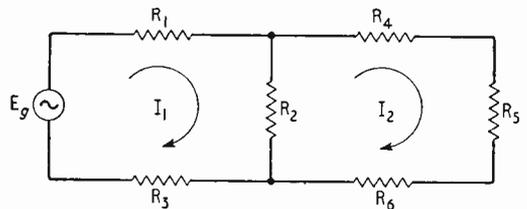


Fig. 2. Two-mesh network.

or capacitor the current is also sinusoidal, and vice versa. This is not the case with any other periodic waveform, which complicates matters when we have to use them.

Common Methods of Effecting Solutions.—The simplest circuits can easily be solved by means of Ohm's Law, which states that the current which flows in a wire is directly proportional to the voltage, provided that the temperature of the wire is maintained constant.

In a multi-mesh network (one in which there are alternative circuits for the current) it is usually best to apply Kirchhoff.

Now Kirchhoff propounded two laws, but as far as most people are concerned he might just as well have saved himself the effort and stuck on one, like Ohm.

His first, and universally used law is:—"The sum of the voltages around any mesh of a network is zero." This merely means that the sum of the back e.m.f.s must equal the applied e.m.f., and this law is the justification for mesh analysis.

Mesh Analysis.—It may be well to revise the principles of mesh analysis so that, with memories refreshed, we can better compare it with nodal analysis, which follows. A mesh, by the way, is defined as a set of branches forming a closed path in a network, provided that if any branch is omitted from the set, the remaining branches of the set do not form a closed path.

The simplest circuit is shown in Fig. 1. Kirchhoff

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states that the sum of the voltages across the resistors equals the applied (generator) e.m.f., i.e.

$$E_g = IR_1 + IR_2 + IR_3 = I(R_1 + R_2 + R_3)$$

It is common to assume clockwise currents as positive and anti-clockwise currents as negative and we will follow this convention.

Now consider the two-mesh network shown in Fig. 2. Kirchoff's equation for mesh (1) will now be:—

$$E_g = R_1 I_1 + R_2(I_1 - I_2) + R_3 I_1 \\ = (R_1 + R_2 + R_3)I_1 - R_2 I_2$$

I_2 is subtracted from I_1 because these two currents pass through R_2 in opposite directions. Similarly for the second mesh, where there is no source of voltage, the equation becomes:—

$$(R_2 + R_4 + R_5 + R_6)I_2 - R_2 I_1 = 0$$

We could write down a standard set of equations for any two-mesh network in the form:—

$$Z_{11} I_1 + Z_{12} I_2 = E_1 \text{ (mesh 1)}$$

$$Z_{21} I_1 + Z_{22} I_2 = E_2 \text{ (mesh 2)}$$

And, for the case we have just considered,

$$Z_{11} = R_1 + R_2 + R_3, \quad Z_{22} = R_2 + R_4 + R_5 + R_6$$

$$Z_{12} = Z_{21} = -R_2$$

We see that Z_{11} is the impedance going round mesh (1) with mesh (2) open circuit, while Z_{22} is the impedance of mesh (2) with mesh (1) open circuit. In a bilateral network (one which does not contain a valve or similar device) $Z_{12} = Z_{21}$ and in this case both equal $-R_2$. The negative sign is due to the fact that I_1 and I_2 pass through the common coupling resistor in opposite directions.

Again, if we had a network composed of n meshes we could still write down immediately a standard set of n equations, without seeing the network. They would have the form:—

$$Z_{11} I_1 + Z_{12} I_2 \dots Z_{1n} I_n = E_1 \text{ (mesh 1)}$$

$$Z_{21} I_1 + Z_{22} I_2 \dots Z_{2n} I_n = E_2 \text{ (mesh 2)}$$

$$\dots \dots \dots$$

$$Z_{n1} I_1 + Z_{n2} I_2 \dots Z_{nn} I_n = E_n \text{ (mesh } n)$$

where $Z_{11}, Z_{22}, Z_{33} \dots Z_{nn}$ are the impedances around meshes (1), (2), (3) ... (n), each one measured when *all* the other meshes are open circuited. Again Z_{12} would be the impedance common to meshes (1) & (2), Z_{13} the impedance common to meshes (1) & (3) and so on, positive when the currents through are additive, and negative where the two currents are subtractive.

If you are new to network theory, check the equations for the Wheatstone bridge network shown in Fig. 3. As a matter of interest the current in the bridge resistor is 2.46 mA.

Elements of Nodal Analysis.—So far we have examined mesh analysis, which is based on Kirchoff's First Law. We have not yet mentioned Kirchoff's

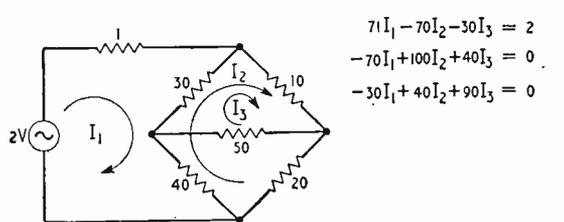


Fig. 3. Wheatstone bridge circuit and its associated network equations.

Second Law, which is very much the Cinderella of network analysis.

The second law states simply that:—"The algebraic sum of the currents at any point in a network is zero." (The current leaving a point must equal the current reaching the point.)

We notice two things about this law. One, it resembles the first law, but refers to current instead of voltage; two, it seems rather self evident since all it says is that electrons can't just disappear. Shown diagrammatically in Fig. 4 we have:—

$$I_3 + I_5 - (I_1 + I_2 + I_4) = 0$$

Just as in mesh analysis we arbitrarily decided that clockwise currents were positive, so here we can decide that currents leaving the nodes (a node is a junction point) are positive and that currents entering a node are negative.

Now in mesh analysis we apply known voltages to a network and equate them against the back e.m.f.s, which are all expressed as currents multiplied by impedance. Our job is to find the values of the unknown currents.

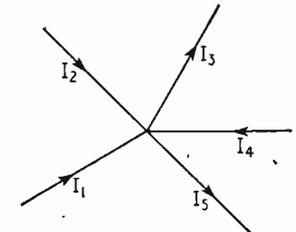


Fig. 4. (Left) illustration of Kirchoff's second law. $I_3 + I_5 - (I_1 + I_2 + I_4) = 0$.

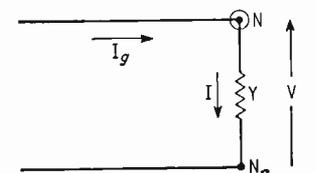


Fig. 5. (Right) simplest single-node network.

In nodal analysis the reverse is the case. We are given known currents which are applied to the network, and we equate against these generator currents the other currents which flow away from the various nodes. Instead of showing these resultant currents as voltages divided by impedances, it is easier to use voltages multiplied by admittances, which is basically the same thing, since $Y = 1/Z$. Given these equations our job is now to find the unknown nodal voltages. Since voltages are measured across two points (or nodes), one node, usually earth, is selected as a reference point, and all the nodal voltages are measured with reference to this common point.

Now many students do not like admittances and shy away from using them. It is important to realize that when this is so it is only because admittances are relatively unfamiliar: they are fundamentally no harder to use than impedances, so that there is not the slightest reason to have qualms regarding them. It is only necessary to remember that whereas we add impedances in series, admittances can only be added when they are in *parallel*. Actually this makes nodal analysis easier to carry out, not harder.

Formation of Nodal Equations.—As with mesh analysis we will first examine the simplest cases.

Take Fig. 5, where a known current from an unspecified source (as yet) is fed into a single admittance Y . There will only be one voltage V , which is developed across Y , so there will be two nodes, one of which will be the reference point.

Now I_o must equal I . But I , by Ohm, must equal YV . Hence $I_o = YV$, and this is the nodal equation. If $I_o = 10$ amperes and $Y = 2$ mhos (equivalent to $\frac{1}{2}$ an ohm) then V would be 5 volts.

Consider next a "pi" network, where there will be two significant nodes and one reference node, as in Fig. 6.

At node (1) $I_o = I_1 + I_2$, and $I_1 = Y_1 V_1$, as in the last example. I_2 , by Ohm, will equal the voltage across Y_2 multiplied by its admittance, i.e.

$$I_2 = (V_1 - V_2) Y_2$$

So the complete equation for node (1) is:—

$$I_o = Y_1 V_1 + Y_2 (V_1 - V_2) = (Y_1 + Y_2) V_1 - Y_2 V_2 \dots (a)$$

For node (2), $I_3 - I_2 = 0$

$$\text{or } Y_3 V_2 - (V_1 - V_2) Y_2 = 0$$

$$\text{giving } (Y_2 + Y_3) V_2 - Y_2 V_1 = 0 \dots (b)$$

Collecting (a) and (b) we obtain the necessary set of two nodal equations:—

$$\begin{aligned} (Y_1 + Y_2) V_1 - Y_2 V_2 &= I_o \\ -Y_2 V_1 + (Y_2 + Y_3) V_2 &= 0 \end{aligned}$$

Suppose we write down a set of standard equations for a two (significant) node network, as we did for mesh analysis. They would have the form:—

$$Y_{11} V_1 + Y_{12} V_2 = I_1 \quad (\text{node } 1)$$

$$Y_{21} V_1 + Y_{22} V_2 = I_2 \quad (\text{node } 2)$$

To find what Y_{11} signifies we short node (2) to the reference point, or node. V_2 must then equal zero, so $Y_{11} = I_1/V_1$, i.e. the admittance between node (1) and the reference point, with node (2) short circuited. Referring to the "pi" network

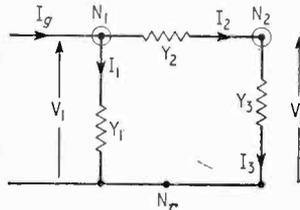


Fig. 6. Two-node "pi" network.

we see that the coefficient for V_1 in the first equation is $Y_1 + Y_2$, which is the admittance between N_1 & N_r when N_2 is shorted out. Similarly Y_{22} equals $Y_2 + Y_3$, which appear in parallel when N_1 is short circuited.

Y_{12} , by the same reasoning, will be the ratio of current flowing into node (1) to the voltage at node (2), when node (1) is short circuited, i.e. it is the common admittance between nodes (1) & (2), with a negative sign, because the current is flowing into the node, not out. All this fits in with the equations for the "pi" network, already found.

We can summarise in this fashion. Suppose we have an n -node network (neglecting the reference node) then—without seeing the network—we can write down a set of n nodal equations.

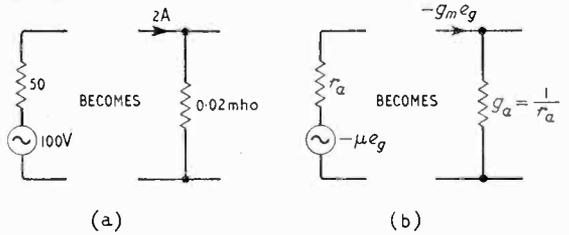
$$Y_{11} V_1 + Y_{12} V_2 + \dots + Y_{1n} V_n = I_1 \quad (\text{node } 1)$$

$$Y_{21} V_1 + Y_{22} V_2 + \dots + Y_{2n} V_n = I_2 \quad (\text{node } 2)$$

$$\dots$$

$$Y_{n1} V_1 + Y_{n2} V_2 + \dots + Y_{nn} V_n = I_n \quad (\text{node } n)$$

where $Y_{11}, Y_{22} \dots Y_{nn}$ are the individual admittances between node (1) and reference, node (2) and reference \dots node (n) and reference, each one taken when all the other nodes are short circuited to the



Figs. 7(a) and (b). Two examples of the transformation of a voltage generator into its equivalent current generator.

reference node. Y_{12} is the common admittance between nodes (1) and (2) with all nodes except node (2) short circuited, having a negative sign because the current is assumed to flow into node (1). The same applies to all the other common admittances between the different nodes.

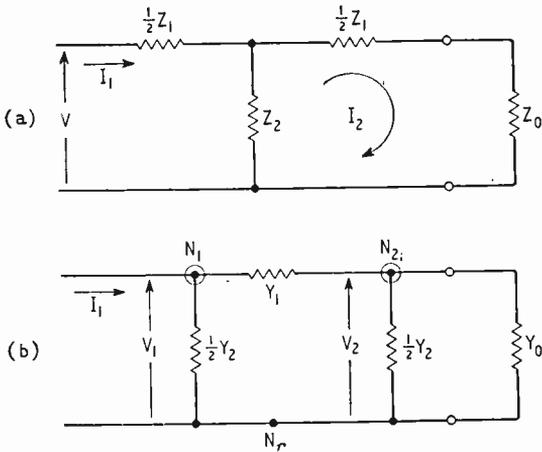
Generators in Nodal Analysis.—The student will have noticed that in nodal analysis the generators supply known currents, whereas he is probably used to thinking of generators which supply a known voltage, like the mains. However, it is very easy, mathematically, to transform a voltage generator into a current generator by the use of Norton's Theorem. This tells us that if we short circuit the output terminals of a voltage generator, the current which flows will be the output current of the equivalent current generator. The generator impedance will have the same value after the transformation, but will appear in parallel with the supply current, instead of in series with the e.m.f. as it does in a voltage generator. In nodal analysis we show it as an admittance. The examples in Figs. 7(a) & 7(b) may help.

Summary.—Now what does all of the foregoing explanation resolve into? We can briefly list it as follows:—

1. We select the nodal points in the network and write down a set of n simultaneous equations, where n is the number of significant nodes (i.e., we exclude the reference or earth node).
2. Y_{22} is the admittance between node (2) and earth (or reference) with all other nodes short circuited; in the general case Y_{bb} is the admittance between node (b) and reference, with all nodes, other than node (b), short circuited.
3. Y_{13} is the common admittance joining nodes (1) & (3), with a negative sign, with all nodes except node (3) short circuited. Similarly Y_{bc} is the common admittance between nodes (b) & (c), with a negative sign, with all nodes except node (c) earthed to the reference.
4. The generators supply a set current, not voltage: the current being equal to that of the short circuited voltage generator being replaced. The current generator will have its internal impedance in parallel with its output terminals, not in series. It will be expressed as an admittance $Y_g = 1/R_g$ where R_g is the impedance of the voltage generator. On no load all the current flows through Y_g , on short circuit all flows through the short, but the magnitude of the current is always constant, irrespective of load.

That is all there is to it. You may protest that after getting used to dealing with open-circuited

(Continued on page 559)



Figs. 8(a) and (b). Symmetrical "T" (a) and "pi" (b) networks terminated in their characteristic impedances.

impedances the changeover to short-circuited admittances is too much for you—a sort of "Alice through the looking glass" adventure, with a strange kind of upside down logic. For myself, I still like wandering with Alice through looking-glass land and it is surprising how many quotations from Alice grace profound mathematical tomes. It's only mental inertia which may hold you back, not the difficulty of the subject. If you wish to acquire dexterity in the mathematical solution of networks, especially those containing valves and transistors, the effort is well worth making.

So let's try some examples.

Examples.—1. Find the characteristic impedance of a symmetrical "T" and a symmetrical "pi" section.

The characteristic impedance of a network is that impedance, placed across the output terminals of the network, which gives the input impedance the same value as itself.

The "T" network (shown in Fig. 8a) has two meshes and three significant nodes. Mesh analysis is obviously better.

We write down the mesh equations:—

$$Z_{11} I_1 + Z_{12} I_2 = V \quad (a)$$

$$Z_{21} I_1 + Z_{22} I_2 = 0 \quad (b)$$

The input impedance will equal V/I_1 and this is to equal Z_0 , the load.

$$\text{From (b)} \quad I_2 = -\frac{Z_{21}}{Z_{22}} I_1$$

Substituting this in (a) we get

$$Z_{11} I_1 - \frac{Z_{12}^2}{Z_{22}} I_1 = V$$

$$\therefore Z_{11} - \frac{Z_{12}^2}{Z_{22}} = \frac{V}{I_1} = Z_0$$

And $Z_{11} Z_{22} - Z_{12}^2 = Z_0 Z_{22}$

From an inspection of the network we see that

$$Z_{22} = Z_{11} + Z_0$$

$$\therefore Z_{11}^2 + Z_{11} Z_0 - Z_{12}^2 = Z_0 Z_{11} + Z_0^2$$

$$\therefore Z_0^2 = Z_{11}^2 - Z_{12}^2$$

Suppose $\frac{1}{2}Z_1 = 168$ ohms & $Z_2 = 987$ ohms.

Then $Z_0^2 = 1,155^2 - 987^2 = 360,000$

$$\therefore Z_0 = 600 \text{ ohms}$$

In the "pi" network (shown in Fig. 8b), we have two nodes and three meshes, so we use nodal analysis. You will see how the equations and result seem almost a mirror image (or Alice's looking-glass reflection) of the "T" network.

Our standard equations are

$$Y_{11} V_1 + Y_{12} V_2 = I_1 \quad (a)$$

$$Y_{21} V_1 + Y_{22} V_2 = 0 \quad (b)$$

$$\text{From (b)} \quad V_2 = -\frac{Y_{21}}{Y_{22}} V_1$$

Substituting this in (a) we get

$$Y_{11} - \frac{Y_{12}^2}{Y_{22}} = \frac{I_1}{V_1} = Y_0$$

And $Y_{11} Y_{22} - Y_{12}^2 = Y_0 Y_{22}$

$$\text{But } Y_{22} = Y_{11} + Y_0$$

$$\therefore Y_{11}^2 + Y_{11} Y_0 - Y_{12}^2 = Y_0 Y_{11} + Y_0^2$$

$$\therefore Y_0^2 = Y_{11}^2 - Y_{12}^2$$

Suppose $Z_1 = 365$ ohms & $2Z_2 = 2,142$ ohms.

Then $Y_1 = 2.74$ millimhos, $\frac{1}{2}Y_2 = 0.468$ millimhos,

$Y_{11} = 3.21$ millimhos and $Y_{12} = -2.74$ millimhos.

$$\text{Then } Y_0^2 = Y_{11}^2 - Y_{12}^2$$

$$= (10.30 - 7.51) \times 10^{-6} = 2.79 \times 10^{-6}$$

$$\therefore Y_0 = 1.67 \text{ millimhos and } Z_0 = 600 \text{ ohms}$$

2. Two identical tuned circuits are coupled, first mutually and then with top capacitance. Compare the effects of varying the coupling on the bandwidth of the circuits.

The mutually-coupled circuits are shown in Fig. 9(a). Where mutual couplings occur it is usually better to use mesh analysis. Starting with the same basic equations and proceeding in the same manner as before we reach the equation

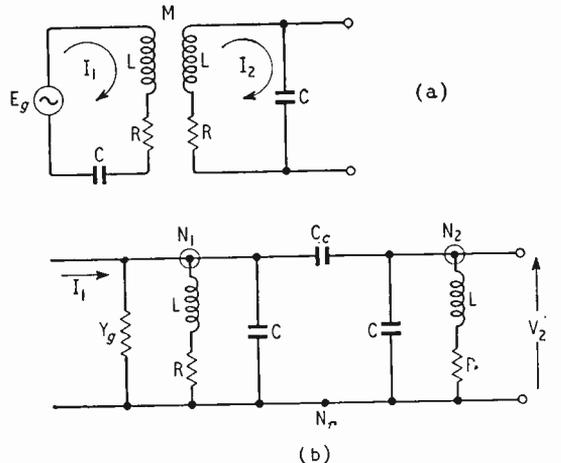
$$I_2 = \frac{-Z_{12} E_g}{Z_{11} Z_{22} - Z_{12}^2} = \frac{-Z_{12} E_g}{Z_{11}^2 - Z_{12}^2}$$

Now $Z_{11} = Z_{22} = R + j\omega L + 1/j\omega C$ and $Z_{12} = j\omega M$.

Remembering that $A^2 - B^2 = (A+B)(A-B)$, we obtain

$$I_2 = \frac{-j\omega M E_g}{[(R + j\omega L + 1/j\omega C) + j\omega M][(R + j\omega L + 1/j\omega C) - j\omega M]}$$

$$= \frac{-j\omega M E_g}{[R + j\omega(L+M) + 1/j\omega C][R + j\omega(L-M) + 1/j\omega C]}$$



Figs. 9(a) and (b). Mutually- (a) and top-capacitively- (b) coupled tuned circuits.

We see that the denominator will have one minimum when $\omega_1(L+M) = 1/\omega_1 C$ and another when $\omega_2(L-M) = 1/\omega_2 C$, which give us the two current peaks we associate with tuned-coupled circuits (Fig. 10a). The peaks will be more or less symmetrical about the resonant frequency of one circuit when isolated from the other. Increasing the coupling M increases the bandwidth more or less symmetrically about the centre point if M/L is < 0.1 .

For the top-capacity coupling (Fig. 9b), we start to count the meshes but quickly decide to employ nodal analysis. In any case the generator is usually a pentode valve, which is commonly called a constant-current valve whilst we are really interested in the output voltage not current.

The standard set of nodal equations will lead us to

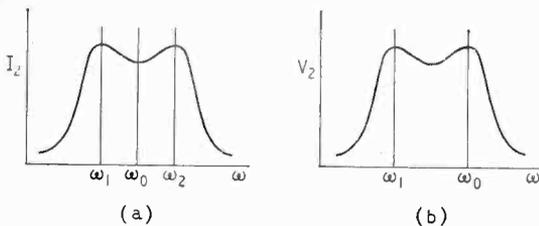
$$V_2 = \frac{-Y_{12} I_1}{Y_{11}^2 - Y_{12}^2}$$

Where, if we neglect resistance,

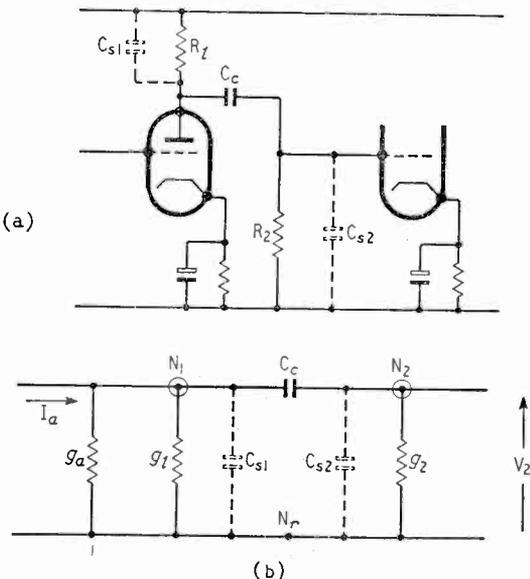
$Y_{11} = Y_{22} = 1/j\omega L + j\omega C + j\omega C_c$ & $Y_{12} = -j\omega C_c$

Using the $A^2 - B^2$ formula again we obtain

$$V_2 = \frac{j\omega C_c I_1}{[1/j\omega L + j\omega C + j\omega C_c + j\omega C_c][1/j\omega L + j\omega C - j\omega C_c]} \\ = \frac{j\omega C_c I_1}{[1/j\omega L + j\omega(C + 2C_c)][1/j\omega L + j\omega C]}$$



Figs. 10(a) and (b). Frequency response curves of mutually-coupled (a) and top-capacitively-coupled (b) tuned circuits of Figs. 9(a) and (b).



Figs. 11(a) and (b). Audio-frequency voltage amplifier circuit (a) and its nodal equivalent circuit (b).

The response curve is shown in Fig. 10(b). We see again that there will be two peaks, but now one of them is independent of the coupling element. Hence increasing the coupling causes the lower peak to move to a lower frequency, but the upper peak remains stationary. This type of coupling is therefore unsuitable for a variable-bandpass circuit, since increasing the coupling makes the passband asymmetrical. This asymmetry applies to all forms of coupling except the mutually inductive, and accounts for the popularity of the latter.

3. Obtain expressions for the gain of an audio-frequency voltage amplifier at low, medium and high audio frequencies.

The circuit, and its nodal equivalent, are shown in Figs. 11 (a) and (b).

At medium frequencies it is usually easy to make the effects of all the capacitances negligible. This reduces the equivalent circuit to having only one significant node, and

$$V_2 = \frac{I_a}{g_a + g_t + g_2}$$

At high frequencies the effect of the coupling condenser can again be neglected, but the stray capacitances must be considered. The equivalent circuit will only have one node as long as C_c may be neglected, so we get

$$V_2 = \frac{I_a}{(g_a + g_t + g_2) + j\omega(C_{s1} + C_{s2})}$$

At low frequencies the stray capacitances can usually be neglected, but the effect of the coupling capacitor cannot: hence we must employ the two nodes, as shown. Let g_a & $g_t = g_1$.

Then $Y_{11} = g_1 + j\omega C_c$, $Y_{22} = g_2 + j\omega C_c$ & $Y_{12} = -j\omega C_c$.

Employing our basic two-node equation and substituting we get

$$V_2 = \frac{-Y_{12} I_1}{Y_{11} Y_{22} - Y_{12}^2} \\ = \frac{j\omega C_c I_a}{(g_1 + j\omega C_c)(g_2 + j\omega C_c) + \omega^2 C_c^2} \\ = \frac{j\omega C_c I_a}{g_1 g_2 + j\omega C_c (g_1 + g_2)}$$

I hope you can see how easily the three equations can be obtained from the one equivalent circuit and set of equations. In the three equations I_a may be replaced by $-g_m e_g$.

Conclusion.—Most valve equations and formulae are formed on the implicit assumption that the valve is truly unilateral, i.e. that voltages and currents in the output circuit of the valve have no effect upon the input; but sometimes this assumption is not valid, as for example, where Miller Effect is present, or when feedback is employed.

Transistors are much worse than valves in this respect, they are seldom if ever truly unilateral. This tends to make the mathematical calculations complicated and tedious. We will endeavour to show, in the second half of this article, that in this connection nodal analysis can effect considerable simplification and is much easier to use.

(To be concluded.)

LETTERS TO THE EDITOR

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

Local Sound Broadcasting

YOU say in your Editorial on Local Sound Broadcasting in the October issue that regional broadcasting as the BBC has organized it is "administratively convenient." I am not sure whether this is meant to be a compliment or a criticism, but the purpose behind the establishment of the regions is the contribution of programmes, both sound and television, to the national networks, and for each region to serve its own audience with programmes which reflect the special interests of the particular area. Certainly BBC regions are large but not too large for regional news bulletins. In most regions VHF transmitters on the Home Service wavelengths are also being used to give programmes of news and general local interest covering a smaller area than the regional news bulletins on medium waves. The BBC policy of having studios in several important centres of population in each region makes this possible.

The BBC has prepared plans for the introduction of a system of local broadcasting on VHF, taking into account the experience gained from the localized area services on VHF which have been developed within the existing BBC regions in recent years. Local broadcasting will need low-power VHF stations with single transmitters to provide local programme services, although there may be a need for supporting medium-wave transmitters in the early years. We believe that a service of local news and other programmes reflecting the interests of smaller self-contained communities will be of real value. Each local station will be free to develop its own characteristic programme in accordance with the wishes of the community it serves, and when not originating local material, the local stations will take their programmes from the main BBC networks.

The BBC has asked for the additional frequencies for this purpose. As you say, this problem is not an easy one, and moreover the success of the scheme will depend on the production of high-quality VHF receivers of all types at the right prices. Three-and-a-half million VHF receivers are already in use and our assessment is that the listening public is very satisfied with the service because of the excellent quality and the reduction in interference.

HAROLD BISHOP

Director of Engineering

London, W.1. British Broadcasting Corporation

Line Standards

I DO not know why Mr. Smye-Rumsby should, in the last paragraph of his letter published in your September issue, make the inaccurate statement that the low-frequency wired television systems do not provide a bandwidth of more than 2Mc/s. The bandwidth of these systems is well over that required for 405-line standards and can readily be extended to cater for 625 or even 819 lines if necessary. In general, the performance of these wired networks is maintained to standards which impose no limitation on the performance of the best television receivers, whether they be designed for operating from an aerial or from the wire.

R. P. GABRIEL,

London, S.W.1. Chief Engineer, Rediffusion Ltd.

IT is difficult to understand why Mr. Smye-Rumsby should make the rather sweeping statement that persons receiving their television signals via "I.F. Wired Systems" do not enjoy a bandwidth of more than 2Mc/s. Assuming that the transmission being received originally contains a full 3Mc/s bandwidth (and this is

by no means always the case) the signal degradation due to the receiving and amplifying equipment in the network is negligible in all systems that I know of even at distances of some 10 miles from the receiving point. Your readers might be interested to know that a large number of families in the London area using this method of reception now receive their transmissions via direct landlines throughout from the B.B.C. and I.T.A. with consequent improvement to the high frequency response of some transmissions. This improvement is clearly visible at the viewers' installations.

K. A. RUSSELL,

British Relay Wireless and Television, Ltd.

London, E.C.1.

IN discussing television line standards, we should bear in mind that the horizontal resolution of a 625-line picture, with 5Mc/s video bandwidth, is no greater than the horizontal resolution of a 405-line picture with 3Mc/s video bandwidth. However, the consensus of opinion nowadays is that we might as well change to 625 lines eventually, if only to pacify those who persist in believing that any increase in the number of lines automatically gives an improvement in picture quality.

The Television Advisory Committee's recommendation of a 5.5Mc/s video bandwidth makes rather strange reading. Paragraph 17 of the Committee's report recalls that, in the 1957/58 Band V Field Trials, the *overall* assessment of a 21-inch 625-line picture with 5Mc/s video bandwidth was not significantly better than the overall assessment of a 405-line picture of the same size—in spite of the fact that the observers noticed the reduced visibility of the scanning lines in the 625-line picture. The report goes on to say that the Technical Subcommittee at first took the view that a 625-line system with 6Mc/s video bandwidth would show a "definite superiority," but that they afterwards concluded that a 5.5Mc/s bandwidth could be used with "no loss in picture quality." In other words they are suggesting that a 0.5Mc/s increase in bandwidth from 5Mc/s to 5.5Mc/s would give a noticeable improvement, but that a 0.5Mc/s restriction from 6Mc/s to 5.5Mc/s would not cause any noticeable loss. Can it be that the Committee wished to avoid recommending standards which have been shown to offer no overall advantage over 405 lines, but at the same time they wished to avoid the political implications of recommending the standards which are used in Eastern Europe?

In your October issue, M. V. Heffernan suggests that, apart from the number of lines, the C.C.I.R. 625-line system is advantageous in that it uses f.m. sound and negative picture modulation. It is difficult to agree with this view, for the following reasons:

(1). The start of 625-line transmissions will be our only opportunity to lay down the best standards for a future compatible colour service. A.M. sound has been shown to have important advantages in minimizing interference with the colour picture, and positive picture modulation to have equally important advantages for the compatible monochrome picture.

(2). The one real advantage of f.m. for sound broadcasting is that it offers greater resistance to some types of interference. This is quite unimportant in television, as it is the picture signal which is always the first to be affected by interference, long before the a.m. sound—with only a quarter of the vision e.r.p.—has run into trouble.

(3). Another of the findings in the Band V Field Trials Report is that synchronizing is better with positive than with negative picture modulation. As this is one of the few instances where such a comparison has

been made on a statistically reliable basis, it seems reasonable to believe that this conclusion is correct.

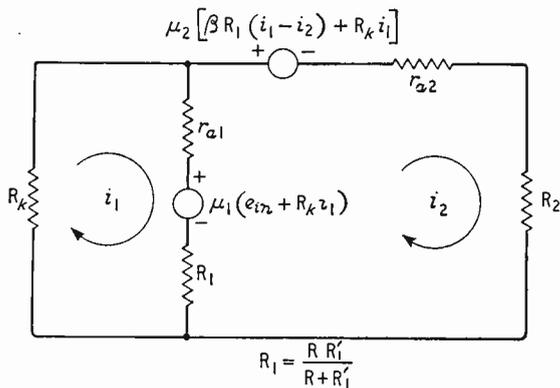
I therefore suggest that the evidence is in favour of using a 625-line system with a.m. sound and positive picture modulation. The exact video bandwidth is comparatively unimportant, as we shall not in any case be able to use the 7 Mc/s needed for equal horizontal and vertical resolution.

London, N.W.9.

CHARLES ROGERS.

Signal-flow Diagrams

I HAVE just been reading the excellent articles on signal-flow graphs by Thomas Roddam which appeared in the February and March issues. Ever since the publication of Mason's work in 1953 I have been trying to convince myself that the signal-flow graph method is quicker than conventional network analysis but have yet to find an example which yields more readily to analysis by the signal-flow graph method. In the March issue a lucid



account is given of the signal flow-graph analysis of a cathode-coupled limiter and it is stated that "the original circuit, as anyone who has ever carried out the solution by algebra knows, is by no means as simple as one might expect."

From Fig. 1 of that article we have at once the linear network representation shown below. The voltage equation is

$$\begin{bmatrix} r_{a1} + R_1 + R_k(1 + \mu_1) \\ R_k(\mu_2 - \mu_1) + \mu_2 \beta R_1 - (r_{a1} + R_1) \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} -1 \\ 1 \end{bmatrix} \mu_1 e_{in}$$

from which the response of the network can be obtained. In particular, for zero switching time (infinite gain), we require the determinant of the above resistance matrix to be zero. Thus

$$R_k(1 + \mu_1)(r_{a2} + R_2) + (r_{a1} + R_1)[r_{a2} + R_2 + R_k(1 + \mu_2)] - \beta \mu_2 R_1 R_k(1 + \mu_1) = 0$$

exactly as obtained by putting $t_i = 1$ in Mr. Roddam's result.

Again, therefore, I fail to see what is gained by using the signal-flow graph method. These remarks, are not meant to detract from Mr. Roddam's excellent articles but I infer from them that he has convinced himself of the superiority of the method. I am wondering if there is anything he might be good enough to say that will convince me.

S. R. DEARDS,

Department of Aircraft Electrical Engineering,
The College of Aeronautics.

Cranfield, Bucks.

The author replies:

Mr. S. R. Deards infers that I have convinced myself of the superiority of the signal-flow graph method, which

is false, and wonders if I can convince him, which is probably impossible. An examination of the literature, however, suggests that there is an increasing number of people who find the method convenient or attractive so that, like it or not, we must understand it.

The particular problem of the cathode-coupled limiter can be handled in at least four different ways. The traditional methods, using the mesh currents and solving the resulting equations by the piece-meal elimination of unwanted unknowns, is tedious and liable to error. It is, unfortunately, the only method which many engineers can understand. Mr. Deards writes down, dare I say with a flick of the wrist, the model matrix. My own choice, based on the habit of almost a quarter of a century, is to use the Streker-Feldkeller matrix approach to avoid the need for thought. Finally we have the s.-f. graph.

I can think of no justification for the first method except the laziness of those who can look forward to a lifetime of drudgery because they will not learn to use the tools of their trade. The nodal matrix is undoubtedly the most elegant and suffers only from the disadvantage that all one's eggs are, as it were, in one matrix. My own choice has very considerable advantages when much of one's time is spent on administration and interruptions are frequent; like knitting, one can take it up or leave it alone.

The signal-flow graph, another step-by-step method, has many of the advantages of the s.-f. matrix. In addition it will throw out without extra effort the conditions at test points. I suspect, however, that its chief virtue is that many people like graphical and quasi-graphical methods, even though they merely represent modern packaging for established algebra. We must hope that users of the s.-f. graph include some engineers who would otherwise have abandoned their problems altogether.

THOMAS RODDAM.

Deeper Amplitude Modulation

WITH reference to the letter from your correspondent M. Konopasek in the August issue, in which he accuses French a.m. stations of excessive sideband splatter, may I be allowed entirely to disagree with him, as far as medium waves are concerned. I also feel that his choice of the adjective "notorious" is singularly inaccurate inasmuch as the R.T.F. is meticulous in its observance of strict technical standards on medium waves.

As a resident in France for several years, I have long enjoyed excellent reception of Lisbon I (665 kc/s) without a whisper of sideband splatter from Rennes (674 kc/s); of the B.B.C. European Service (1340 kc/s) without QRM from the R.T.F. chain on 1349 kc/s; even of the Light Programme chain on 1214 kc/s, under good conditions, without excessive "splash" from the local 100-kw transmitter on 1205 kc/s. Note that there is a 9-kc/s separation between these channels. One could continue citing such examples. It is your correspondent's receiver, I think, not the R.T.F., which needs readjustment.

On the other hand, the R.T.F. 164 kc/s transmission on long wave is indeed much more deeply modulated, as several of your correspondents have indicated. This is for two reasons:—

(1) To overcome certain problems of coverage caused by the use, by day, of a relatively low-powered transmitter (250kW) and to try for a European coverage by night when power is doubled and when this station puts out programmes which are meant to be, and often are, of European interest.

(Continued on page 563)

(2) To overcome the QRM which is experienced, especially in Eastern France, from the famous V.o.A. transmitter on 173 kc/s (to say nothing of the jamming thereto attracted).

It is worth remarking that the sacrifice in quality which all this involves has been noticed by the average listener to the France I programme in this country, and is believed to be one of the contributory causes of the popularity here of dear old commercial Europe No. 1.

In conclusion, as a listener with many years' experience of the medium-wave broadcast band, I tender the opinion that the chief "muckers-up" (the French have a much more expressive verb than this) of this band are, certainly *not* the R.T.F., but the Spaniards and the East Germans with their nasty signals scattered where they cause the maximum of interference.

Bordeaux. GERARD A. CASEY

I AM horrified at the suggestion made by your correspondent W. Blanchard (June issue) that the B.B.C. should increase modulation levels on their medium- and long-wavelength transmissions.

Really excellent quality can frequently be obtained from these using ordinary receivers, although modification of detector, a.g.c. and output stages to reduce distortion is needed in many cases.

I find the distortion caused by clipping over-modulation extremely distressing, and obvious volume compression fatiguing to the ear, and am very grateful to the B.B.C. for their careful efforts in minimizing these. These efforts might well be extended to television sound, where heavy clipping is often painfully obvious even through all programmes in a series (e.g. "Look") or in a "celebrity" concert.

No; good quality transmission should be kept available on medium and long waves at least until transistor v.h.f. portables giving good reproduction are a commonplace and distortion due to multipath reception of f.m. has been abolished. If Mr. Blanchard wishes to fit additional filtering, clipping and volume compression circuits into his car radio he can, of course, do this for himself.

Malvern, Worcs. G. F. JOHNSON.

The Genius of A. D. Blumlein

EVER since I began to take an interest in the origins of the waveform techniques that I and many other engineers use and almost take for granted, I have been learning how very many of them are due to A. D. Blumlein. I was therefore extremely interested in the article in September's issue on this great circuit engineer and in the description of his contributions to the whole field of electronics. While many of those relating to waveform manipulating circuits have passed into general use, a study of some of his patents shows that many useful techniques are still little known. For example, his patents^{1,2} on the long-term pair envisaged

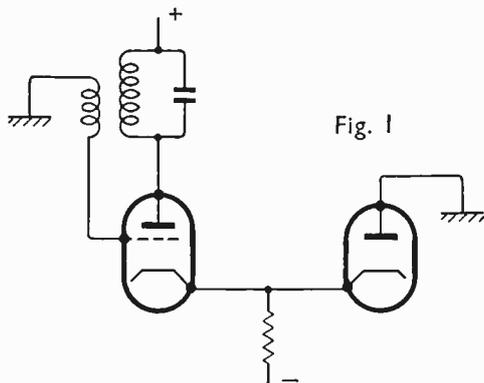


Fig. 1

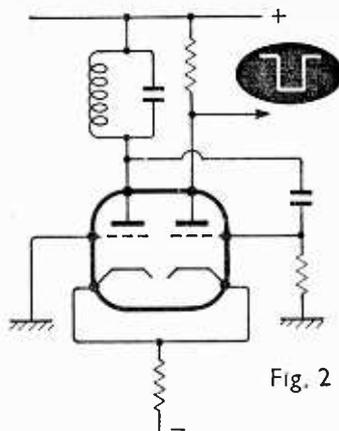


Fig. 2

much more than the use of the circuit as a phase splitter or as an amplifier with discrimination against push-push signals.

Circuits are described which use a "pair" as a "switch" actuated by the differential grid voltage. Cross-coupled neutralizing capacitors for sharpening the pulse outputs are also shown, and this application of positive feedback from the "switch" outputs to the controlling grid circuits clearly foreshadows a whole family of multivibrators, oscillators, trigger circuits and so on,^{3,4,5} based on this circuit and which are readily "designable."

The controlled-amplitude oscillator Mr. Scroggie mentions is a good example of a designable circuit using this principle. If the circuit is redrawn, Fig. 1, for use with a negative supply line its long-tailed-pair characteristics are more obvious. If a complete pair, Fig. 2, is used the phase-reversing inductive coupling can be dispensed with, and an approximately square output waveshape also obtained.

These circuits, and transistor developments of them, have many valuable features and are particularly useful in the higher audio and ultrasonic frequency range.

Newcastle-upon-Tyne. R. FOSS,
Department of Electrical Engineering,
University of Durham.

REFERENCES:

- ¹ British Patent 482,740.
- ² " " 514,065.
- ³ " " 535,778.
- ⁴ " " 540,941.
- ⁵ Newman, E. A.; Clayden, D. O.; Wright, M. H. "The Mercury Delay Line Storage System of the ACE Pilot Model Electronic Computer." *Proc. I.E.E.*, 1953, Vol. 100, Pt. 2, p. 445.

QUIZ

DO you know the address to which one applies for a U.K. transmitting licence?

The full title and address of the I.U.P.A.P.?

What frequencies were allocated at the Geneva Conference for ionospheric and tropospheric scatter?

In what section of the spectrum X-band radar operates?

The relationship between m.k.s. and c.g.s. units?

The length of a dipole for a Band II aerial?

The colour code for a 150-mA fuse?

You will find the answers to all these questions in the 1961 *Wireless World* Diary. In addition to the week-at-an-opening diary pages it includes the usual 80-page reference section giving in tabloid form much of the technical and general information one so often needs but is so seldom readily available. It costs 6s 9d (leather) or 4s 9d (Rexine), including purchase tax. Overseas prices are respectively 5s 9d and 4s. Postage 4d. s1961

ITALIAN NATIONAL RADIO SHOW

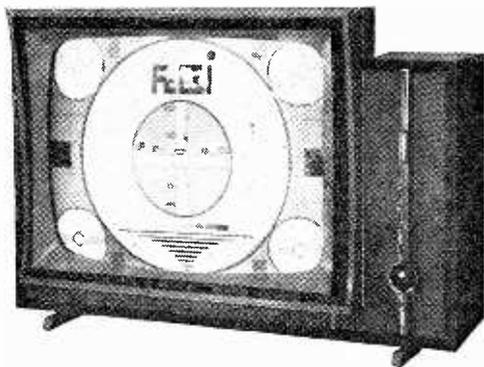
Characteristic Features of Design in Domestic Receivers

HELD at the Palazzo dello Sport, Milan, from September 10th until 19th, the 26th Italian National Radio Show included a component "salon" comprising in all nearly 200 stands. The output of the Italian industry for 1959 was worth about 100,000M lire (some £57.5M sterling), an increase in five years of 35% and the fact that in Turin—a relatively prosperous industrial community—only one family in five has a television receiver—may be taken as a pointer for future growth, although it is only fair to note that in Naples, poor by Turin's standards, one family in three has a receiver. At the moment, there is only one television programme network in Italy, using, because of the many stations, all of Bands I and III for its 625-line narrow-bandwidth service. A second service is due to start next year in Milan in the u.h.f. bands: already a few u.h.f. aerials have made their appearance on the Milan skyline.

On the Radiotelevisione Italiana (R.A.I.) stand a series of panels emphasized the potentialities of sound broadcasting, giving particular reference to f.m. with which very good coverage is given by (on the last day that we visited the show!) 795 transmitters. According to these panels, 5M families do not have a radio receiver, but of these 2M are in a position to buy one "tomorrow." The R.A.I.'s 26,700 hours of home sound broadcasting in four programmes (rather similar to our Home, Light, Third and Network Three) in 1959 compares well with the B.B.C.'s 20,000 or so hours.

Perhaps the most noticeable feature of the television receivers was provision for u.h.f. reception, usually by a second tuner unit and control knob. A fair variety of u.h.f. tuners was found: in the main these use at least a crystal mixer and valve oscillator, and at most a three-valve r.f.-mixer-oscillator line up. This practice of providing circuits capable of better performance than that of the simplest possible arrangement seemed to be fairly general practice, in spite of the fact that many centres of dense population must be in transmitter "swamp" areas. For instance, the number of valves in a receiver is usually 18 to 22 explaining, no doubt, the good reproduction of pictures from the Swiss transmitter in the Ticino, without, as far as the eye could see, anything too esoteric in the way of aerials on the roof of the exhibition hall. Many of the receivers without a.f.c. (which was the rule rather than the exception on sets with motor-driven tuners for remote control) had magic-eye tuning indicators.

Receiver power supplies are something of a problem because in Italy many of the mains supplies are in the region of 150 or 160V—too high for convenient voltage-doubling, as is American practice with the 117-V line, and too low for direct rectification as is common in 200 to 250-V countries. In the simplest arrangement an auto-transformer is used to supply a half-wave rectifier and a series heater chain; but other forms include an "overwind" for full-wave rectification and employ parallel-connected heater circuits. Mains-voltage regula-

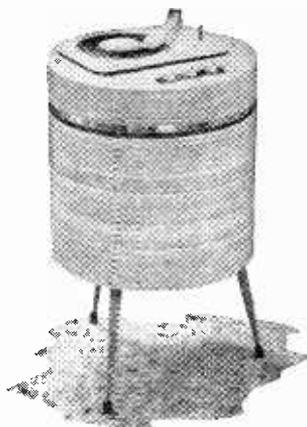


In the 23-in Voxson TV receiver (left) the c.r.t. extends just beyond the confines of the box, but familiar chassis construction is used. The Philco 19-in model (below left) has the major part of the chassis flat, in the lower part of the "box." A step further is to enclose the tube in a protective shell: the 19-in c.r.t. of the Atlantic TV-radio-gram shown (below) is raised from the cabinet by a motor drive: table models by Philco and Phonola have a flat chassis in a box below the pedestal, whilst Atlantic have a set with the c.r.t. on top of a floor-standing pedestal.

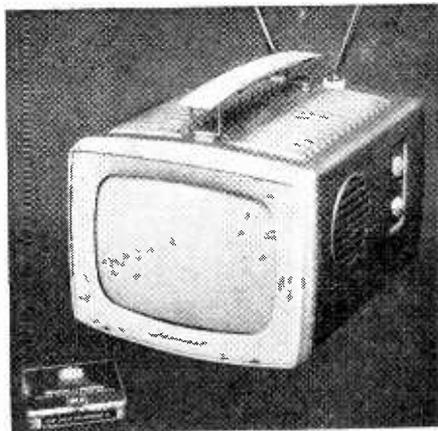




Radio Allocchio Bacchini: small table radiogram to which legs can be fitted.



Framez "Modern Juke-Box" gramophone.



7-in portable television receiver by Irradio, with cigarette packet for scale.

tors were found in various forms as a separate unit, built into a "television table," or even disguised as a trough of flowers or a large book (Corghi).

Naturally, some new ideas on styling would be expected in a country such as Italy, and certainly an effort has been made to get away from the ubiquitous "box" round the c.r.t. Some models house the c.r.t. in a plastics moulding which is mounted on top of a flat case or a pedestal containing the chassis, and another approach is to allow the cabinet to reflect to a greater extent than is normal in Great Britain the shape of the c.r.t., whilst keeping the receiver as one unit. C.r.t. sizes seem fairly evenly distributed between "large" (21 and 23-in) and "medium" (17 and 19-in). The smallest set in the show, and probably the cheapest, was an Irradio portable receiver using a 7-in c.r.t. and priced at about £52 sterling, but even this had a full complement of 21 valves.

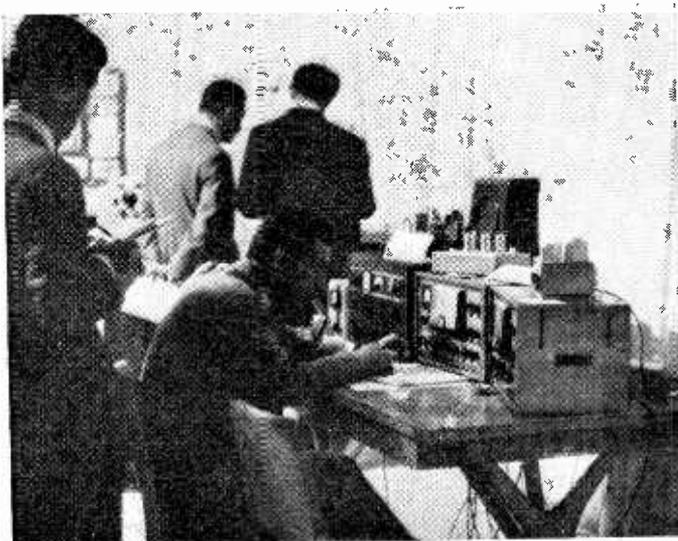
Some projection receivers were seen, one (Prestal) looking something like a radiogram. The screen is on the inside of the top lid, whilst an L-shaped section carrying a mirror folds down from the front of the set so that the light from the projection unit, which faces the viewer, is reflected back to the screen, the path being several feet long. Other projection receivers treat the unit very much as a piece of apparatus like a cine-projector, rather than as an item of furniture: they thus roughly resemble a streamlined oscilloscope on a tripod or pedestal support.

Few transistor receivers were on show, and we found transistor v.h.f. sets a distinct rarity. The Geloso portable m.w. and f.m. "Sideral" employs nine transistors and four diodes. It has a "V" aerial and the power supply is four 1.5V cells. Sockets provide for output to an earpiece and tape recorder. Valve receivers with v.h.f./f.m. facilities often have tuning ranges covering the television sound channels (also f.m.). Usually the buyer has the choice of two models—one covering Band I, and the other Band III.

A record player—the Framez "Modern Juke-Box" which was seen on several firms' stands—has the interesting construction of a drum-shaped bass reflex chamber with the turntable and amplifier mounted on top. A transparent cover excludes dust when not in use. Small table radiogramophones are popular and the radio section invariably has a comprehensive specification, often having f.m., bandspread s.w. and m.w. facilities.

Test gear exhibits in the components section covered the whole range of equipment for developing and testing receivers, and two firms—L.A.E.L. and T.E.S.—were showing monoscope test-card generators. An impression gained here was that there is great interest in communal aerial systems for TV: this is natural enough as most of the new domestic building in towns is large blocks of flats. Valves and c.r.t.s were included in the displays, both 19-in and 23-in rectangular-cornered c.r.t.s. with "ears" for ease of mounting in the cabinet were on show.

Finally, the Associazione Radiotecnica Italiana (the contemporary of the R.S.G.B.) had a stand with an operating 50-W station (call sign IARI) and a display of equipment both "ancient" (1926 onwards) and modern.



50-W amateur radio station IARI was manned throughout the exhibition.

Communication via Satellites

NEW STATION FOR EXPERIMENTS WITH REFLECTED SIGNALS

By MICHAEL LORANT

AN experimental radio station has been built in the U.S.A. by Bell Telephone Laboratories at Crawford Hill, Holmdel, New Jersey, for tests on the long-distance transmission of radio signals by reflection from artificial satellites of the earth. This may point the way to a whole network of radio terminals for sending telephone messages and television programmes to distant parts of the world. The stations would "bounce" radio signals off dozens of artificial satellites acting as "sky mirrors," and would include facilities for communication experiments with objects in outer space. One of the uses of the Holmdel installation will be to take part in communication projects sponsored by the U.S. National Aeronautics and Space Administration.

One of the projects will test the quality of radio signals transmitted between stations on opposite sides of the United States by means of satellite reflections. Although single telephone channels will be used in the experiment, the objective is to determine whether wide-band television signals could also be transmitted. The microwave radio signals to be used in the experiment will be analysed to obtain information about transmission effects. The data will also be studied to discover the reflection characteristics of satellites in orbit.

The signals will be received and transmitted between a tracking station of the U.S. National Aeronautics and Space Administration, at Goldstone, California, and Bell Laboratories, which are some 2,300 miles apart.

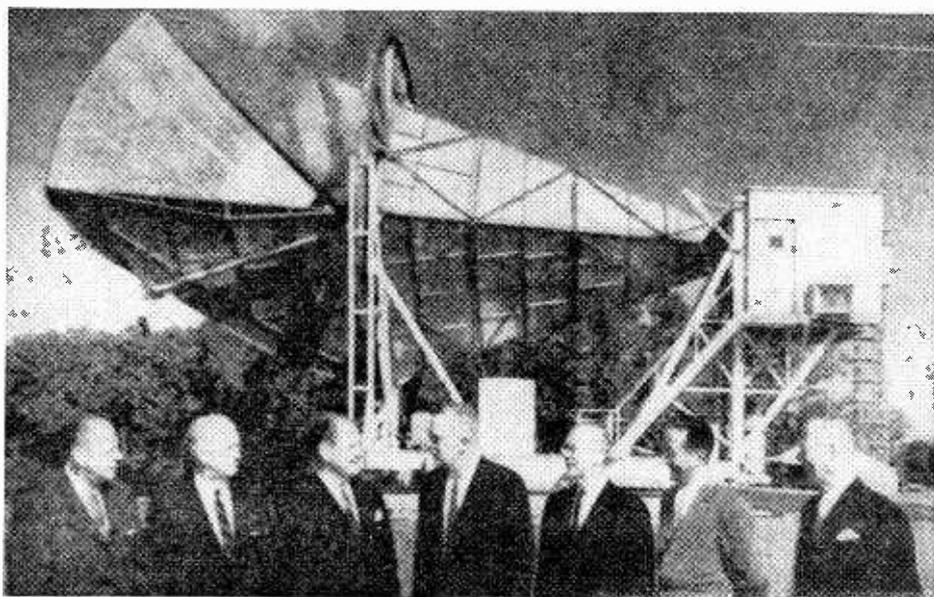
The Holmdel installation includes a commercially

available dish aerial to transmit signals, and a highly directional horn-type aerial for the receiver. The last-mentioned has been designed by Bell Laboratories and is a large version, adapted for tracking, of a horn-reflector aerial which was developed some years ago at Holmdel for radio relay use in the Bell System. It is about 50ft long and the aperture measures about 20ft by 20ft. In conjunction with the horn, a highly sensitive receiver is required. This utilizes extremely low-noise amplifiers, either a pair of parametric amplifiers or masers, or a combination of one of each.

One of the initial and crucial problems in these experiments will be the precise tracking of satellites, and for this purpose Bell Laboratories will devise its own special equipment. Data predicting the "passes" of satellites will arrive in coded form and the new equipment will rapidly convert the information into a form suitable for controlling the aeri-als.

The first proposal for a system of satellite communications was made in *Wireless World* in 1945 by A. C. Clarke.* In 1955 Dr. John R. Pierce, Director of Communications Research at Bell Laboratories, proposed a system of passive satellite relays. Since then Bell Laboratories have been developing many of the devices required for the tests. A discussion on the general problems of communication by satellites, by R. J. Hitchcock, appeared in the April, 1960, issue of *Wireless World*

* "Extra-Terrestrial Relays," by Arthur C. Clarke, *Wireless World*, October 1945.



Members of the Federal Communications Commission with T. Keith Glennan, administrator of the National Aeronautics and Space Administration, on a visit to the Holmdel station. This untouched picture of the Bell Telephone Laboratories receiver horn was transmitted by reflection from the Echo satellite.

k —and why it is 1.38×10^{-23}

By "CATHODE RAY"

FROM the number and variety of places where *k* crops up, one would guess that it is something important and fundamental. I mean, not counting the times when textbook writers and the like choose *k* to represent any constant. The *k* we are after just now is the particular constant associated with the name of Boltzmann.

So far as electronics is concerned, I suppose most people come across it first in connection with noise—the variety called Johnson noise, which is due to the random movements of electrons in resistive parts of circuits. The formula is so simple that it is handed out at quite an elementary stage of the subject: maximum noise power received from any resistance at absolute temperature *T*, within the frequency band *B* c/s, is *kTB*. But even advanced books

deduce without much of a struggle that *kT* denotes a very small amount of energy. Putting the various contexts together, we might guess that it is the energy of an electron at temperature *T*. But the energy of an electron can be vastly increased by accelerating it with a high voltage without raising its temperature—or does it? How does one know the temperature of an electron other than by its velocity? And, if so, is temperature relative, in the Einstein sense?

In my schooldays (just after Tom Brown's) we were taught the laws of Boyle and Charles, which together led to the conclusion that the product of pressure and volume of a given mass of gas was directly proportional to its absolute temperature:

$$PV \propto T$$

This, it was admitted, was strictly true only of a fictitious "perfect" or "ideal" gas, but was shown to apply to ordinary air within the rather considerable latitude of school experimental error. (No; you haven't turned over two pages by mistake—this is still "*k*," by "Cathode Ray". Have patience.) The thing can of course be converted into an equation by prefixing *T* with the appropriate constant, the magnitude of which obviously depends on the mass of gas that is given. It is usual to choose a number of grams equal to the molecular weight of the gas in question, this quantity being called the gram-molecular weight or mole. The point of this choice is that if you weigh the same volume of different gases at the same pressure you find that the weights are proportional to the molecular weights; therefore the number of molecules therein is the same for every gas (Avogadro's law). In one mole there are (so I am told) 6.03×10^{23} . This number is often denoted by *N*. And the constant (*PV/T*) appropriate to a mole of gas is denoted by the letter *R*, making the equation $PV = RT$. In m.k.s. units (except for the grams making a mole) *R* is 8.32.

We are now approaching the punch line. Remember, the constant connecting $P \times V$ with *T* for 6.03×10^{23} molecules is *R*. The corresponding constant for one molecule is *k*. So $k = R/N$.

You don't quite see the connection between this and noise, semiconductors, or thermionic emission? No, I hoped you wouldn't because if you did you ought to be writing this rather than reading it. So let's press on.

For a start, this definition makes *k* look absurd. Gas molecules can only have pressure and volume (and temperature?) when there are lots of them. In this scientific era every schoolboy presumably knows that the pressure of a gas is due to the impact of its countless molecules against the walls of the container, and that most of its volume is really empty space. In fact, the simple gas law we are considering only applies when the molecules themselves fill a negligible part of the volume. If they are crammed close together by very high pressure, $PV = RT$ is not even

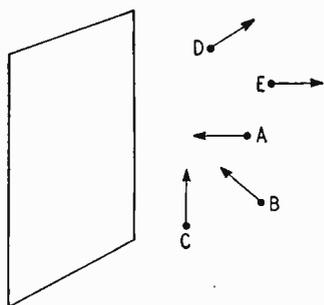


Fig. 1. Of the five molecules shown, only A will hit the surface at right angles. B will hit it at 45°, and the others not at all until they have rebounded elsewhere.

confine their information on *k* to the statement that it is Boltzmann's constant, equal to 1.38×10^{-23} joules per degree.

The next appearance is likely to be quite a bit farther on, when we are learning why semiconductors conduct so much more at a slightly higher temperature, in contrast to metals, which conduct slightly less. Any formulae at all in connection with this

inevitably include a term such as $\exp\left(\frac{E - E_f}{kT}\right)$.

Either before or after this we shall have been informed about emission from valve cathodes, in

which case the remarkably similar expression $\exp\frac{\phi}{kT}$

may have been brought to our notice.

The more we study these subjects, the more we see of *k*. But we are unlikely to be told any more about what *k* is and why. Well, I suppose it is human nature for curiosity to be aroused in proportion to reluctance to impart information, and I wanted to know.

Looking at what we already have, we note that *k* and *T* seem inseparable, and since the more talkative of the authorities go so far as to tell us that *k* is reckoned in joules per degree of temperature we

approximately true. So in relation to the thing for which it is defined k doesn't seem to make sense, and to the things where it might make sense it doesn't seem to have any relationship. What have noise, etc., to do with ideal gases? To find the missing link we shall have to inquire deeper.

First the apparently irrelevant ideal gas. Anyone who is unfamiliar with the details can look them up in a physics book under the heading "Kinetic Theory of Gases." It is usually given some prominence, partly because of its fundamental importance—being connected with so much else, such as the things we are aiming at—and partly because it makes an excellent exercise in the application of still more basic principles, such as Newton's second law of motion.

According to that, force is equal to mass times acceleration. Or, now that mass is no longer assumed to be unalterably constant, the law is often put in the more general form "force equals rate of change of momentum," momentum being mass

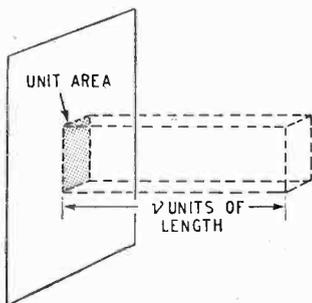


Fig. 2. If all the molecules were moving straight towards the surface with velocity v , all those within the dotted zone (volume, v units) would hit the unit area in one second.

times velocity. When, as is reasonable for most purposes, the mass is regarded as constant, the two statements come to the same thing.

Pressure is force per unit area, and in this case is due to the impacts of gas molecules. It is assumed that they rebound with the same velocity with which they strike the surface, so their change of momentum is twice the momentum with which they approach the surface. If we had to consider individual molecules we would stick at that point, because we wouldn't know the rate of change. But fortunately there are such vast numbers of them that their separate impacts merge into an almost steady pressure. All we need know is the number of hits on unit area per second, and of course their velocities. The mass of a molecule of the kind of gas concerned can be looked up in a table.

The difficulty, of course, is that even if we could assume that all the molecules had the same velocity in the direction of their flight (and as it happens we can't) the components of their velocities towards any surface would vary from a maximum (say v) for those approaching directly at right angles, down to zero for those travelling parallel to it. And at any given moment a lot of them are moving away. For instance, molecule A in Fig. 1 will hit the surface full in the face, and its original velocity will thereby be altered from v to $-v$, so the change of velocity will be $2v$. Molecule B will strike at an angle of 45° , so its velocity towards the target will be $0.707v$ and the change correspondingly less. Molecules C, D and E will not hit at all on that transit, but only after impacts with other surfaces or molecules.

We can easily find by experiment that gas pressure in a closed space with no draughts is the same in all directions, and conclude that at every moment equal numbers of molecules are moving in all directions. When the effect of this has been calculated, it is found that the result is equivalent to one-sixth as many molecules all moving directly towards the surface. The number hitting unit area in one second in this way is equal to the number contained in v units of volume, as shown in Fig. 2. If N is the total actual number in the whole space, and V its volume, the number of impacts per second is therefore $\frac{1}{6}v N/V$. The change of momentum is this number multiplied by the mass of each molecule and twice its velocity. So the pressure is

$$P = \frac{1}{6}v \frac{N}{V} m 2v$$

$$\text{or } PV = \frac{1}{3}Nmv^2$$

Although, as I have just said, the velocities of the molecules are not all the same, we know by experience that the pressure is practically constant—so long, at least, as the area on which it is exerted is not very small. So evidently the average of v^2 (which will probably sound more familiar as the mean-square value) is similarly constant. The usual way of indicating that the average is meant is to write it \bar{v}^2 .

The equation can be rearranged slightly:

$$PV = \frac{2}{3}N(\frac{1}{2}m\bar{v}^2)$$

The point of doing this is to make a separate factor of $\frac{1}{2}mv^2$, which should be recognizable as a kinetic energy, in this case obviously of any molecule.

Earlier on we chose a mole of gas as a convenient quantity, and now we shall regard V and N as applying to the same quantity. And as we already know that for this quantity $PV = RT$ we can conclude that

$$\frac{2}{3}N(\frac{1}{2}m\bar{v}^2) = RT$$

$$\text{or } \frac{2}{3}(\frac{1}{2}mv^2) = \frac{R}{N} T$$

And as k is defined as R/N we arrive at

$$\frac{2}{3}(\frac{1}{2}mv^2) = kT$$

So here is our k in association with T , and we have found that this ubiquitous combination is two-thirds of the mean kinetic energy of a molecule of an ideal gas.

The $\frac{2}{3}$ comes into the picture because a molecule of gas has three "degrees of freedom," but that is hardly significant enough for our purpose to take up our time just now.

A much more important point is that the mean k.e. of each molecule—and therefore of the gas as a whole—depends on only one thing: temperature, being directly proportional to it. So the heat of a gas is simply the kinetic energy of its particles.* That is why this subject may be alternatively called the Kinetic Theory of Heat.

We see, then, that k is the constant connecting the kinetic energy of gas molecules with their temperature. So although pressure and volume are meaningless when referred to a single molecule, the fraction of R applicable to a single molecule connects temperature with its kinetic energy, which

* Some authorities have taken to drawing a distinction between random molecular energy derived from a hotter body (which they call heat) and that from mechanical work (which they don't), but this is rather too subtle for our present purpose.

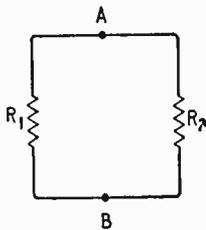


Fig. 3. When two resistors are connected as shown, each feeds the other with Johnson noise power.

en masse, is the cause of the pressure and occupies the volume. And although I can't think of any way of measuring the temperature of a single molecule, it is a tempting idea to calculate it as $\frac{1}{2}m\bar{v}^2/k$. However, because its velocity is varying all the time, authority has declared the concept to be meaningless.

In working out the kinetic theory we made several assumptions, not all of which have been explicitly mentioned. We did say that the presence of molecules mustn't reduce the amount of free space appreciably; in other words, the gas mustn't be too highly compressed. Another thing: there must be no appreciable attraction between the molecules. This assumption also would be unjustified if the gas were very compressed. And it is assumed that the effects of gravity are negligible. This would of course not be true of the air in a mine shaft, where gravity causes the pressure to be very appreciably greater at the bottom than at the top; but it is near enough in a room.

Subject to these, however, we put no restrictions on the size or mass of the molecules. We didn't even say they had to be molecules. In fact, the equation arrived at applies just as much to grains of dust floating about in the gas. They are of course enormously heavier than the molecules, so their mean random velocities for the same kinetic energy per particle are much less. The interesting thing about this is that they and their random (Brownian) movements can be seen and measured through a microscope, and so the theory can be checked by experiment, as was done in the classic experiments by Perrin†. The said random movements of the grains are caused by the molecules bashing into them. Because the grains are so small there are appreciable fluctuating inequalities in the numbers hitting them on each side. These can be regarded as minute differences in pressure, and it is an interesting fact that if the human sense of hearing were a little more sensitive than it is these variations would be audible‡. So here is a connection between k and literal noise.

The kinetic theory being true for larger particles than molecules, it is reasonable to expect it to be true for smaller ones, such as electrons. But it might seem to be pushing our luck too far to apply it to the electrons roaming around inside solids. For one thing, we would expect solid material to be too cluttered up to be regarded as an ideal gas! And the rule about forces between the particles being negligible certainly seems to be right out, for mutual electrical repulsion between electrons is relatively enormous.

Yet physicists did dare to try assuming that the free electrons in solids behaved like an ideal gas, and the results were so helpful that with considerable

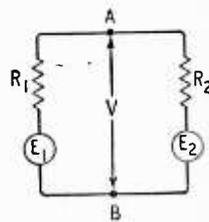
modifications this supposition is still the basis for modern theories about the solid state. The reason why the negative electrical charges of the electrons don't completely upset the thing is that they are exactly neutralized by the positive charges of the remaining parts of the atoms, distributed evenly amongst them. And although solids look solid, electrons are so exceedingly small that they find plenty of empty space to circulate in. Since Johnson noise is the result of precisely these random movements of electrons in solids, the presence of kT in the basic formula now ceases to surprise.

What does surprise one about the formula for noise power— kTB —is that it says nothing about the number of electrons. At first thought one would have expected—I would, anyway—that the noise created by electrons would depend on how many of them there were. The noise created by a disorderly mob increases with the number of people in it. But then that is noise in the everyday sense; not Johnson "noise," which is a fluctuating electric current. Certainly a very bulky resistor has more random electron movement going on inside it than a small one, but the only thing that matters from a practical point of view is the effect at the terminals. If this were in any sort of proportion to the number of electrons, then if the whole earth as one resistor were connected to a subminiature resistor we would expect the latter to be just about burned out by the noise power it received, which would so much exceed what it could feed into the earth! But we find by experiment that resistors of the same value produce the same noise at their terminals, regardless of their size.

If it were not so, it would not only be contrary to the calculation that kTB is the maximum noise power, but contrary to the general principle known as the second law of thermodynamics, which says that when two bodies are placed in contact there cannot be a flow of random energy from one to the other unless the receiver of energy is at a lower temperature than the giver.

You may have noticed that I referred to "resistors of the same value" and wondered what that had to

Fig. 4. The noise voltage V between the terminals of the resistors is assumed to be the combined result of two noise e.m.f.s, E_1 and E_2 , in the resistors. If calculations are correct, V must clearly be equal to the open-circuit noise voltage of a single resistor equivalent to R_1 and R_2 in parallel.



do with it, since kTB says nothing about resistance. That is because it is the maximum available noise power, and in accordance with the well-known matching law the maximum power is received from a generator when the resistance of the load is equal to that of the generator. If two resistors are connected together as in Fig. 3, R_1 generates noise energy which it feeds to R_2 . At the same time R_2 is a noise generator feeding R_1 . Assuming they are both at the same temperature, the two powers must be equal, so there is no net transfer from one to the other. But the maximum (kTB) flows each way only when $R_1 = R_2$.

What one is usually interested in is the noise

† "Atoms" by Jean Perrin (Constable).
 ‡ According to Stevens and Davis ("Hearing," p. 57) the threshold of normal hearing is about 10dB above this natural noise, but exceptionally acute hearing goes down almost to the same level as the noise.

voltage between the terminals A and B. It can be assumed to be due to noise e.m.f.s E_1 and E_2 in series with R_1 and R_2 , as in Fig. 4. Then the voltage between A and B due to E_1 (call it V_1) is $\frac{E_1 R_2}{R_1 + R_2}$, and the power fed into R_2 thereby is that voltage squared, divided by R_2 . It is a maximum (kTB) when $R_2 = R_1$

$$\left(\frac{E_1 R_1}{2R_1}\right)^2 / R_1 = \frac{E_1^2}{4R_1} = kTB$$

$$\therefore E_1 = \sqrt{4R_1 kTB}$$

Similarly $E_2 = \sqrt{4R_2 kTB}$

Now the total noise voltage (V) between A and B, due to *any* resistances R_1 and R_2 , is not simply $V_1 + V_2$, because V_1 and V_2 are not in phase; they are random. But the powers due to them are equal, so

$$\begin{aligned} V^2 &= V_1^2 + V_2^2 \\ &= \left(\frac{E_1 R_2}{R_1 + R_2}\right)^2 + \left(\frac{E_2 R_1}{R_1 + R_2}\right)^2 \\ &= \frac{4 kTB (R_1 R_2^2 + R_2 R_1^2)}{(R_1 + R_2)^2} \\ &= \frac{4 kTB R_1 R_2}{R_1 + R_2} \end{aligned}$$

Since $R_1 R_2 / (R_1 + R_2)$ is the resistance of R_1 and R_2 in parallel, which we can call R , we have found that

$$V = \sqrt{4 kTB R}$$

This is as it should be, for $\sqrt{4 kTB R}$ is the noise e.m.f. of a resistance R , and therefore its open-circuit voltage.

One factor in this formula (and in the one for noise power too) may arouse some questioning—B, the frequency band. If one had a pure resistance, without any filter or tuning circuit to limit the bandwidth of the noise voltage at its terminals, the formula might seem to be saying that the noise power and voltage would be infinitely large. Which would be absurd in any case, but especially so of a power that we know never exceeds a very small fraction of a microwatt. The explanation is that even an isolated resistor has some self capacitance, and even if there were nothing more it would be enough to limit noise power to a very small amount, as can be found by trying some actual values.

One can, in fact, arrive at a still simpler formula by considering a resistor and a capacitor in parallel. If (as we assume for simplicity) the capacitor itself has no resistance, so that electrically it is a pure reactance, it cannot be the source of any noise, and one can calculate the noise voltage across the common terminals of the resistor and capacitor over an unlimited frequency band. I did this in the June 1956 issue, p. 270, and it came down to the delightfully simple result

$$V^2 = \frac{kT}{C}$$

Even the resistance goes out! This may surprise us; but Prof. E. B. Moullin in his book "Spontaneous Fluctuations of Voltage" pointed out that the capacitor stores the fluctuating noise energy generated

by the resistor. The well-known formula for the energy stored by a capacitor is $CV^2/2$. The energy $kT/2$ per degree of freedom which we found is possessed by particles of *any size* in a gas has been discovered to be a general principle of very wide application. Applying it to our capacitor, which has one degree of freedom as regards voltage, by equating its energy to $kT/2$, we get

$$\frac{CV^2}{2} = \frac{kT}{2}$$

$$\text{or } V^2 = \frac{kT}{C}$$

as before. Moullin used this line of thought to find the value of k by experiment.

k in Valves and Transistors

That is all very elementary algebra, but I'm afraid that derivation of the formulae for emission from cathodes and the currents in semiconductors is so far beyond what would be tolerated here that even fairly advanced books on electronics dodge it by referring readers to still more recondite works. The kernel of all such formulae is $\exp(x/kT)$, which means e to the power x/kT (for convenience in printing) or, if you insist,

$$e^{\frac{x}{kT}}$$

where x is a quantity of energy appropriate to the particular problem. In emission, for example, it is the quantity usually denoted by ϕ and called the work function, being the amount of work that an electron has to do to escape from the metal concerned. So it needs that amount of energy or more. The index of e , then, is the ratio between a certain fixed energy and the average energy of electrons at temperature T . ϕ is usually reckoned in electron-volts, so k must be in the same units. Our previous value, 1.38×10^{-23} , is in joules/deg., and a joule is a coulomb-volt, and one electron has a charge of 1.6×10^{-19} coulomb, so k in electron-volts/deg. is $1.38 \times 10^{-23} / 1.6 \times 10^{-19} = 8.6 \times 10^{-5}$. ϕ ranges from about 1.8 to 5.5 according to the metal, so for any reasonable temperature ϕ/kT is a fairly large quantity, and $\exp(\phi/kT)$ much larger. The emitted current is inversely proportional to it. But the important point is that a comparatively small change in the index of an exponential function (yes; that is what it is) makes a lot of difference.

Suppose the metal is tungsten, for which ϕ is 4.5, heated to 3,000°K. Then ϕ/kT is 17.4, and e to that power is 75 million. Now suppose the temperature of the emitter falls by 10%, to 2,700°K. The exponential consequently rises to 613 million—a 716% change.

The same sort of relationship applies to the "intrinsic" current in semiconductors, such as the uncontrolled current in transistors, usually designated I_{c0} . That is why I_{c0} rises so steeply with temperature, and special precautions have to be taken in power stages to prevent thermal runaway. Instead of ϕ there is the "energy gap," which is about 0.7eV for germanium and 1.2eV for silicon. That may seem a small difference, but in an exponential function it has a very considerable effect. And so I_{c0} is very much less in silicon transistors than in germanium.

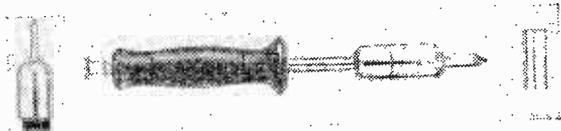
Manufacturers' Products

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Chemically-heated Soldering Iron

SOLDERING out-of-doors, even when an electricity supply is available, is not the easiest of tasks. Recourse usually has to be made to a blowlamp, which could be an unwelcome addition to the general paraphernalia of, for instance, the radio amateur on a field day.

The Jenolite "Quik-shot" soldering iron should prove useful in such circumstances because not only is its bit



Quik-shot iron with $\frac{5}{8}$ -in bit fitted. Also shown are 10,000-calorie heating cartridge and $\frac{3}{8}$ -in bit.

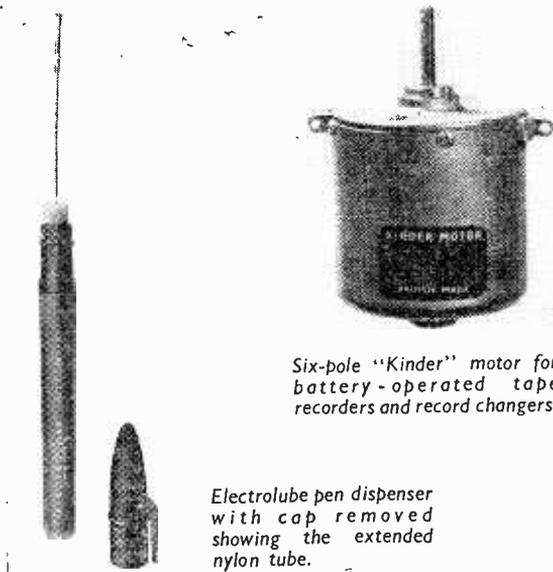
temperature about 460°C, but also it is heated by an exothermic chemical reaction, the materials for which are contained within a cartridge.

In use the bit is unscrewed and a cartridge inserted. After replacing the bit the reaction is started by releasing a firing plunger mechanism contained in the handle, when the cartridge heats the bit to working temperature in a few seconds. Then the iron remains at soldering temperature for several minutes.

Five bits, ranging upwards in size from $\frac{3}{8}$ in diameter, are available for the "Quik-shot" and the cartridges are stated to be non-explosive and non-inflammable. Manufacturers: Engineering Supplies Division, Jenolite, Ltd., 13-17, Rathbone Street, London, W.1.

Switch Lubricant Pocket Dispenser

A CONVENIENT pocket-sized dispenser for applying Electrolube switch cleaner and lubricant economically to normally inaccessible parts has been introduced by



Electrolube pen dispenser with cap removed showing the extended nylon tube.

Electrolube Ltd., Oxford Avenue, Trading Estate, Slough, Bucks.

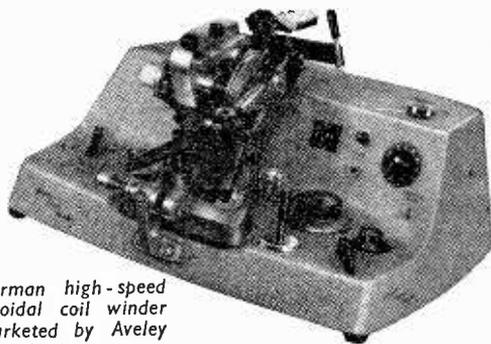
A sharp pull on the fountain-pen type cap releases a thin 3-in long flexible tube and controlled drops of lubricant can then be applied exactly where required by squeezing the flexible body of the pen reservoir.

Electrolube is claimed to loosen tarnish and corrosion providing clean contacting surfaces and thus effectively reducing contact resistance in all types of switches, socketry and valve holders to mention a few items only.

Two forms of the lubricant are available in the pen-type dispenser; No. 1 is for most electronic applications where there is no arcing at the contact surfaces and its container has a green-coloured cap. No. 2 is for use on electrical contacts where arcing is liable to occur in normal operation and its container has a red-coloured cap. Electrolube is available only to electrical and electronics industry personnel and distribution is through recognised trade channels. No. 1 pen dispenser costs 10s and No. 2 dispenser 12s.

Toroidal Coil Winder

SHOWN in the illustration is the Gorman Model 600 high-speed toroidal coil-winding machine recently made available in the U.K. by Aveley Electric. It winds at any pre-set speed up to 1,200 turns per minute with wires of between No.27 s.w.g. and No.48 s.w.g. inclusive, and accommodates cores up to 2in outside diameter.



Gorman high-speed toroidal coil winder marketed by Aveley Electric.

Winding can be carried out over the full 360° of the toroid or over any lesser angle as required. An electronic transistorized turns counter is embodied but provision is made for attachment of an alternative type of counter which stops the machine after any pre-determined number of turns has been completed.

Further details are obtainable from Aveley Electric Ltd., Aveley Industrial Estate, South Ockendon, Essex.

Small D.C. Motor

DESIGNED to meet the requirements of manufacturers of battery-operated record players, record changers and tape recorders, the "Kinder" range of 3-pole and 6-pole motors is being marketed by Greencoat Electronics, Ltd., 2, Princes Row, London, S.W.1.

For single-speed record players there are a number of types including the 6C, designed for 4.5V battery operation with a torque of 1gm-cm at 45mA and speed of 1,810 r.p.m. Successful operation of some existing

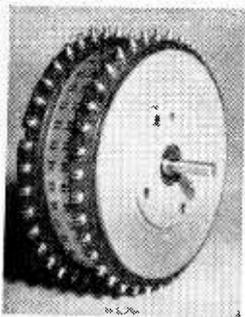
4-speed record-changer mechanisms has been achieved with the types 3C and 4C operating from 6-V and 9-V batteries respectively, the latter giving a torque of 1.5gm-cm for a consumption of 23mA.

Where a higher torque is required, as in tape recorders, the 6-pole motor will, for example, give a torque of 6gm-cm for 63mA at 6V.

All these motors are speed-controlled by a centrifugal switch arranged to open-circuit part of the motor windings when the critical speed is exceeded.

Adjustable "Law" Potentiometer

SHOWN in the illustration is a new type of precision potentiometer embodying a toroidal, wire-wound, linear resistance with 33 intermediate tappings at 10° intervals, in addition to the usual end and slider connections. The intermediate tappings are brought out to a double ring of turret-type soldering tags arranged round the circumference of the component. The purpose of the intermediate tappings is to enable fixed resistors to be connected externally across various sections of the toroidal winding so that any non-standard "resistance law" may be obtained and readily modified should the occasion demand.



Miles Electronics adjustable "law" precision potentiometer.

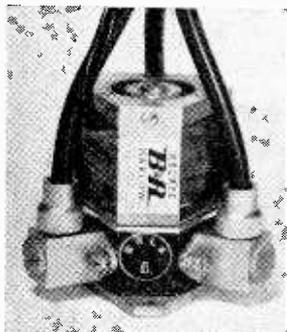
The model shown is the Type MCD30/FG and this is housed in a machined aluminium case measuring 3in in diameter and 1½in deep (back to front). The wiper spindle rotates through 340° and is 0.1875in in diameter. Provision is made for ganging up to six potentiometers in tandem. This model is available in linear resistance values of from one

to 100kΩ and with tolerances of ±0.5%, ±0.25% or ±0.2% as required, with a nominal rating of 6W.

There is also a Type MCD30/CT which has a centre-tapped toroidal linear resistance winding, also provided with intermediate tappings. Further details can be obtained from Miles Electronics, Ltd., Shoreham Airport, Sussex.

Coaxial Change-over Relay

B. & R. RELAYS LTD Type A07 coaxial relay can be used at frequencies up to 500Mc/s (s.w.r. at 300Mc/s, 1.15 maximum). The actuator consists of a solenoid, whose central armature is extended to carry the moving contact assembly in the contact chamber. Projecting into the contact chamber are fixed contacts joined to the inners of the flying coaxial leads. In the unenergized



Type A07 coaxial relay is about 2-in high.

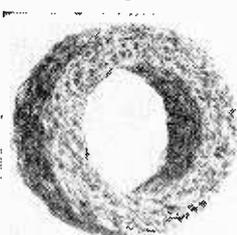
condition two leads are joined and the third is earthed; when the solenoid is energized (power required 2W) the armature moves into the coil, changing the connections so that the input is joined to the other flying lead. Again the unused contact is earthed. The characteristic impedance of the cables, which may be 50 or 75Ω, is preserved by connecting a capacitor in impedance equal to the cables entering the fixed

contacts to earth. This capacitor is formed by the contact assembly itself, and ensures perfect matching for the r.f. signal (Patent No.812546). Power handling capacity is 100W: the relay resists accelerations in any plane up to 10g and at right angles to the longitudinal axis up to 20g, between 50 and 500c/s.

The address of B. & R. Relays, Ltd. is Temple Fields, Harlow, Essex.

Wire Mesh R.F. Shields

THEORETICALLY the ideal screening for r.f. apparatus is a metal container without openings and with all joints and seams welded. Although shielding of this kind is not practicable a close approach to it seems to



Knit Mesh r.f. seal for spindles of controls on electronic equipment.

be attainable by the use of a screening material described as "Knit Mesh." This is a knitted, not woven, wire mesh and as available for electronic applications takes the form of annular spindle gaskets, rectangular gaskets for panels, lids and hinged flaps on screening cabinets and also for certain fittings of screened rooms. Another form is a combined r.f. shield and air seal for sealing the doors or "drawers" of cabinets housing electronic

apparatus. This consists of a "Knit Mesh" covering over a rubber tube.

These strips and gaskets can be made in any metal capable of being produced in filament form and in a wide range of sizes and patterns with metal content ranging from 50% to 99% as required. Further details can be obtained from Knit Mesh Ltd., 36, Victoria Street, London, S.W.1.

Transistorized Output Power Meter

IN the Dawe Type 610C a.c. output powers are measured simply by amplifying the voltage across a suitable resistor load. Forty alternative load values are provided, distributed at approximately equal logarithmic intervals from 2.5Ω to 20kΩ. By determining the load in which maximum power is developed, source impedances can also be measured. The resistive loads are accurate to ±2% from 20kΩ down to 20Ω, this accuracy decreasing to ±(5% + 0.25Ω) below 20Ω. Four alternative power ranges are provided with full scale deflections of 10, 100, 1,000 and 10,000 mW. Power measurements are accurate to within ±1dB at frequencies between 20c/s and 20kc/s. This accuracy is not affected if direct current is superimposed on the a.c. current through the load, unlike the case with power meters having the more usual multi-ratio transformer design. The 610C is battery-operated. It costs £68 (provisional) and is manufactured by Dawe Instruments Ltd., of Harlequin Avenue, Great West Road, Brentford, Middlesex.



Dawe Type 610C transistor output power meter.

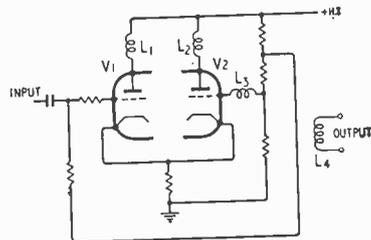
Home-Made High-Vacuum technique described by J. H. Owen Harries in the August 1960 issue of *Electronic Technology* enables pressures as low as about 3×10^{-8} mm of mercury to be obtained without expensive pumping equipment or special cleanliness precautions. In this technique the assembly to be evacuated is first cleaned simply by washing it in a household detergent solution. It is then baked in a home-made oven at about 350°C for about an hour. The pressure is first reduced to about 3×10^{-6} mm of mercury either by means of an ordinary mechanical pump or alternatively by filling the assembly with carbon dioxide which is then absorbed in refrigerated activated charcoal. A further reduction in the pressure down to about 3×10^{-8} mm of mercury is then obtained by means of BaAl and Ti getters. The pumping action of a Penning ion current pressure gauge is then used to keep the pressure at this level even with relatively "dirty" assemblies.

Technical Notebook

observed scatter from as high as 400 miles and it is hoped to extend this range. In addition, scattered radiation should in principle enable measurements to be made of the temperature as well as the electron density in the upper atmosphere. In the U.S. National Bureau of Standards measurements a frequency of 41Mc/s and peak pulse power of 6MW are used. Vertically-returned scatter is detected using an aerial made up of as many as 1024 half-wave dipoles and covering in all 4 acres: part of this aerial is shown in the photograph.

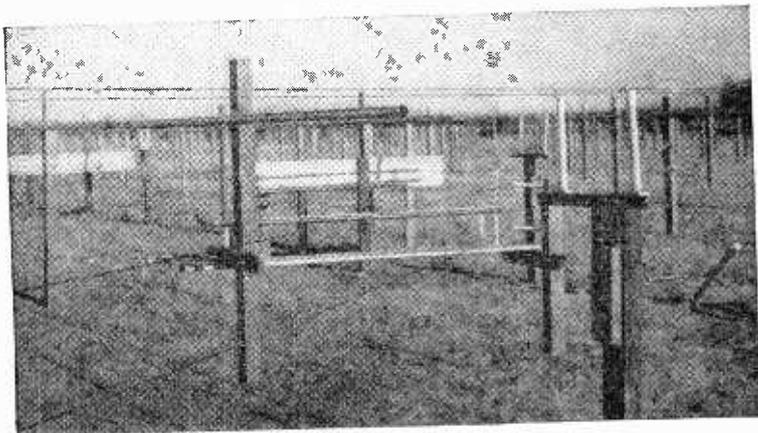
Confluxer is a circuit developed by Lintronic Ltd. (47 Charing Cross Road, London, W.C.2) for generating pulses of constant charge from zero crossings of any types of waveform, even slowly-varying ones. The quantity of charge generated depends almost solely on a passive element and so does not vary by more than about 1% for extreme changes in valve characteristics or power supply voltages. The Confluxer thus gives a mean output accurately proportional to the input frequency or pulse rate. The circuit of the Confluxer is shown in the diagram. The four windings (L_1, L_2, L_3, L_4) are all wound on the same toroidal core, a core material with a rectangular hysteresis loop and high retentiveness being chosen. In the quiescent state valve V1 is conducting much more heavily than V2 since its grid is connected to a more positive potential. In this state the core is thus

saturated in the sense determined by the winding of L_1 . When a negative-going signal is fed to the grid of V1 this reduces the current in this valve. This produces a voltage across L_1 which in turn induces voltages across L_2 and L_3 . These are wound in such a way that this lowers the anode voltage of V2 and



raises its grid voltage, thus increasing the current in V2. The whole action is regenerative and V2 soon conducts heavily while the current in V1 is materially reduced. This reverses the magnetization of the core to saturation in the opposite sense, since L_1 and L_3 are wound in opposite senses. When the input waveform goes positive V1 again conducts heavily while the current in V2 is materially reduced; this again reverses the magnetization of the core. Pulses are thus induced in the output winding L_4 due to the reversals of the core magnetization. Since the total flux change during each such reversal depends almost solely on the core parameters, output pulses of very nearly constant charge are generated. In fact either a 12AT7 ($\mu=60$) or 12AU7 ($\mu=16$) can be used as the valve with little change in the output.

"Scatter" Radiation is more promising than reflected radiation as a source of information about the upper atmosphere. Whereas reflected radiation can only provide information about those layers in which ionized electrons are dense enough to produce reflection, re-radiation or "scatter" can be excited from all levels of the atmosphere above about 50 miles. In particular, scattered radiation can be observed from above the normal reflecting layers: in fact the U.S. National Bureau of Standards have



Very Long Electromagnetic Waves, of the order of 20,000 metres or so, were at one time used extensively for long-distance radio communications, but once it was realized that world coverage was possible on short waves, with only a fraction of the power needed for long-wave transmission, the long waves experienced a spell in the doldrums. However, in recent years interest in them has revived for certain specialized applications and about three years ago the U.S. National Bureau of Standards sponsored a symposium on the very low

frequencies (VLF) in the band 3kc/s to 300kc/s.

In January of this year N.B.S. invited some 50 prominent scientists and radio engineers to a conference at their Bolder (Colorado) laboratories for the express purpose of exchanging information and ideas on the propagation and potential applications in the communications field of electromagnetic waves below 3kc/s.

According to a brief report of the conference in the May, 1960 *N.B.S. Technical News Bulletin* at these extremely low frequencies (ELF waves they are called) terrestrial and extra-terrestrial sources radiate electromagnetic energy in one form or another. It is, of course, well known that ordinary lightning discharges radiate considerable energy on frequencies down to 10c/s or lower and these "signals" have been used for some years to study propagation conditions in this region of the electromagnetic wave spectrum.

Frequencies of this order appear to be propagated with very low attenuation and to penetrate rocks and soil with relatively small loss. They have been used extensively in geophysical survey work.

It is also said in the N.B.S. report that because the ELF waves exhibit certain magneto-ionic characteristics they might well be expected to penetrate the ionosphere and be usable for communication with space vehicles. Such penetration appears to be feasible on theoretical grounds at about 3kc/s, where it is said, there is evidence of a "window" in the ionosphere. Furthermore, these low frequency waves should be diffractable around planetary bodies.

Variable-Tuned Microwave R.F. Stage—even though it is only passive—is an unusual feature of the American Polarad Model R receiver imported into this country by B. & K. Laboratories. The tuning of the r.f. cavities is carried out by plungers which are mechanically ganged to the klystron local-oscillator tuning control. Two coupled cavities are used to give the usual improvements of a flatter band-pass response with steeper sides.

Adhesive-Backed P.T.F.E. Tape is now available from the Fluorocarbons Department of the Radio and Electronic Components division of A.E.I. Samples applied to steel showed a peel strength of the order of 2lb per inch width of tape. Although the adhesive becomes thermoplastic above 300°F it is still useful up to 390°F. It has a high resistance to attack by acids and alkalis but is affected by most organic solvents.

Double Frame-Grid structure with two pairs of parallel backbones round which grids are wound is used in the new 8P1 valve developed by the

G.P.O. By making the extra (second) pair of backbones with a slightly greater diameter than the first, the second (screen) grid can be positioned very close to the first. This allows an anode potential as low as about 45V to be used which is a great advantage in the submarine telephone cable repeater application for which this valve has been designed. A high slope of about 25mA/V is obtained by the normal utilization of the frame grid method of construction to wind the control grid very close to the cathode.

Low Melting-Point Glasses suitable for encapsulating electronic components have been recently developed by Drs. S. S. Flaschen and

A. D. Pearson of the Bell Telephone Laboratories. The glasses are made up of arsenic and thallium together with various proportions of sulphur or selenium. These new glasses become fluid at temperatures between 125° and 350°C—i.e. some 300° to 400°C lower than does any previously known glass. When fluid the new glasses have viscosities which enable an object to be coated simply by dipping it into the glass. The glasses have resistivities which vary from 10⁹ ohm-cm to over 10¹⁴ ohm-cm, and thermal expansion coefficients of the order of 30×10⁻⁶ per °C. The solubility characteristics of the new glasses are similar to those of glasses in general except that they are insoluble in hydrofluoric acid.

NOVEMBER MEETINGS

Tickets are required for some meetings; readers are advised, therefore, to communicate with the secretary of the society concerned.

LONDON

1st. I.E.E.—"Transistor instrumentation in rockets" by G. G. Haigh at 5.30 at Savoy Place, W.C.2.

2nd. I.E.E.—"The ionosphere—a review of recent progress" by Professor W. J. G. Beynon at 5.30 at Savoy Place, W.C.2.

2nd. Brit.I.R.E.—Discussion on "Radar—pulse or C.W.?" at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel St., W.C.1.

2nd. British Kinematograph Society.—"Transmission of films by cable using the slow scan method" by C. B. B. Wood and J. J. Shelley (B.B.C. Research Department) at 7.30 at the Central Office of Information, Hercules Road, S.E.1.

7th. I.E.E.—Discussion on "The impact of television on society" opened by Lord James of Rusholme at 5.30 at Savoy Place, W.C.2.

9th. Brit.I.R.E.—"Diagnostic applications of ultrasonic" by T. G. Brown at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

9th. Institution of Production Engineers.—"Induction heating" by D. G. Jones at 7.15 at 10 Chesterfield Street, W.1.

10th. Television Society.—"Masers and parametric amplifiers: their use in ultra low noise receivers" by C. R. Russell (G.E.C. Research Laboratories) at 7.0 at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, W.C.2.

10th. Radar & Electronics Association.—"V.H.F. aerial techniques" by C. A. Burgess at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

11th. I.E.E.—"The future of 'electronics' and 'electronics' in aircraft and guided missiles" by the Rt. Hon. the Viscount Caldecote at 5.30 at Savoy Place, W.C.2. (Joint meeting with the Royal Aeronautical Society.)

14th. I.E.E.—Discussion on "Tunnel-diode applications and circuitry" opened by Dr. G. B. B. Chaplin and Dr. R. W. A. Scarr at 5.30 at Savoy Place, W.C.2.

16th. I.E.E.—"Radiocommunication in the power industry" by E. H. Cox and R. E. Martin at 5.30 at Savoy Place, W.C.2.

16th. Brit.I.R.E.—"Digital computing elements for instructional use" by Lt.-Col. I. W. Peck at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

18th. Institution of Navigation.—A one-day symposium held jointly with the British Interplanetary Society on "Navigation for the early exploration of the moon" at 10.0 at the Royal Geographical Society, 1 Kensington Gore, S.W.7.

18th. Institution of Electronics.—"Magslips, synchros and their applications" by J. H. Batchelor at 7.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

22nd-24th. I.E.E.—Conference on electronic telephone exchanges at Savoy Place, W.C.2.

23rd. Brit.I.R.E.—"Objective and subjective requirements for loudspeakers" by F. H. Brittain at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

25th. Television Society.—"Measurement techniques for television broadcasting" by L. E. Weaver and I. J. Shelley (B.B.C.) at 7.0 at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, W.C.2.

30th. I.E.E.—"The potentialities of artificial earth satellites for radiocommunication" by W. J. Bray at 5.30 at Savoy Place, W.C.2.

30th. British Kinematograph Society.—"16-mm fast pull-down television recorders" by M. E. Pemberton (Marconi Research Laboratories) at 7.30 at the Central Office of Information, Hercules Road, S.E.1.

BIRMINGHAM

23rd. Brit.I.R.E.—Discussion on "The various routes to professional qualifications in electronic engineering" with Professor D. G. Tucker in the chair at 6.15 at the University, Edgbaston.

23rd. Television Society.—“Eurovision” by J. H. Holmes (B.B.C.) at 7.30 at the New Physics Lecture Theatre, The University.

BRISTOL

22nd. Brit.I.R.E.—“Transistors in control circuits” by E. Wolfendale at 7.0 at the School of Management Studies, Unity Street.

CAMBRIDGE

15th. I.E.E.—“Channelling — a sketch” by T. B. D. Ferroni (Electronics and Communications Section chairman), at 8.0 at the Cavendish Laboratory.

24th. I.E.E.—“Television recording: a survey of the problems and methods currently in use” by J. Redmond at 8.0 at the Cavendish Laboratory.

CARDIFF

23rd. Brit.I.R.E.—“Radio navigational aids in aircraft” at 6.30 at the Welsh College of Advanced Technology.

CHELTENHAM

22nd. Society of Instrument Technology.—“The operation and control of ERNIE” at 7.30 at the Belle Vue Hotel.

CHESTER

14th. I.E.E.—“Teaching and learning machines” by C. E. G. Bailey at 6.30 at the Town Hall.

DERBY

17th. Society of Instrument Technology.—“The wavelength standard of length” by K. J. Hume at 7.15 at the Derby & District College of Technology, Kedleston Road.

DUBLIN

17th. I.E.E.—“Aviation, navigational systems” by G. Jones at 6.0 at the Physical Laboratory, Trinity College.

EDINBURGH

8th. I.E.E.—“Advances in semiconductor devices and circuits” by Dr. J. Evans and T. H. Walker at 7.0 at the Carlton Hotel, North Bridge.

9th. Brit.I.R.E.—“V.H.F./F.M. transistor receivers” by H. A. Heins at 7.0 at the Department of Natural Philosophy, The University, Drummond Street.

FARNBOROUGH

22nd. Brit.I.R.E.—“Radio aids for automatic landing developed by the Blind Landing Experimental Unit” by J. S. Shayler at 7.0 at Farnborough Technical College.

GLASGOW

7th. I.E.E.—“Advances in semiconductor devices and circuits” by Dr. J. Evans and T. H. Walker at 6.0 at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent.

9th. I.E.E.—“The digital computer” by Dr. I. Cochrane at 6.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

10th. Brit.I.R.E.—“V.H.F./F.M. transistor receivers” by H. A. Heins at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

IPSWICH

28th. I.E.E.—“An introduction to electronic computers” by R. C. M. Barnes at 6.30 at Electric House.

LEEDS

8th. I.E.E.—Discussion on “City and Guilds or National Certificate?” opened by G. P. Evans at 6.30 at the College of Technology, Calverley Street.

LIVERPOOL

16th. Brit.I.R.E.—“The design of high quality sound reproducing equipment” by R. I. Lakin, K. Davin and F. C. Gibson at 7.0 at the Adelphi Hotel.

28th. I.E.E.—“Thermistors—their theory, manufacture and application” by Dr. R. W. A. Scarr and R. A. Settrington at 6.30 at the Royal Institution, Colquitt Street.

MALVERN

3rd. Brit.I.R.E.—“Electronic sector scanning” by Professor D. G. Tucker at 7.0 at the Winter Gardens.

MANCHESTER

3rd. Brit.I.R.E.—“Video-tape recording” by P. R. Denby at 7.0 at the Reynolds Hall, College of Technology.

9th. I.E.E.—“The applications of microwaves” by Professor A. L. Cullen at 6.15 at the Engineers’ Club.

NEWCASTLE-UPON-TYNE

9th. Brit.I.R.E.—“Distribution of sound and television by wire” by A. W. Mews at 6.0 at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road.

14th. I.E.E.—“Thermistors—their theory, manufacture and application” by Dr. R. W. A. Scarr and R. A. Settrington at 6.15 at the Rutherford College of Technology, Northumberland Road.

21st. I.E.E.—“Radiocommunication in the power industry” by E. H. Cox and R. E. Martin at 6.15 at the Neville Hall, Westgate Road.

RUGBY

16th. I.E.E.—Faraday Lecture on “Transistors and all that” by L. J. Davies at 6.30 at the Temple Speech Room.

SOUTHAMPTON

8th. I.E.E.—“Error correction in digital data transmission system” by Dr. J. E. Meggitt at 6.30 at the University.

STOKE

18th. I.E.E.—“Radiocommunication in the power industry” by E. H. Cox and R. E. Martin at 7.0 at the Technical College.

TORQUAY

16th. I.E.E.—“The Post Office Type 10P valves for submarine telephone repeaters” by F. H. Reynolds at 3.0 at the S.W.E.B. Electric Hall.

WOLVERHAMPTON

9th. Brit.I.R.E.—“Modern computer techniques,” by K. C. Johnson at 7.15 at the College of Technology.

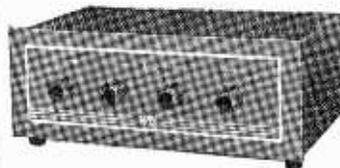
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RANDOM RADIATIONS

By "DIALLIST"

"Needles"

CURIOS— isn't it?—how often a new wireless project is found to be a cause of unwanted interference.* That may be the last nail in the coffin of operation "Needles" suggested by the U.S. Army Air Force and referred to on page 484 of the October issue. The idea is to put large numbers of metal strips into orbit round the earth and to use them as reflectors to help world-wide communications. When the plan was announced an outcry arose from the International Scientific Radio Union, which was meeting in London. Professor A. C. B. Lovell told the meeting that "needles" would seriously hamper both radio astronomy and visual astronomy. There's also the possibility that it might have serious effects on long-distance radar. You probably remember "Window" used by our bombers in the last war. On their journeys out and home they dropped quantities of metallized strips and these completely confused enemy radar. American scientists say that it should be possible to work out a position for a belt of "needle" dipoles in which they wouldn't be in anyone's way. That may be so; but it has to be borne in mind that once you put things into orbit they're there and you can't get 'em down again until they fall to earth in their own good time.

Do They Still Want Lines?

WOULD a satisfactory system of removing the liness from television images stand a good chance of acceptance by the man-in-the-TV-street if introduced today? I rather think that it would. Spot-wobble was made part of Ekco receivers at a time when all sets had manual focussing. There's no doubt that users of sets with this kind of focusing rely largely on the lines to indicate whether or not correct adjustments have been made. But in all modern sets the focus is adjusted by the man who installs or services the set and it stays put. One would have thought that in these

* When the satellite balloon "Echo" was put into orbit Capt. H. J. Round pointed out to us that it would be "aperiodic" and would not be an unmixed blessing since it would increase the field strength of interference.—Ed.

days of smallish living rooms and larger and larger TV screens a line eliminating system would be welcomed, at any rate by those whose sets have no manual focus controls. Myself, I think that spot-astigmatism (or elongation) is probably better than spot-wobble. This can now be done optically by a method evolved and at present being developed by the Saba company in Germany.† In this a transparent plastic panel in which horizontal lenticular grooves are cut is placed in front of the viewing screen of the c.r. tube. The line structure is made invisible and a good, clear picture results.

Telegazing

WHY should there be so strong an urge to watch other people at work? I'm thinking of manual work, such as digging or building. The urge is certainly there and some five years ago one big firm of building contractors did their bit towards satisfying it by erecting platforms from which all the world and his wife could see what was going on. These platforms have always been well patronized and now the firm has gone one better. On a site at the junction of Gracechurch Street and Fenchurch Street in London Taylor Woodrow have fitted the platform

with Marconi closed-circuit TV. The public has a fine view of what's afoot on a 21-in receiver. Not only that, but a remote control unit near the receiver enables the watcher to move the camera in bearing and in elevation, so that different parts of the site can be viewed. As the job isn't due to be completed until the autumn of next year, telegazers are assured of a long spell of watching.

Radio Doctors

IF sufficient practitioners in a locality are willing to play, a scheme has been worked out which may result in a kind of wireless-linked medical service. The idea is that the cars of all who take part shall be fitted with suitable v.h.f. transmitter-receivers like those used in radio taxi systems. Doctors on their visiting rounds would be in constant touch with a central transmitting station. In the ordinary way most general practitioners have to find a telephone call box or return to their surgeries in the course of their visiting rounds to see whether any messages have come in for them. This wastes time and would become unnecessary if they were in touch with a central station. There is also the important consideration that in case of an accident or other emergency medical help would be available in the shortest

† *Wireless World*, August 1960. p. 262.



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possible time. The initial cost of installing transmitter and receivers is substantial but it seems to me that the saving of time makes this well worth while.

Cheaper C.R. Tubes

IT'S good to see that the prices of cathode-ray tubes have been further reduced. That and the twelve months' guarantee and the additional fact that the rebuilding or reconditioning of tubes that have become defective is now so widely practised have removed the somewhat hard-up viewers' worst headache. It's no longer a disaster if the c.r.t. packs up, for it can be reconditioned or replaced at no staggering cost. I've known folks who were frightened in the old days of going in for TV by the tales of calamity they heard from others. The c.r.t. might "go"—and too often it did—soon after the expiring of the then six months' guarantee. Since reconditioning hadn't arrived then, there was nothing for it but to spend a heap of money on a new tube and, if you hadn't got it, you had to forgo viewing until you'd saved up.

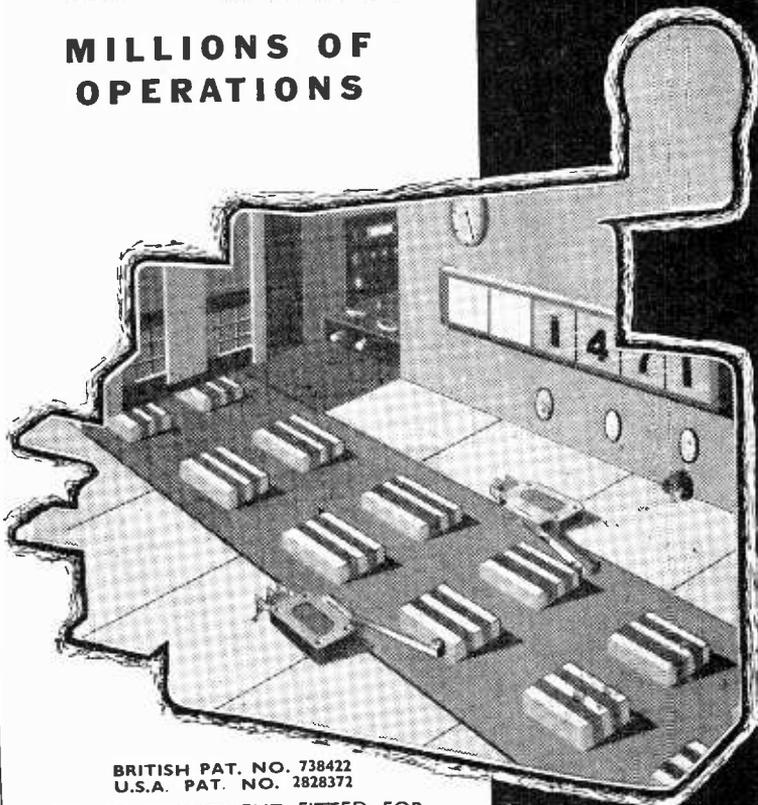
For Blind Switchboard Operators

THE Royal National Institute for the Blind realizes how much electronics has already done to help blind people and is always on the look out for possible new applications. Recently it suggested to Mullard Research Laboratories that the transistor and the photoelectric cell might be made to give assistance to blind operators of telephone switchboards, and the result has been the development of prototype equipment which is now undergoing field trials. It is designed for use with the Post Office P.A.B.X.1 type of board and the board itself needs no modification. A standard fitting of the board issues an audible warning when some action is needed and a carriage containing a photocell is then moved by the operator along rails which form part of the board. If any call lamp is glowing, the cell responds when over it and causes a transistor oscillator and a loud-speaker to give rise to a note—steady if the lamp glows continuously and interrupted if it is flashing. I've little doubt that first the R.N.I.B. and then blind operators who come to use it will be delighted with the simple device.

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'Things Great and Small'

I HAVE followed with interest and growing impatience the correspondence in recent issues regarding the system of numerical prefixes put forward by A. P. G. Peterson and quoted by Frederick T. Van Veen in a letter to the Editor (September issue). But the letter of D. B. Pitt (October issue) has finally exhausted my patience, and I can hold my peace no longer.

Mr. Pitt, by inference, pleads for the retention of certain prefixes. All those he quotes are as numerically meaningless as mega (great). The first three he mentions are respectively derived from the Latin *nanus* (dwarf), and Greek *gigas* (giant) and *teras* (monster). It is a minor point, but I would remind him that these two latter words are far from "dead" as he implies in the earlier part of his letter. They are all very much alive and used in modern Greek. The Latin prefix "pico," which Mr. Pitt also favours, probably comes to us from the *litera picata* of mediæval manuscripts (later it passed into the jargon of printers); it could also come from the non-U Latin source which gives us the Italian *piccolo* (small).

Unlike Mr. Pitt, Mr. Van Veen disapproves of these words as much as I do but he, too, falls into grievous error. After giving us a table of the Peterson system he says: "It is a pity that Peterson's article [in an I.R.E. publication] wasn't published ten years ago before such allogical absurdities as giga won their acceptance through default." It is clear Mr. Van Veen is ignorant of the fact that the allogical absurdities which he deplors were decried, not ten but over twelve years ago, and a new system proposed which, in my opinion, is far better than the one now put forward by Mr. Peterson.

This pre-Peterson 1948 system was a logarithmic one in which all prefixes had a definite numerical value. It is best explained by the accompanying table which I reproduce from page 304 of the August, 1948, issue of *Wireless World* where

10 ³ Treis	10 ⁻³ Tres
10 ⁶ Hex	10 ⁻⁶ Sex
10 ⁹ Ennea	10 ⁻⁹ Novem.
10 ¹² Dodeka	10 ⁻¹² Duodecim

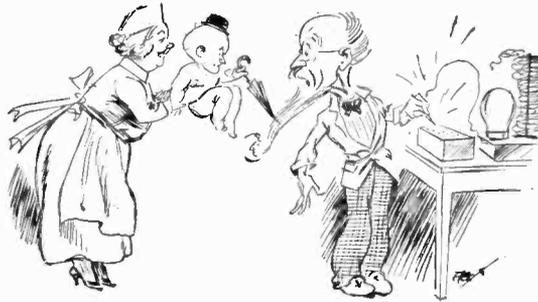
it originally appeared. The Greek multiple prefixes in the left-hand column and the Latin sub-multiple ones in the right-hand column can, for the sake of euphony, be slightly modified by omitting the final letter, if a consonant, or by adding a vowel,

as is done freely in the ordinary metric system where, in addition, "k" usually becomes "c" as in decametre.

In this 1948 system, a megacycle would be called a hexacycle and a microfarad would become a sexofarad. The system could be extended more or less indefinitely. We should lose our old friend "kilo," of course, but does that matter? It is not, and never was, the word for a "thousand" in Greek or any other language but was introduced arbitrarily into French in 1795 to prevent people talking of chiliometres. In any case, a few years ago we lost the old familiar "capacity" and "condenser" but we soon got used to it.

18-track Tape

RIGHT from the moment of my birth as I arrived just after Big Ben had boomed out the first stroke of midnight ushering in April 6th, so



"From the moment of my birth."

causing my father to lose a year's income-tax allowance for me, I have been unpunctual.

It was a bad start and unpunctuality has always seemed to dog me ever since. Incidentally, with unpunctuality goes laziness; indeed, some people say the latter is the cause of the former. I certainly am lazy and one of the results is that I like to loll back in a comfortable armchair while Mrs. Free Grid reads one of my favourite books to me.

But frequently her time and temper are both short, and I am wondering, therefore, if it would not be possible for some publisher to issue for people like me, tape recordings of books read by somebody specially trained for the job. The ideal way would be to have each book dealt with on the lines of Mrs. Dale's diary, and to have the purple passages in love scenes actually acted,

vocally speaking, by some ravishing blonde and tender-tongued swain.

All this would, of course, take yards and yards of tape (even if it were of the later 4-track variety) for a complete novel. But recorders have now been designed for the blind in which no fewer than eighteen tracks are squeezed on to a ½-in tape. This gives a maximum playing time of no less than twenty hours which would, I think, be enough even for the garrulous Mrs. Dale. For some time, of course, there have been talking-books for the blind but mainly on discs which are now to be allowed to fade slowly away like old soldiers. Henceforth all recordings are to be on this 18-track tape.

I think the most interesting part of the apparatus is the cassette. This holds not only a full-length novel—or what have you—on an endless tape but has its own built-in playing head. The idea is, of course, to simplify changing the record for blind users.

For those of us with the good fortune to have the use of our eyes, such an arrangement would not be really necessary but it would certainly simplify mass production of these records. The advantage of this would be that it would lessen overhead expenses to have only one type of record and so possibly make them available at a lower price to the Royal National Institute for the Blind which, in co-operation with St. Dunstan's, organizes the Nuffield Talking Book Library for the blind.

B.B.C. Scrapbooks

I WAS very interested to read the letter (October issue) from Vernon Harris, the producer of the B.B.C. Scrapbooks, in which he explains that the B.B.C. never allows genuine morse signals to be broadcast in dramatic productions.

I was interested to learn, too, that the errors of the times are also placed on record by putting them into the mouths of people like the young woman at the New Year's Eve ball. It is certainly a good idea, and if I am ever in doubt about my facts when writing for *Wireless World* I must remember to put them into the mouth of Mrs. Free Grid.

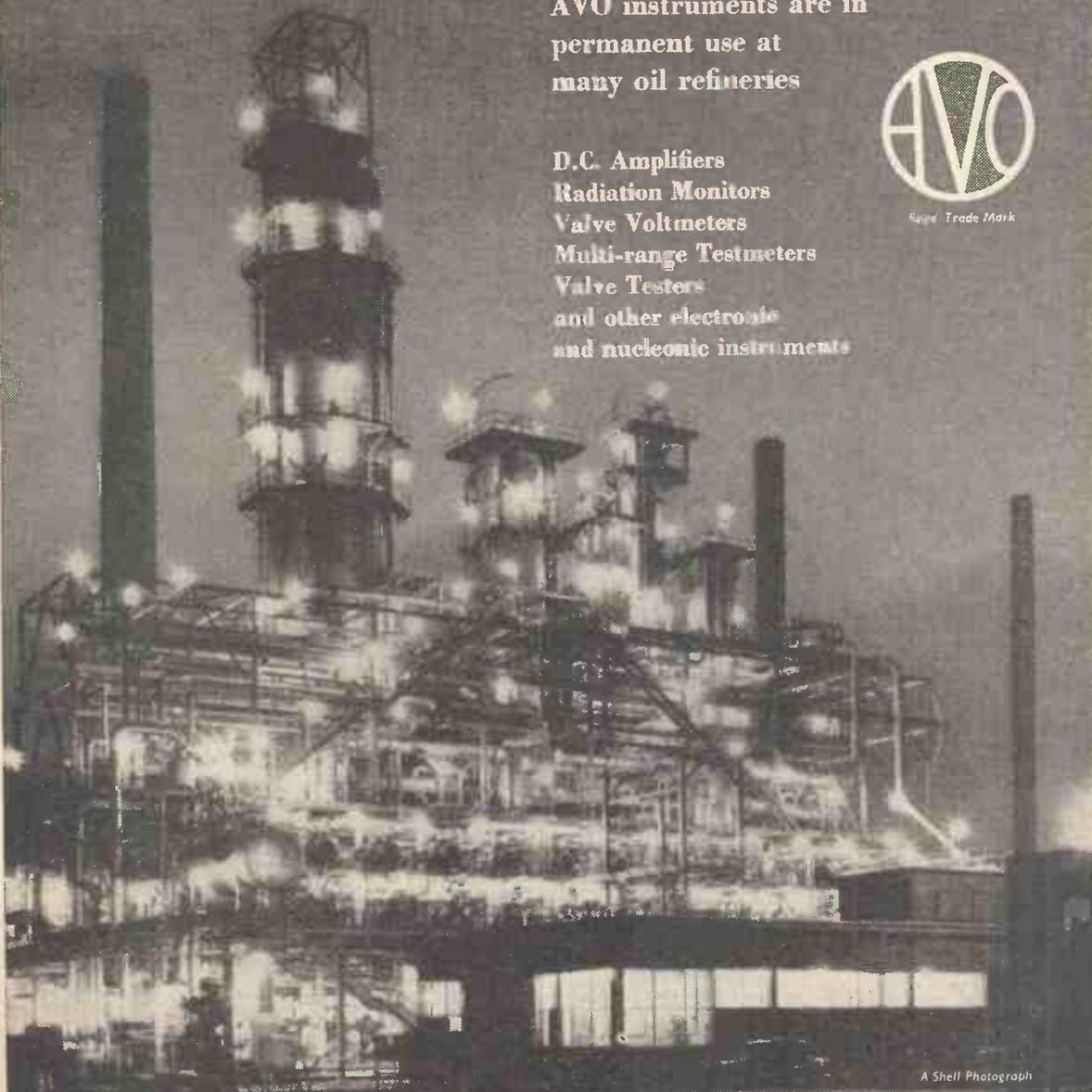
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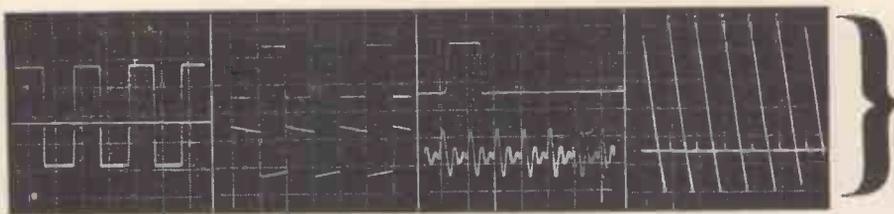


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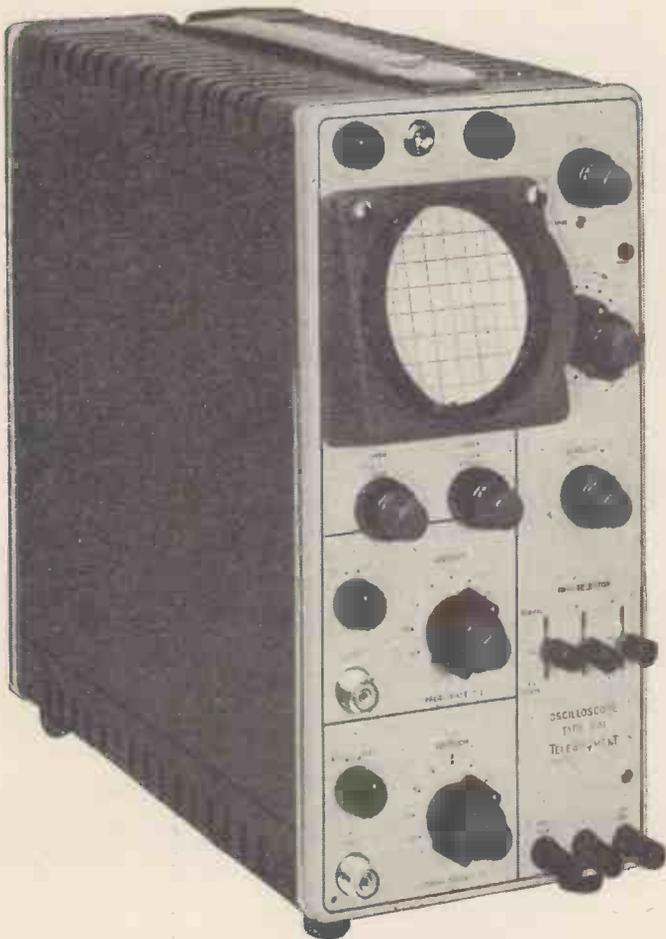


A Shell Photograph

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D 3 1



D.31 double beam Serviscope*

D.C. amplifiers and slow speed time base (down to 5 sec/cm if necessary) are eminently suitable for servo work and similar applications. Fast rise time (.06μ sec) and high writing speed (10cm/μsec at maximum expansion) are essential for any work dealing with fast pulses or TV waveforms. The unique triggering arrangements enable complex waveforms to be examined in detail with complete accuracy of synchronisation. At this moment the D.31 is in use in the diverse fields of computer development and servicing, radar equipment, telemetering applications, closed circuit and broadcast TV, automatic telephone equipment... and is proving itself ideally suited to laboratory work where an oscilloscope has, of necessity, to be somewhat of a jack of all trades.

Potentialities per pound

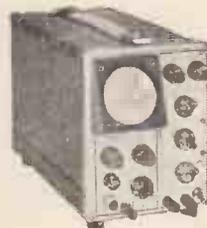
Both per £ and per lb., each Serviscope offers greater flexibility, accuracy and reliability than any oscilloscope of comparable specification. A radical reassessment of design and production techniques has enabled smaller, lighter, instruments with many improved features to be offered giving a far higher performance than their low price would suggest.*

Weight: 26 lbs. **£ 9 5**



D 3 1 R

Electrically identical, but designed for mounting in standard 19½" racks.



S 3 1

single beam oscilloscope has the same specifications with a single beam display. The original, highly successful, 'Serviscope'.

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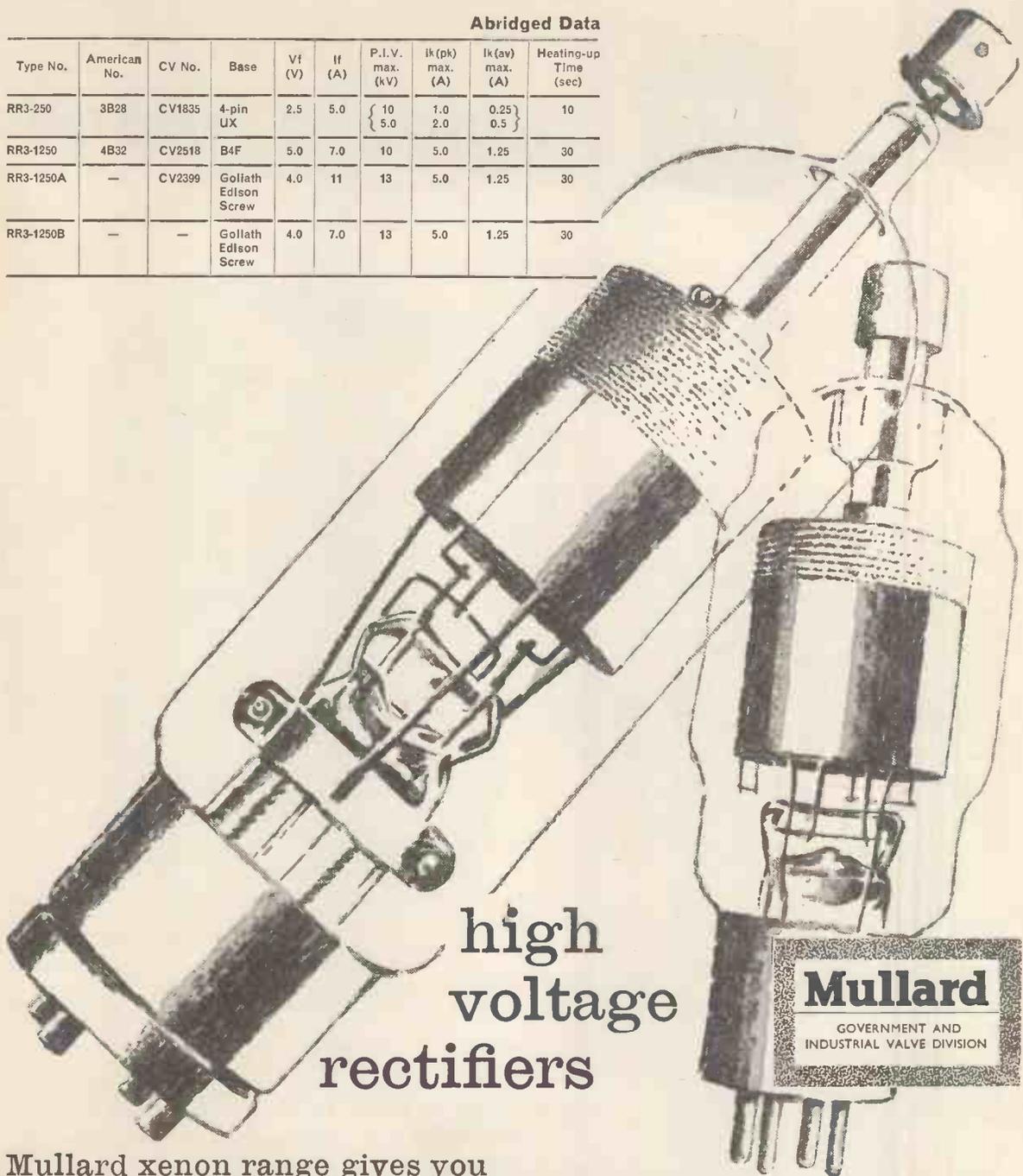
* 'Serviscope' is the registered trade mark of Telequipment Ltd.

TELEQUIPMENT



Abridged Data

Type No.	American No.	CV No.	Base	Vf (V)	If (A)	P.I.V. max. (kV)	Ik (pk) max. (A)	Ik (av) max. (A)	Heating-up Time (sec)
RR3-250	3B28	CV1835	4-pin UX	2.5	5.0	{ 10 5.0	{ 1.0 2.0	{ 0.25 0.5	10
RR3-1250	4B32	CV2518	B4F	5.0	7.0	10	5.0	1.25	30
RR3-1250A	—	CV2399	Goliath Edison Screw	4.0	11	13	5.0	1.25	30
RR3-1250B	—	—	Goliath Edison Screw	4.0	7.0	13	5.0	1.25	30



high voltage rectifiers

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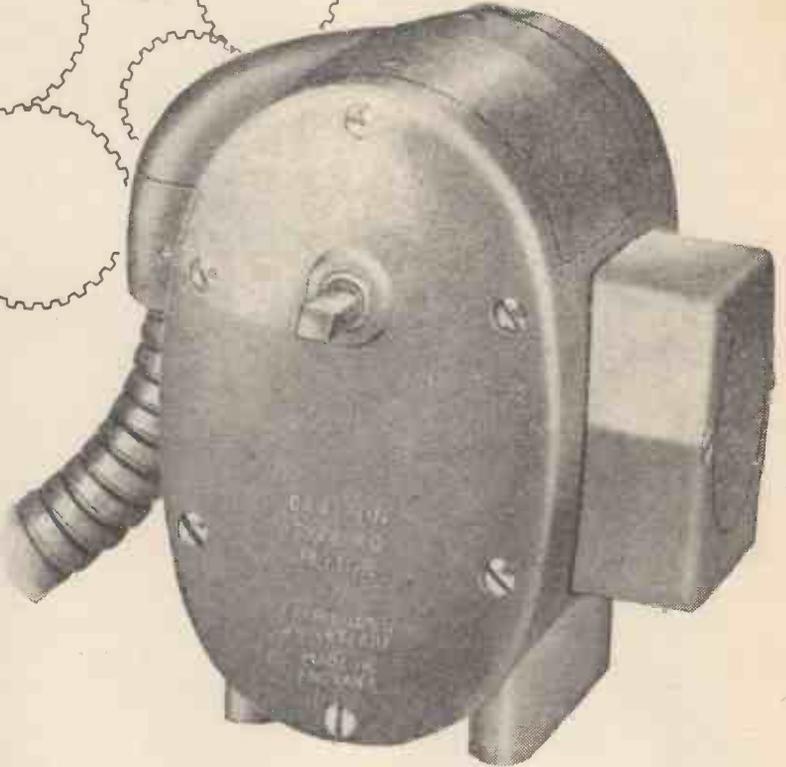
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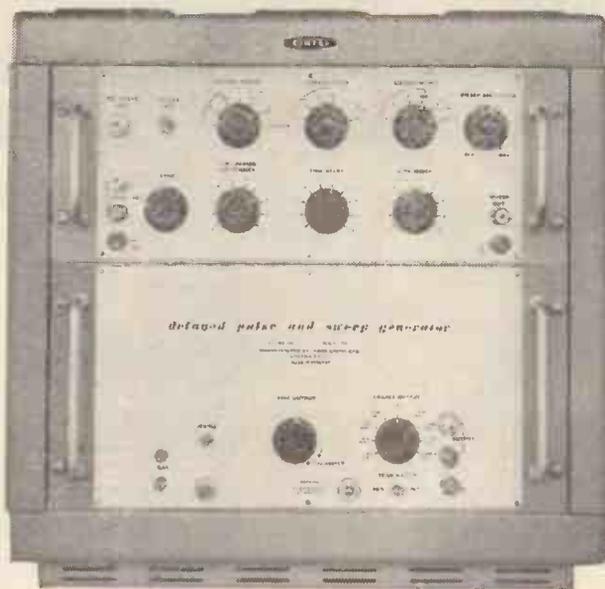
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Continuously variable from $0.9\mu\text{sec}$ to 1.05sec i.e. 0.95c/s to 1.1Mc/s . Accuracy $\pm 5\%$.

Pre-pulse

$40\mu\text{sec}$. 8V peak in 75Ω , positive going.

Main pulse

Width: Variable from $0.09\mu\text{sec}$ to 105msec
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Amplitude: Control gives 4:1 attenuation of each of four maximum outputs as follows:
5V max in 75Ω rise time $10\mu\text{sec}$
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Accuracy: $\pm 2\%$.

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D.C. coupled negative going sawtooth same width and delay as main pulse.
15V peak max.

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Obtained from short circuited pure line. One positive and one negative going pulse coincident with main pulse.
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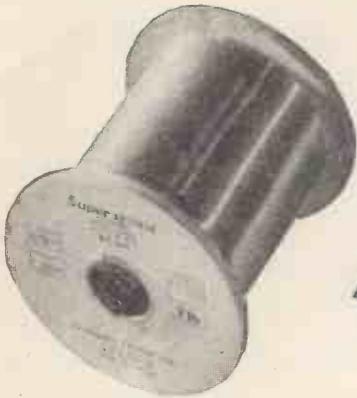
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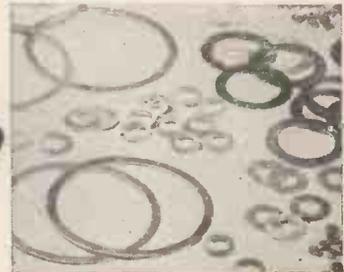
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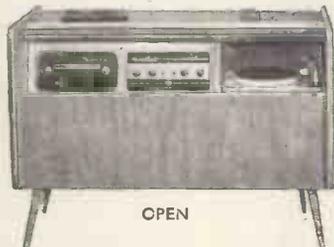
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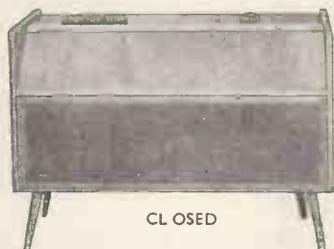


GLOUCESTER STEREO CABINET KIT



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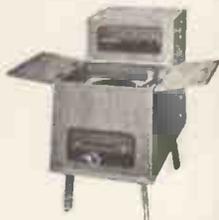
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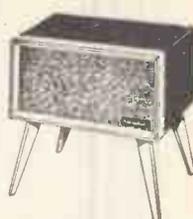
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Sold separately Total **£13 12 6**

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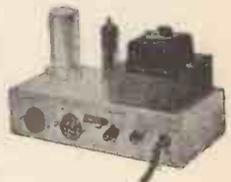
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- 4-speed Transcription Record Player Model RP-1U **£12 10 0**
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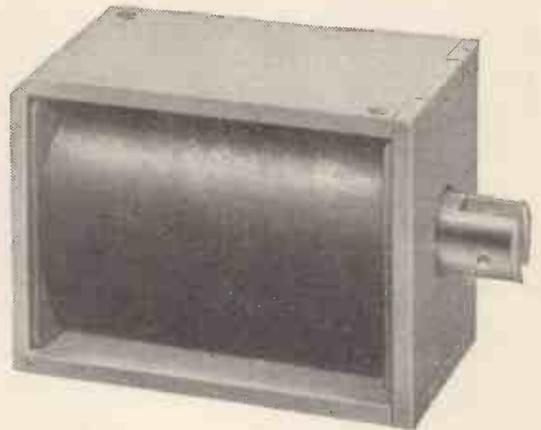
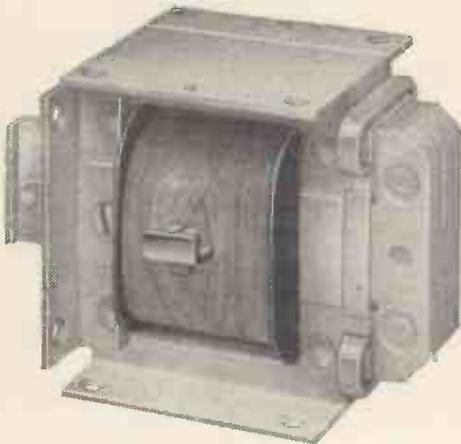
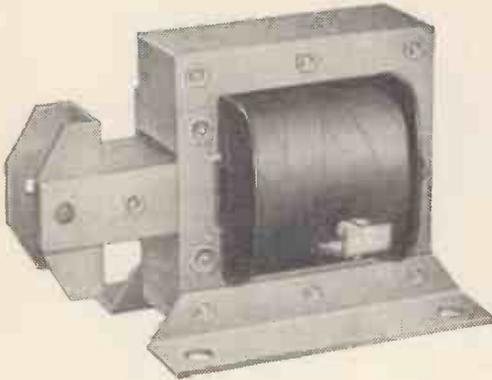
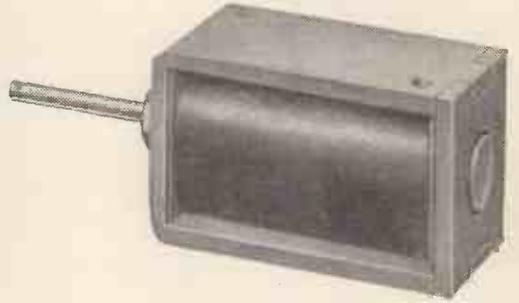
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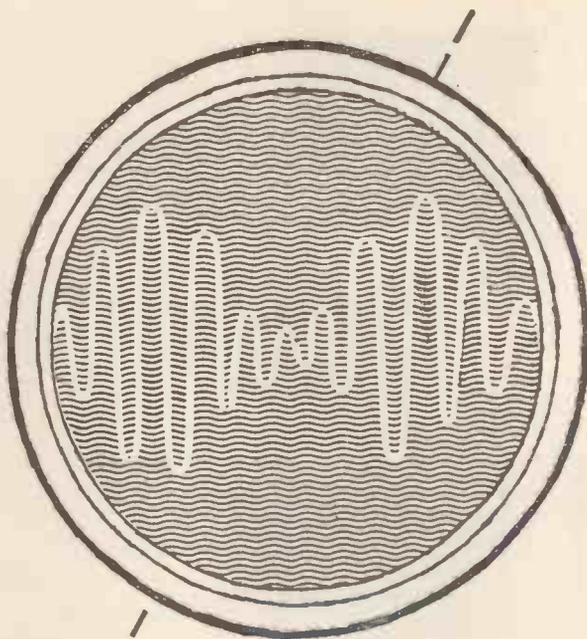
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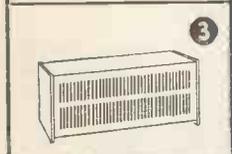
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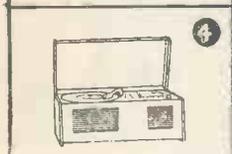
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Model PKG5 Radiogram, in natural sycamore



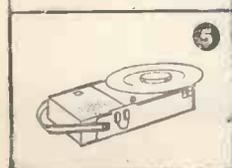
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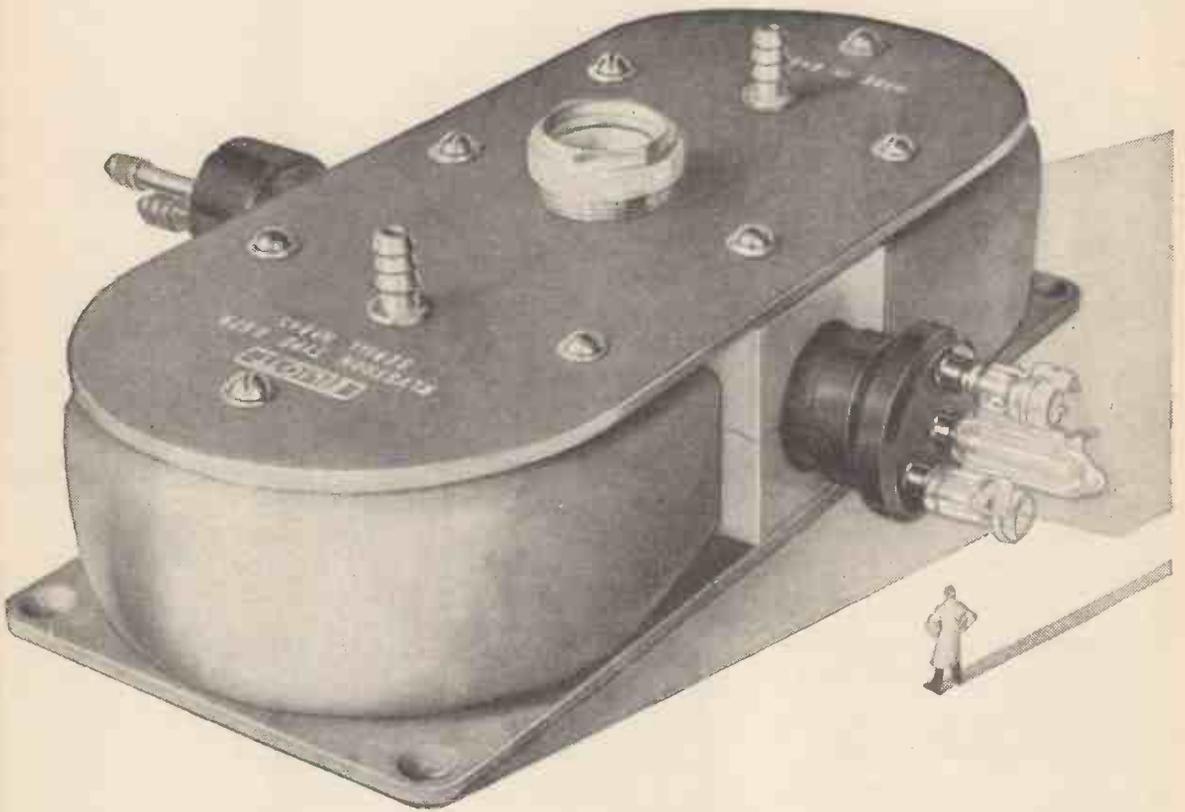
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Magnetising force for H_{max} -oersteds	0.20 to 0.40	0.025 to 0.04	0.2 to 0.5	0.03 to 0.10	2.0 to 6.0
Maximum flux density-gauss	16 000	8 000	13 000	14 000	24 000
Coercive force in oersteds for B_{max} = 5 000 gauss	0.15	0.03	0.15	0.05*	2.3†
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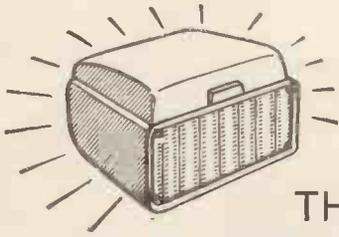
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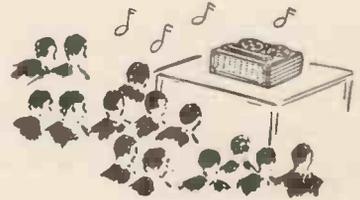


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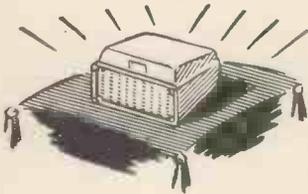
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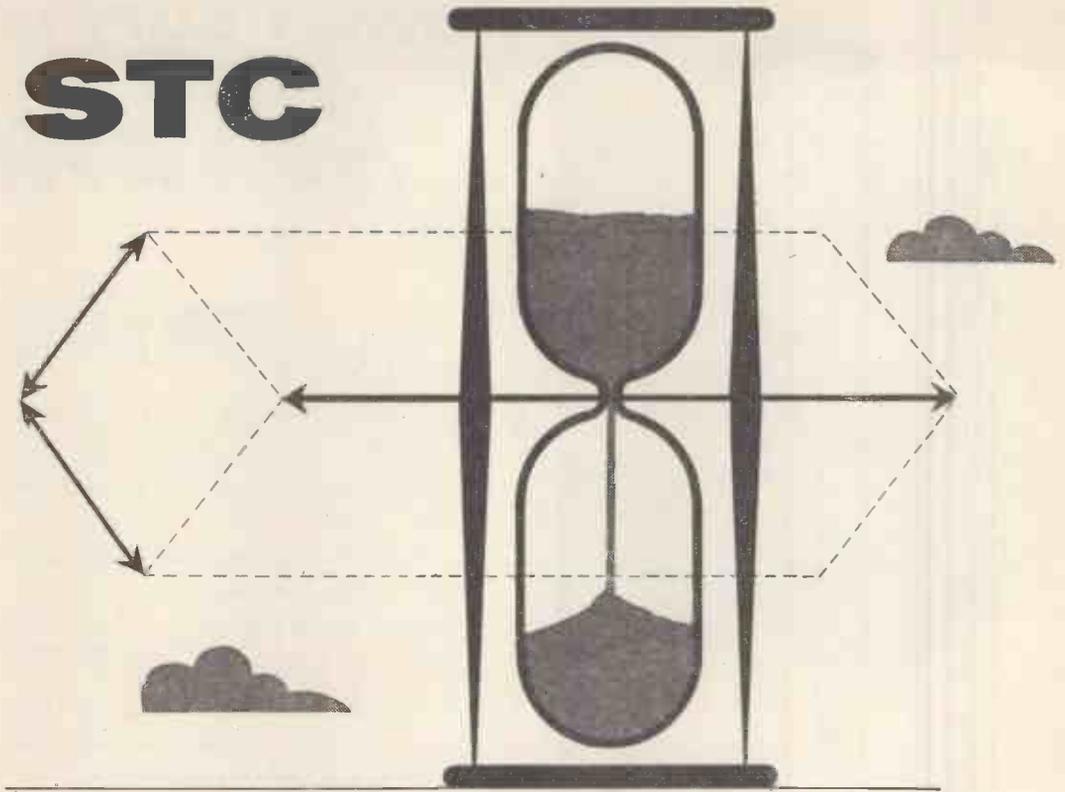
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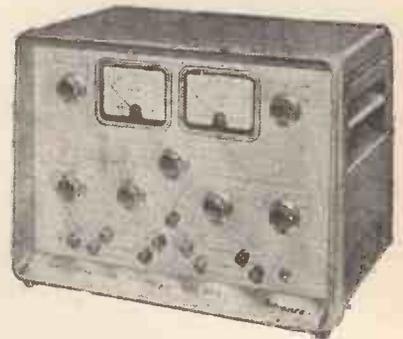
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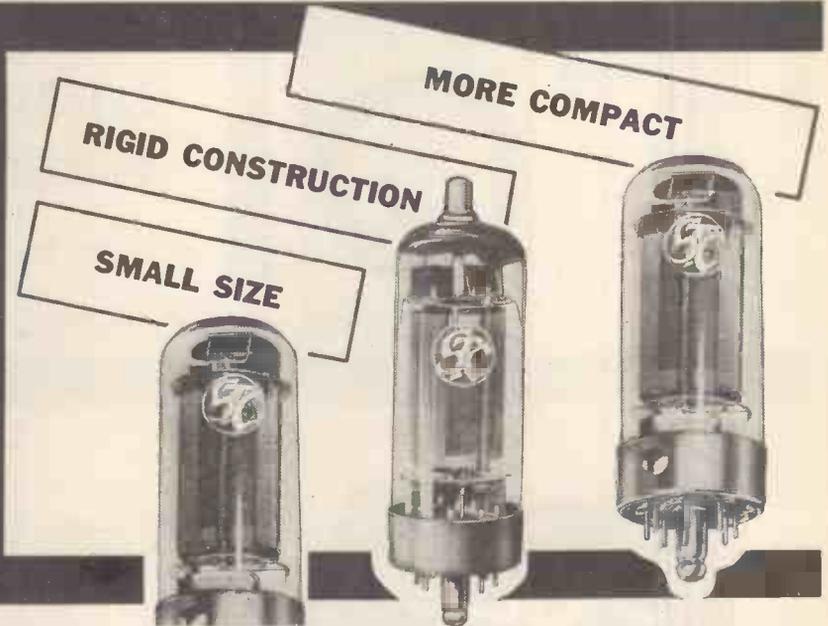
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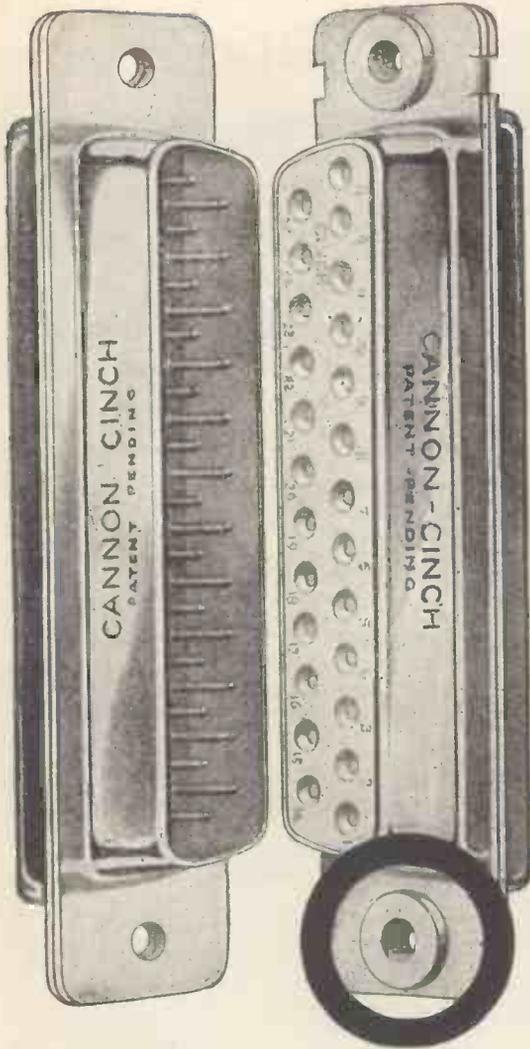
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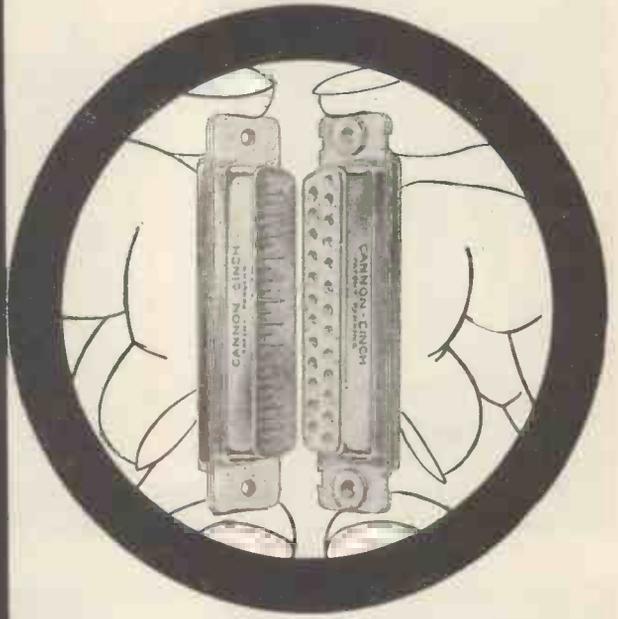
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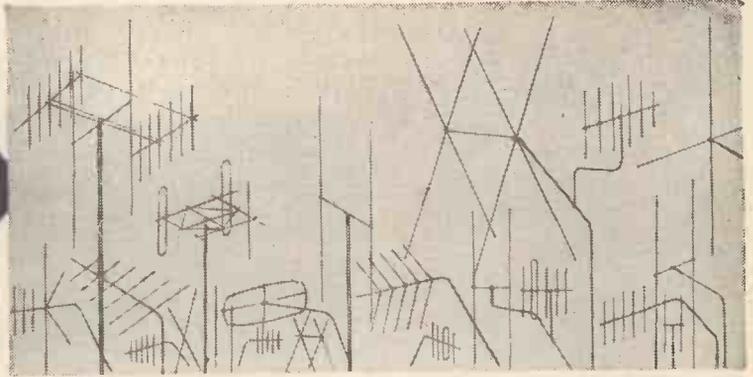
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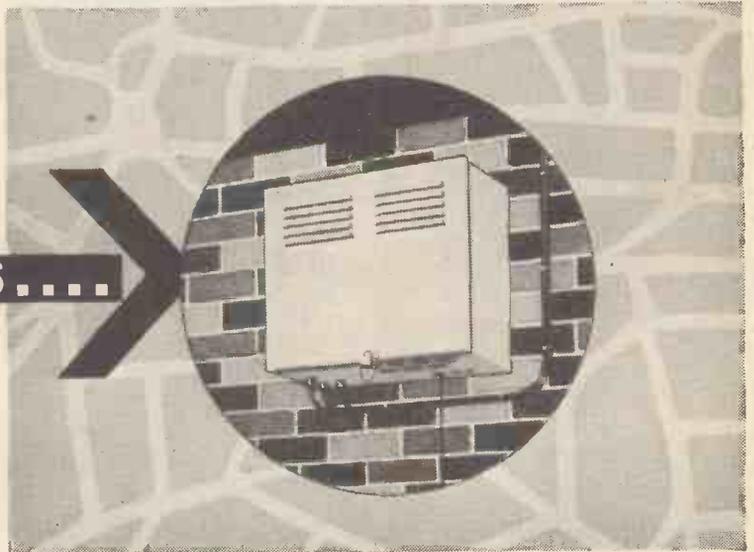
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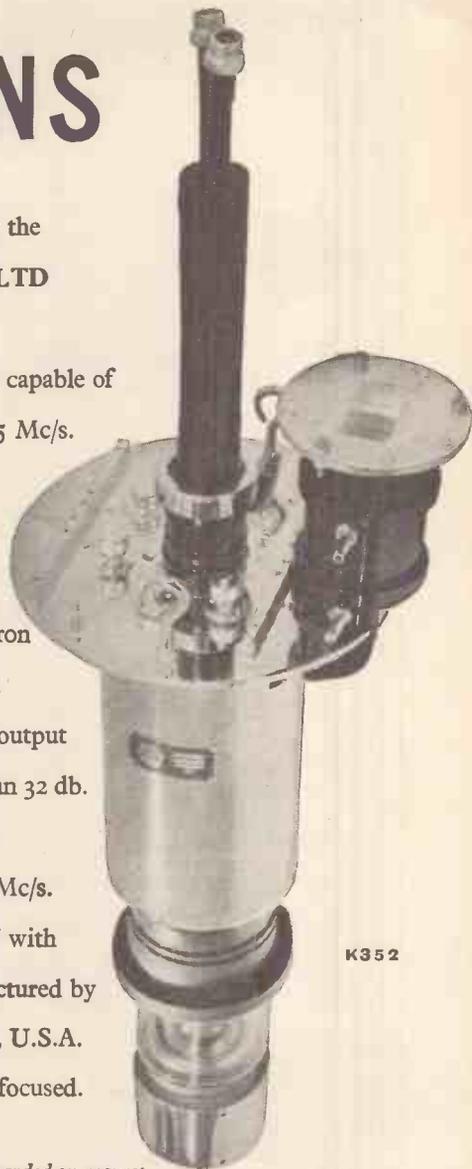
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K347



K352



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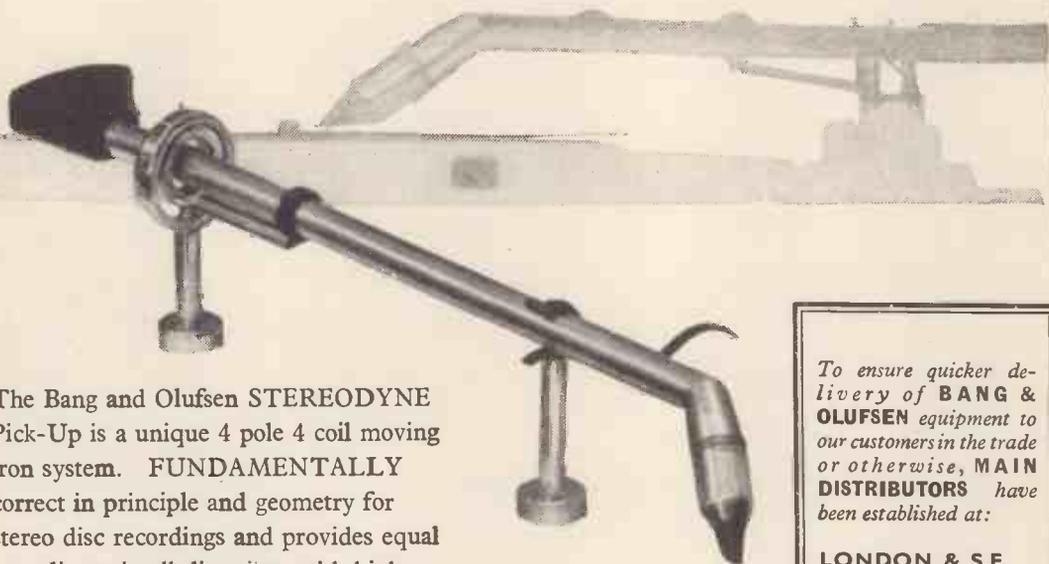
ENGLISH ELECTRIC VALVE CO. LTD.



Chelmsford, England
Telephone: Chelmsford 3491

Perfectly Poised

For true-depth reproduction



The Bang and Olufsen STEREODYNE Pick-Up is a unique 4 pole 4 coil moving iron system. FUNDAMENTALLY correct in principle and geometry for stereo disc recordings and provides equal compliance in all directions with high channel separation through the entire frequency range.

- ★ PRECISION ENGINEERED LIGHT ALLOY ARM
- ★ LOW FRICTION — LOW MASS
- ★ ADJUSTABLE TRACKING PRESSURE 1 - 4 grams.
- ★ PLUG-IN CARTRIDGE — EASY CHANGE, DIAMOND STYLUS
- ★ HIGH OUTPUT — LOW IMPEDANCE, HUM BALANCED SYSTEM

Stereodyne arm complete :	£17.17.0 inc. P.T.
Cartridge	£7. 7 0 inc. P.T.
Diamond stylus	£2.14.0 inc. P.T.

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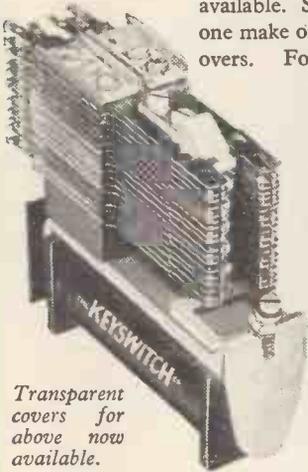


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MAJOR TYPE 'BPO 3000'

The best known and most useful relay available. Spring sets allow from one make or break to 12 changeovers. For minute or heavy switching. Sensitivity down to 20 milliwatts. Adjustable for critical timing, fast or slow operation. Standard or Tropical finish. Special adaptations can be supplied.



Transparent covers for above now available.

and now PLUG-IN 3000 Type Relays

Plug-in facilities in addition to all the versatility and well-established, reliable features of the world's best known relays.

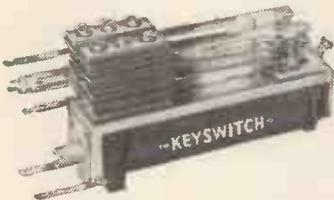
- ★ Positive contact between male and female pins.
- ★ Contacts: up to 18 light duty or 12 heavy duty.
- ★ Complete transistorized units.
- ★ A.C. or D.C. operation.
- ★ Transparent or metal cover.
- ★ Clip retains relay positively in any position.



SOCKETS AND FITTINGS ARE AVAILABLE FROM STOCK for immediate assembly of units.

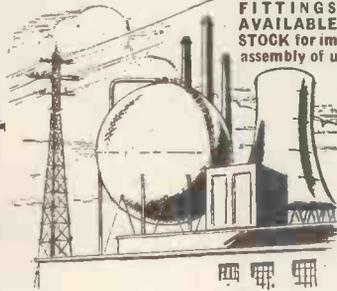
PLUG-IN — TRANSISTORIZED UNIT

Operation AC or DC Switching or Signal Current AC or DC 5 to 500 micro-amps. Transfer switching current 10 amps. or 500 v.



MINOR TYPE '600' (Fitted with double pole changeover for 250 volts, 2 amps.)

Ideal for simple switching operations where lightness, compactness and economy are prime considerations. When fitted with contacts similar to those of the "B.P.O. 3000" type it is faster in operation and release.



This relay incorporates 15 amp. Micro Switch; 5 amp. Mercury Switch and standard 0.3 to 8 amp. contacts.



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The results have far surpassed our most optimistic expectations, for we go from strength to strength, and today there is hardly any part of the world in which **HALTRON** receiving and transmitting tubes are not doing a first class job.

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1. We have the most comprehensive stock in the world of receiving, special purpose, transmitting tubes and also transistors, totalling over 3,000 types.
2. Most competitive prices, consistent with quality.
3. Prompt shipments, which is the envy of our competitors.

If you are not on our mailing list, please contact us. Your enquiries for special types to CV, JAN, MIL specifications are invited.

OUR ORGANISATION IS AIR REGISTRATION BOARD APPROVED.

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Tel.: Gulliver 8531 (10 lines) Telex 2-2573 Cables: "Hallectric London"



*A simple
and logical
system of
control*



The Quad 22 Control Unit incorporates every practical refinement for the full appreciation and enjoyment of the discriminating listener. For instance . . .

THE BALANCE CONTROL

Immediately beneath the volume control is a differential balance control used to correct any volume level unbalance between the two channels, in the programme. With proper control in record manufacture or radio broadcasting this control should require little attention after initial adjustment for listening environment.

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**FOR THE
CLOSEST
APPROACH TO
THE ORIGINAL
SOUND**



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GM 6025

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It should be noted that all Philips electronic voltmeters contain calibration standards which enable the user easily and rapidly to check, and, if necessary, to re-calibrate his voltmeter at any time without the use of additional instruments.

PHILIPS *electronic measuring*

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Overseas enquiries please, to the manufacturers,

N.V. Philips, EMA-Department, Eindhoven, the Netherlands.

VHF Voltmeter, type GM 6025
frequency range up to 800 Mc/s
sensitivity 10mV f.s.d.

Frequency range

0.1 Mc/s - 800 Mc/s flat from 1 Mc/s - 300 Mc/s
 - 1dB at 0.1 Mc/s (see graph below)
 + 1dB at 800 Mc/s

Measuring range

10 mV (f.s.d.) - 10 V divided into 7 ranges in a 1-3-10 sequence.

Accuracy

The overall accuracy is better than 5% with respect to full scale.

Input impedance

Input capacitance : 1 μ F
 Input resistance at:
 1 Mc/s 65 k Ω
 100 Mc/s 50 k Ω
 200 Mc/s 35 k Ω

Linear scale

Thanks to voltage-dependent feed-back the scale is linear. It is calibrated directly in the r.m.s. value of the VHF voltage and has an effective length of 5".

Calibration voltages

The frontpanel contains a calibration socket which for any setting of the measuring selector provides the appropriate calibration voltage for that range.

Replacement of the probe crystal

The probe crystal can be easily replaced and the instrument rapidly re-calibrated by the user.

Coaxial T-connector

For measurements on 50 Ω -coaxial lines the T-connector, type GM 6050T can be ordered separately.

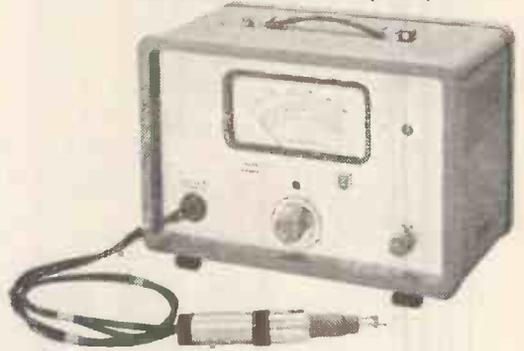


GM 6012

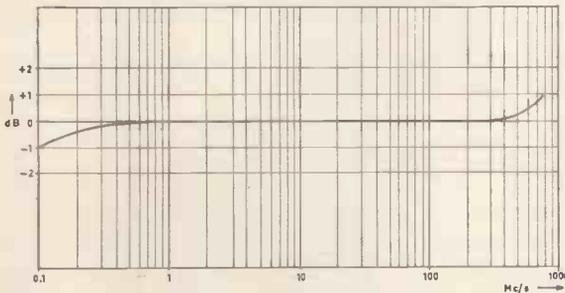
2 c/s - 1 Mc/s, 1 mV (f.s.d.) - 300 V

GM 6014

1 kc/s - 30 Mc/s, 1 mV (f.s.d.) - 30 V



millivoltmeters



Response curve with T-connector, type GM 6050T

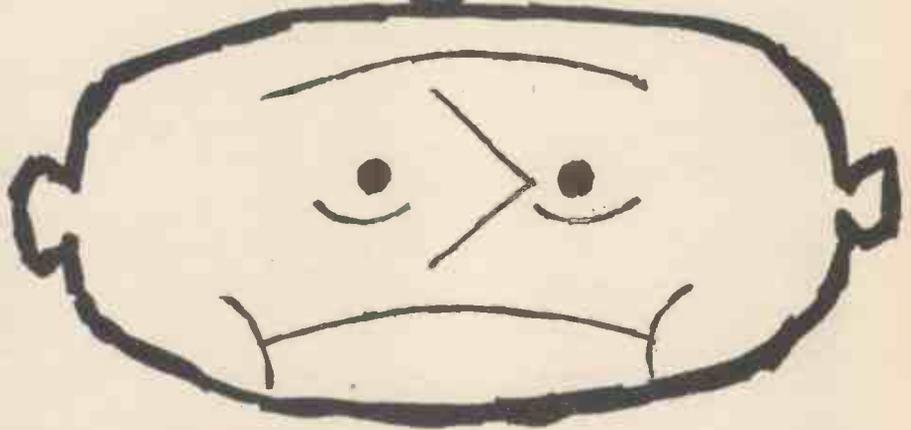
GM 6020 D.C. 100 μ V (f.s.d.) - 1000 V



instruments: quality tools for industry and research



MI5?
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MCC?
mpg?



MS4

that's
the stuff!

MS4? Extraordinary sort of name.

Still it's extraordinary sort of stuff—a non-melting, highly water-repellent silicone grease with excellent dielectric properties and a working temperature range of -50° to $+200^{\circ}\text{C}$. Extraordinarily good for lubricating, protecting and sealing disconnectable plugs and sockets, cable harnesses, ignition circuits, for maintaining high surface resistivity in wet conditions, for lubricating turret tuners and preventing 'leakage' around the anode caps of CRT's—in fact for so many uses that we cannot possibly list them all here. Why not write in for our special brochure on MS4?

MS4 Silicone Insulating Compound

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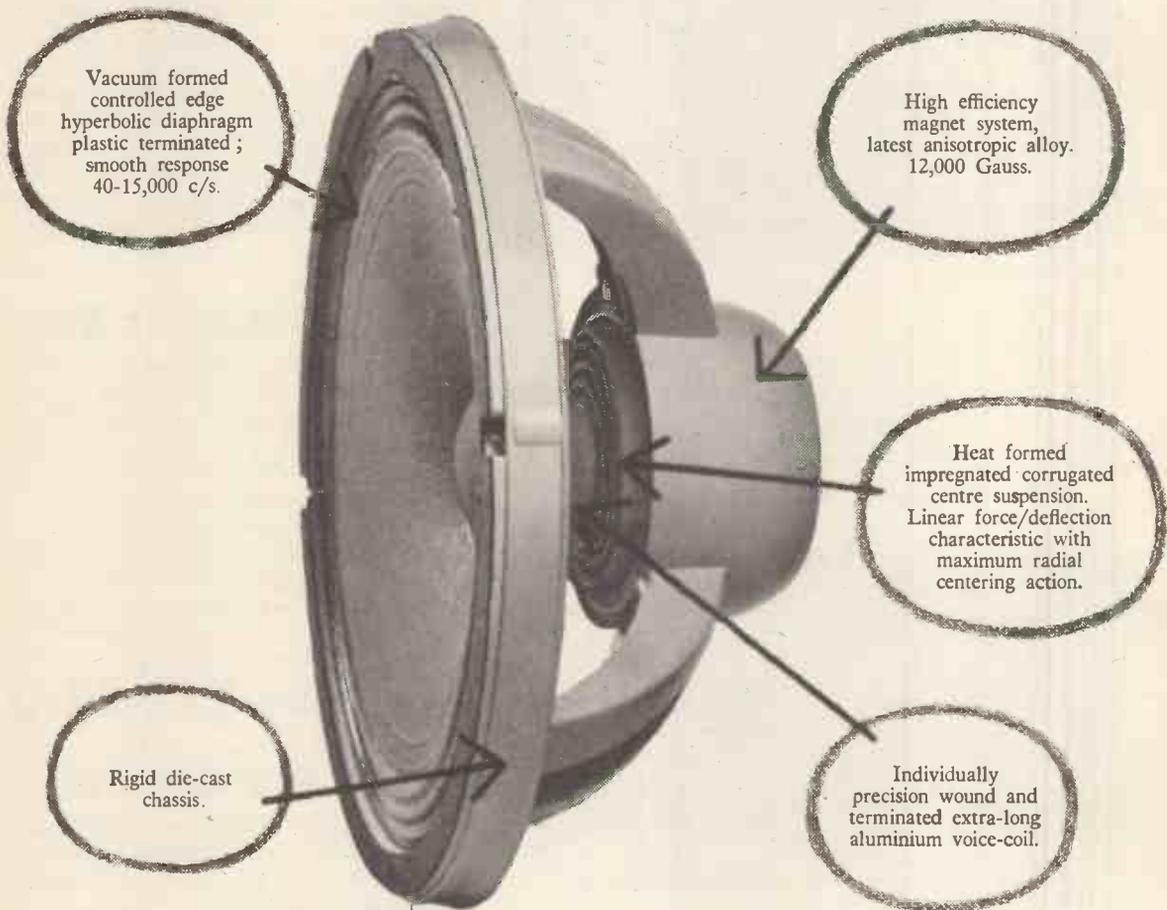
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Vacuum formed controlled edge hyperbolic diaphragm plastic terminated; smooth response 40-15,000 c/s.

High efficiency magnet system, latest anisotropic alloy. 12,000 Gauss.

Heat formed impregnated corrugated centre suspension. Linear force/deflection characteristic with maximum radial centering action.

Individually precision wound and terminated extra-long aluminium voice-coil.

Rigid die-cast chassis.

AXIOM 110.

Frequency range : 40-15,000 c/s.
Power Handling : 10 WATTS.
Fundamental resonance: 45 c/s.
Flux Density : 12,000 Gauss.
Impedance : 15 Ohms.

Price £3. 15. 9.
(Plus P.T. £1. 4. 3.)

—and if **EXTRA POWER HANDLING** and **EVEN BETTER TRANSIENT PERFORMANCE** is required—the **AXIOM 112** has a capacity of **12 WATTS** and a flux density of **16,000 GAUSS.**

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Frequency range : 40-15,000 c/s. Power Handling : 12 Watts .
Fundamental resonance : 45 c/s. Flux Density : 16,000 Gauss.
Impedance 15 Ohms.

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Please send copy of High Fidelity Manual.

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GOODMANS INDUSTRIES LIMITED

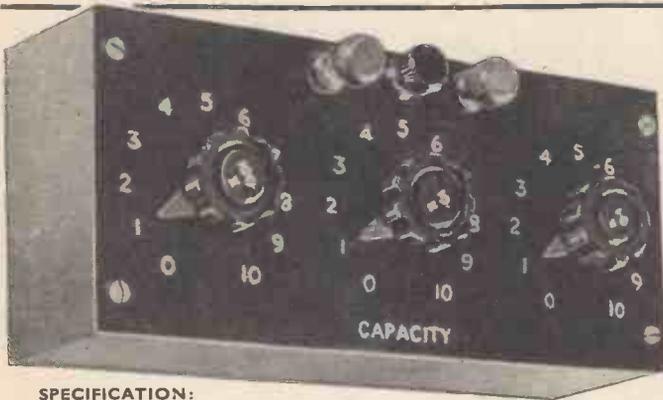
Axiom Works, Wembley, Middlesex.

Tel.: WEMbley 1200 (8 lines) Grams : Goodaxiom, Wembley, England.

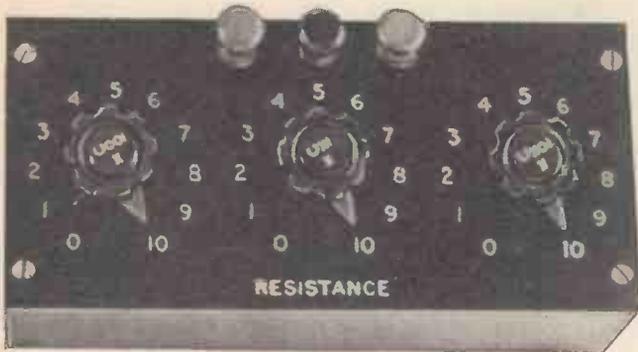
Available in all countries

In every sense the greatest range—in every country the greatest name.

WINSTON DECADE BOXES



SPECIFICATION:
 Range .001 mfd. to 1.11 mfd.
 Zero capacitance 50 pf.
 Accuracy $\pm 5\%$.
 Maximum voltage 750V D.C.
 Terminals Screw type.
 Mounting Metal case and panel.
 Finish Blue hammertone case.
 Black and silver photoetched panel.
 Dimensions Height 3 ins. (7.5 cms.)
 (overall) Width 8 ins. (20 cms.)
 Depth $3\frac{1}{2}$ ins. (9.5 cms.)
 Weight 5 lbs. (2.3 Kgs.)



SPECIFICATION:
 Range 100 ohms to 111,000 ohms.
 Zero resistance 0.006 ohms.
 Accuracy $\pm 1\%$.
 Maximum current: 10's decade 100 mA.
 100's decade 35 mA.
 1000's decade 10 mA.
 Terminals Screw type.
 Mounting Metal case and panel.
 Finish Blue hammertone case.
 Black and silver photoetched panel.
 Dimensions Height 3 ins. (7.5 cms.)
 (overall) Width 8 ins. (20 cms.)
 Depth $3\frac{1}{2}$ ins. (9.5 cms.)
 Weight 5 lbs. (2.3 Kgs.)

These resistance and capacitance decades were developed by one of our engineers some years ago. The reason for the development was that when engineers wish to ascertain the required value of a condenser or resistance in a part of a circuit, or when they are using decades for normal test functions, there is no point in purchasing expensive decades of the 1% variety. Our engineer considered that resistance and capacitance boxes giving normal commercial tolerances at about one-quarter of the normal price would be most attractive to laboratories, universities and factories throughout the world.

Decade Capacitor Box

Accurate decade capacitors are valuable for use in work where a widely variable capacitor of accurately known value is required for audio frequency use. Mechanical and electrical shielding is provided by the metal case and panel. The capacitor elements have no electrical connection to the case and panel for which a separate shield terminal is provided. Positive detent mechanisms and pointer knobs permit the operator to sense the switch position without looking.

Price £11-11-0

Decade Resistor Box

Accurate decade resistors are valuable for use in work when a widely variable resistance of accurately known value is required for D.C. and audio frequency use. Mechanical and electrical shielding is provided by the metal case and panel. The resistance elements have no electrical connection to the case and panel for which a separate shield terminal is provided. Positive detent mechanisms and pointer knobs permit the operator to sense the switch position without looking.

Price £13-13-0

WINSTON

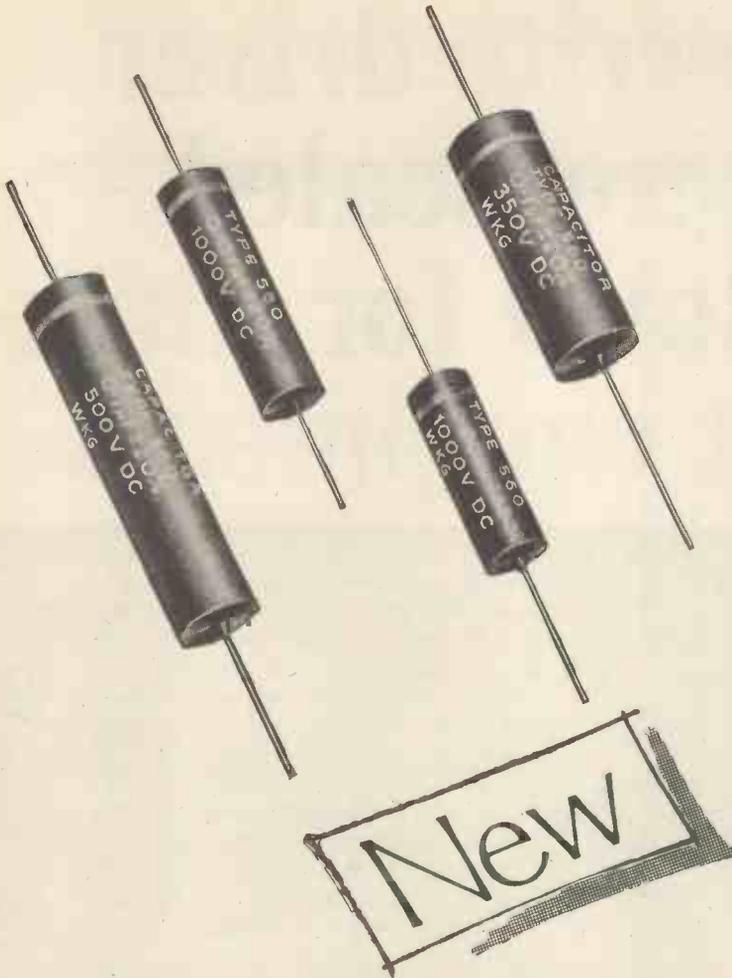
ELECTRONICS LIMITED

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● No exposed metal parts other than terminations, which are clean solder coated, thereby ensuring easy soldering.

● Body and terminations free of wax coating or any other low melting point material.

● Long life without voltage derating.

● Designed to meet the requirements of British Joint Service Standards RCS 131 and BS 2131 with humidity classification H.2.

● Solid construction eliminates internal movement, preventing damage by severe vibration.

DUBILIER ENCAPSULATED PAPER DIELECTRIC TUBULAR CAPACITORS HAVING OUTSTANDING CHARACTERISTICS

The Dubilier Capacitor Type 560 is a new approach to capacitor requirements for all radio and electronic applications. It is constructed to meet long and arduous service conditions. The paper dielectric element is impregnated with a plastics material to produce a solid unit. The terminations are of great mechanical and electrical strength and the assembled element is sealed in an encapsulated mineral loaded epoxy resin so that there are no parts capable of movement, making the capacitor completely immune to shock and all normal atmospheric conditions.

Capacitance Tolerance; $\pm 20\%$ normal $\pm 10\%$ by selection. Power Factor; Less than 1% at 1,500 c/s. Insulation Resistance; Better than 20,000M Ω at normal temperature. Voltage Application; From -40° to $+125^\circ\text{C}$ for d.c. and from -40° to $+70^\circ\text{C}$ for a.c.

CAPACITANCE μF	VOLTAGE RATINGS			DIMENSIONS	
	d.c. Wkg. at -40°C to $+125^\circ\text{C}$	d.c. Test at 20°C	a.c. Wkg. r.m.s. at -40°C to $+70^\circ\text{C}$ and up to 60 c/s	Diameter $+0.020^\circ$ -0	Length $\pm 0.040^\circ$
0.001	1,000	2,500	250	$\frac{1}{8}$	1
0.002	1,000	2,500	250	$\frac{3}{16}$	1
0.005	1,000	2,500	250	$\frac{1}{4}$	1
0.01	1,000	2,500	250	$\frac{5}{16}$	$1\frac{1}{8}$
0.02	750	2,250	250	$\frac{3}{8}$	$1\frac{1}{4}$
0.05	500	1,500	250	$\frac{1}{2}$	$1\frac{1}{2}$
0.1	350	1,000	180	$\frac{5}{8}$	$1\frac{3}{4}$
0.1	500	1,500	250	$\frac{3}{4}$	$1\frac{3}{4}$

DUBILIER

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA ROAD, NORTH ACTON, LONDON W.3.
 Telephone: ACOrn 2241 (5 lines) Telegrams: Hivoltcon London Telex
 Cables: Hivoltcon London Telex: 25373

DN 2428

ferrite driver transistor scaled down for ultra- compact equipments

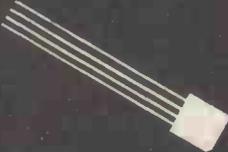
The OC123 is a ferrite core driver transistor similar to the OC23, but scaled down into a small metal can for those applications where space saving is of cardinal importance—such as in closely packed printed circuit boards—and where the dissipation rating need not be so high as with the OC23.

The total dissipation rating of the comparatively small OC123 is, in fact, 200 mW at an ambient temperature of 45°C. The peak current is 1 amp, and the voltage rating and current gain are also high. Even at a collector current of 1 amp α' is 50 minimum.

The OC123 is particularly suitable for gating current pulses generated by its larger companion type OC23 for driving ferrite cores. In such an application, a 350mA 2 microsecond pulse with a leading edge rise time of 0.4 microsecond can be passed by the transistor when it is fully bottomed.

Abridged details are given below—for full data please write to Mullard House.

V_{cb} max. ($I_e = 0$)	-50 V
V_{ce} max. ($V_{be} > +0.5V$)	-50 V
V_{ce} max. ($I_c = 0.5A$)	-25 V
i_c (pk) max.	1.0 A
I_c (av) max. (averaging time 20 ms)	0.5 A
P_{tot} at 45°C ambient	200 mW
T_j max.	90°C
Junction temp. rise above ambient in free air	0.22°C/W
Junction temp. rise above case	0.06°C/W
V_C (knee) ($I_C = 400$ mA)	-350mV
f_1 ($V_C = -2V, I_C = 100$ mA, $T_j = 25^\circ C$)	1.5Mc/s



OC123

Mullard

industrial
semiconductors



COMPACT SPEAKER SYSTEMS

with clean bass

In each of the models mentioned in this advertisement L.F. output is produced by a special 12in. unit type WLS/12 fitted with a heavy cone and a new type of suspension which permits large linear excursions and gives a low fundamental resonance of 25/30 c/s.



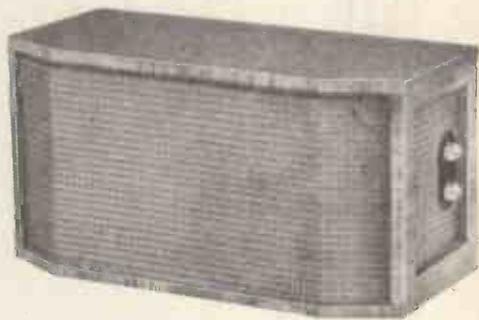
W2

A two-speaker model complete with treble volume control. Cabinet size 23½" x 14" x 12". Weight 42 lb. complete. Impedance 15 ohms. Max. input 15 watts. Price **£29.10.0** complete, tax free.



W3

A three-speaker system complete with mid-range and treble volume controls. Cabinet size 28" x 14" x 12". Weight 48 lb. complete. Impedance 15 ohms. Max. input 15 watts. Price **£39.10.0** complete, tax free.



W4

A four-speaker system complete with mid-range and treble volume controls. Cabinet size 35" x 24" x 12". Weight 65 lb. complete. Impedance 15 ohms. Max. input 15 watts. Price **£49.10.0** complete, tax free.

Each model is available in a choice of Walnut, Oak or Mahogany Veneers. Also available in Whitewood slightly cheaper. Tropical models with resin bonded plywood approximately £2 extra.

Wharfedale

WIRELESS WORKS LTD
IDLE BRADFORD YORKS

Catalogue giving full technical details, response curves and oscillograms of the above models, available on request.

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Telegrams: 'Wharfdel' Idle, Bradford

welded wire terminations



MASTERPIECES IN MINIATURISATION

Advanced production methods incorporating such important refinements as welded terminal wires, enable Swindon Condenser Company Limited to offer the smallest electrolytic capacitors of their type in the world. These masterpieces of miniaturisation are an outcome of advanced basic research. The type of research that is widely associated with this Company, and its performance-proved products.

As examples of maximum capacitance, voltage and size within the range, the following may be of interest. The full range includes more than one hundred. Others can be provided on request.

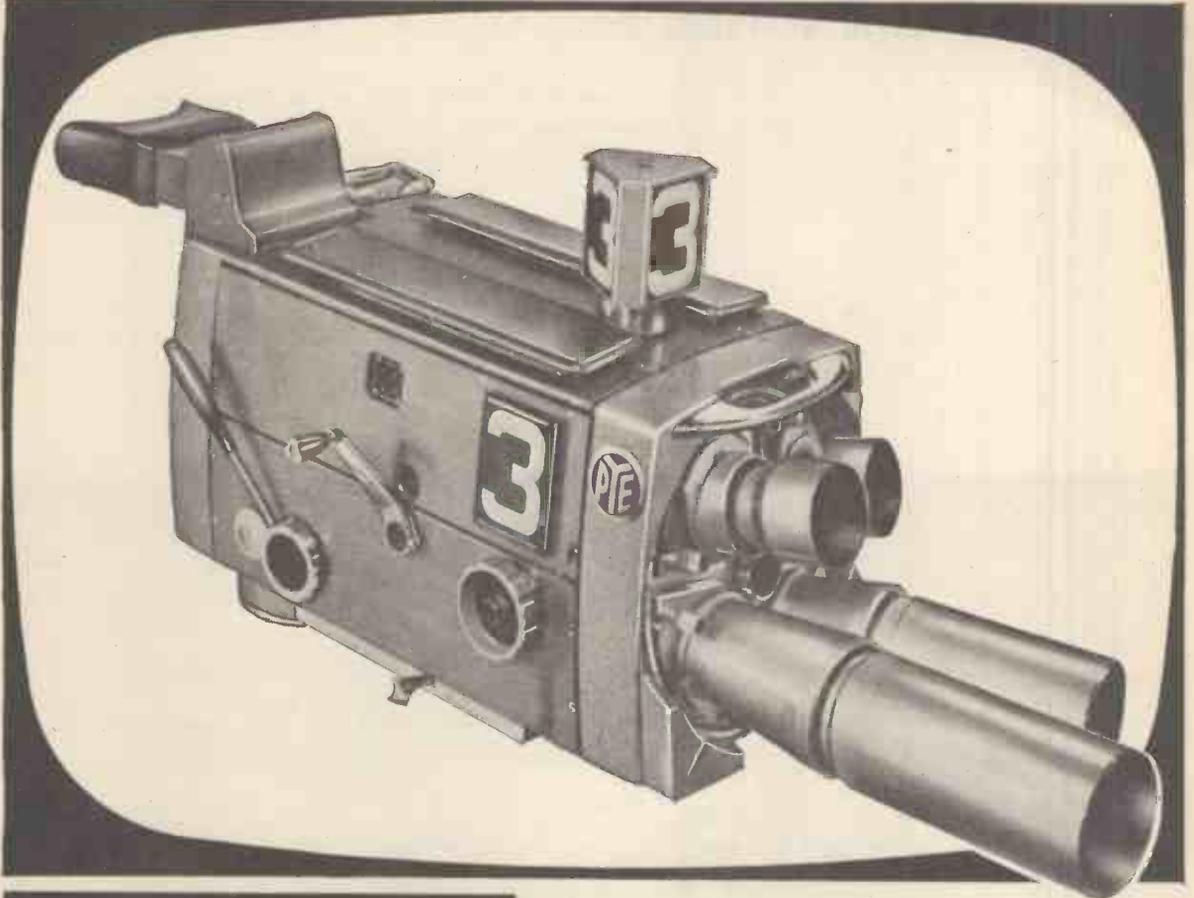
Maximum Capacitance MFD	Working Voltage	Size (Diameter)	Size (Length)
50	6	1/4"	5/8"
40	6	3/16"	5/8"
12	3	1/8"	9/16"
2	6	1/10"	13/32"

WELDED WIRE TERMINATIONS—*Patent applied for*



SWINDON CONDENSER COMPANY LIMITED

Industrial Estate, Swindon, Wiltshire
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The New



**3" IMAGE
ORTHICON
TV CAMERA**

4½" also available

Exacting standards of design have resulted in a high-grade camera capable of reproducing the fine picture quality demanded in studio use, yet, at the same time, light and strong enough for field use.

OUTSTANDING FEATURES:

- ★ Pick-up Tube can be replaced in one minute without disturbing cover or lenses.
- ★ 'Image orbiting' device reduces risk of target 'burn-in'.
- ★ Built-in hour meter records pick-up tube running hours.
- ★ Electronic viewfinder with 7" diagonal rectangular tube. It presents a picture which is perpendicular to the line of vision.
- ★ All chassis of plug-in type for easy maintenance and replacement.
- ★ Servo control of light by filter or iris.
- ★ Thermostatic temperature control of pick-up tube.



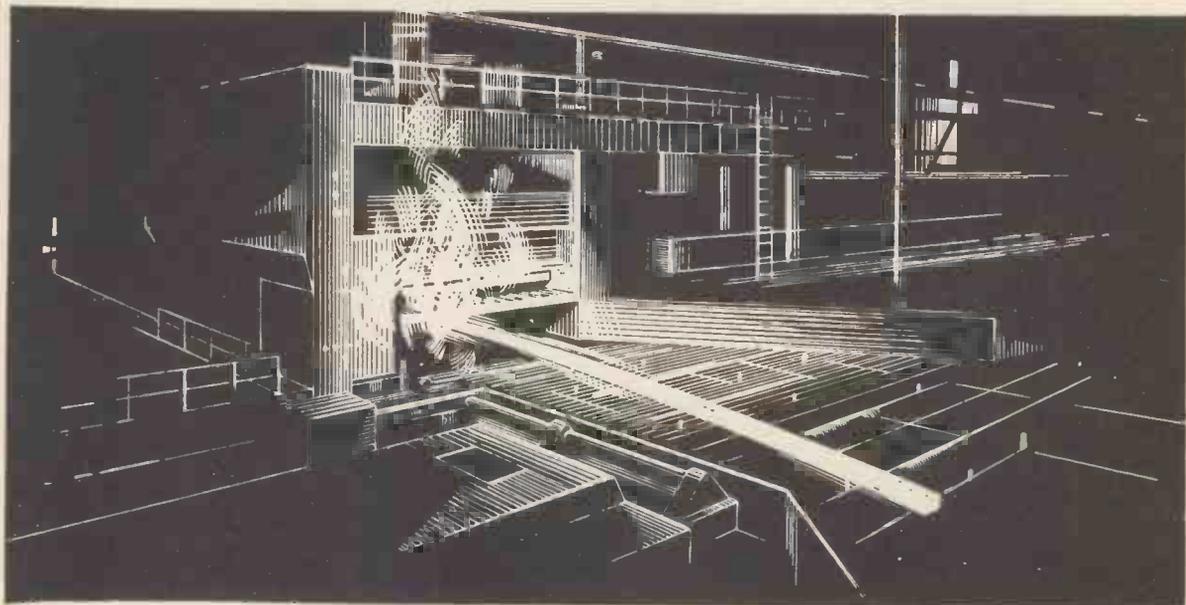
For full technical details, please write to:

PYE T.V.T. LIMITED, CAMBRIDGE, ENGLAND

Gates to the World of Tomorrow

Automation—which means rational, continuous production, increased output in all branches of industry. Even in rolling mills gigantic production units today operate with the highest precision without the control of a human hand. The perfected electronic equipment of the machinery permits of control at the highest possible speed without any delayed action, so that the shortest turn-round times are rendered possible.

Thyratrons only need a hundred-thousandth part of a second in order to effect switching operations. This is one hundred times less than the shortest exposure time of a precision camera—and it just cannot be compared at all with the time required for human reactions.



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LATEST DESIGN—
RELIABILITY**



Essential Tools for Automation

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★Underline the ones you are interested in.

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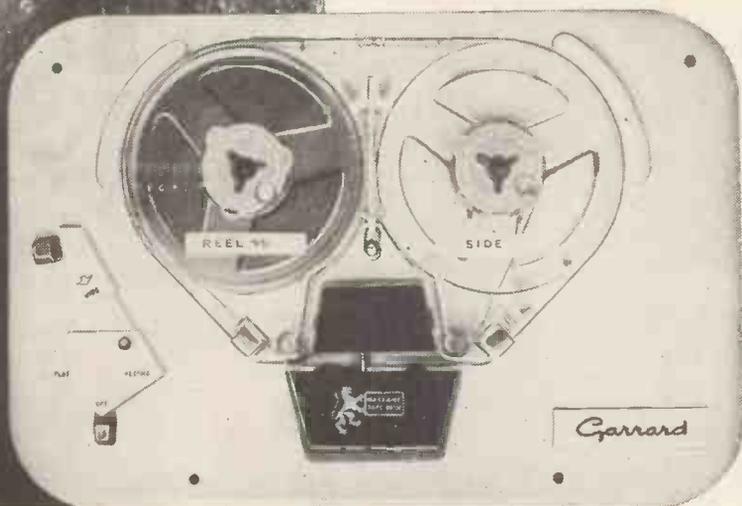
REMARKS

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Designed by Garrard to bring quality tape recording and playing within the range of everyone. Controls reduced to an absolute minimum plus magazine loading—anyone can operate this deck. No threading, anchoring or spilling of tape. All the pleasures of tape recording without the headaches.

THE MAGAZINE TAPE DECK



only with

Garrard

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For the guidance of the trade and public we publish below a list of the most popular ELAC replacement loudspeakers.

We have made this selection from our wide range of speakers as they cover practically all the requirements of the replacement trade.

The new prices are now operative.

POPULAR REPLACEMENT MODELS

Type	Ref	Flux	Retail Price	Purchase Tax
5in.	5G	6500 g	20/6	6/7
6½in.	6G	6500 g	21/6	6/11
7 x 4in.	47G	6500 g	20/6	6/7
7 x 3in.	37G	6500 g	20/6	6/7
8 x 3in.	38G	6500 g	20/6	6/7
8 x 5in.	58C	8500 g	24/6	7/10
8in.	8C	7000 g	25/6	8/2

All loudspeakers have Standard 3 Ohm impedance. Higher impedances can be supplied at an extra cost of 3/- plus 1/- Purchase Tax.

Please write for leaflets and further details.



ELECTRO ACOUSTIC INDUSTRIES LIMITED

Stamford Works, Broad Lane, Tottenham, N.15 Tel: TOTtenham 0505

MODEL 5G-5"



MODEL 6G-6½"



MODEL 58C-8x5"



MODEL 8C-8"



THE SCALE IS INSIDE!



EDISWAN 6-In. Aluminised Indirectly Heated Cathode Ray Tube for Radio DF Compass and other applications. High Brightness Level. Internal Scale.

This Ediswan Radio DF Compass Tube ends parallax errors for the simple reason that the scale is printed on the inside face in actual contact with the phosphor screen. The scale pigment used is completely inert and unaffected by the electron beam. It is a dense black and does not fade after prolonged use.

Contrast is further improved by the aluminised screen which greatly intensifies the brilliance of the trace.

Anti-Dazzle Face All CRTs in this range have a flat face, treated on the outside with a robust process which eliminates distracting specular reflections and gives the impression of a soft matt ground glass finish.

Scale Applications The tube is available with an octantly corrected scale (31C1) or a uniformly graduated scale (31C2). Other versions can be supplied printed with selected portions of the Smith's Impedance Diagram.

Invitation We should welcome discussions with designers and manufacturers who have specific requirements involving special scales.

BRIEF SPECIFICATION		
Heater voltage (volts)	V_h	40-63
Heater current (amps)	I_h	0.72-0.8
Anode voltage, rating (kV)	V_a (max)	100
Anode voltage, typical operation (kV)	V_a	85

EDISWAN

INDUSTRIAL VALVES & CATHODE RAY TUBES

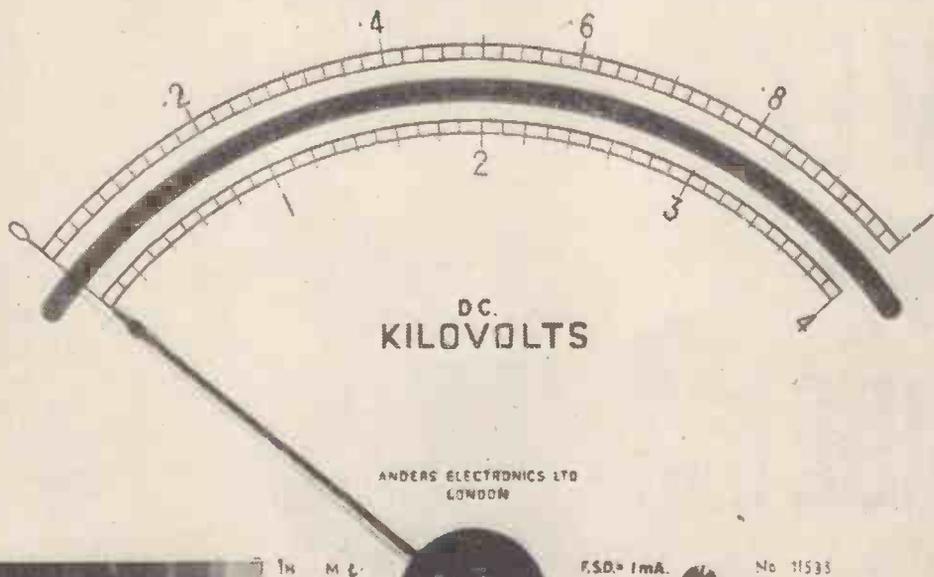
Associated Electrical Industries Limited

Radio & Electronic Components Division

155 CHARING CROSS ROAD, LONDON W.C.2. TELEPHONE: GERRARD 8660

ERC 16/13

meters made to measure



This Multi-range E.H.T. Series 705 meter is one of a number of instruments supplied to the M.O. Valve Company Ltd. by Anders Electronics at very short notice. These meters are used in the M.O. Valve Company Production Test Equipment for Travelling Wave Tubes shown here. Just the kind of work Anders excel in: special meters for very special equipment. Anders are indebted to the M.O. Valve Company for their kind permission to illustrate this test gear.

special EHT meter rushed through for MO Valve Company

The Anders Instrument Centre is in a unique position to meet the most urgent, and the most unusual, meter requirements from production, development and research. Many standard meter ranges are available immediately from stock. Non-standard meters are calibrated, tested and normally ready within 10-14 days. All shapes; sizes from 1½" to the largest switchboard meters. All well-known makes and all types including moving coil, moving iron, thermocouples, electrostatic, dynamometers and full range of meter accessories. Anders would like to demonstrate the kind of service they can give you and look forward to your enquiries, by letter or by telephone.

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FOR INSTRUMENT TUBES



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the

ETEL

range

It is more than likely that your instrument tube requirements can be met by the present comprehensive range now available from Electronic Tubes Limited. Economy with performance is characteristic of this range which is the outcome of years of specialisation in the design and production of instrument cathode ray tubes.

Brief details of the range are given here — for full data please use the coupon at the foot of the page.

ABRIDGED DATA — Typical operation

TUBE	ICPI Monitor	3AFPI General Purpose	3AZPI Double Gun*	4EPI General Purpose	4LPI Split Beam	5BKPI Helical P.D.A.	5BUPI General Purpose	5BVPI High Writing Speed	5BVPIA High Writing Speed	5CLPI High Sensitivity
V _{a1} (kV)	0.5	1.0	1.5	2.0	1.5	1.4	2.0	4.0	1.5	1.5
V _{a3} (kV)	0.5	1.0	1.5	2.0	1.5	1.8	2.0	4.0	4.0	1.5
V _{a4} (kV)	—	—	—	4.0	3.0	4.0	4.0	8.0	8.0	15
V _{a5} (kV)	—	—	—	—	—	10	—	—	—	15
Y scan (mm)	28	55	70	80	75	60	95	95	95	60
Y sensitivity .. (V/cm)	45	11.5	16	23	27	12.5	17.5	36	36	2.7
X scan (mm)	28	55	90	90	90	95	115	115	115	100
X sensitivity .. (V/cm)	53	20	23	36	27	26.5	29	60	60	11.2
Screen diameter (mm)	30	71	94	108	108	137	137	137	137	137
SCREEN TYPES:										
Medium persistence ..	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Long afterglow	No	Yes	Yes	Yes	Yes	Yes	To order	To order	To order	To order
Blue photographic ...	To order	To order	Yes	Yes	Yes	To order	To order	To order	To order	To order
Short persistence	To order	No	No	To order	No	No	No	To order	To order	No

* Data is given for each gun.

Please send me data on the types ticked

Name.....

Position.....

Company.....

Address.....

.....

.....

ICPI 5BKPI

3AFPI 5BUPI

3AZPI 5BVPI

4EPI 5BVPIA

4LPI 5CLPI



Electronic Tubes Limited

Kingsmead Works · High Wycombe · Bucks
Telephone: High Wycombe 2020

Transistorized analogue frequency meter

TYPE TSA501

Skilled transistor circuit design has produced an extremely compact instrument giving accurate readings over an exceptionally wide frequency range. Ten steps . . . selected by a 10-position switch . . . cover the range 3 c/s to 300 kc/s, each step being capable of expansion x3 or x10. At the lower frequencies the meter needle can be damped, for greater facility in reading, by a x5 or x20 time-constant.

The instrument can be made fully portable by fitting two standard 6V batteries inside the case. Provision is also made for operation from external supplies of 12V, 100-125V or 200-250V.

This is just one of a great variety of electronic instruments manufactured by Venner for industrial and research applications. Our 'short form' catalogue describes many more; if you have not yet received your copy, send us a note on your company letter-head and it will be sent by return of post.

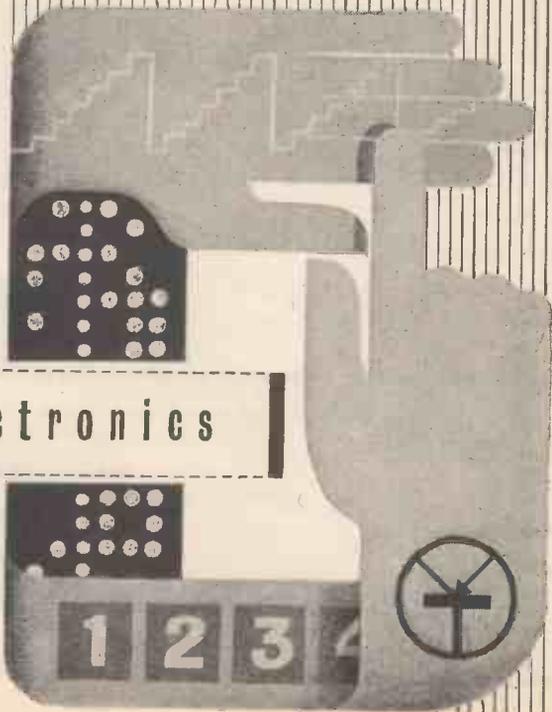
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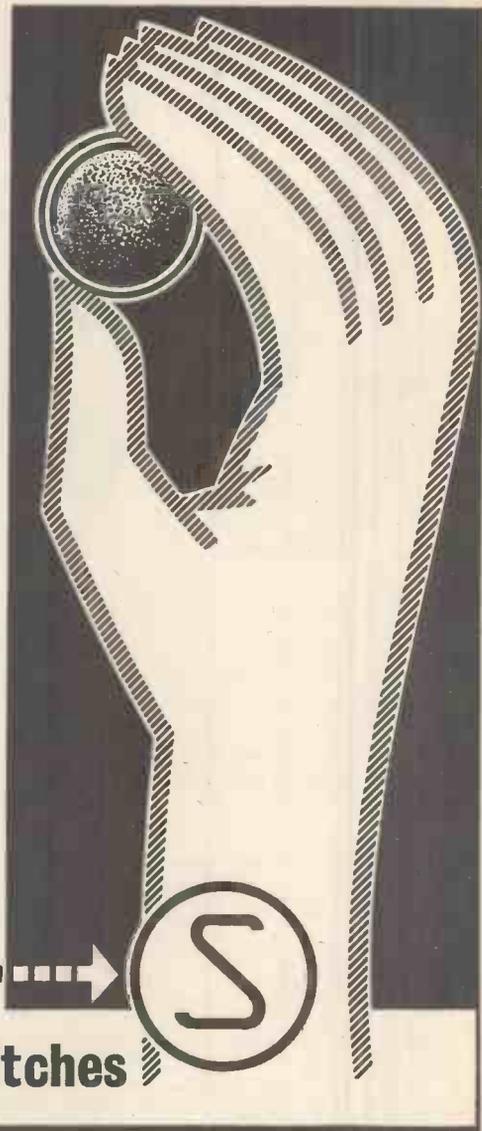


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on-off-
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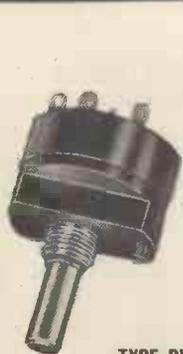
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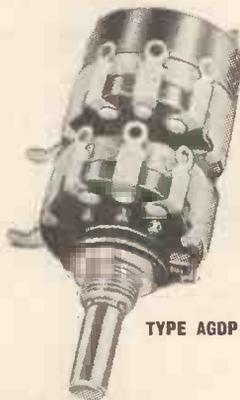
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TYPE RV



TYPE ADP



TYPE AGDP



TYPE AMDP

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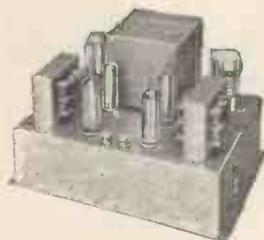
Output 8 watts. Frequency response 30-20,000 c.p.s. Hum -70 db. Output impedance 3 and 15 ohms. Price £19.19.0



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Providing outstanding reproduction when used in conjunction with Stentorian 8in. or 10in. units. Provision for Tweeter Unit. Size 33in. x 19in. x 19½in. Price £11.11.0

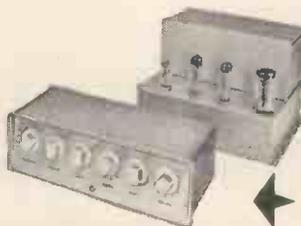
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JUNIOR BASS REFLEX CORNER CONSOLE

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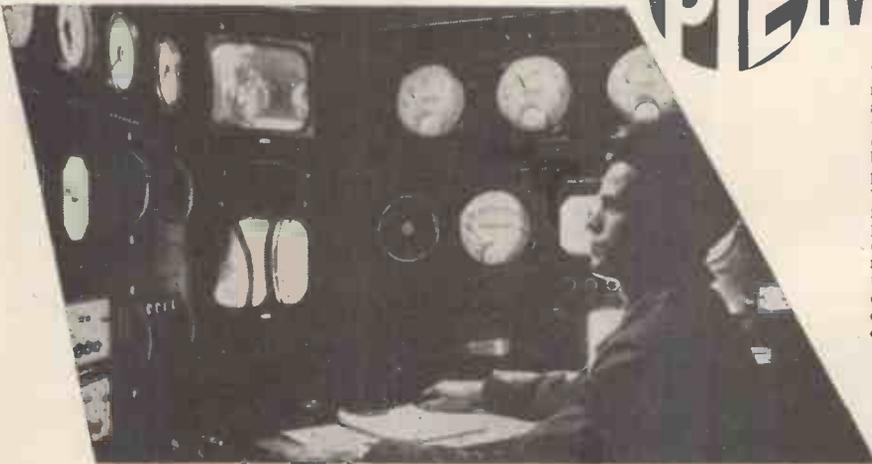




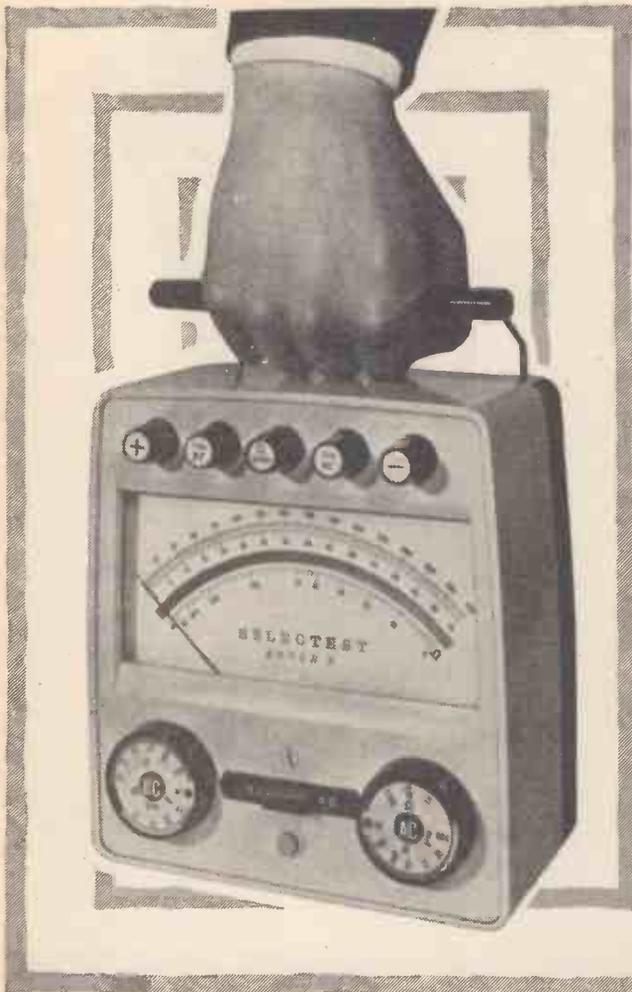
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THE BRENELL MARK 5 TAPE RECORDER

No small amount of money this. Nevertheless, you know that a machine which really satisfies an enthusiast, usually costs much more. The question of how much value for money does the Brenell offer, is largely answered by the specification below. We believe you will agree that it leaves little or nothing to be desired. But even that is not all. The Mark 5 (and every other Brenell) now has a main motor of a new and remarkable kind. An **HYSTERESIS SYNCHRONOUS MOTOR** with a balanced outer rotor, and a heavy statically and dynamically balanced flywheel. It brings 'wow and flutter' down to below .1% at 7½ ips! Although this motor is an increased component cost, the prices of our equipment remain unaltered.

And there are still more features to be taken into account. The Mark 5 will take 8½in. diameter reels. There's provision for two extra heads for dual channel, stereo, or monitoring. The amplifier can be used independently.

How much value does all this add up to? Listen to the Brenell. Compare it. Look inside and see the fanatical care with which we manufacture and assemble. It would be sixty-seven pounds four shillings very well-spent.

Sole Manufacturers:

**BRENELL ENGINEERING CO. LTD. 1a DOUGHTY STREET, LONDON WC1
CHANCERY 5809 and HOLBORN 7358**

Abridged Specification

3 INDEPENDENT MOTORS
4 RECORDING SPEEDS
FAST REWIND either direction. 1,200ft. reel rewound in 45 seconds.

WOW AND FLUTTER
Below .05% at 15 ips.
Below .1% at 7½ ips.
Below .15% at 3½ ips.
Below .25% at 1½ ips.

FREQUENCY RANGE
15 ips: 50/16,000 c/s ± 3 db.
7½ ips: 60/12,000 c/s ± 3 db.
3½ ips: 60/7,000 c/s ± 3 db.
1½ ips: 60/4,000 c/s ± 3 db.

SELECTIVE FREQUENCY CORRECTION At 15, 7½ and 3½ ips.

SENSITIVITY
Microphone: 2.5 mVs into 2 megohms.
Radio or pick-up: 100 mVs into 150K/ohms.

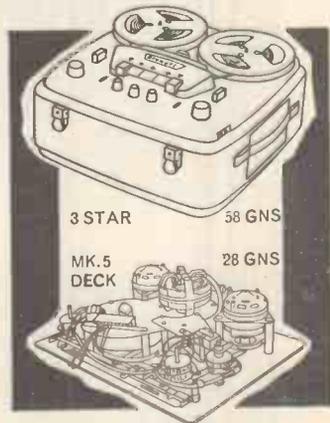
OUTPUT
4 watts into 15 ohms.

INTERNAL SPEAKER
9in. x 5in. elliptical hi-fidelity model.

- SOCKETS**
- (input) for high impedance microphone.
 - (input) for pick-up, radio or F.M. tuner.
 - (output) for headphone monitoring or to feed signal to ext. amplifier.
 - & 5. Two co-axial sockets on chassis for permanent Radio/Gram input connection, and monitoring through extra amplifying system.
 - (output) for ext. loudspeaker. Plug insertion automatically disconnects int. speaker.

EXTRAS
Crystal microphone £3/3/-.
Ribbon microphone £10/10/-.
Metered amplifier £5/5/-.

- * 3 STAR..... 58 gns
- MK.5 DECK..... 28 gns
- * 3 STAR STEREO..... 89 gns
- MK.5 STEREO..... £99.12.0
- * ¼ track models available.



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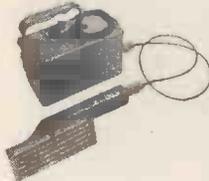
Medium Price 4-Digit Voltmeter



Model 484. Ranges from $\pm 9.999/99.99/999.9$ volts. Snap-out type readout $\pm 0.01\%$ of reading or 1 digit accuracy, 1 second average balancing time, front panel sensitivity control, automatic ranging and polarity print controls; used for quality control, calibration laboratories, production line testing and receiving inspection. Dimensions: $5\frac{1}{2}$ in. high, $15\frac{1}{2}$ in. deep, for 19 in. rack mounting. For 110-220 volts, 50/60 cycles.

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Model PAC-ISA. Alpha Counter-Scintillation Type. Designed for surveying alpha contamination over a wide range of activity levels and under wide temperature variations. Consists of a probe, a single conductor 36 inch shielded cable, and rate meter. All units waterproof. Controls and scale selector, etc., are conveniently grouped around handle and can be operated by one finger of the carrying hand even when wearing protective gloves.

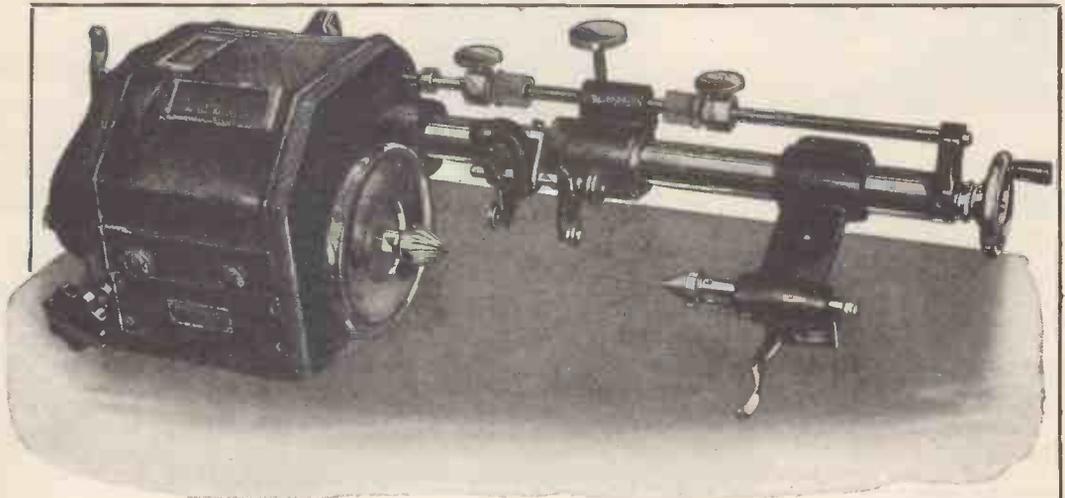
EBERLINE INSTRUMENT CORP.

New Frequency Selective Voltmeter



Model 125A. Both an A.C. voltmeter covering 3 to 600 kc. in one band and an A.C. VTVM with flat response (± 0.2 db) from 1 to 600 kc. Selectivity settings of 250 cps and 2.5 kc. Measures voltages from -90 to $+32$ dbm within ± 1 db; frequencies ± 1 kc. to 100 kc., and ± 2 kc. between 100 and 600 kc. As a flat A.C. VTVM, it has a range of -30 to $+32$ dbm. 40 in. precision frequency scale.

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AUTOMATIC COIL WINDING MACHINE

TYPE A1/1 (25/50 S.W.G.) TYPE A1/X (19/46 S.W.G.)

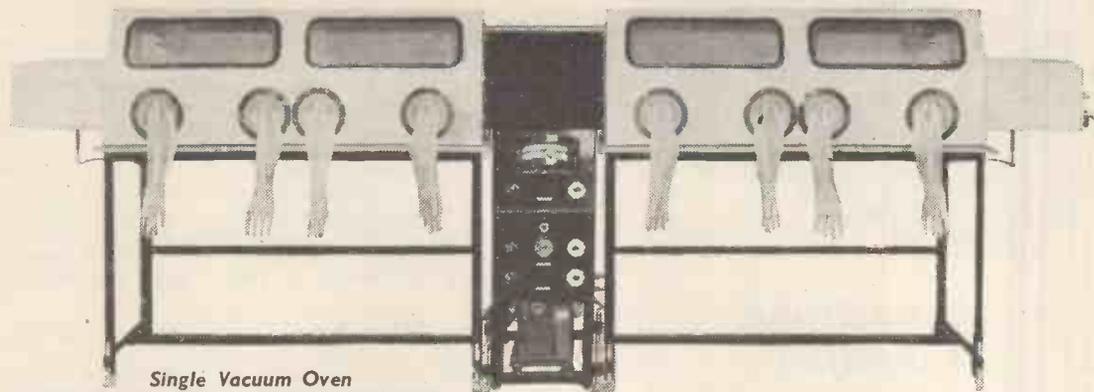
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Width of coil quickly adjusted within fine limits. Adjustable tailstock fitted with spring loaded live centre and quick release lever. Machines to stop automatically at a required number of turns can be supplied.

We will be pleased to send you an illustrated leaflet giving a full technical specification on request.

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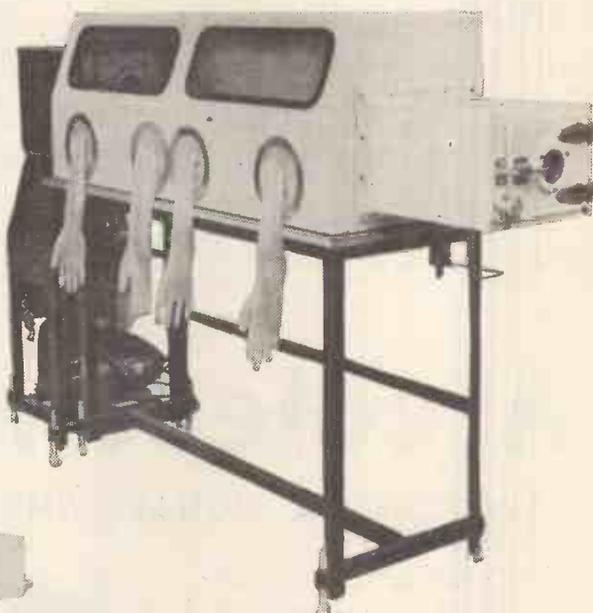
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*Single Vacuum Oven
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- ★ Rectangular with shelf spacings to suit.
- ★ Double ended controls.
- ★ Electrical interlocking of air inlet and isolation valves.
- ★ Outer cover hermetically sealed.
- ★ Temperature range 0°-300°C or equivalent F.
- ★ Temperature Control: Normal $\pm 7\frac{1}{2}$ °C. Special \pm IC.
- ★ Internal Spacing 7in. x 8in. x 18in. (can be altered to special requirements).
- ★ Vacuum Range: To 10-4.
- ★ Respective Vacuum Gauges incorporated.
- ★ Automatic air inlet valve on Backing Pump.
- ★ Visual Indicators and fuses on all switches.
- ★ Flanged for fitting into Dry Box.



*View showing automatic interlocking of
unloading compartment on glove box.*



*Vacuum Oven with
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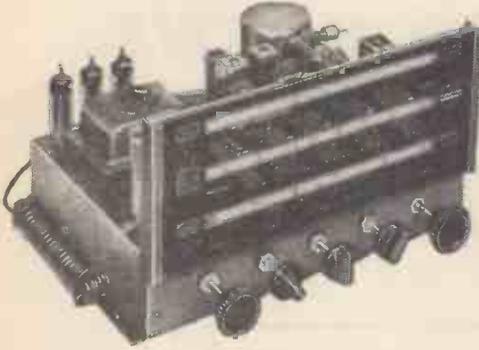


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For Radio . . . For Records . . . For Tape . . . an *Armstrong* Chassis



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PABO-3 16 GNS.

Designed to operate with almost any tape deck and with any good quality amplifier. Ideal for use with all Armstrong amplifiers and chassis, including those featured in our other advertisement in this issue. See also page 185.

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An Armstrong chassis is more than just a radiogram chassis. It is a carefully designed combination of tuner, control unit and amplifier in one compact and convenient unit which can be used as the basis of a complete high fidelity system. A system which can include tape recording and playback as well as the normal AM and FM radio and record reproduction. All Armstrong chassis, including the new Jubilee Mk. 2 model illustrated here, are suitable for use with a complete tape recorder or with a tape deck and its associated tape pre-amplifier. Where a tape deck is used we recommend the Armstrong Pabo-3 tape pre-amplifier.

JUBILEE Mk 2 (illustrated) 29 GNS.

8 watts push-pull output. ● Full VHF band (87-108 mc/s) medium and long waves. ● Inputs for all pick-ups, tape record and playback. ● Separate tone controls. ● Automatic frequency control on VHF. ● Ferrite aerial and magic eye tuning.

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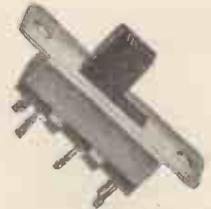
S.L.166: Very small low cost
mains neon indicator

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Popular switch for tape recorders

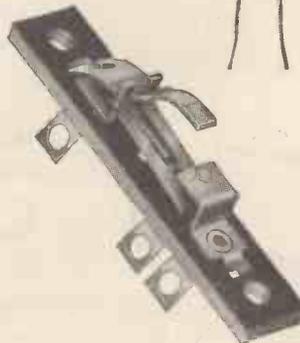
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with tags to fit printed circuit boards



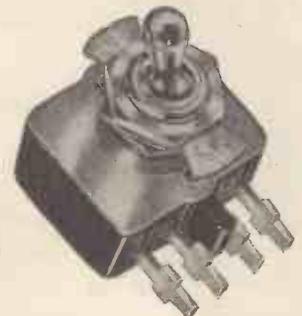
S.L.166



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T.626

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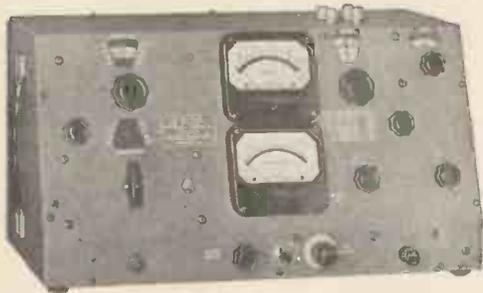
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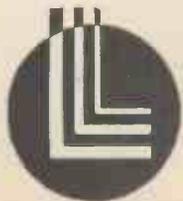
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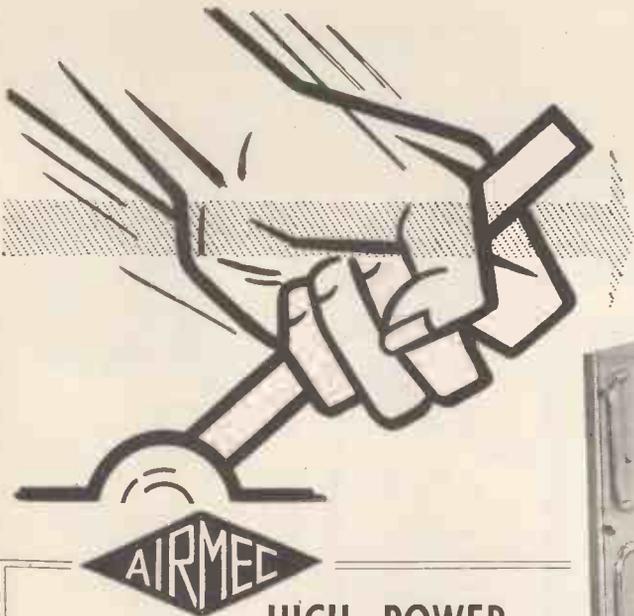
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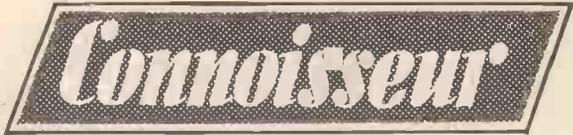
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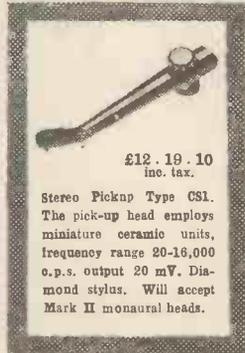
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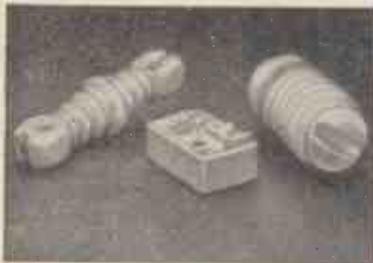
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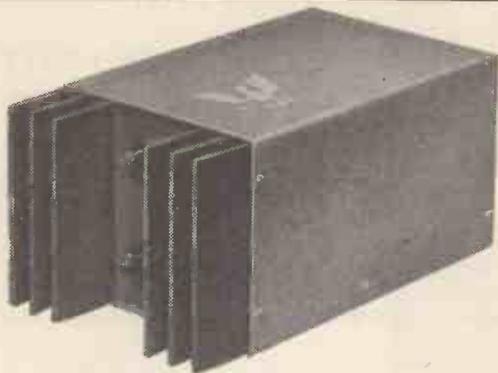
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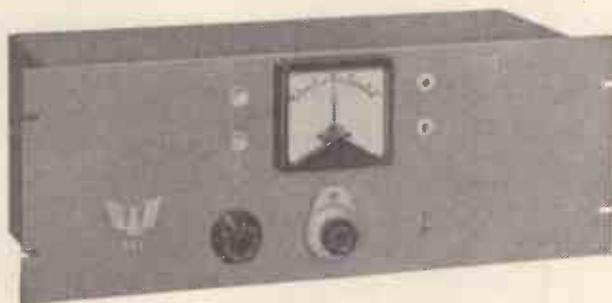
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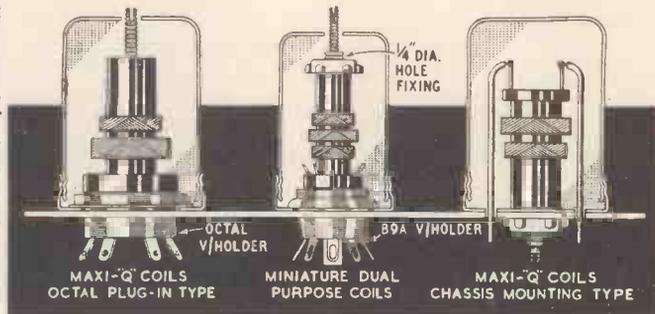
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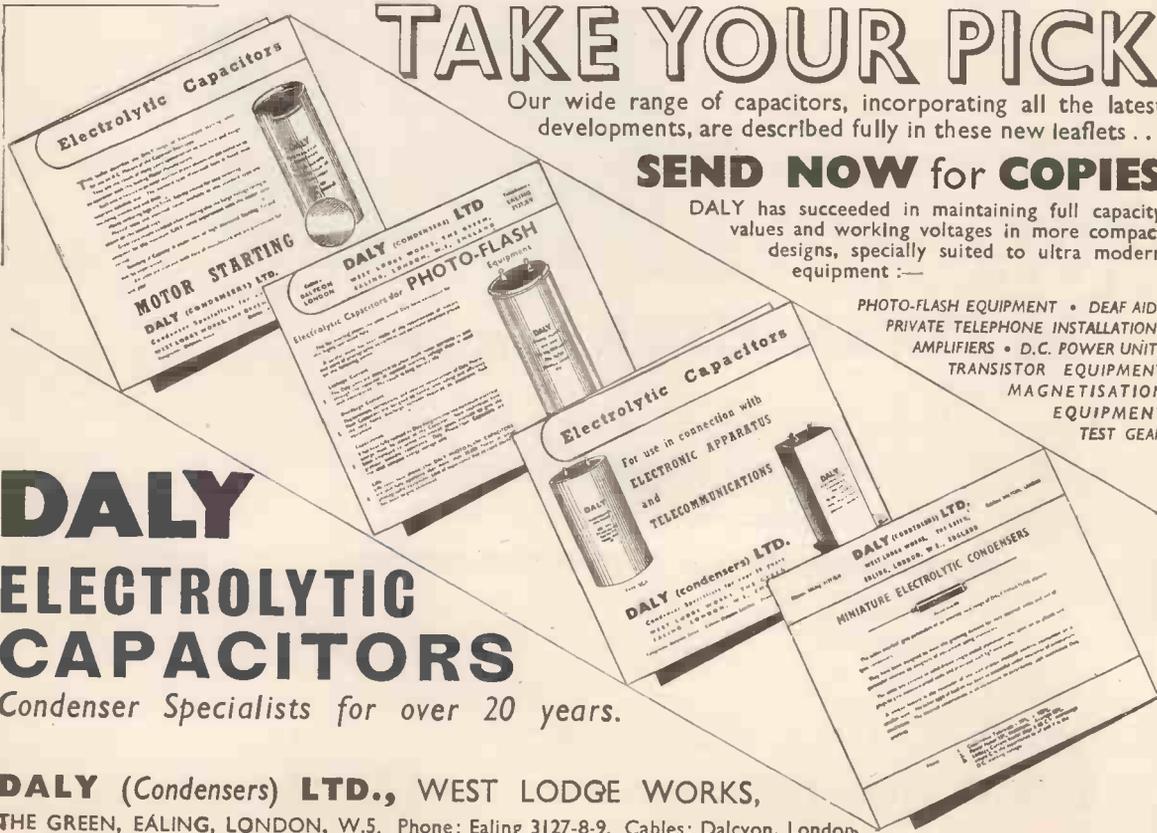
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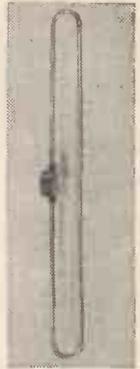
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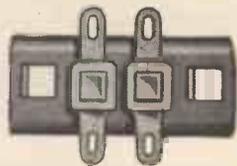
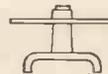
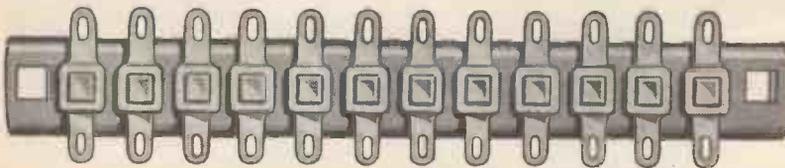
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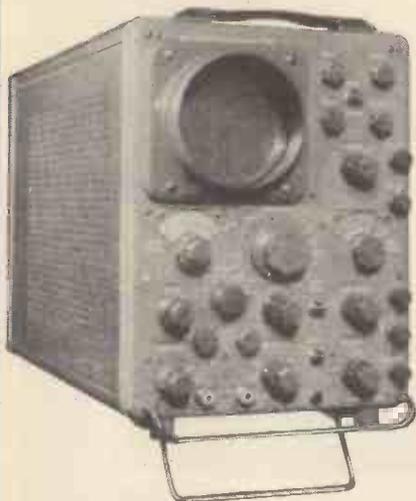
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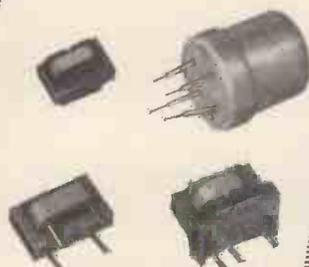
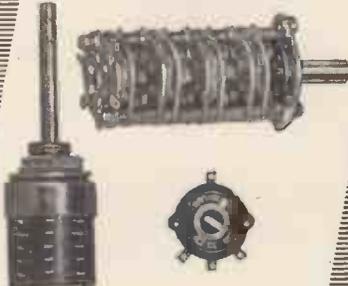
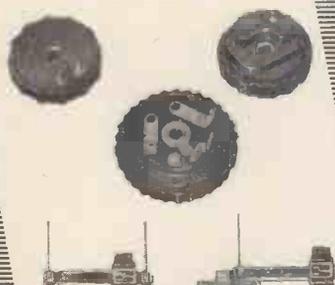
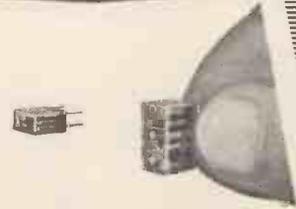
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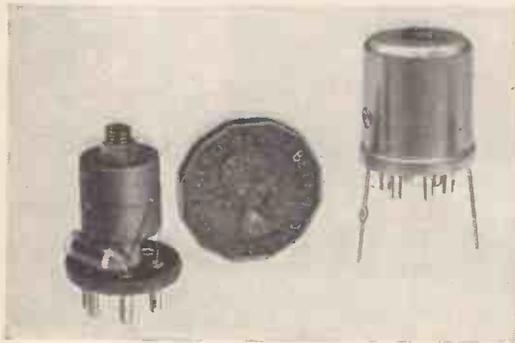
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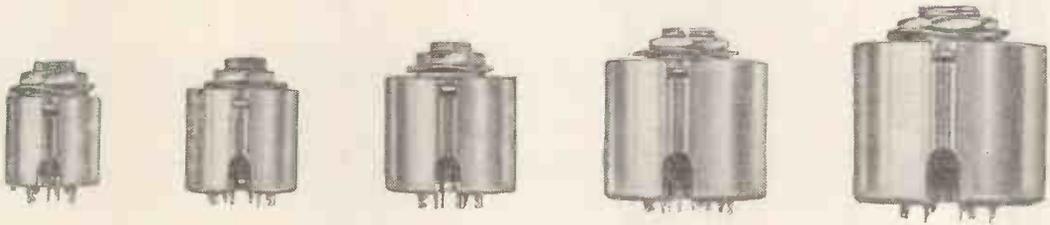
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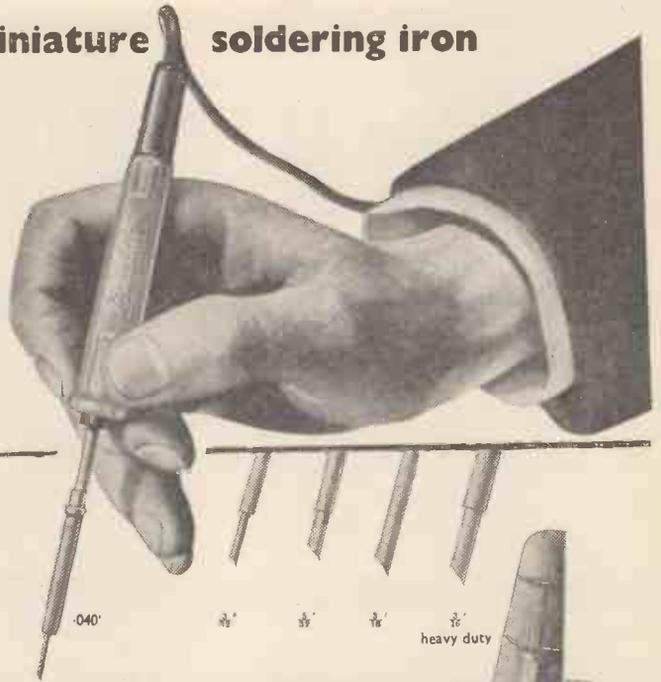
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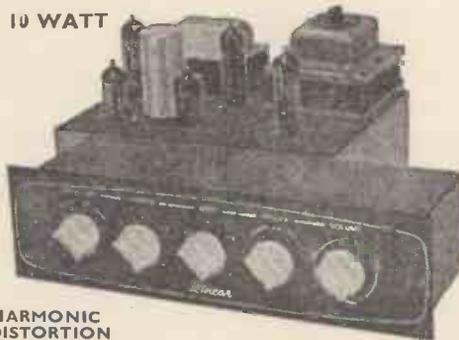
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DIATONIC 10-14 WATT. High Fidelity amplifier with integral pre-amplifier. Retail 12 gns.

CONCHORD 30 WATT. Hi-Fi amplifier with two separately controlled inputs. Retail 16 gns.

L50 50 WATT AMPLIFIER. Size approx. 13 x 9 x 7in. Sensitivity 25 m.v. Outputs for 3 and 15 ohm speakers. Retail price 19 gns.

L3/3 STEREOPHONIC AMPLIFIER. Sensitivity 150 mv. Output 3 watts on each channel. Retail 7 gns.

MULLARD VALVES:
EF86(1); ECC83(2); EL84(2); EZ81(1).

OUTPUT MATCHINGS
For 3 ohm and 15 ohm L/Speakers from high grade sectionally wound output transformer

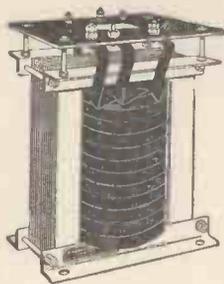
RESERVE POWER SUPPLY (for Radio Tuner) 300 v. 30 m.a. smoothed and 6.3 v. 1.5 a. at 4-pin socket.

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LINEAR PRODUCTS LTD. ELECTRON WORKS, ARMLEY, LEEDS

Tel.: Leeds 63-0126
(3 lines)

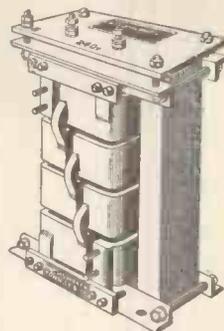
TRANSFORMERS



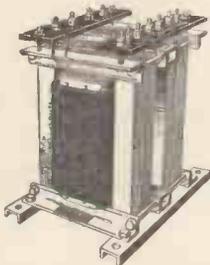
5 V	80 A	... £10
4 V	100 A	... £10
60 V	7 A	... £8
110-120 V	4 A	... £9
18 V	30 A	... £9
6 V	100 A	... £12
24 V	30 A	... £12
30 V	25 A	... £12
55 V	15 A	... £12
5 V	150 A	... £14
110-120 V	10 A	... £15
40 V	25 A	... £17
5 V	300 A	... £20
6-12 V	50 A	... £10
12 V	60 A	... £12
12 V	100 A	... £16
50 V	60 A	... £29
10-15-25 V	100 A	... £28
10-20-30 V	100 A	... £33
110 V centre tapped	25 A	... £29
6-12-18-24-30 V	12 A	... £11

All for 240 V Input. Other Supply Voltages as Required
CONTINUOUS RATING. Short Rating Transformers also available

5 V	5,000 A	..... £110
2.5 V	5,000 A	..... £64
4 V	5,000 A	..... £94
2 V	10,000 A	..... £98
3.5 V	20,000 A	..... £127
2 V	30,000 A	..... £130
10 V	2,000 A	..... £103
10 V	1,000 A	..... £59
10 V	900 A	..... £55
10 V	500 A	..... £38
10 V	300 A	..... £28
20 V	800 A	..... £80
20 V	3,000 A	..... £150
5 V	1,000 A	..... £39
22 V	1,000 A	..... £90



TRANSDUCTORS SATURABLE REACTORS



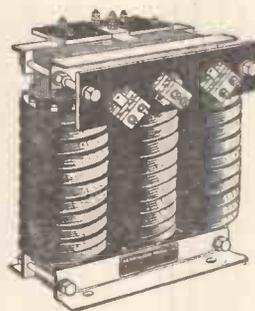
Saturable Reactors for controlling AC loads from .5kVA to 300kVA. Available for all standard AC supply voltages, single-phase and 3-phase. Standard DC control volts: 12, 24, 36, 110 and 240 V.

THREE-PHASE TRANSFORMERS

Input 400/440 V.

40 V	50 A 3-phase	£40
230 V	50 A 3-phase	£78
110 V	100 A 3-phase	£90
4 V	5,000 A 3-phase	£130

These and other Transformers can be supplied for 3-phase, 6-phase and 12-phase Rectifiers.



VOLTMOBILE VOLTAGE SELECTOR AUTO-TRANSFORMERS

Range: From 1.6% to 100% of Supply Volts in 64 steps of 1.6%.
ON LOAD SWITCHING.

VOLTMOBILES can be used by themselves or in the primary of another transformer to give very fine changes of output. Overvoltage available as extra.		Single Phase Units	240 V	440 V
		15 A	£28	£37
		30 A	£39	£50
		60 A	£69	£81
		100 A	£99	£121

D-C MOBILE RECTIFIER SETS

For 240 V AC. The larger outputs are available for 3-phase supply.
Full load DC Volts and Amps are stated.
Prices are without Meters and Regulators.

6 V	15 A	..... £14	36 V	20 A	..... £32
12 V	10 A	..... £15	36 V	40 A	..... £42
12 V	20 A	..... £19	36 V	60 A	..... £55
12 V	30 A	..... £25	110 V	5 A	..... £32
12 V	60 A	..... £35	110 V	10 A	..... £42
12 V	105 A	..... £55	110 V	15 A	..... £53
12 V	210 A	..... £71	110 V	20 A	..... £67
12 V	1,000 A	..... £185	110 V	25 A	..... £84
24 V	12 A	..... £23	220 V	130 mA	..... £15
24 V	20 A £27	250 V	6 A £49
24 V	30 A £33	250 V	10 A £70
24 V	60 A £41	250 V	15 A £89
24 V	105 A £70	250 V	20 A £110
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24 V	750 A £262			
36 V	10 A £26			



Built in to order—Ammeters—Voltsmeters—Rheostats—Stabilising Circuits—Chokes—Variacs.

CARRIAGE EXTRA on all units.
SPECIFIC ENQUIRIES are invited for
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in HEAVY CURRENT EQUIPMENT.

HARMSWORTH, TOWNLEY & CO.
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Gaumont-Kalee Fluttermeter Type 1740

Brief Technical Data

Operating carrier frequency 3,000 c.p.s. $\pm 5\%$
 Minimum input signal 50 mV R.M.S.
 Input Impedance 1 Megohm.
 Input amplifier bandwidth -3dB at 2,500 and 3,500 c.p.s.
 Effective limiter range ± 10 dB.
 Meter scaling—"Peak wow" 0 to $\pm 1\%$ (centre zero).
 "Wow" and "Flutter" 0 to 1% and 0 to 0.2% R.M.S.
 Crossover frequency 20 c.p.s.
 "Flutter" meter response—3dB at crossover.
 —3dB at 200 c.p.s.
 "Wow" meter response —3dB at crossover.
 —1dB at 0.5 c.p.s.
 C.R.O. output frequency response level down to zero frequency—3dB at 200 c.p.s.
 3,000 c.p.s. oscillator output level 5V R.M.S. into 0.5 Megohm 100 mV R.M.S. into 500 ohms.
 Accuracy: Meter presentations $\pm 2\%$ f.s.d.
 Power consumption 35 watts.
 Mains 100/150v. and 200/250v.
 Single phase 45/60 c.p.s.

Watch that **WOW!**

with the Gaumont-Kalee **FLUTTER METER**

Accurate measurement of sound equipment speed deviations

The Flutter Meter measures those components which are commonly described as "Wow" and "Flutter" resulting from speed variations in sound recorders and reproducers. This instrument is equally suitable for use with machines employing perforated film, tape, wire or disc records.

Type 1740 is of entirely new design. More compact, lighter in weight and costing considerably less than earlier Gaumont-Kalee Flutter Meters, but with the same high performance and facilities.

Dimensions: Height 10½" 26.04 cm.
 Width 12½" 31.12 cm. Depth 14½" 36.47 cm.
 Nett Weight: 29lb. 13.15 Kilos.

Write for full details to:



RANK PRECISION INDUSTRIES LTD

G.B.-KALEE DIVISION (STUDIO), WOODBER RD., LONDON, W.12, ENGLAND

Tel: SHEpherds Bush 2050.

Cables: RAN&PRESTU. LONDON

Important users of Gaumont-Kalee Flutter Meters include:

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 Commission Supérieure Technique, Paris.
 Commonwealth of Australia, Melbourne.
 Compagnia Commerciale di Cinematografia, Milan.
 Dept. Posts and Telegraph, Dublin.
 Egyptian State Broadcasting.
 E.M.I. Research Laboratories.
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 Magnavox Corporation of U.S.A.
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Phoenix

EYELETTING and light PUNCHING MACHINES

AUTOPHOENIX No. 6A. A new and improved air-operated machine for the automatic insertion and closing of eyelets. The deep throat, high vertical gap and projecting base make this an ideal machine for the eyeletting of components in radio chassis even in the closest corners and, of course, for spinnings, cylinders and plastic mouldings. It can be supplied with built-in air compressor.

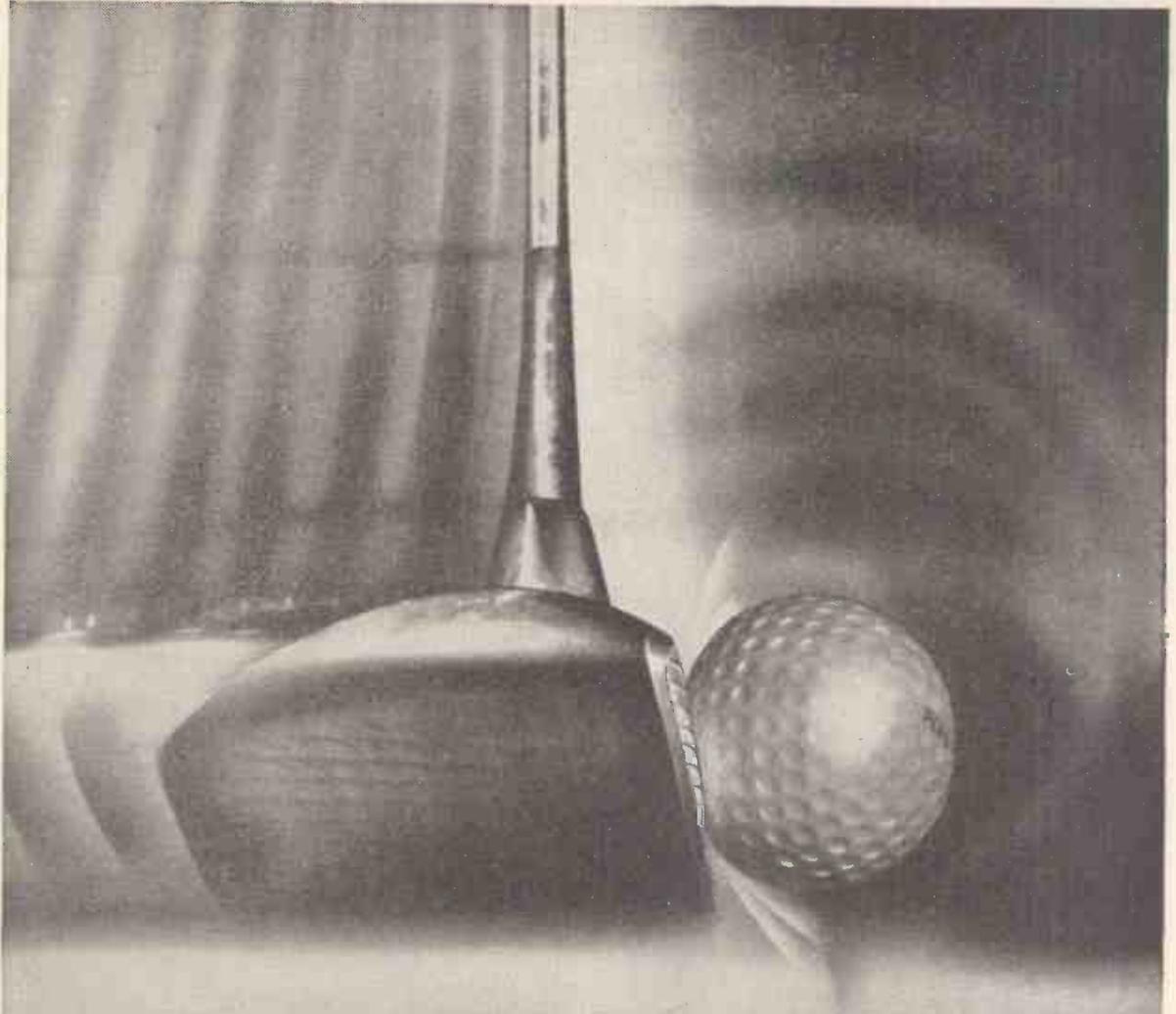
We manufacture a large range of hand and automatic Eyeletting and Piercing Machines and also stock eyelets which we can supply in small or large quantities. Full illustrated brochure of the "Phoenix" machines, write for leaflet W.W.2.

HUNTON LTD.

PHOENIX WORKS, 114-116 EUSTON ROAD, LONDON, N.W.1

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In the past five years Suflex polystyrene capacitors have created a marked impact on the electronic industry, and now they can be found in millions of domestic radio and television receivers, and in industrial instruments everywhere.

By extensive research in the past the Suflex organization has developed capacitors that provide compactness *and* reliability — the criteria by which modern electronic equipment is judged. Continuing research ensures that Suflex will remain in the forefront of future developments in this field. In the meantime, Suflex can offer to users the fruits of their labours — experience based on over twenty-five years of manufacturing, an unsurpassed service, and a deep understanding of electrical problems.

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PAT. NO 497725 (JAPAN)



SPECIFICATION

	BATTERY		CHARGER
Dimension	25x16x49mm	31x22x66mm	38x24x80mm
Weight	TR-9 37g.	TRC-9-2A1 23g.	TRC-9-2B1 35g. TRC-9-2B24 40g. TRC-9-2B25 42g. TRC-9-3B1 43g.
Voltage	A-Type A.C. 100-130V		B-Type A.C. 200-240V

KIND OF PLUGS

- TRC-9-2A1 2 flat pins
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- TRC-9-2B24 2 round pins (4mm)
- TRC-9-2B25 2 round pins (5mm)
- TRC-9-3B1 3 flat pins

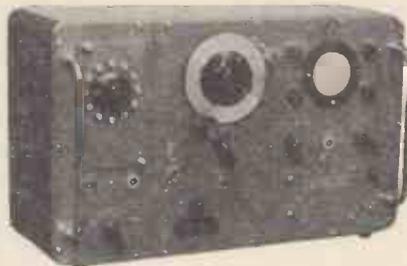
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Resistance: 0.01 Ω to 10 MΩ. Capacity: 1 pF to 100 μF, superposed DC 0 to 500 V. Inductance: 10 μH to 1,000 H, superposed DC 0 to 100 mA. Measures loss angle tangent and Q factor. Internal measurement frequency—DC, 50 c/s, 1,000 c/s. External measurement frequency possible.

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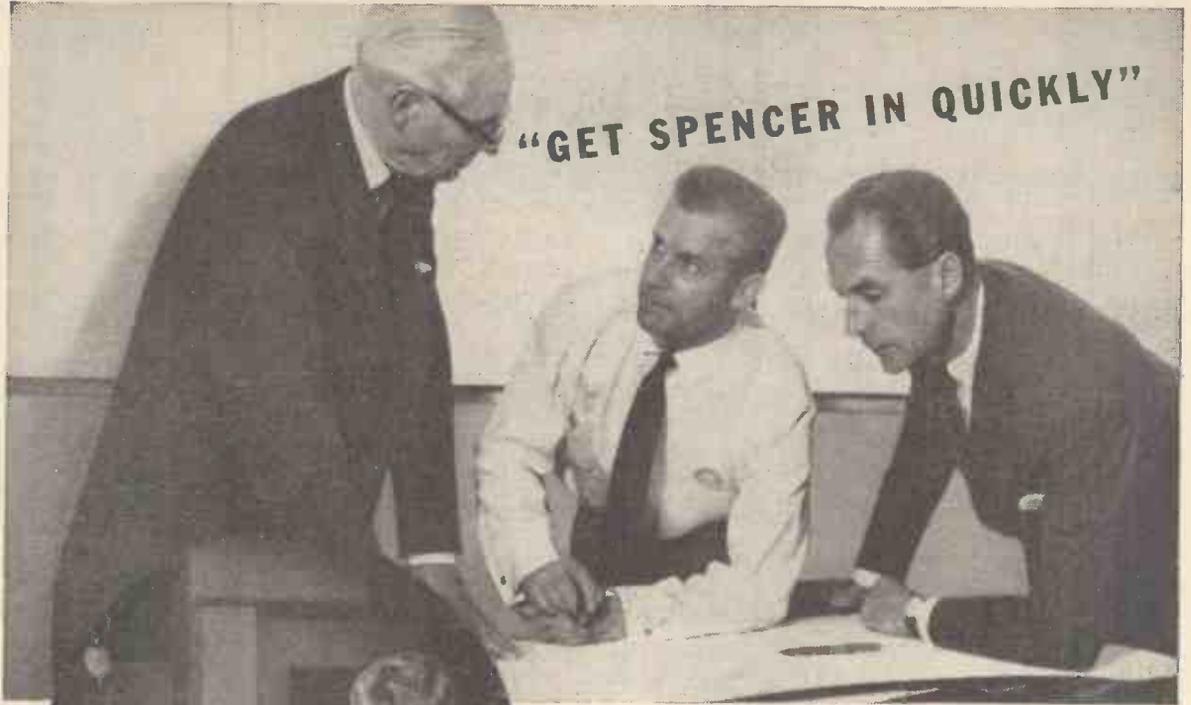
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- VALVE VOLTMETERS
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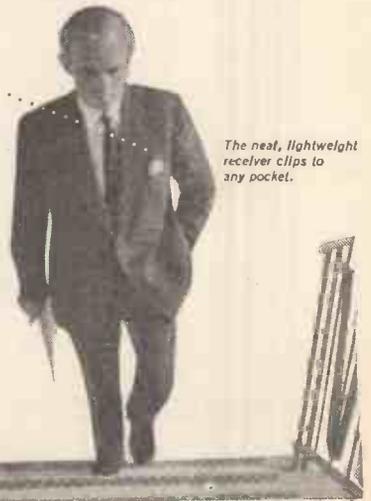


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anywhere on your premises
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... and without disturbing anybody else?

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Cossor 1602 4 Tr. 3 spd.	59 gns.	\$127
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Leak Stereo Varislope III	£25 0 0	\$72

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 - Complete with fitted carrying case, leads, plugs. Foot Control. A.C. mains.

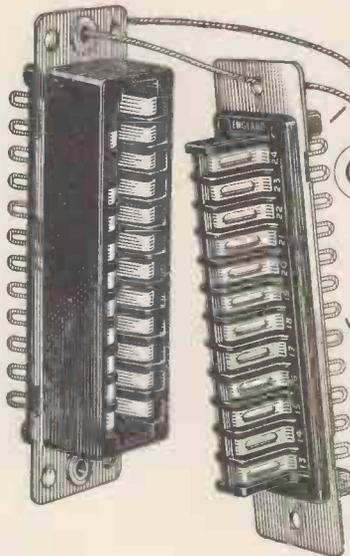
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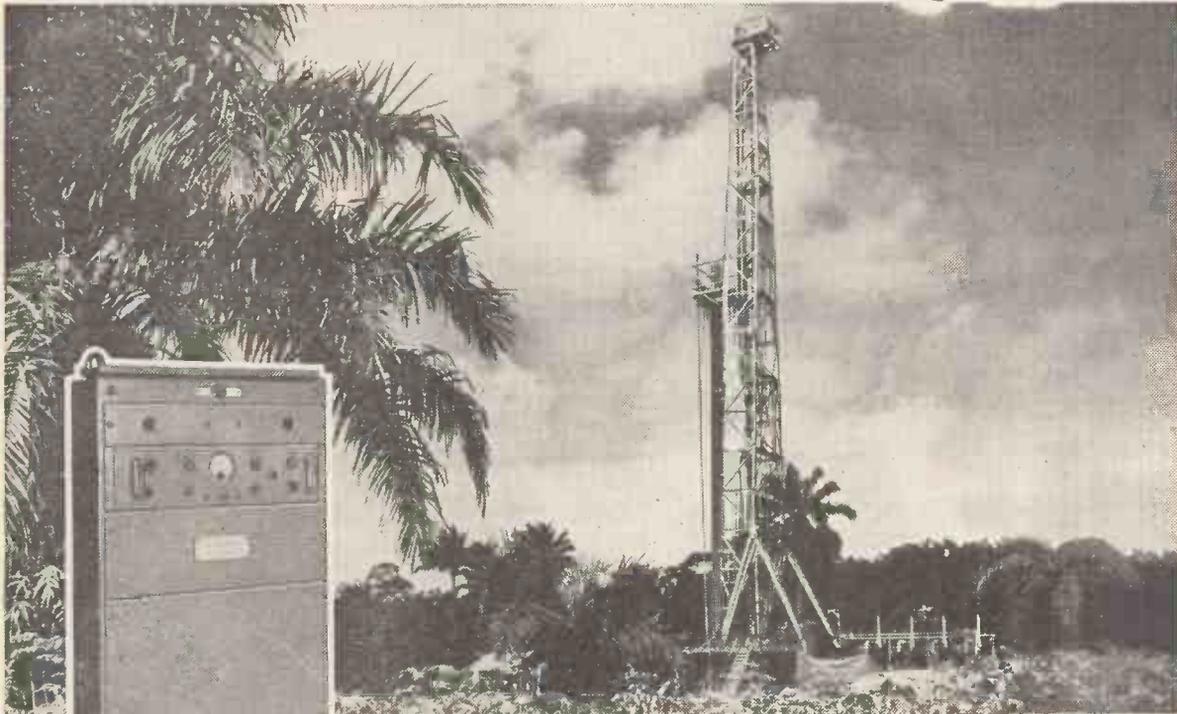
- 8 WAY
- 16 WAY
- 24 WAY
- 32 WAY

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THE McMURDO INSTRUMENT CO. LTD., ASHTEAD, SURREY Telephone: ASHTEAD 3401

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Communications for Oil Pioneers



TYPE 800

ATE Radiotelephones are used by industrial, mining, agricultural, civil and military enterprises—and by research and survey teams—in 60 countries.

The derrick has been erected and the drilling of an appraisal well is ahead of schedule. For the men in this isolated community in the African bush modern means of communication are essential for the exchange of technical and administrative information necessary for the efficient day to day running of the site.

By means of the ATE Type 800 equipment such remote spots can now be linked direct to the nearest telephone exchange and provided with full signalling and dialling facilities. The new Type 800, latest in the ATE single channel VHF rural radio-telephone range, is specially equipped with full signalling and control equipment for this purpose. Exhaustive testing under actual climatic extremes has fully proved its outstanding practicality and efficiency.

- Extended frequency coverage over VHF and UHF bands.
- New compact cabinet-type construction with slide-in chassis for easy access and maintenance.
- Plug-in test meter facilities.
- High or low power versions to suit propagation conditions.
- Will work into any type of telephone exchange with improved 'outband' tone signalling facilities.
- Modern design conforming to British Post Office, Canadian Department of Transport and Crown Agents' specifications.



If you would like to know more about the new Type 800, write for full details to your local representative . . . or send for bulletin REB 410111

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Golden Silence

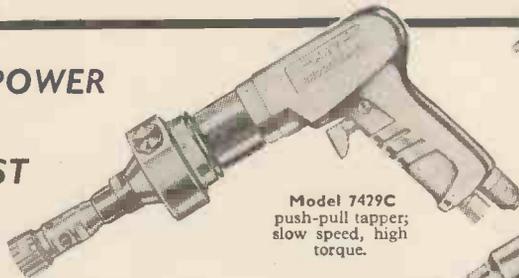
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push-pull tapper;
slow speed, high
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high speed drill.



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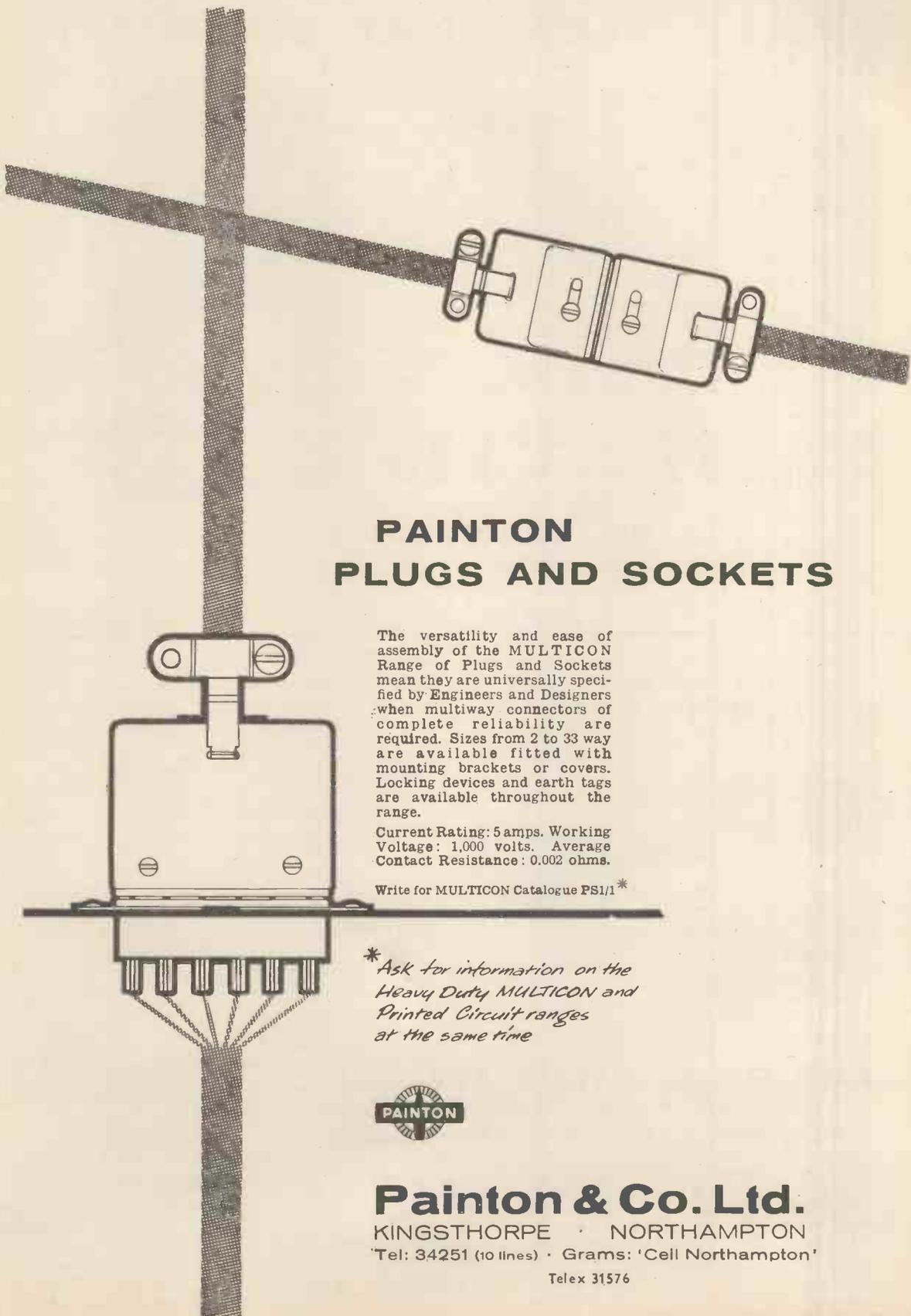
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Current Rating: 5 amps. Working Voltage: 1,000 volts. Average Contact Resistance: 0.002 ohms.

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** Ask for information on the Heavy Duty MULTICON and Printed Circuit ranges at the same time*



Painton & Co. Ltd.

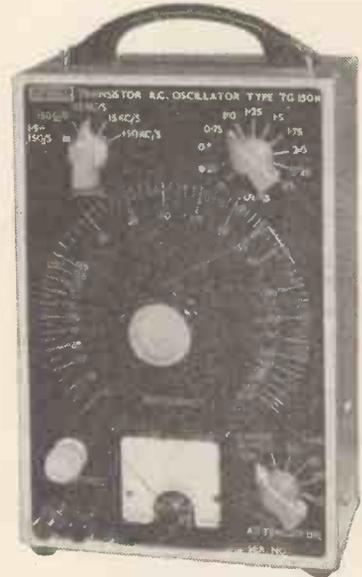
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Telex 31576

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Less than 0.1% at 1 kc/s
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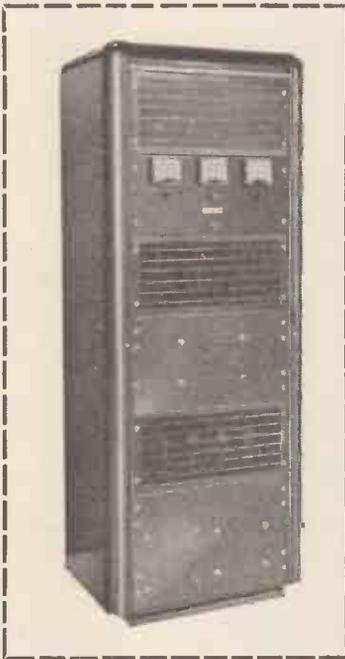
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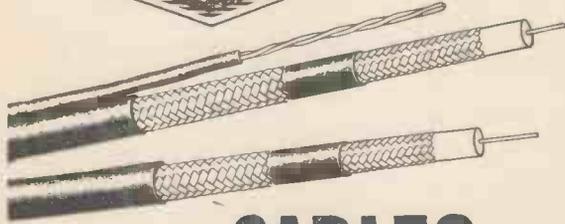
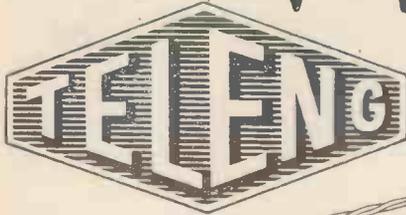
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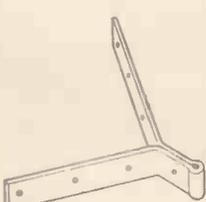


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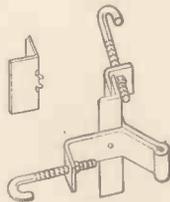
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I_c max.	6.0A
P_{tot} max. (at mounting base temperature 45°C).....	30W
T_J max. (continuous operation)	90°C
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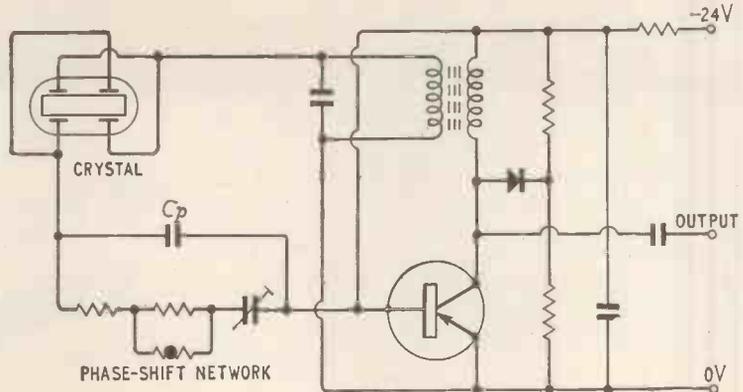


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ARTICLES IN THE NOVEMBER ISSUE INCLUDE:

TELEVISION NOISE LIMITING

Noise limiting in the sound channel of amplitude-modulated television receivers is discussed in detail in this article. The author gives complete design and circuit details of several noise-limiting circuits and shows that a considerable improvement in the noise suppression of an indifferent receiver can often be made without resorting to expensive and complicated circuitry.

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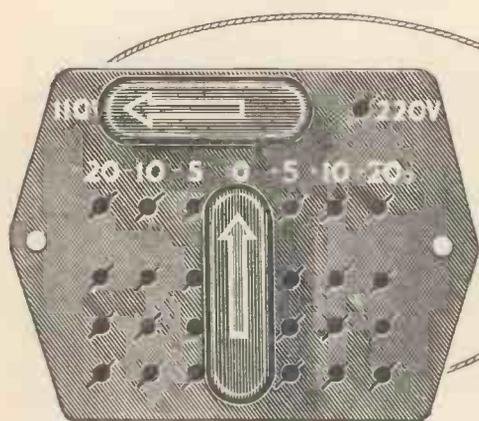
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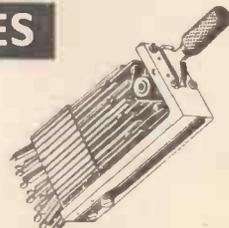
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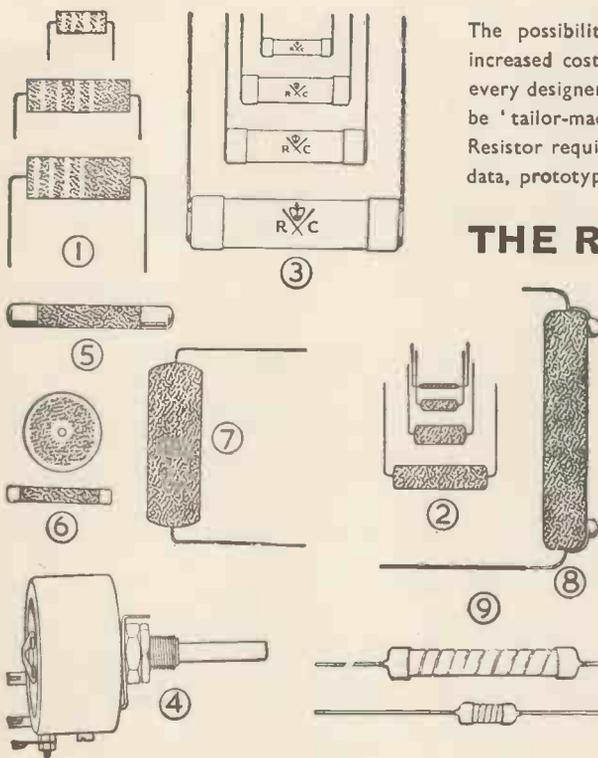
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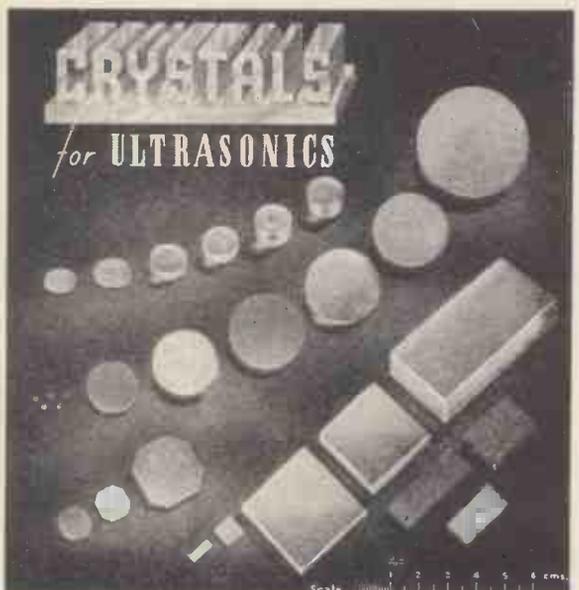


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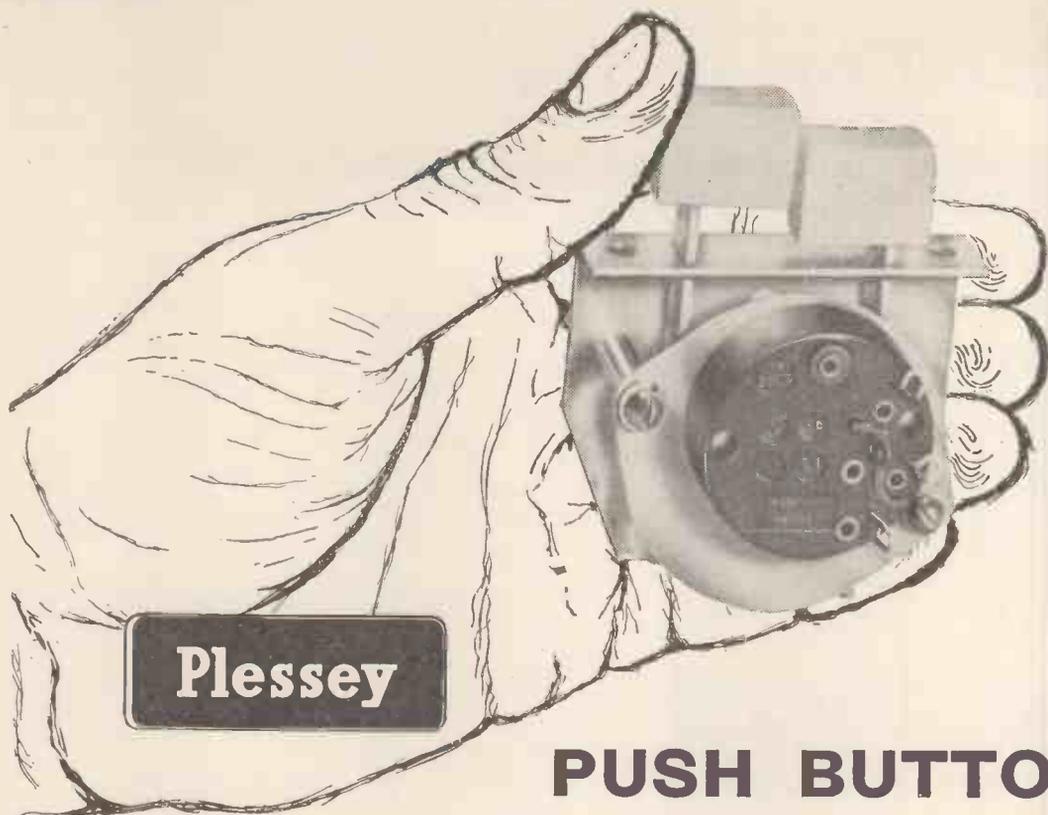
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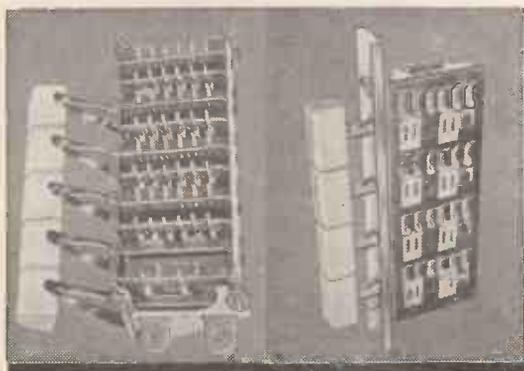
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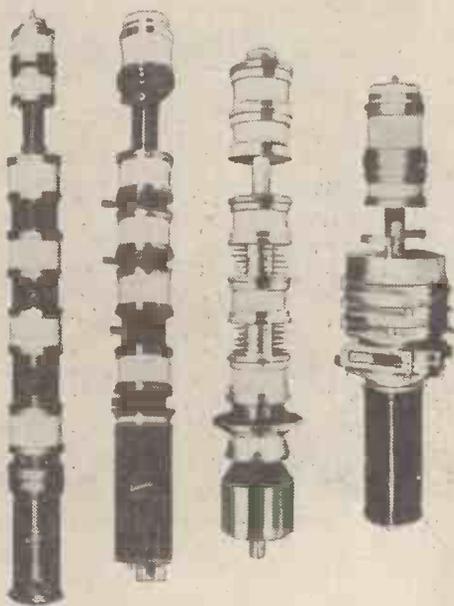
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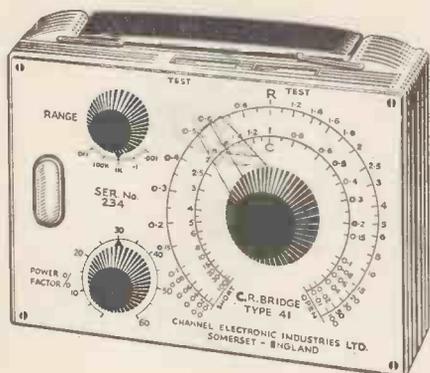
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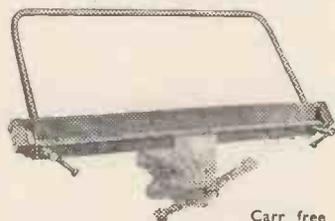
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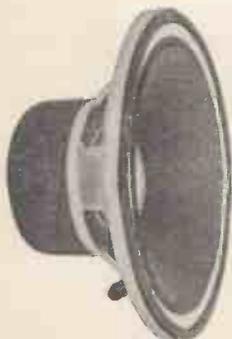
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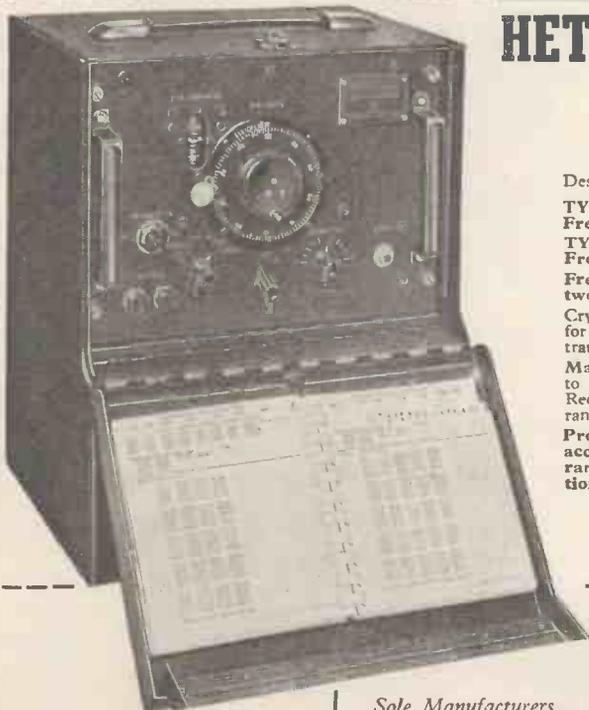
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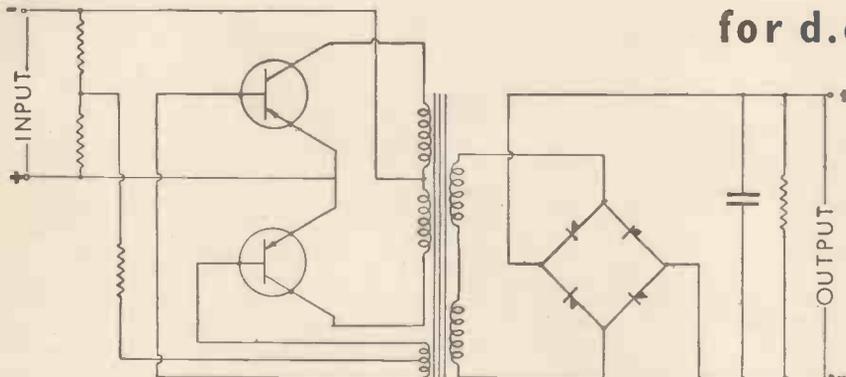
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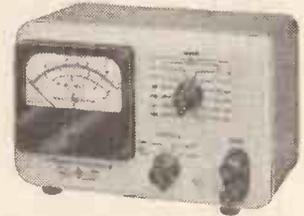
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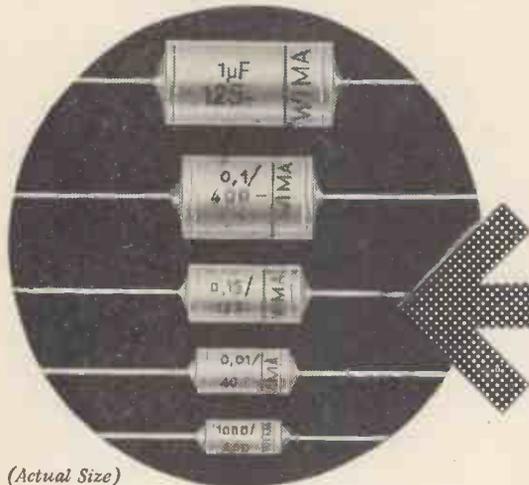


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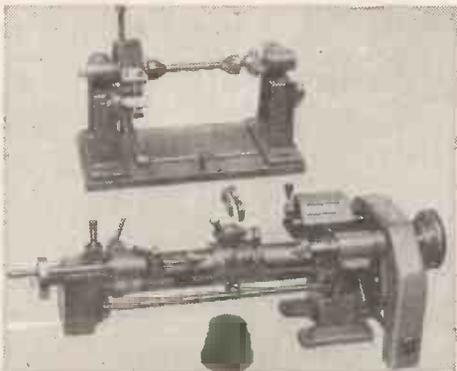
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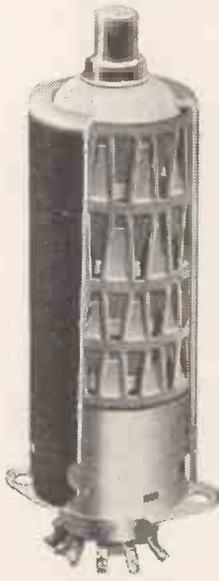
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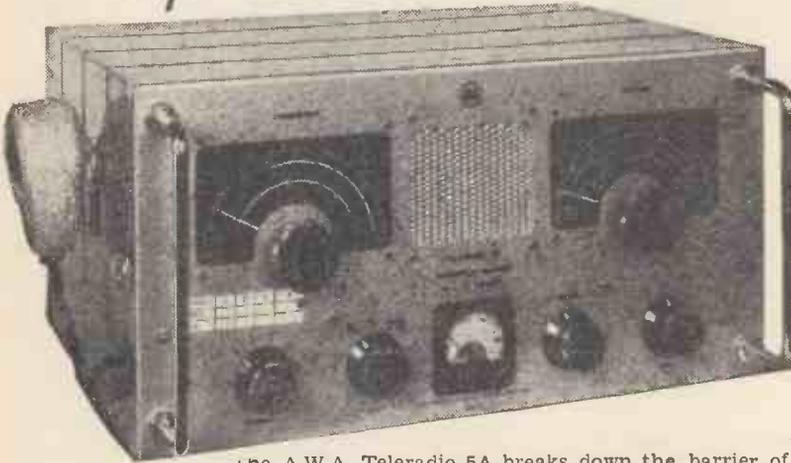
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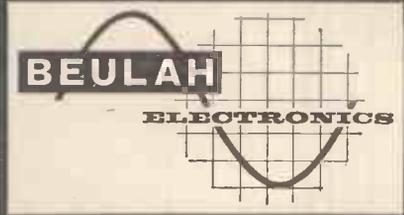


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PUBLISHED MONTHLY (4th Monday of preceding month) by ILIFFE & SONS, LTD., Dorset House, Stamford Street, London, S.E.1. Telephone: Waterloo 3333 (65 lines). Telegrams: "Ethaworld, Sedist, London." Annual Subscriptions, Home and Overseas, £1 15s. 0d. Canada and U.S.A., \$5.00. Second-class mail privileges authorised at New York, N.Y. BRANCH OFFICES: BIRMINGHAM: King Edward House, New Street, 2. Telephone: Midland 7191. COVENTRY: 8-10, Corporation Street. Telephone: Coventry 25210. GLASGOW: 62, Buchanan Street, C.1. Telephone: Central 1265-6. MANCHESTER: 260, Deansgate, 3. Telephone: Blackfriars 4412. NEW YORK OFFICE: U.S.A.: 111, Broadway, 6. Telephone: Digby 9-1197.

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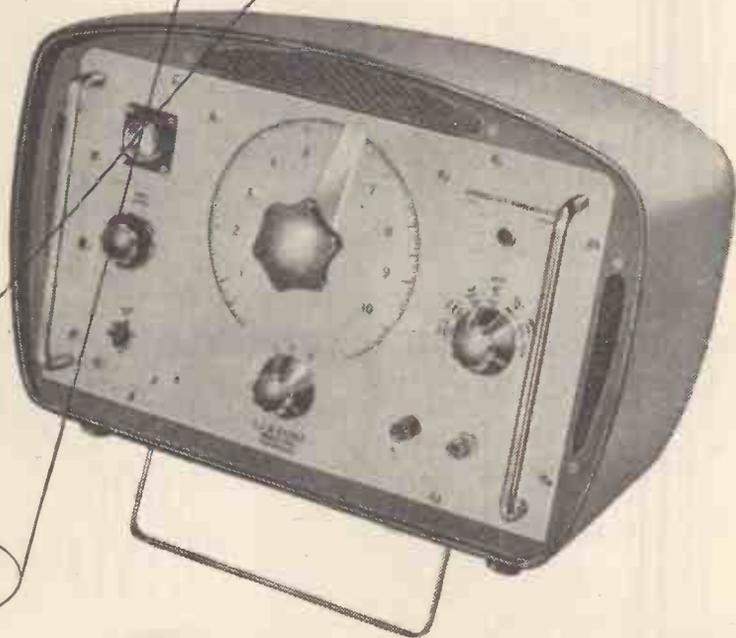


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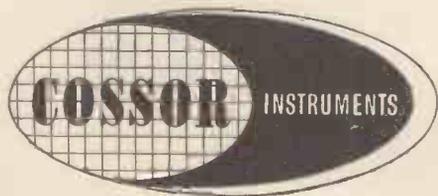
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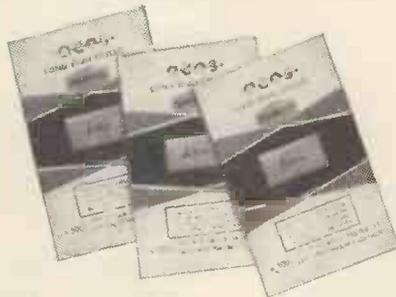
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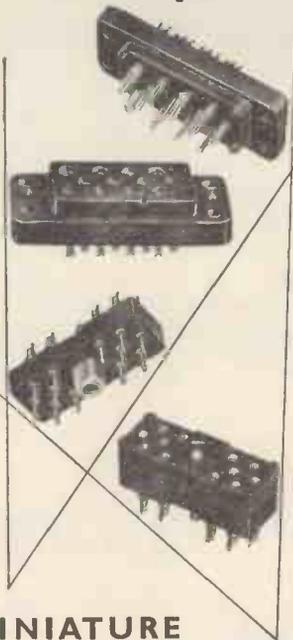
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No. 22 of a Series
FUSING, PART 6

The kind of fuselinks we talked about last month operate within 10 seconds under the conditions described, and are defined as a "Quick Action" type. Other characteristics can be obtained by employing more elaborate forms of construction, albeit this is almost inevitably accompanied by higher manufacturing costs.

The two other main categories commonly encountered are designated "Delay" and "Super Delay," with respective operating times in the order of ten, and one hundred times greater than that of the Quick Action class under normal overload conditions. Such fuselinks are, however, quick-acting under short-circuit conditions, and inherently possess very much better surge handling properties than the simple Quick Action type. While many variations of construction are possible, all delayed-action fuselinks employ the principle of a heat sink in combination with a heating element; the heater behaves in the manner of a normal fuse-element when a short-circuit fault occurs, but on moderate overloads its prime function is to "fill up" the heat sink as a prelude to fusion. The heat sink also acts as a thermal shock-absorber when current surges are experienced, provided that these are not of sufficient intensity to melt the heater portion of the element directly, nor of sufficient energy content to fill the heat sink and thus initiate operation of the fuse.

Fuselinks in each of these three categories may be further classified into "Light Duty" and "Heavy Duty" types, according to the magnitude of the prospective currents which they can handle; their cartridges are made of glass or ceramic, respectively. In general, Light Duty fuselinks are not intended to handle prospective currents greater than 50 amp., depending on the circuit voltage and time-constant, although a higher limit may be set if the maximum voltage is kept below the level at which an arc can be sustained.

A typical application for Delay fuselinks is in circuits containing electric motors which have a high initial starting current, this in itself not being harmful. Super Delay fuselinks meet the requirements of circuits associated with C-core transformers, where very heavy currents are experienced during the first few cycles after switching on. Other special requirements can also be met by different forms of construction, such as fuselinks having faster operation than the Quick Action type, for the protection of silicon rectifiers.

We are considering issuing a reprint of this series, "Notes on Fusing", on completion. Will any readers who would like to have a copy please send us a postcard?

No. 22A of a Series

Printed Circuits in Diplexers and Triplexers

It is gratifying to note the continuing popularity of our "old-fashioned" Diplexer, L.1338, which is constructed round wound coils in a conventionally wired circuit, but at the same time this is difficult to account for in view of the better performance and lower price of the modern printed circuit types, L.1353 and L.1354. The following figures show what we mean:—

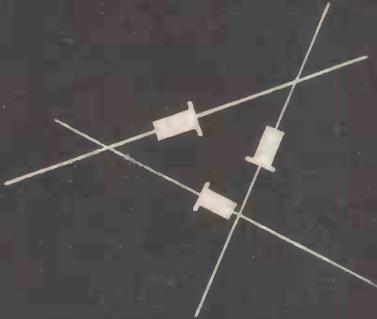
List No.	Insertion Loss (S.B.)	Price
L.1338 (Wire wnd.)	19db	11/-
L.1353 (Ptd. circuit)	25db	10/-

The insertion loss is a measure of the effectiveness of the filter. In the pass-bands, where no reduction of signal is wanted, it is less than 1db for each type, which is small enough to be entirely negligible in most applications. In the stop-band (S.B.), however, the printed circuit type is four times as effective as the conventionally wired one in reducing the power of the unwanted signal. This is entirely due to the fact that the printed circuit technique makes it possible to produce circuitry with a greater repetition accuracy than can be achieved by ordinary methods of assembly and point-to-point wiring, and even the filter coils are produced more consistently by printing than by winding them of wire. At high frequencies, where the performance of a circuit can be made or marred by quite small variations in construction due to the effect which these can have on the overall inductance and capacitance, greater repetition accuracy means that circuits of higher intricacy and performance can be employed, which would be too critical for efficient use if random variations in circuit values were likely to be introduced either in the course of manufacture or in subsequent handling. Incidentally, even a simple high-frequency filter employing self-supporting wound coils and wiring can have its performance drastically altered by accidental displacement of the circuit elements without anything to show what has occurred.

On the score of reliability, we have always maintained that with a proper choice of materials printed circuits leave nothing to be desired (See January Notes, No. 12.) Surely there can be no more convincing proof of this than the fact that they are now used so extensively throughout the electronics industry, even in such complex equipment as the large calculating machines which, "per se," constitute criteria of reliability and accuracy.

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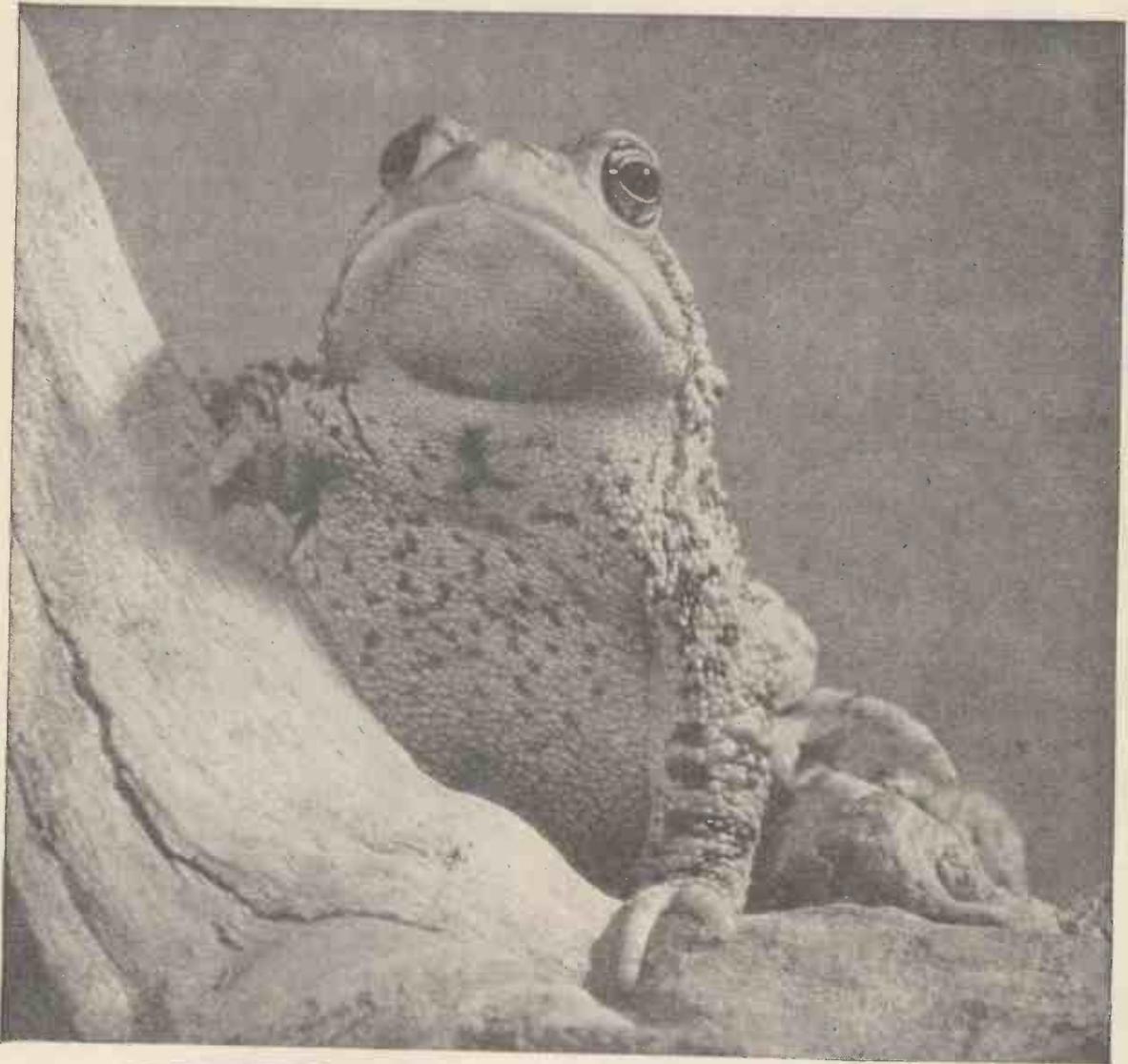
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Aspects of design

This is the twenty-eighth of a series of special features dealing with advanced problems in circuit design to be published by The Ediswan Mazda Applications Laboratory. We will be pleased to deal with any questions arising from this or other articles, the twenty-ninth of which will appear in the December 1960 issue.

The charge storage parameters described in the previous "Aspects of Design" have two purposes.

With a suitable control on the parameters, they are a means of ensuring that all transistors of a type will function properly in a specified circuit and, with certain qualifications, they can also be used to predict transistor response times.

As an example of the former application, the transistor in Fig. 1 is considered operating only in the active region, when the failure of the stage to reproduce the shape of the input waveform can be attributed to the injection of an incorrect charge into the base of the transistor (Fig. 2).

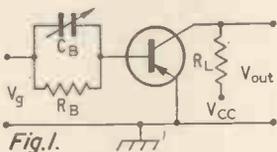


Fig. 1.

$$\beta \frac{V_g - V_{BE}}{R_B} < \frac{V_{CC} - V_{CE(SAT)}}{R_L}$$

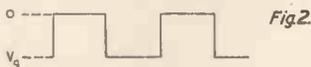
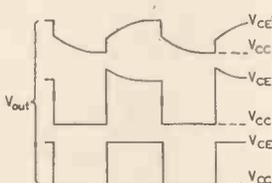


Fig. 2.

$$(V_g - V_{BE}) C_B < Q_{ON}$$

$$(V_g - V_{BE}) C_B > Q_{ON}$$

$$(V_g - V_{BE}) C_B = Q_{ON}$$



The injection of a charge $(V_g - V_{BE})C_B$ into the base of the transistor almost immediately establishes a collector current, which has the same value as that subsequently maintained by the base current $\frac{V_g - V_{BE}}{R_B}$, only if $(V_g - V_{BE}) C_B = Q_{ON}$. In this context, "... almost immediately ..." implies a very brief delay of the order of the transit time of carriers in the base of the transistor.

Alternatively, the transistor in Fig. 1 is initially bottomed by a base current $\frac{V_g - V_{BE}}{R_B}$ and requires the extraction of a charge Q_{OFF} to switch it off. This is achieved by making $(V_g - V_{BE}) C_B = Q_{OFF}$, when the switch-off transient of the output waveform will resemble the corresponding part of the input pulse. If however $(V_g - V_{BE}) C_B < Q_{OFF}$, the initial change in collector current for some transistors may be less than that required (Figs. 3, 4) whilst others, having partly or completely switched off, will tend to switch on again momentarily (Fig. 5), with the attendant risk that these unwanted pulses may trigger off operations in connected circuitry.

Increasing the product $V_g C_B$ does not necessarily decrease the time taken for the transistor to switch off and can lead to increased switching times if the repetition rate is high enough.

The transistor switching times partly defined in Fig. 6, can be predicted with useful accuracy with the aid of charge storage parameters.

In order to avoid ambiguities in the definition of the delay time t_d arising from variously shaped output waveforms (Fig. 6), t_d is defined as ending when the final rise of the leading edge of V_{out} has reached 10% of its total change from "OFF" to "ON". If initially, the transistor is switched off and the emitter

reverse biased, forward emitter current cannot flow until the effective stray and junction capacities between emitter and base have been discharged, and the output waveform is consequently delayed. An additional delay is due to the transit

time, $\approx \frac{1}{4 \omega \alpha}$, of the injected carriers across the base of the transistor, but this is often negligible compared with the former effect. In the case of an earthed emitter transistor, the largest effective input capacity occurs when the collector load is small (Fig. 7), and is equal to the sum of the emitter and collector junction capacities C_{te} and C_{tc} respectively, and their associated stray capacities C_{se} and C_{sc} . For a given total capacity, reducing the junction capacities shortens the delay time.

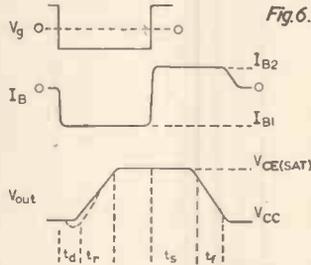


Fig. 6.

The rise time t_r and fall time t_f , determined by the 10% and 90% points in each case, can be predicted for a defined base current drive from the formulae:

$$t_r = \beta_0 \left(\tau_{co} + \frac{Q_v}{I_c} \right) \log_e \left(\frac{I_{B1} - 0.1 \frac{I_c}{\beta_0}}{I_{B1} - 0.9 \frac{I_c}{\beta_0}} \right)$$

$$t_f = \beta_0 \left(\tau_{co} + \frac{Q_v}{I_c} \right) \log_e \left(\frac{0.9 I_c - \beta_0 I_{B1}}{0.1 I_c - \beta_0 I_{B1}} \right)$$

The storage time t_s can be computed from the approximate formula:

$$t_s = \tau_s \log_e \left(\frac{I_{B1} - I_{B2}}{\frac{I_c}{\beta_0} - I_{B2}} \right)$$

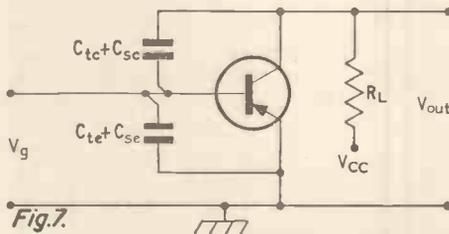


Fig. 7.

For XA151 and XA152 transistors operating under the conditions listed below, the discrepancies between the computed and measured rise, fall and storage times are generally less than 20%, but it should be noted that this accuracy is obtained with parameters and response times measured under similar conditions, and may be poorer when such information is not available. The formula for t_s is not accurate for values of storage time comparable with the transit time of carriers in the base of the transistor.

OPERATING CONDITIONS

I_c	0-10 mA	I_e	0-100 mA
V_{cc}	4.1 V - 0.1 V	V_{ce}	4.2 V - 0.2 V
$I_{B1} = I_{B2}$	= 0.75 mA	$I_{B1} = I_{B2}$	= 15 mA

TYPICAL SWITCHING TIMES

t_r	= 0.55 μ sec	t_r	= 0.13 μ sec
t_s	= 0.35 μ sec	t_s	= 0.4 μ sec
t_f	= 0.35 μ sec	t_f	= 0.18 μ sec

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EDISWAN MAZDA XA151 AND XA152 SWITCHING TRANSISTORS

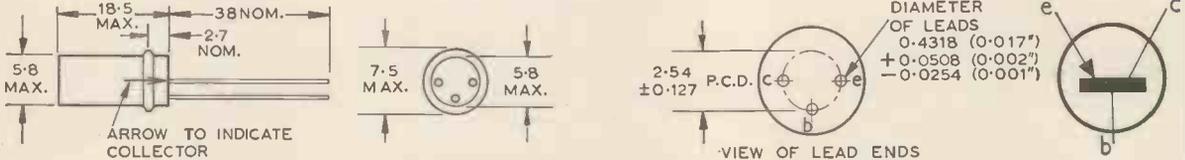
The XA151 and XA152 are germanium pnp alloy junction transistors intended for switching applications.

TENTATIVE RATINGS AND DATA

Maximum Temperature Ratings (Absolute Values)	
Junction Temperature (°C)	65
Storage Temperature (°C)	65
Maximum Ratings (Absolute Values for T_{amb} = 45 °C)	
Peak or Mean Collector/Base Voltage (Common Base Circuit) (volts)	-15
Peak or Mean Collector/Emitter Voltage (V _{be} ≥ 0.5 V or R _{be} = 0)	-15
Peak or Mean Emitter/Base Voltage (volts)	-12
Collector Dissipation (mW)	66

General Characteristics.	T _{amb} (°C)	
	25	66
Maximum Collector/Base Leakage Current (V _{cb} = -15 V, Emitter open circuit) (μA) ...	—	-50
(V _{cb} = -15V, V _{be} = +0.5 V) (μA)	-10	-50
Maximum Emitter/Base Leakage Current (V _{eb} = -12 V, Collector Open Circuit) (μA)	-10	—
Thermal Resistance in Free Air (°C/mW)	0.3	—

DIMENSIONS AND BASING



Dimensions in mm except where stated otherwise. Dimensions include insulated sleeve.

XA151 SWITCHING CHARACTERISTICS

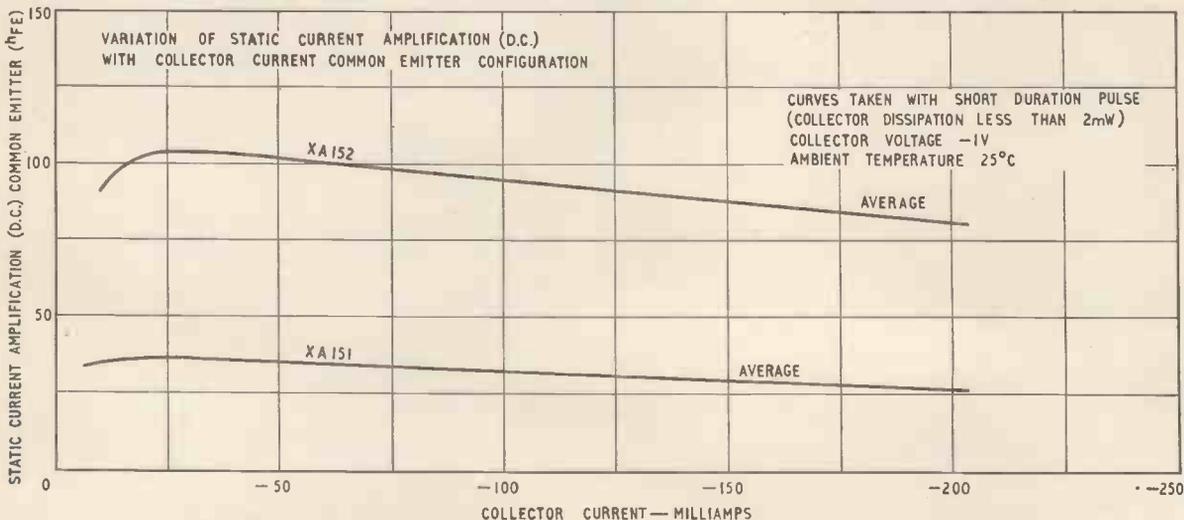
	Typical Production Spread		
	Min.	Av.	Max.
Static Current Amplification (d.c.)			
(V _{ce} = -0.25 V, I _c = -10 mA)	20	—	90
(V _{ce} = -0.25 V, I _c = -50 mA)	20	—	80
(V _{ce} = -0.25 V, I _c = -125 mA)	10	—	60
Collector/Emitter Saturation Voltage (volts)			
(I _c = -10 mA, I _b = -0.6 mA)	-0.04	—	-0.14
(I _c = -50 mA, I _b = -3 mA)	-0.06	—	-0.2
(I _c = -125 mA, I _b = -14 mA)	-0.06	—	-0.28
Base Resistance r_{bb'} (Ω)			
(V _{ce} = -6 V, I _c = -1 mA)	—	75	—
Cut-off Frequency f_t* (Mc/s)			
(V _{ce} = -2 V, I _c = -10 mA)	3	—	—
Collector Depletion Capacity (pF)			
(V _{cb} = -6 V, I _e = 0)	—	11	16
Collector Time Factor τ_{co} (μs)			
(V _{ce} = -0.25 to -4.25 V; I _c = -10.85 to -0.85 mA)	—	30	70
Saturation Time Factor τ_s (μs)			
(I _c = -10.85 mA; I _b = -0.62 mA)	—	0.8	—
(I _c = -10.85 mA; I _b = -0.62 mA)	—	27	—

XA152 SWITCHING CHARACTERISTICS

	Typical Production Spread		
	Min.	Av.	Max.
Static Current Amplification (d.c.)			
(V _{ce} = -0.25 V; I _c = -10 mA)	40	—	—
(V _{ce} = -0.25 V; I _c = -50 mA)	40	—	—
(V _{ce} = -0.25 V; I _c = -125 mA)	20	—	—
Collector/Emitter Saturation Voltage (volts)			
(I _c = -10 mA; I _b = -0.3 mA)	-0.04	—	-0.14
(I _c = -50 mA; I _b = -1.5 mA)	-0.06	—	-0.2
(I _c = -125 mA; I _b = -7.5 mA)	-0.06	—	-0.28
Base Resistance r_{bb'} (Ω)			
(V _{ce} = -6 V; I _c = -1 mA)	—	75	—
Cut-off Frequency f_t* (Mc/s)			
(V _{ce} = -2 V; I _c = -10 mA)	5.5	—	—
Collector Depletion Capacity (pF)			
(V _{cb} = -6 V; I _e = 0)	—	11	16
Collector Time Factor τ_{co} (μs)			
(V _{ce} = -0.25 to -4.25 V; I _c = -10.85 to -0.85 mA)	—	25	40
Saturation Time Factor τ_s (μs)			
(I _c = -10.85 mA; I _b = -0.23 mA)	—	0.9	—
(I _c = -10.85 mA; I _b = -0.23 mA)	—	36	—

* Frequency at which the modulus of the common emitter current amplification is equal to unity.
† β_s is defined as the collector current almost immediately available on closing the collector circuit, per unit steady base current.

Tentative Characteristic Curves of Ediswan Mazda Transistors Types XA151 and XA152



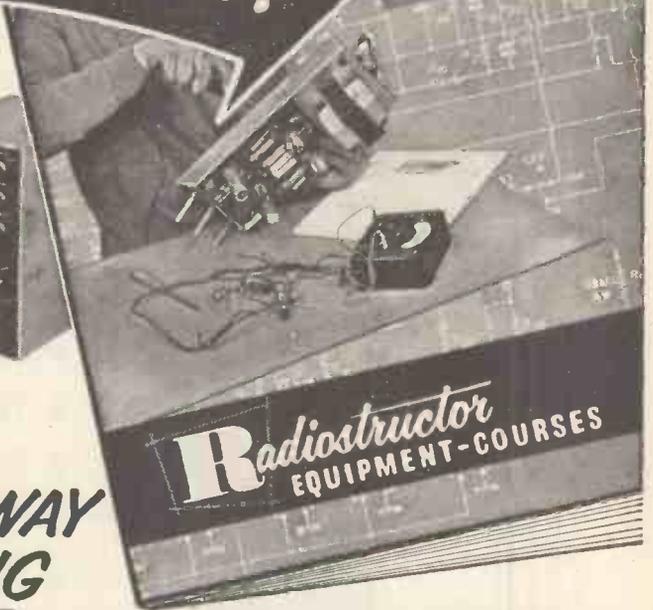
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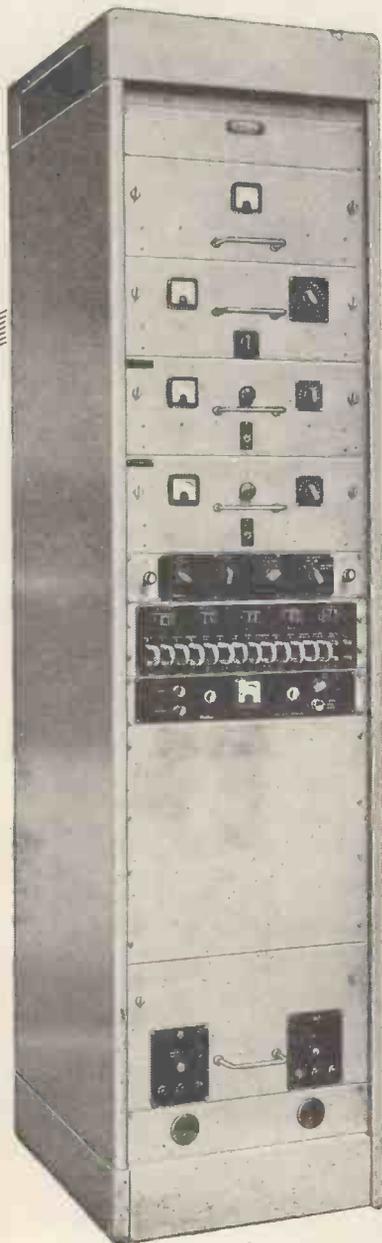
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30/50 WATT AMPLIFIER

Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than -85 dB referred to 30 watt.

It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.



ELECTRONIC MIXER/AMPLIFIER

This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxendale 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 impedances 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 7½ x 9½ in. deep.

Price of standard model £49.

Also 3-way mixers and Peak Programme Meters.

4-way mixers.

12-way mixers, and 2 x 5-way stereo mixers with outputs for echo chambers, etc. Details on request.

Full details and prices of the above on request

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19

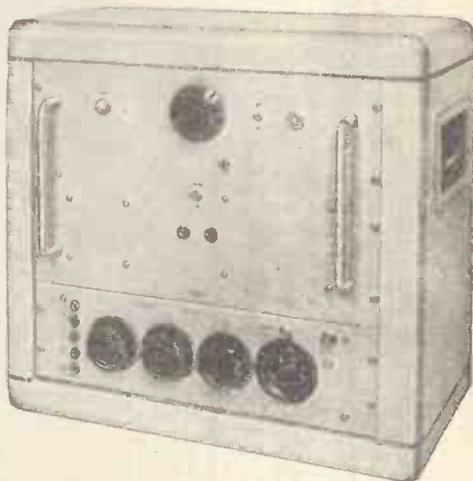
Telephones: LI Berty 2814 and 6242-3

Telegrams: "Vortexion, Wimble, London."

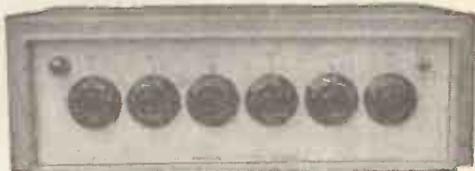
Vortexion

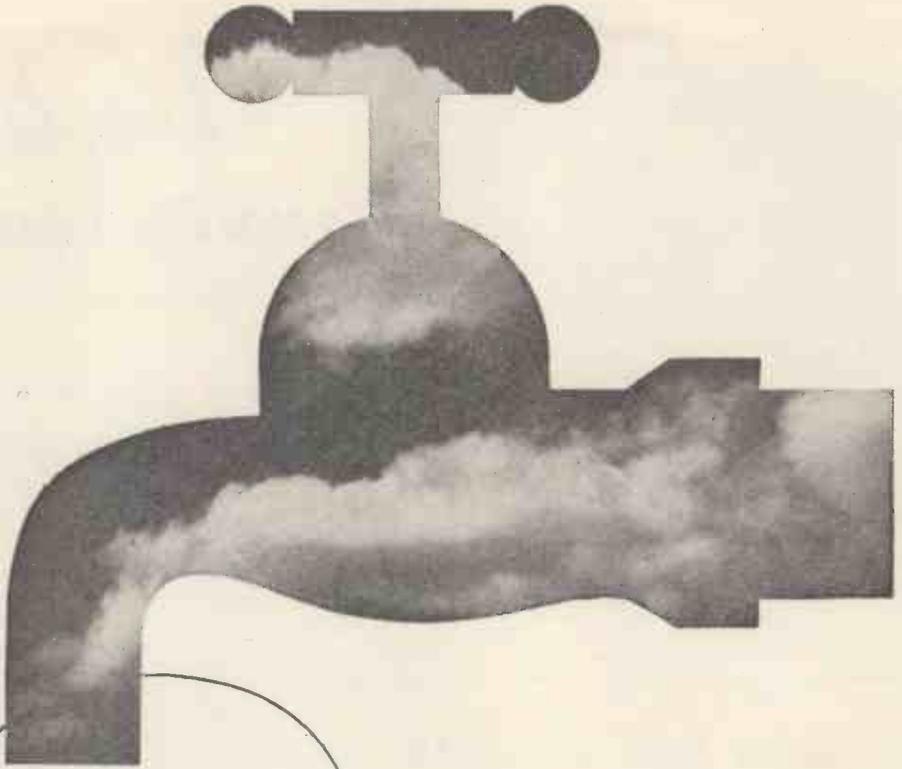
quality equipment

120/200 WATT AMPLIFIER



Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level -95 dB. A floating series parallel output is provided for 100-120 V. or 200-250 V. and this cool running amplifier occupies 12½ inches of standard rack space by 11 inches deep. Weight 60lb.





NOW!
WEATHER
INFORMATION
FOR THE
PILOT
ON TAP BY
TELEPRINTER

**THE MARCONI AD308 TRANSISTORISED
AIRBORNE TELEPRINTER RECEIVER**

AD308 provides automatic teleprinting of continuously broadcast weather information whenever the pilot needs it.

AD308 high selectivity receiver and low noise ferrite loop aerial gives continuous reception across the North Atlantic.

AD308 using narrow band L.F. reception clears the HF band for vital ATC communications.

AD308 being automatic, radically reduces the flight deck work load.

AD308 light weight receiver is contained in a short 4 A.T.R. case and weighs only 9 lbs (4.1 Kgs).



MARCONI

AIRPORT AND AIRCRAFT RADIO SYSTEMS

* Fitted in B.O.A.C.'s fleet of Boeing 707's



Television history was made at night, at 10 p.m. to be exact, when a 45-second "live" Commercial was flashed across Europe from race-track to the screens of Britain's TV network within four hours of Stirling Moss winning the Monaco Grand Prix.

A telephone interview with the winning driver was recorded over land lines from Monte Carlo to the A.B.C. Studios, while photographs were wired to Fleet Street and rushed by motor-cycle to Teddington.

For permission to reproduce this picture of the editing of the interview we are indebted to The Dunlop Rubber Company Limited and Charles F. Higham Limited, their Advertising Agents, and to A.B.C. Television Limited, in whose Teddington Studios the photograph was taken.

Evidence in Camera



Of interest not only for its story, this picture has provided (quite unintentionally) striking evidence of the reputation enjoyed by LEAK. It is a typical incident of the use of LEAK equipment by professional audio engineers in broadcasting and recording studios throughout the world, who choose LEAK for quality of performance and reliability. Does *your* installation measure up to these standards? If it does not, your LEAK Dealer can help you. The prices of LEAK studio quality equipment are made possible only by world-wide sales.



The new LEAK Varislope Stereo pre-amplifier (illustrated above) incorporates facilities which make it the most comprehensive pre-amplifier presently available.

PRICE £25

We shall be pleased to send you a copy of Thomas Heintz' review of this "Remarkable new control unit for stereo" reprinted from "Records and Recording."

Whether you are for Monaural or Stereo, LEAK equipment offers you the best of either. These suggestions may help you.

Monaural

Varislope III Pre-Amplifier
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Southdown Cabinet.
Total £55 13 0

Stereo

Point One Stereo Pre-Amplifier
Stereo 20 Power Amplifier
Southdown Cabinet
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Telephone: SHEpherds Bush 1173. Telegrams: SINUSOIDAL, EALUX, LONDON

NEW LINE OUTPUT BEAM TETRODE

Ediswan Mazda 30P19

This new line output beam tetrode is specially suitable for use with 110° cathode ray tubes in a.c./d.c. television receivers.

Heater Current (amps)	I_h	0.3
Heater Voltage (volts)	V_h	25

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

Anode Dissipation (watts)	$P_a(max)$	10
Screen Dissipation (watts)	$P_{g2}(max)$	5
Cathode Current (mA)	$I_k(max)$	160
Anode Voltage (volts)	$V_a(max)$	400
Peak Anode Voltage—		
Pulse Positive* (kV)	$V_{a(pk)max}$	7†
Screen Voltage (volts)	$V_{g2}(max)$	250
Peak Screen Voltage—		
Pulse Negative* (volts)	$V_{g2(pk)max}$	2000
Heater to Cathode Voltage (volts rms)	$V_{h-k}(max) rms$	200‡
Grid 1 to Cathode		
Circuit Resistance (MΩ)	$R_{g1-k}(max)$	1

* The pulse ratings are for Television Line Scan where the applied voltage pulse does not exceed 15% of one scanning cycle or 15 microseconds duration.

† The absolute rating of 8.5 kV must not be exceeded.

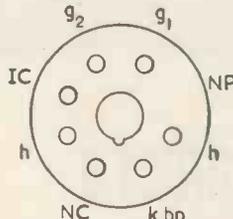
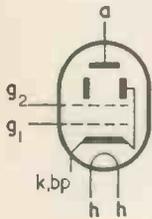
‡ Measured with respect to the higher potential heater pin.

Inter-Electrode Capacitances (pF)

Grid 1 to Earth	C_{1a}	20
Anode to Earth	C_{out}	10
Anode to Grid 1	C_{a-g1}	0.3

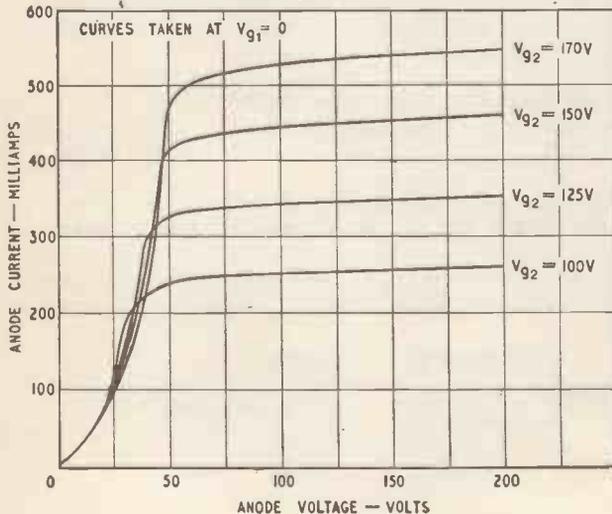
Maximum Dimensions (mm)

Overall Length 113 Diameter 32 Seated Height 99
 Base: International Octal (107)
 Top Cap: CT1—Anode.

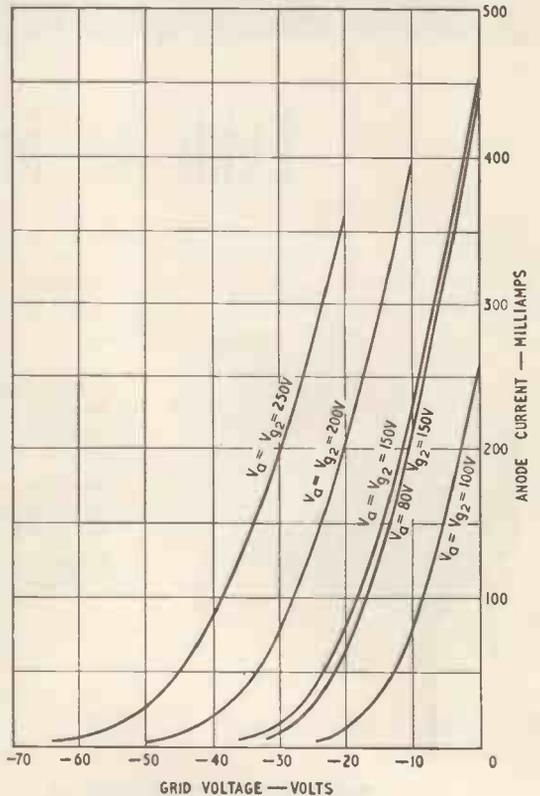


View of free end

Tentative characteristic curves of Ediswan Mazda Valve Type 30P19



Tentative characteristic curves of Ediswan Mazda Valve Type 30P19



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 Radio and Electronic Components Division
 Technical Service Department
 155 Charing Cross Road, London, W.C.2
 Tel: GERrard 8660. Grams: Sleswan, Westcent, London

EDISWAN
 MAZDA

TRANSISTORISED STETHOSCOPE



Trace signal right through—Radio, T.V., Tape amplifier, Hi-Fi, etc.—simplest way to fault find—carry it like fountain pen—all parts including transistor barrel crystal, everything except battery. 12/6 plus 1/6. Battery 6d.—data included or separately 1/6.

A.C./D.C. Multimeter Kit



Ranges: D.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000 A.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000 D.C. milliamperes 0-5, 0-100, 0-500, 0-1,000 Ohms 0-50,000 with internal batteries, 0-500,000 with external batteries. Measures A.C./D.C. voltage, D.C. current, and Ohms. All the essential parts including metal case, 2in. moving coil meter, selected resistors wire for shunts, range selector switches, calibrated scale and full instructions. price 19/6, plus 2/6 post and insurance.

Suppressor Condenser



Stop your irritating interfering with your or your neighbour's radio or television. Simple instructions given. 1/6 each. 12/- dozen.

Band III Converters



Suitable Wales, London, Midland, North Scotland etc. All the parts, including 2 EP80 valves, coils, fine tuner, control, condensers and resistors (Metal case available as an extra). Price only 19/6, plus 2/6 post and insurance. Data free with parts or available separately. 1/6. Please send two more kits, the one you sent last week is performing magnificently. We receive this sort of letter every day of the week, so if you have hesitated because you thought our kits too cheap you need hesitate no longer.



Very modern cream cabinet, size 5 1/2 x 3 1/2 in. with chrome handle, tuning knob and scale. Price 7/6, plus 1/6 postage and packing.

Cine Cameras



16 mm. motorised (24 V. A.C.) for 18 frames per second, contains fine 1/8" triple anastigmatic lens and spool to carry 25ft. of film—probable cost around £150, brand new and in sealed carton £8.10/- or 20/- deposit and 13 fortnightly payments of 10/- . Post and insurance 3/6.

High Voltage Rectifiers

CV19 65 kV., Peak 800 mA.	£2 17 6
CV194 60 kV., Peak 1,200 mA.	£5 17 6
CV74 40 kV., Peak 800 mA.	£2 17 6
CV1948 8 kV., Peak 1,000 mA.	£1 17 6
CV1111 14 kV., Peak 350 mA.	7 6

PHILIPS TRANSCRIPTION UNIT



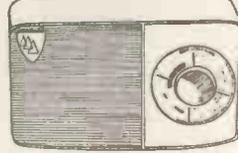
Philips AG2009 Record Player, 4 speed. Ideal for the enthusiast. Pick-up arm wired for stereo, fine adjustment on all four speeds. Continuously variable pick-up weight (2-12 gms.) Supplied with Philips Hi-Fi crystal head, type AG8019 for micro-groove and 7R e.p.m. Frequency response 30-15,000 c/s Pick-up lifting and lowering device. Individually balanced, heavy ironable. Muting switch. Can be used with any amplifier or radio set. Complete with mono-aural pick up £10/10/- or 2 gns, deposit and 20 fortnightly payments of 10/- . Available also with stereo head diamond or sapphire stylus. Prices on request. TRANSCRIPTION SET.

Another Battery Charger Bargain



Car Battery Charger—ready-made high output battery charger in stove enamelled sheet steel, brushed case. New complete and ready to work. Rated at 12 v. 5 amps, and variable rate selector for trickle charging. Also a meter to show charging rate. Suitable for 230/250 A.C. mains. Special snip price of 65/- plus 3/6 post and ins.

TRANSISTOR LOUDSPEAKER RADIOS

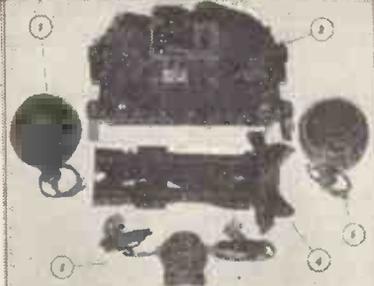


Results Guaranteed. Nothing can be more disappointing than to find that despite care in making up, your little radio just will not work. This is unlikely to happen with our kits, but if it does send it in for service, we guarantee good results. Pocket 4, uses three transistors and one diode and has refinements for receiving weak stations, price 42/6. Pocket 5 uses 4 transistors at truly big output 55-. Every set complete to last and beat, with proper case, tuning condenser and miniature loudspeaker. Our sets do not need external aerial, also they may be built in stages to a radio output. Post and insurance 2/6.

Motor Snip



Miniature motor 2 1/2 in. long x 1 1/4 in. diameter, laminated poles and armature, separate winding for reversing. Operates off 20-30 v. D.C. or off A.C. mains through step-down transformer. Original cost at least £3 each. Snip price for one month only 8/6. Plus 1/6 postage and insurance.



TABBY EQUIPMENT COMPLETE

Complete equipment for seeing in the dark, as fitted to Army vehicles for night driving, etc. Complete working equipment comprises: 2 Infra Red Radiators, adjustable binoculars, power pack for 6 or 12 volts, control units and inter-connection cables. Original cost, probably around £100. Unused and in perfect order—£6.19/6 or 10/- deposit and 15 fortnightly payments of 10/-.

Component Storage Drawers



Stout board construction these drawers are ideal for small parts. Supplied complete with single erection instructions. 1/6 each or 12 drawers each 6 x 2 1/4 x 6 1/2 in. 13/6, post 2/-.

SPECIAL THIS MONTH—

Sub-miniature electrolytics for transistor sets 1 mfd. 18 v. 2.5 mfd. 6 v. 8 mfd. 6 v. 5 mfd. 12 v. 10 mfd. 6 v. 25 mfd. 6 v. 30 mfd. 3 v. 50 mfd. 3 v. All 1/9 each. Transistor ferrite rod aerial with medium and long wave coils with circuit. Price 7/6. Oscillator Coil and set of 3 I.F. transformers for transistor set with circuit. Price 23/6. Midget 3in. P.M. Loudspeaker for transistor set. 3-ohm coil. Price 18/6. Magnet 208 pF - 176 pF two-gang Tuning Condenser with trimmers for transistor set. Price 9/- plus 1/- post. Push-Pull Output Transformer for transistors OC78, etc. Sub-miniature. Price 8/6. Push-Pull Input Transformer to match the above Output Transformer 8/6. .0005 mfd. Single Tuning Condenser. Solid dielectric film spindle for transistor of Crystal set, 3/9, ditto with spindle taped 6/8A 4-. Transistors tested suitable as mixers, 9/6 each. Suitable as I.F. amplifiers 8/6. Suitable for B.P. and Regen circuits 8/6, matched pairs for Push-Pull Output 15/- a pair. 8uh gain for single ended output 7/6. Ordinary white spot 3/9, red spot 3/6. Resistors, miniature quarter-watt type for transistor sets. All popular values 5d. each. Miniature ceramic condensers 6d. each. Auto Transformer, totally enclosed primary 200-250, secondary 110-120 v. 150 w. Normally 27/6, Price 17/6. I.F. Coils, standard size, by Weymouth. 465 kc/s. dust cores. Normally 12/6. Price 6/6 per pair. Pilot Bulbs, 3-5 volt 0.3 amp. 3/6 a box of 25. Dinchby Mast, tubular aluminium, extends from 10m. to 17ft. Price 4/6. Magnet Generator (hand), as used in telephones. Price 7/6. Push-Pull Transformers, input and output, midge, posted, price 5/- pair. F.O. Type 3000 Relays, 2,000 ohm coil, 6 contacts 7/6, 4 contacts 6/6. Versatile Wire, single strand, 18 gauge, with p.c. covering. New 1-mile on drum. Price 7/6 (3/8 carriage). Wire Joiner (welder for 28 gauge or thinner), in bakelite case with trigger switch, works off step-down transformer. Price 2/6. Philips Trimmer, 0-30 pF. Price 9d. or 7/6 dozen. B70 Holder, with skirt for screening can. Price 6d. or 5/6 dozen. Metal Rectifiers, 250 v. 50-80 mA., ideal for mains set or instrument, or to replace that expensive valve. Price 3/9. Multi-speed Motor with gearbox, works on A.C./D.C. mains, gives any speed from 1 r.p.m. Price 17/6 (2/6 postage). 5 amp. 12 v. full-wave Charger Rectifier. Normal price 17/6. Price 10/- . Filament Transformer, 6.3 v. 1 1/2 amps. Normally 9/6. Price 6/6 plus 1/- post. 250-0-250 60/80 mA. Mains Transformer, with 6.3 v. filament winding, half-shrouded, drop through, standard replacement in many receivers, made to sell at 19/6. Price 13/6 plus 2/6 post and ins. Ditto with additional 5 v. winding for rectifier. Price 14/6 plus 2/6 post and ins. **ORDERS over £2 post free except for heavy items where postage or carriage is mentioned separately.**

Morganite Potentiometers

Single and 2-gang types available, standard size with good length spindle, all new and boxed. Single types 1/- each, values available: 5K, 10K, 25K, 50K, 100K, 200K, 1 meg., 2 meg., Gang type 3/- each—values available: 5K + 5K, 100K + 100K, 1 meg. + 1 meg., 2 meg. + 2 meg.

Heavy Duty Thyatron

Heater 8 volt 20 amp. Peak anode 16,000 volts. Peak plate current 120 amps. Unused, perfect condition. 25.

Magnetron

American and British makes. Several types in stock. New and unused, for example, American type 725A. Price £5/10/-.

Klystrons

Several types in stock. For example, American type 714AB. Price 30/-.

ELECTRONIC PRECISION EQUIPMENT, LTD.

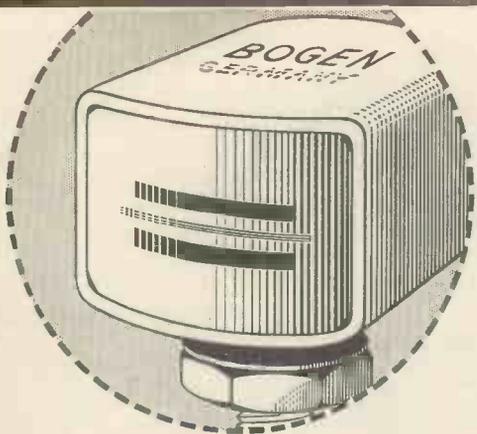
post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 65 Grove Road, Eastbourne, marked Department 2. Callers may use any one of the Companies below.

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THE BEST IN THE WORLD FOR MODERN 4-TRACK RECORDERS

- ★ **BOGEN HEADS.** are made in a vast variety of types for recording purposes in all branches of science, industry and research.
- ★ **BOGEN HEADS** as used in domestic recorders are used in exactly the same version for the production of commercial pre-recorded tapes.
- ★ **BOGEN 4-TRACK HEADS** as used for stereo and mono recorders employ standard gaps of less than 0.0001375in. which prove best for use in currently available equipment. A Bogen head using a one micron gap was produced in 1957 with a response from 30-16,000 c/s. at 1 7/8 i.p.s.
- ★ **BOGEN HEADS** use special mu-metal screening techniques, mirror-smooth working surfaces to tape and colour coded leads.
- ★ **BOGEN 4-TRACK HEADS** have a 30-16,000 c/s. response at 3 3/4 i.p.s. and a normal working life of 10,000 hours (equal to 10 years average use of a domestic recorder).
- ★ **BOGEN HEADS** are available for and in use by leading Broadcasting systems, automation designers computers, TV recording, film studios as well as for domestic, semi, and fully professional recorders.
- ★ **BOGEN HEADS** already incorporated into many fine Continental recorders are also used in Recorders by C.Q. Audio, Reps., Chitnis and other manufacturers for four track models, stereo and mono.

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MAGNETIC HEADS FOR ALL RECORDING REQUIREMENTS

- ★ **BOGEN 4-TRACK HEADS** are available for manufacturers' requirements and also for individual users. Retail price per set of record/replay and erase heads 15 gns. **ENQUIRIES INVITED.**

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AVAILABLE TO EXPORT AND QUANTITY BUYERS

NEW MODEL—HIGH QUALITY

6 TRANSISTOR PORTABLE RADIO

- RANGES 187-545 M AND 1095-1825 M
- TWO-COLOUR GRAIN FINISH P.V.C. CASE
- HIGH SENSITIVITY AND 500 mW OUTPUT
- WEIGHT 3 1/2 LBS. SIZE 10 x 8 x 3 1/2 INS.



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CHANNEL ELECTRONIC INDUSTRIES LTD.

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INSTRUMENTATION
PEOPLE

VARIABLE VOLTAGE TRANSFORMERS



TYPE B5
5 amp. 260 v. output, as illustrated £8 10 0

TYPE B10
10 Amp. 260 v. output £17 15 0

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20 Amp. 260 v. output £32 0 0

Large easily read Dial calibrated 0-260 v. Totally enclosed with Input and Output Terminals. Ideally suited for Laboratory experimental work and Schools.

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Table with multiple columns listing various electronic components and their specifications, including part numbers, descriptions, and prices.

Terms of business: Cash with order or C.O.D. only. Post/Packing charges 6d. per item. Orders over £5, post free. C.O.D. 2/6 extra. Any parcel insured against damage in transit for 9d. extra. We are open for personal shoppers. Mon-Fri. 8.30-5.30. Sat. 8.30-1 p.m.
Latest catalogue of over 1,000 different valves, also metal rectifiers, volume controls, electrolytic condensers, transistors, germanium diodes, valve holders, and Hivac miniature valves, with full terms of business, price 6d.
All valves boxed fully guaranteed, and new manufacturers' stock or government stores surplus. First-grade goods only, no seconds or rejects. Please enquire for any type not listed. S.A.E. please.



CHITNIS FOUR-TRACK STEREO AND MONO

Designed to exceptionally good standards

Chitnis 4-Track Tape Recorders are characterised by features that make them particularly important to users demanding performance well above average. These instruments which offer choice of stereo or mono, 4 and 2 track and single and two speeds, are very compact yet robustly built. Response at $3\frac{3}{4}$ i.p.s. is from 30 to 16,000 c/s, performance made possible through the use of BOGEN HEADS. 15 ohm outlets are provided as well as usual facilities required in modern domestic and advanced recording techniques. Papst motors, Bogen heads, and high quality speakers are used throughout. From every point of view Chitnis Recorders offer quality, dependability and value to make them amongst today's finest recorders. **LEAFLETS ON REQUEST.**

9/54K FULL STEREO

All inputs and outputs paired for stereo. $3\frac{3}{4}$ i.p.s. Low level, 5 ohm and 15 ohm outlets. Controls include channel selector, stereo balance, pause, superimpose, etc. Digital counter, fluorescent indicator. Fused at mains inlet. Built-in speaker. Tape and microphone(s) extra

62 GNS.

KM/33 FOUR TRACK MONO, 2-SPEED

Speeds— $3\frac{3}{4}$ and $1\frac{1}{2}$ i.p.s. With Chitnis M.50/Tr Dynamic mic. and tape.

62 gns.

KM/22— $\frac{1}{2}$ track version of KM/33 model with mic. and tape 54 gns.

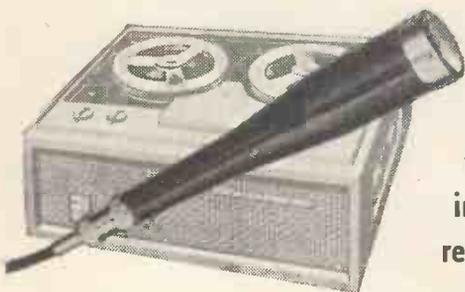
TRADE DISTRIBUTION THROUGH WHOLESALE CHANNELS

Chitnis 4 TRACK Recorders

1, LONG ACRE, LONDON, W.C.2

Telephone COVent Garden 1918/9

Grampian DP4



brings out the best in any recorder

Even the most expensive recorder will only give its best performance if a good quality, reliable microphone is used.

In the DP4, with a uniform wide frequency response from 50 c/s to 15,000 c/s, Grampian have developed an outstanding, moderately priced instrument which will please the most exacting recordist.

The DP4 is equally suitable for Public Address, Broadcasting, Call Systems etc.

OUTPUT LEVELS

DP4/L low impedance 25 ohms 86 dB below 1 volt/dyne/Cm².
DP4/M, medium impedance 800 ohms 70 dB below 1 volt/dyne/Cm².
DP4/H, high impedance 50,000 ohms 52 dB below 1 volt/dyne/Cm².

Retail Price: DP4/L complete with connector and 18ft. screened lead, £7/11. (Medium or High Impedance models. £1 extra).

A complete range of stands, swivel holders, etc., is available also.

A matching Unit (Type G7) can be supplied for adapting the microphone for a Recorder having a different input impedance, or when a long lead is required. Retail Price £3/5/.

Write or telephone for illustrated literature.

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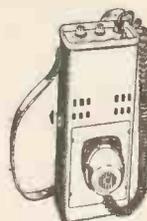
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CONTRACTORS TO G.P.O., M.O.S., L.E.B., ETC.

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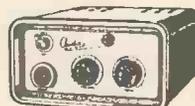


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STANSTED 3132

HARVERSON SURPLUS CO. LTD.

83 HIGH STREET, MERTON, S.W.19. CHERRYWOOD 3985/6/7

1/6 H.P. MOTOR

140 Watt (Approx. 1/6 H.P.). Series wound, 220/250 volt 50 cycle motor. Off load 14,000 rev/min. on load 8,500 rev/min. Ideal small saw, sewing machine, etc. **30/-** post free.

MINIATURE AMPLIFIER

Miniature amplifier, size 3 1/2 x 2 1/2 x 4 1/2 ins. Ideal for record player, etc. Controls, volume/on-off, bass and treble. Supplied ready built, less valves (UY85, UF89, UL84), and mains transformer, at the give away price of **14/-** P. & P. 2/6.

HARVERSON SUPERHET 4 KIT

A medium and long wave superhet, incorporating two I.F. stages, modern B9 valves (UCH81, UBF89, UCL83, U785), built-in ferrite rod aerial. All you need supplied from theoretical wiring diagram to last nut and bolt (main components ready mounted), including an attractive contemporary styled cream plastic cabinet with gold trimmings. Size 11 1/2 x 4 1/2 x 6 1/2 ins.

PRICE **£6.12.6** Post 3/6.

HARVERSON T.R.F. EASY. FOUR KIT

All parts and theoretical wiring diagram only. OUR PRICE **£4.0.0** Plus P. & P. 3/6.

THE FAMOUS E.M.I. ANGEL TRANSCRIPTION P.U. (Model 17A)

A Pick-up for the connoisseur originally priced at £17.10.0. The last remaining few offered at **£4.10.0** Plus P. & P. 5/-.

TAPE RECORDER

★ CONTEMPORARY Red and White Tygan Cabinet. Size 13 1/2 x 14 1/2 x 9 1/2 inches.
★ B.S.R. DECK.
★ MAGIC EYE tuning.
★ INPUTS for RADIO and MIKE.
★ VOLUME and TONE Controls.
This instrument has to be seen and heard to be believed. Complete with ACOS Xtal Mike. **ONLY 18 gns.** P. & P. 8/6.

EXTENSION SPEAKER

An attractive cabinet 8 x 6 x 2 in. fitted with 3 ohm 5 in. speaker complete with lead, a few only.

19/6 P. & P. 2/6.

AM/FM RADIOGRAM CHASSIS

★ By famous manufacturer. ★ 220/250 volts A.C. ★ Coverage 1000-1900 m. 200-500 m. 88-98 Mc/s. ★ Tuned by 5 "Piano Keys"—Off, LW, MV, FM and Gram. ★ Sockets for P.U., Ae., E. Extn. Spkr. and Dipole. ★ Tuning and tone controls fitted. ★ Valves, ECH81, EF89, EABC80, EL84, ECC85 and EZ80.

50 Only at ridiculous price of **12 gns.** plus 8/6 P. & P.

MIDGET GRAM AMPLIFIER READY-BUILT with Speaker

A 2 1/2 watt gram amplifier, fitted with bass, treble, and vol./on-off controls. Supplied complete with 6 x 4 in. 3Ω speaker, valves (UY85, UF89, UL84), knobs, etc., all mounted on an attractive baffle board, size 10 1/2 x 7 1/2 ins.

OUR PRICE **49/-** P. & P. 3/-.

SPEAKER FRET

Super quality heavily woven fret. 54 inches wide. Usual price 50/- per yard. P. & P. 1/-.

OUR PRICE, **19/-** per yard

MIDGET I.F. TRANS & COILS

A pair of midget 465 kc/s. I.F. transformers, plus LW and MV coils. OUR PRICE 10/- per sec. P. & P. 1/9. Set of I.F. transformers for transistor superhet. 9/- P. & P. 1/9.

CYLDON 12 CHANNEL TURRET TUNERS

New purchase offered at still lower price. I.F. 33-38 Mc/s. Complete with PCC84 and PCF80 valves and 8 sets of Coils for 5 Band III channels and 8, 9, 10 Band III. New and unused. Value over **£7**

OUR PRICE, Post paid. **32/6**

CONDENSER / RESISTOR PARCEL

50 mixed P.F. Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor. **ONLY 10/-** P. & P. 1/-.

GUARANTEED VALVES ★ NEW and BOXED ★ PROMPT DISPATCH ★ POST 6d. per Valve extra ★

ATP4	3/3	EB34	1/9	ECL82	9/8	EY81	9/3	KTZ41	3/3	PV80	7/-	U50	7/6	UL41	9/6	IC5GT	11/9	384	7/-	6A45	7/-	616	4/6	6K7M	6/8
AZ1	9/3	EB41	8/-	EP41	9/3	EY86	9/3	N37	18/6	PY81	8/-	U78	7/6	UL44	26/-	116	11/9	3V4	8/-	6A76	8/-	6CH6	9/9	6K90	7/6
AZ31	11/2	EBC39	6/3	EP42	10/3	EZ40	7/8	N78	18/6	PY82	6/8	U01	38/-	UL46	85/-	116	11/9	5R4GY	9/-	6A78	9/9	6P80	7/-	6K9T	6/6
B36	14/-	EBC41	8/9	EP50	3/9	EZ80	6/6	N339	28/-	PY83	8/-	UAB80	9/6	UL84	8/6	1H5GT	10/-	514G	6/8	6P40	3/9	6P81	7/-	6K9T	5/6
CB131	22/9	EBF80	9/-	EP80	7/-	EZ81	8/6	Q24	5/-	PZ30	18/6	DAF42	8/9	U6	18/6	114	6/-	5V4	10/8	6B88	7/-	6P1	13/-	6K9T	9/6
CH33	22/9	EBF89	9/-	EP86	7/-	EZ90	7/-	P61	3/3	PEN4DD	8/6	UB41	8/6	U08	25/-	11B3	3/-	5V90	7/6	6B88	7/6	6P13	13/-	6K98	18/6
CL3	18/-	EBC82	7/-	EP89	8/-	KT32	9/3	PCF80	9/-	SP41	2/9	UC84	10/-	UY21	11/9	1R5	7/-	5Z4G	8/6	6B88	8/6	6P17	11/9	6L1	14/6
CV31	15/8	ECC88	8/6	EP91	5/8	KT83C	8/-	PCF82	11/9	SP61	2/9	UC88	10/6	UV41	7/-	1R4	9/9	5Z4M	9/6	6B88	8/6	6P33	16/6	6L8M	9/-
DAF98	8/3	ECC84	9/3	EL38	24/6	KT86	28/-	PCL82	11/6	SP46	9/9	UCF80	15/6	UV86	6/8	1S5	6/-	6A7	14/6	6B87	11/9	6H8	9/3	6L7G	7/-
DF96	8/6	ECC85	9/-	EL41	9/6	KT85	28/6	PCL83	13/6	SP47	9/9	UCF42	9/9	VP41	8/-	1T4	5/8	6A80	8/6	6B89	8/6	6H8T	2/3	6L18	10/3
DH63	11/6	ECP90	11/3	EL42	9/6	KT81	8/6	PL38	16/6	T11	22/-	UCB81	9/9	VP13	14/-	2K2	4/-	6A7	6/-	6B7	9/-	6JGT	4/6	6L19	14/-
DK98	8/6	ECP82	12/3	EL31	15/6	KT82	7/-	P438	14/6	U22	7/6	UCL82	15/6	X22	18/9	3A4	8/6	6A85	6/6	6A	3/8	6J5M	6/-	6VGT	7/-
EA50	1/3	ECH42	9/-	EM84	8/6	KT86	16/-	PL81	11/9	U25	13/-	UCL83	11/6	IA3	3/-	3A8T	5/6	6A85	6/6	6C5GT	6/-	6J6	5/8	6P28	25/-
EABC80	8/6	ECH81	8/6	EM80	9/8	KT88	21/-	PL82	8/-	U26	11/9	UF41	8/6	IA8GT	5/8	3D6	4/6	6A85	6/6	6C8	4/6	6J7G	6/-	6Q7G	7/-
EAP42	9/6	ECL80	9/8	EM81	9/6	KTW61	6/-	PL83	11/9	U37	25/-	UF85	8/6	IA7GT	11/9	3Q4	7/8	6A85	11/9	6C31	7/-	6J7M	8/6	6Q7GT	9/-
		ECL80	9/8	EM81	9/6	KTW63	7/-	PY28	11/9	U45	14/-	UF89	8/6	IA2	11/-	306GT	9/-	6A86	4/6	6J7G	28/-	6K7G	8/8	6A7GT	7/-

TRANSISTOR BARGAINS

ALL MULLARD FIRST GRADE

OC71	8/-
OC72	12/-
OC72 Matched Pair	25/-
OC45 Green Spot	15/-
OC45 Blue Spot	15/-
OC44	15/6
SB305 Semi Conductor	10/6
OA41 Diode	3/6

Postage on all the above 6d.

RECORD CHANGERS

GARRARD RC 98 Mk. 4H. 4-speed autochange	£16.10.0
RC 120/D Mk. 2	£9.0.0
RC 120 Mk. 4D	£9.0.0
RC 120 Mk. 4H	£9.0.0
RC 121 Mk. 1	£11.0.6
RC 121 Mk. 4H	£11.0.6
RC 121/40 Mk. 2	£11.0.6
COLLARO RC 54 4-speed autochanger	£6.19.6
RC 594	£7.19.6
Conquest	£6.12.6
Challenger	£7.19.6
B.S.R. Monarch UAB 4 speed autochange	£6.19.6
TUB 4-speed single player less pick-up	£2.10.0

Carriage and ins. on each of above 5/- extra.

NOTE: Any of the above with Stereo Cartridge and Fittings, 16/- extra.

TAPE DECKS

LATEST B.S.R. MONARDECK (single speed) 3 1/2 in. per sec., simple control, uses 5 1/2 in. spools **£9.19.6** plus 5/6 carriage and insurance (tapes extra).
COLLARO STUDIO DECK piano key controls, pause control, space for additional head, uses 7 in. spools, with counter **£14** plus 6/- carriage and insurance (tapes extra).

YOU ARE INVITED!

Spend a day browsing around our premises at **83 HIGH ST., MERTON, S.W.19** (one minute South Wimbledon Tube.)

We have a wealth of components, valves, chassis, tape decks, autochangers, amplifiers, F.M. tuners, record players, tape recorders, cabinets, and a host whole of other things we just don't have the space to describe. Please come and look for yourself. We will be pleased to see you, and there's no obligation to buy.

MONAURAL AMPLIFIER

This amplifier as illustrated, made by a leading manufacturer. Mullard valves—ECC83, EL84 x EL84, EZ80. Bass Treble and Volume on remote panel. Elegant Knobs. OUR PRICE one month only **£4.16.6** plus P. & P. 3/6.

RECTIFIERS FOR BATTERY CHARGERS

12 v. 1 amp. 4/3 12 v. 4 amp. 12/6
12 v. 2 amp. 7/- 12 v. 5 amp. 14/6
12 v. 3 amp. 10/- P. & P. 6d.

PICK-UP CARTRIDGE BARGAINS

STUDIO P	17/6
ACOS HIGH G	17/6
E.U. POWER POINT	12/6
RONETTE	18/6
G.C.Z.	16/6

P. & P. 1/-.

COSSOR C.R.T. SNIP

108K 10-inch. New and boxed, **15/-**, plus 6/- P. & P.
75K 10-inch. New and boxed, **15/-**, plus 6/- P. & P.

ION TRAP MAGNETS

To suit the above, 2/9 each. P. & P. 3d.

STEREO AMPLIFIER

Complete with 2 Loudspeakers. A compact amplifier combining latest features with good reproduction, and ample volume. Complete with valves (ECL82, ECL82, EZ80), panel, knobs, etc. and 2 matched 3Ω loudspeakers. Few only—Order Now. **£5.10.0** Plus 4/6 P. & P.

PREMIER RADIO

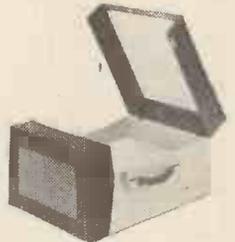
23 Tottenham Court Rd., London. W.1. Tel: MUSEum 3451/2



THE EASY SIX
6-Transistor Battery Portable
MAY BE BUILT FOR **£9.15.0** plus 3/- p. p.
Ever Ready PP7 Battery Extra 3/3
STAB FEATURES: ★ Six 1st grade Mullard Transistors ★ Internal Ferrite Rod Aerial ★ ★ Provision for Car Radio Aerial ★ 5in. Loud-speaker ★ Printed circuit, with component positions indicated ★ Pre-assembled Dial Assembly ★ 500 milliwatts. Push Pull output ★ Full medium and long waveband coverage ★ Attractive two-tone Blue/Cream Vynide covered Cabinet, dimensions 9 1/2 in. x 6 1/2 in. x 3 in. ★ Full point-to-point instructions supplied. ★ Weight 8 1/2 lb with battery.

Assemble it yourself and **SAVE £ £ £'s**

COMPACT GRAM. AMPLIFIER
2-valve printed circuit type for use on A.C. or D.C. 200/250 v. mains incorporating modern miniature valves. Output 2 watts, overall dimensions 6 1/2 x 2 x 3 1/2 in.
Price 59/6, plus P. & P. 2/6.
Amplifier Cabinet, £2/19/6, plus 6/- P. & P. 7 x 4 in. Elliptical Speaker. £1/1/6, plus 1/6 P. & P. Latest-type Collaro Conquest 4-spd. Changer, £7/19/6, plus 6/- P. & P.
If all the above items are purchased at the same time they can be supplied at £13/15/-, plus 10/- P. & P.



DRAMATIC PRICE REDUCTIONS

AVANTIC DL735 Power Amplifier. Specifications: power output 54 watts peak; L.S. impedance 4, 8 or 16 ohms, power inputs 105-250 v. Valve line-up GZ34, 2-EL34, ECC83, EF86. Dimensions 14 1/2 x 9 x 8 1/2 in. Original price 30 gns. P. & P. 12/6. **OUR PRICE £16/19/6.**

AVANTIC SP21. Stereophonic Pre-amp Control Unit. Brief specifications: 6 inputs for each channel, bass, treble, volume control, on/off stereo/3D/reverse stereo switch, stereo phase switch, low pass filter. Power requirements 6.3 v. at 1.3 A., A.C. 350 v. at 5 mA. D.C. Dimensions 14 1/2 x 9 x 4 in. Original price £28/10/- P. & P. 7/6. **OUR PRICE £16/19/6.**

AVANTIC SP11 Stereophonic Amplifier. Technical details: power output (each channel) 10 watts peak, L.S. impedance, 4, 8 and 16 ohms 6-position input selector, bass, treble, volume on/off controls, stereo reverse switch, phase reverse switch, stereo balance control, P.U. balance control. Dimensions 14 1/2 x 8 1/2 x 4 in. Original price 28 Gns. P. & P. 7/6. **OUR PRICE 19 Gns.**

AVANTIC PL621 20-watt monaural Amplifier, frequency response 10 c/s -30 Kc/s. 1bB. L.S. impedance, 4, 8 or 16 ohms. Dimensions 14 in. x 8 1/2 in. x 7 1/2 in. Original price 29 Gns. P. & P. 7/6. **OUR PRICE 19 Gns.**

AVANTIC STEPII. Stereophonic Magnetic Pick-up Amplifier Unit. Price £4/4/-.

All this equipment is Brand New and in manufacturers' original sealed cartons. Full descriptive literature available.



THE Petite PORTABLE

MAY BE BUILT FOR **£7.7.0** p. & p. 3/-

Batteries extra.
H.T. 10/- (Type B126) or equivalent.
L/T 1/6 (Type AD 35) or equivalent.
● High Q frame aerials.
● High sensitivity on both wavebands.

- Medium and long wave superhet circuit.
- Instruction book 1/6.
- Size only 8 x 8 x 4 1/2 in.
- Weight including batteries 5 1/2 lb. ● 4 valves of the economy type.

WHY NOT TAKE ADVANTAGE OF THIS WONDERFUL OFFER!

Two DL735 POWER AMPLIFIERS. Combined Price **47 Gns.**
SP21/2 STEREO CONTROL UNIT. **47 Gns.**

A SIX TRANSISTOR POCKET RECEIVER

complete with Earpiece and Plastic case, Battery extra 2/6.
£14. 14. 6 Plus 2/- P. & P.
This amazing Receiver is so small that it will fit snugly into a shirt pocket or ladies' handbag, size being only 4 x 2 1/2 x 1 1/4 in. Ferrite Rod Aerial is used, full station selectivity on medium wave band-



PREMIER BATTERY ELIMINATOR

Housed in two containers which are to replace AD 35 and B126 batteries.
KIT 37/6 plus 2/- post and packing. *Only suitable for use with DK 96 Series valves.*

THE MODEL FMA/1 FERGUSON FM TUNER

13 gns plus 3/- p. & p.
This Tuner has been designed for use with Radio Receivers or Hi-Fi equipment. The Unit is completely self-contained being self-powered and housed in a hammered metal finished steel case, measurements 10 x 7 1/2 x 2 1/2 in. Brief technical specifications: Frequency coverage 87.8-100 Mc/s (continuously). Valve line-up: 2-2F80, DCF80, 2 germanium diodes and metal rectifier, for operation on A.C. mains 200/250 v. 50-60 cycles.



WHY NOT DO IT YOURSELF!

SUPERHET may be built for **£7. 7. 0** Plus 3/- p. & p.

T.R.F. may be built for **£5. 10. 0** Plus 3/- p. & p.

These two receivers use the latest type circuitry and are fitted into attractive cabinets 12 x 6 1/2 x 5 1/2 in., in either walnut or ivory Bakelite or wood 1/- extra. Individual instruction books 1/- each, post free.



THE 'CLARION' TAPE RECORDER

Transistorised miniature battery-operated
★ Completely transistorised circuit.
★ Constant governed speed of 3 1/2 I.P.S.
★ Recordings interchangeable with other recorders.
★ Remarkable reproduction on both speech and music.
Price complete with Microphone **25 GNS.** plus 3/- P. & P.

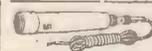
THE 'MID-FI' A NEW DESIGN 4 WATT AMPLIFIER KIT

MAY BE BUILT FOR **95/-** Plus 3/- p. & p.

A new circuit for the home constructor requiring a good quality medium-powered Amplifier for reproduction of Records or F.M. Broadcasts. Technical Specifications: separate bass and treble controls. Valve line-up EF86, EL34, E280. Voltage adjustment for A.C. mains from 200/250 volt, 3 or 15 ohms impedance. Negative feedback, Size 7 x 5 x 2 1/2 in., overall height 5 1/2 in. Silver-hammered finished Chassis.



THE VICEROY QUALITY CRYSTAL MICROPHONE A good-quality crystal Microphone for the discerning enthusiast, finished in polished steel with Muting Switch and detachable lead. Price 42/-, P.P. 1/6.



FOR THE BEGINNER
A two-transistor, medium wave, receiver, ideally suited for the young enthusiast or the beginner. Incorporating two transistors and one diode and operating on two pen torch batteries. Simple to construct, with full instructions supplied. No headphones required. Complete set of components, including plastic case. **22/6** plus 1/6 P. & P. Batteries extra.



THE MODEL VT41 VALVE FILAMENT TESTER
Will instantly check the filaments of all Radio and T.V. Valves, Fuses and Dial T.V. Valves. Will also give an accurate circuit continuity test and also has built-in 7 and 9 valve straighteners. Size 5 1/2 x 3 1/2 x 1 1/2 in. **PRICE 30/-** with Battery, post paid.

OABY MODEL B20 MULTI-METER
DC/V 0-0.5 v. 0-2.5 v. (2K.ohms/V)
DC/V 10-40-250-500-1000 v. (4K.ohms/V).
AC/V 10-50-250-1000 v. (4K.ohms/V).
DC/mA 0-100 microamps (500mV)
DC/mA 0-2.5-25-250mA (250mV)
OHMS. 2K-20. meg.
COMPLETE WITH TEST LEADS—
PRICE £6/10/0 plus 2/- P. & P.

GABY MULTI-METER A-10
DC/V 10-50-250-500 1kΩ (2kΩ/V)
AC/V 10-50-250-500-1kΩ (2kΩ/V)
Range: DC/mA 0.5-25-250 (250mV)
OHM 0-10 kΩ-1MΩ.
Complete with test leads **£4/17/6** P. & P. 2/6.

PREMIER RADIO

309 Edgware Rd., London. W.2. Tel: PADington 6963



Visit our large and comprehensive HI-FI showrooms



The 'Carol' TR/1 TAPE RECORDER

(AT A PRICE YOU CAN AFFORD) INCORPORATING THE NEW B.S.E. TAPE DECK. A Quality Tape Recorder at a price that YOU can afford. The operation of this Recorder is simplicity itself and the quality in both reproduction and finish, leaves nothing to be desired, the cost being well below present-day prices. Amplifier Controls. On/Off Tone and Volume Controls. Power Output, 3 watts. Overall Size: 12 1/2 x 12 x 8 in. Weight: 20 lb. STAR FEATURES: Deck Controls. Record/Playback Switch and rewind switch with interlocking device to prevent accidental erasure. Speed: Single 3 1/2 in. per sec. Playing Time: 5 1/2 in. Standard Tape 1 1/2 hrs. L.F. Tape 2 hrs. 5 mins. Inputs: Sockets for Microphone, Radio, Gram, etc., with extension Speaker Socket.

PRICE, including Mic., Tape and Spare Spool. **Only 19 Gns.** plus 15/- P. & P.

The 'Magnaphon'

A truly top quality and versatile Tape Recorder at a price well below the original cost. Incorporating the latest Collaro 3-speed Studio Tape Deck. ★ Volume and Tone Control for recordings. ★ Volume and separate Bass and Treble Controls for replay. ★ Facilities for monitoring. ★ Output 4 watts. ★ Separate Output Sockets for Amplifier and Extension Speaker. ★ Mixing Facilities. ★ Housed in attractive red and beige two-tone Cabinet with detachable lid. ★ Fully guaranteed and supplied complete with the following accessories:— Good quality Crystal Microphone with Lead and Jack Plug fitted, 5 1/2" Reel of Standard Tape and Spare Reel, spare Lead fitted with Jack Plug and Wander Plugs for recording from Radio.



Price **£32.0.0** Plus 21/- P. & P.

TAPE DECKS

LATEST BSR MONARDECK. Single speed 3 1/2 i.p.s. Will take 5 1/2 in. spools. **£9/19/6.** P. & P. 5/-.
COLLARO STUDIO TAPE TRANSCRIPTION. 3 speeds 1 1/2, 3 1/2, 7 1/2 i.p.s. 3 motors. Push-button controls. Will take 7 in. spools. **£12/19/6.** P. & P. 7/6.
COLLARO MK. 4 TAPE TRANSCRIPTION. Twin track operation, 3 speeds, 3 1/2, 7 1/2, 15 i.p.s. Will take 7 in. spools. **£17/19/6.** P. & P. 7/6.
TAPE RECORDER AMPLIFIER. specially designed to match the Collaro Studio Tape Deck. **£10/19/6.** P. & P. 4/-. Size 1 1/2 x 5 x 3 in., uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. l.s. jack, superimposing switch, with matching knobs.

SINGLE PLAYERS

Collaro Junior 4-speed Player, complete with Pick-up **£3 15 0**
Garrard 4SP 4-speed Player, complete with Pick-up and automatic stop ... **£6 19 6**
Garrard TA Mk. 2, 4-speed Player, wired for stereo, with plug-in Head ... **£8 10 0**
Philips AG2009, 4-speed Player, with diecast turntable and Microflit, wired for stereo **£10 10 0**
P. & P. 2/6 on above units.

STEREO ADAPTOR

Why not convert your Record Player or Radiogram to stereo with this easy to install Stereo Conversion Unit, complete and ready to install giving an output of 3 watts. STEREPHONIC PICK-UP CARTRIDGES AVAILABLE, 35/- post paid.

PRICE **£2. 19. 6** Plus 2/- P. & P.

RECORDING TAPE

By well-known manufacturers, brand new, boxed and fully guaranteed. 1,800ft. on 7 in. spool **32/6**
1,800ft. on 5 1/2 in. spool **22/6**
P. & P. 1/- per spool.

RECORD CHANGERS

BSR UA8, 4-speed **£6 19 6**
BSR UA8 4-speed with stereo cartridge **£7 19 6**
BSR UA12, 4-speed, wired for stereo and complete with Stereo cartridge **£5 19 6**
Collaro Conquest, 4-speed Changer **£7 19 6**
Collaro RC457, latest type 4-speed changer **£8 10 0**
Garrard RC111 3-speed Changer: **£7 19 6**
Garrard RC20 Mk. 2, 4-speed **£8 19 6**
Garrard RC121/4D, 4-speed **£9 19 6**
Garrard RC121 Mk. 2, 4-speed, wired for stereo and with plug-in Head **£10 19 6**
P. & P. 5/- on above units.

The 'Vogue'

A quality tape recorder, at a popular price including microphones, tape and spare spool. Price **29 gns.** Plus 21/- P. & P.
★ Collaro 3-speed Tape Deck.
★ Separate Input for Microphone and Gram Recording.
★ Separate Volume Controls for recording.
★ Volume On/Off and Tone Control for replay.
★ 3 watts output.
★ Housed in smart two-tone Blue/Beige Cabinet with detachable Lid.



AMERICAN RECORDING TAPE

Manufactured by FerroDynamics, brand new and fully guaranteed. 1,200ft. on 7 in. spool **25/-**
1,800ft. on 7 in. spool **35/-**
600ft. on 5 in. spool **16/-**
P. & P. 1/- per spool.

TRANSCRIPTION UNITS

Garrard 301 **£22 7 3**
Garrard 301 (Strobe turntable) **£23 18 4**
Garrard 4HF (Stereo) **£19 4 8**
Garrard 4HF (GC8) **£18 9 9**
P. & P. 7/6 on above units.

TAPE RECORDER RADIO JACK

May be built for 29/6 plus 1/6 p. and p. Tape Recorder Plug Extra.

Improve the quality of your recordings with the most inexpensive Radio Jack available, suitable for any type of Tape Recorder, only a short external Aerial required for full medium waveband coverage. Phono Plug—9d., Jack Plug—3/-.

INSTANT BULK TAPE ERASURE

Erase complete Reels of Tape in a matter of seconds. PRICE 27/6 post paid.



MODEL 1629 AM/FM RADIOGRAM CHASSIS BY FAMOUS MANUFACTURER

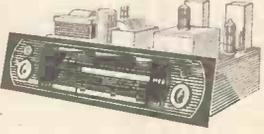
PRICE **£15.19.6** plus 7/6 p. & p. Due to a fortunate bulk purchase we are able to offer these exceptionally good quality Radiogram Chassis at the ridiculously low figure. Guaranteed Star features of this Chassis are: piano key wavechange Internal Ferrite Rod Aerial for AM and Magic Eye Tuning Indicator waveband coverage: Long Wave 1098-2027 metres Medium Wave 188-547 metres VHF/FM 87-101 Mc/s. Valve line-up: EOC85, ECH81, EF89, EM81, EA8C80, EL84, suitable for use on 200/250 v. A.C. mains. Dimensions 15 1/2 wide, 12 in. high, 4 1/2 in. deep.

THE PREMIER TRANSISTORISED BABY ALARM

79/6 Plus 3/- P. & P. Battery extra 2/9 (Ever-Ready PPI 6 volt or equiv.) The answer to the modern Parents' problem for "Baby Sitting", this extremely efficient Unit is completely safe being battery operated, its portability enables you to place the Master Unit in any part of the house. Extra Microphones may be used in different rooms without impairing the efficiency of the Unit. It is the most economical Unit of its kind and will run on one Battery for approximately two months of continuous day and night use. It is housed in an attractive bakelite Cabinet in either ivory or pastel blue. The price includes one microphone, extra Microphones can be supplied at 12/6 and Microphone Lead at 5d. per yard.

3-WAVEBAND RADIOGRAM CHASSIS

By Famous Manufacturer **£10.19.6** plus 5/- p. & p. A special offer for a limited period only of this Continental style Radiogram chassis. Brief details. Long. Medium and short wavebands covering 1007-1960 metres, 185-555 metres. 16-32 metres. Valve line-up: ECH81, EBF80, ECL82. Mains voltage 200/250 v. A.C. Gramophone Pick-up Input. Dimensions 17 1/2 in. long, 5 in. high, 6 in. deep.



LASKY'S RADIO



AMAZING NEW TAPE RECORDER BARGAIN OFFER

A complete Tape Recorder using Collaro Studio 3-speed Deck, 1½, 3½, 7½ i.p.s. Twin track, with pause control, rev. counter, latest type electronic recording indicator. Superimposing switch, volume and tone controls, 7 x 4 loudspeaker, 4 watts output. Takes 7in. spools. In contemporary design carrying case. 9½ x 16 x 16in. Brand new, fully assembled ready for use. Limited number.
LASKY'S Complete with Microphone, Tape and Spool.
PRICE 29 GNS. Carr. & ins. 25/-

LONDON'S LEADING Hi-Fi SPECIALISTS

Visit either of our addresses for selective Demonstrations of the very latest Hi-Fi Equipment.



- AMPLIFIERS
- F.M. TUNERS
- TAPE RECORDERS
- TRANSCRIPTION TURNTABLES
- SPEAKERS
- PICK-UPS
- CABINETS

Our Fabulous Hi-Fi Catalogue IS INVALUABLE. SEND FOR A COPY TODAY

"Hi-Fi Journey with Lasky's" is the title of our superb new catalogue and it takes you all through the realm of high fidelity reproduction. Nothing like it has ever before been offered. Over 100 large pages, 11½ x 8½in. in photogravure and colour. It is a COMPARATOR-CATALOGUE to enable you to choose from all the latest and most advanced equipment. Price 3/6, part post 6d.
Fully refunded on making your first hi-fi purchase.

TAPE RECORDERS

Largest stocks in London.
 BRENNELL, CLARION, COSSOR, ELIZABETHAN, ELEKTRON, FIDELITY, FI-CORD, FERGUSON, FERROGRAPH, GRUNDIG, HARTING, KORTING, MINIVOX, PHILIPS, REFLECTOGRAPH, SOUND, SIMON, STEELMAN, STUZZI, TANDBERG, TELEFUNKEN, TRUVOX, TRIX, STELLA, WALTER

TAPE RECORDER AMPLIFIER

for use with Collaro Studio Transcripitor. Uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mkt/gram/radio inputs, ext. l.a. jack, superimposing switch. Complete with gold/black knobs.
12 Gns. Post 3/6.

PLASTIC TAPE SPOOLS

3in. 2/9	5in. 2/9	7in. 2/9	8in. 5/6
7in. Metal Spools, 1/9 each. Post extra.			

"INSTANT" BULK TAPE ERASER

and Head Demagnetiser. Erases a complete reel of magnetic Tape in few seconds. 27/6. Post free.

SPECIAL OFFER OF TAPE

Famous make. P.V.C base on latest type plastic spools. Brand new, boxed and quarantined. 1,800ft. on 7in. spool, **32/6**



1,200ft. on 7in. spool	20/-
1,200ft. on 5½in. spool	21/-
850ft. on 5½in. spool	16/6

SCOTCH PLASTIC TAPE

1,200ft. on 7in. spool 25/-
 Post: 1 spool, 1/6.
 Orders over 60/- post free.

GEVAERT L.P. TAPE

1,700ft. on 7in. spool	35/-
850ft. on 5in. spool	16/6
210ft. on 3in. spool	5/11

Post: 1 spool 1/6.
 Orders over 60/- post free.

ALL MAKES OF TAPE. Long Play, Double Play and American "MYLAR."

TAPE DECK OFFERS



B.S.R. "MONARDECK" single speed, 3½ i.p.s., uses 5in. spools. Lasky's Price including 850ft. Tape **£8/19/6.** Carr. free.



COLLARO STUDIO TAPE TRANSCRIPITOR. 3 motors, 3 speed, 1½, 3½, 7½ i.p.s., takes 7in. spools. Push button controls. Lasky's Price complete with Tape and Spool **£12/19/6.** Carr. & Ins. 12/6.

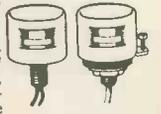
COLLARO TAPE TRANSCRIPTOR Mk. IV, fitted digital counter. List **£25.** Lasky's Price **£17/15/6** Carr. & Ins. 12/6. Tape extra.

TRANSCRIPTION MOTORS

GARRARD 4HF, stereo and monaural, complete with two plug-in heads **£18/9/-**
 Carr. & Ins. 12/6.
 GARRARD 301 **£22 7 3**
 GARRARD 301 (Strobe) **£23 18 4**
 PHILIPS **£10 10 0**

HIGH FIDELITY TAPE RECORDER HEADS

Leading make, new and unused. Upper or lower track. RECORD/PLAYBACK, high impedance. Double wound and will reproduce up to 12,000 c.p.s. at 7½ i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7½ i.p.s. ERASE, low impedance. Lasky's Price **29/6** per pair. Post free.
 Please specify upper or lower track.



Avantic

For 200-250 v. A.C. mains. Brand new in maker's cartons, fully guaranteed. Full details of any item post free.



SPA11 Stereo Amplifier and Pre-Amplifier, twin 10 watts output. 3-dimensional monaural reproduction by combining both channels. 3 inputs for each channel. Size 14½in. wide, 4in. high, 8½in. deep.
 List **£29/8/-.** Lasky's Price **19 Gns.**
 Carr. & Ins. 7/6



SP21/2 Stereo Pre-Amplifier Control Unit, twin channel. Designed primarily for use with two DL7-35 Power Amplifiers (as on right). 6 inputs for each channel. Freq. response 40 c/s. 15 Kc/s. List **£28/10/-.**
 Lasky's Price **£16/19/6**
 Carr. & Ins. 7/6.



DL7-35 Power Amplifier, 54 watts peak output. Freq. response 5 c/s-30 Kc/s ± 0dB. Two DL7-35 Amplifiers can be used in conjunction with SP21/2 Pre-Amplifier Control Unit for stereophonic reproduction. Size 14½in. long, 9in. wide, 8½in. high. List Price **£31/10/-.**
 Lasky's Price **£16/19/6**
 Carr. & Ins. 12/6.

SPECIAL COMBINED OFFER
 The above Unit and two DL7-35 Power Amplifiers offered at a special inclusive price of 47 Gns.
 Carr. Extra.

BUILD THIS FINE 3-SPEED TRANSISTOR RECORD PLAYER

FOR £9.19.6 Carr. 7/6

6 volt operation. For all L.P. and standard records. Complete parcel comprises:—

AMPLIFIER. 300 milli-watts output, using two OC71 and two OC72 transistors. Fully assembled. 79/6. Knobs 3/6 extra.

LOUDSPEAKER. 30 ohms, 7 x 4 in. elliptical

Speaker matched to amplifier. 25/-

3-SPEED TURNTABLE with rubber mat and speed adjustment, complete with t.o. crystal cartridge and two sapphire styli. 79/6.

CARRYING CASE as illustrated, handsome two-tone finish, size 17 in. deep, 14 in. wide, 6 1/2 in. high. 49/6.

Batteries extra. All components available separately. Build this modern Record Player for ££s less than an equivalent ready-built player



BARGAINS IN 4-SPEED AUTO-CHANGERS

New and Unused in Maker's Cartons



B.S.R. type UA8..... £6 19 6
 B.S.R. UA8, stereo..... £7 19 6
 B.S.R. UA12, stereo..... £8 19 6
 B.S.R. type UA14 £7 19 6
 COLLARO Conquest, wired for stereo, with monaural p.u. £6 19 6
 As above, stereo £7 19 6
 Post on all above 5/-

GARRARD

Model 121. Mk. II..... £10 10 0
 121, Mk. II STEREO £11 10 0
 121, Mk. II, with monaural and Stereo heads £12 10 0
 RCC.88 £12 19 6
 RC.88 STEREO..... £13 19 6

SINGLE PLAYERS

Auto start and stop. Complete with pick-up and crystal cartridge.
GARRARD 4SP £6 19 6
GARRARD 1A Mk. II, wired for STEREO, plug-in head £8 9 0
E.M.I. 4-sp., wired for STEREO and fitted Acos stereo T.O. cartridge £6 19 6
 Post on all above 5/-

B.S.R. TU9, non-auto Turntable and separate Pick-up... 79/6
 Post free.

COLLARO JUNIOR 4-speed motor and separate pick-up with cartridge styli 75/-
 Post free.

PICK-UP CARTRIDGES

ACOS HGP.59 or HGP.37 turnover crystal cartridge with L.P. and standard styli. List 39/7.

Lasky's Price 18/- post free.

ACOS 73-1A STEREO. List 52/6.

Lasky's Price 29/6 post free.

ALL TYPES OF CHASSIS

We hold the largest selection of leading makes: **ARMSTRONG, DULCI, EMPRESS**, etc. A.M. chassis (L., M., S.) from 7 Gns.
 A.M./F.M. chassis from 14 Gns.
 A.M./F.M. STEREO from 22 Gns.

H.P. TERMS AVAILABLE
 on certain goods.
 Call or write stating your requirements.

LASKY'S RADIO

MICROPHONE BARGAINS

The "Diana." High impedance moving coil mike with unique magnetised table base. Response 30 15,000 c.p.s. Ideal for tape recorders. List 4 Gns.
Lasky's Price 55/-
 Post free.



ACOS CRYSTAL 8TICK MIKE, type MC.39/1, complete with cable. Listed at 55/-.
Lasky's Price 39/6
 Post free

MINIATURE moving coil dynamic microphone, incorporating switch and complete with pocket clip. As used for the "Fi-Cord", 35/-.
 Post 1/6.

EXPORT ORDERS

Our Export Dept ships goods to all parts of the world. We also operate the "Personal Export Service" (free of purchase tax) for visitors to Great Britain.

LASKY'S MIDGET T.R.F.



CAN BE BUILT FOR £4.19.6 Post & Pkg. 5/-

For A.C. mains, 200-250 v. Med. and Long wave. Uses 2 double-purpose valves EBF89 and ECL80 contact-cooled rectifier. 5in. P.M. Speaker. Plastic cabinet, 8 1/2 x 6 x 4 1/2 in. deep. Circuit diagram, shopping list, 1/6.

BUILD THE "VANCOUVER" 3-TRANSISTOR POCKET RADIO

Employs 3 transistors plus germanium diode, on printed circuit size 3 1/2 x 4 x 1/2 in. Tunable over medium and long waves. Built-in Ferrite rod aerial.



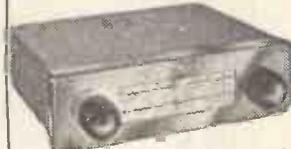
CAN BE BUILT FOR 39/6 Post 1/6.
 Circuit diagram and step-by-step instructions, 1/6 (free with parcel).

BUILD THE "EASY SIX" TRANSISTOR PORTABLE

Covers medium and long wave. Uses six selected transistors and 7 x 4 loudspeaker. Handsome duo-tone wood case, 8 1/2 x 6 1/2 x 8 in., with carrying handle.
CAN BE BUILT FOR £9/15/- Post 1/6. Circuit diagram and full instructions, 1/6 (free with parcel).

LASKY'S CAR RADIO CAN BE BUILT ABSOLUTELY COMPLETE

FOR £11.19.6 Post 3/6.



★ Small size. Will fit any car.
 ★ 12 volt operation.
 ★ New Hybrid circuit.
 ★ Transistor output.
 ★ New Type Primer valves.
 ★ No Vibrator, 12 volt H.T. & L.T.
 ★ T.C.C. Printed Circuit and Components.
 ★ Tuned R.F. stage.
 ★ Medium and long waves.
 ★ Permeability tuning.
 ★ 7in. x 4in. elliptical speaker.
 Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list 2/6 (returned if you order).

SPECIAL OFFER! PRINTED CIRCUIT GRAM AMPLIFIER

Uses two valves, ECL82 and E280 and separate mains transformer to minimise hum. Incorporates Elac 8 x 6 in. loudspeaker with output transformer mounted concentric volume and tone controls. Size of printed circuit: 4 x 3 x 2 1/2 in.
Lasky's Price 69/6 complete, Post 2/6. Less Speaker, 55/-.

STEREO ADAPTOR

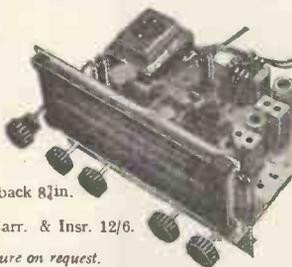
Will convert any radiogram to give stereophonic reproduction. 2-valve Amplifier using EP0X and EL84 metal rectifier (full-wave bridge). Mains voltage 105-250, 50/60 c.p.s. Ganged volume control and ganged tone control.

CAN ALSO BE USED AS A SINGLE-END AMPLIFIER.
LASKY'S PRICE complete with printed circuit, circuit diagram, full service data and 2 new valves..... **59/6**
 Post & Pkg. 3/6.

SPECIAL OFFER. The above, plus Acos 73-1a Stereo Cartridge and 6in. or 8in. Loudspeaker, 95/- Post 5/-.

7-VALVE AM/FM RADIOGRAM CHASSIS

Few only. Famous make. For 200-250 v. A.C. Output 4 watts matches to 3 ohms speaker. 7 valves: ECC85, ECH81, EF89, EABC80, EL84, EZ80, EM81, magic eye tuning indicator. Covers medium, long and V.H.F. bands.
 Length 12 in., height 7 1/2 in., front to back 8 1/2 in.



LASKY'S PRICE £16.19.6 Carr. & Insr. 12/6.
 Available on H.P. terms. Brochure on request.

"LINEAR" AMPLIFIERS

"DIATONIC" 10-14 watts 12 Gns.
 "CONCHORD" 30 watt 15 Gns.
 L45 4-5 watt Amplifier £5/19/6
 LT45 Tape Deck Amplifier 12 Gns.
 L50 50 watt Amplifier 19 Gns.
 L10 10-12 watt with pre-amplifier 15 Gns.
 L3/3 Stereo Amplifier 7 Gns.
 All other types in stock.

P.M. SPEAKERS

ROUND
 3 1/2 in. 4 in. 5 in. 6 1/2 in. 8 in.
 17/6 19/6 14/6 16/- 16/6
ELLIPTICAL
 7 x 4 9 x 6 10 x 2 1/2 10 x 6 10 x 7
 15/6 22/6 25/- 25/- 32/6
 Post extra.

SHORT WAVE CONVERTER FOR CAR RADIO

Smith's "Radiomobile" Converter offers short wave reception of your favourite stations. 6 or 12 v., positive or negative earth. Uses 6BB6 heptode freq. changer. Easily installed, may be used with any car radio. Chrome escutcheon, cream push buttons. Size 1 1/2 x 7 x 5 in. All plugs and sockets included. Supplied with 3 removable coil units of your choice. Bandspread: 16, 10, 25, 31, 41, 49, 60, 90 metres.
LASKY'S PRICE 89/6 Post 2/6.
 Additional Coil Units, 6/- each.

LASKY'S RADIO

TAPE RECORDER KITS

- Look at these star features:—
- ★ Very latest Printed Circuit T.C.C. condensers.
- ★ Amplifier can be supplied fully assembled and connected to Deck.
- ★ New Mullard valves: EF86, ECC83, EL84, EM34, magic eye, EZ80 rect.
- ★ Choice of speaker: 7x4, 8x5, 9x4, 8in., 8in., etc.
- ★ Collaro Studio or B.S.R. Monardeck Tape Deck.
- ★ Complete with Acos 39/1 Mike, Tape and Spool.

PRICES FROM

20 GNS. 25 GNS.

(B.S.R. deck) (Collaro deck)
All components available separately
Full details and shopping list post free on request.



TEST METER BARGAIN

"ALFA" MULTI-RANGE RADIO TEST METER. A.C. and D.C. 3,333 ohms per volt. Ohms ranges to 2 megs. Volts A.C. and D.C. up to 1,200. 300 microamps—300 mA. Decibels, 2 ranges —20 to +23 db; +20 to +37 db. Accuracy ±3%. Large full vision dial. Overall size: 5 1/2 x 3 1/2 x 1 1/2 in.

LASKY'S PRICE 89/6
including Leads.
Post 2/-.

SEND FOR THE FINEST COMPONENTS CATALOGUE

produced for the "ham" or service man. OVER 100 PAGES, SIZE 8 1/2 in. x 5 1/2 in. COPIOUSLY ILLUSTRATED.

Price 2/- Post 6d.

Our latest 12-page "BARGAIN BULLETIN" free with each copy or available separately by post, price 6d.

LARGEST AND MOST COMPREHENSIVE STOCKS FOR ALL CONSTRUCTORS

20,000 VALVES IN STOCK
Mullard, Brimar, G.E.C., Mazda, Cossor, E.M.I., Philips, Pinnacle, Telefunken, etc. Send for our latest Valve List.

CABINETS
W/B PRELUDE, G. PLAN, NORDYK, CAPRIOL, etc., etc.



THE LABGEAR A.F. POWER METER KIT

offers the home constructor a complete kit of parts which together with clear step-by-step instructions will enable an accurate Power Meter to be constructed at very low cost. Printed Circuits eliminate a large proportion of wiring and assembly time is halved. The net result is an instrument of the highest quality at a fraction of normal cost.

SPECIFICATION

Power: 25 mW. to 10 w. in two switched ranges.
F.S.D.: 1 watt x 10 watts.
Input Impedance: 2, 15 and 600 ohms unbalanced.
Accuracy: 5% scale reading and impedance.
Dimensions: 4 1/2 x 6 1/2 x 3 1/2 in.
Finish: Silver hammer-tone enamel with matt aluminium legend plate.
(Moving Coil Meter, 2 1/2 in. F.S.D. 1 m/s).

LASKY'S PRICE 59/6

Post 3/6.

Complete Kit including full step-by-step instructions, circuits, data, etc.

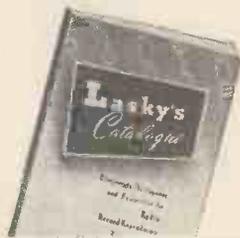
LASKY'S F.M. TUNER PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION

Uses 5 valves, 2 germanium diodes and brand new T.C.C. condensers. The PRINTED CIRCUIT ensures that the I.F. and R.F. amplifiers are extremely stable at maximum gain and results are consistent on all tuners.

CAN BE BUILT FOR 7 GNS. (including valves) Post free.

G.E.C. FM TUNER BOOK plus our full data and Shopping List 2/6 post free. All parts available separately.

ALIGNMENT SERVICE available.



MAKER'S SURPLUS TELEVISION COMPONENT BARGAINS

WIDE ANGLE 38 mm.

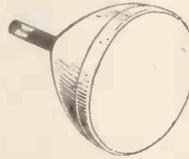
Line E.H.T. Trans. Ferro-cube core, 9-16 kv	19/6
Scanning Coils, low imp. line and frame	19/6
Ferro-cube cored Scanning Coils and Line Output Trans., 10-15 kv, EY81 winding Line Trans. with width and linearity controls, circuit dis., pair	50/-
Frame Output Transformer	6/6
Frame or line block osc. Transformer	4/6
Focus Magnets Ferro-cube	12/6
P.M. Focus Magnets, iron cored	12/6
Duomagn Focallisers	15/-
300 ma. Smoothing Chokes	10/6

STANDARD 35 mm.

Line Output Transformers 6.9 kv. E.H.T. and 6.3 v. winding, Ferro-cube	17/6
Scanning Coils, low imp. line and frame	7/6
Frame or line blocking oscillator Transformer	4/6
Frame Output Transformer	4/6
Focus Magnets: Without Vernier	9/6
With Vernier	12/6
200 ma. Smoothing Chokes	7/6

G.R. TUBE BARGAINS

NEW AND UNUSED



FERRANTI 9in. type T9/3. 4 v. heater, or 12 in. types T12/44 and T12/54, 4v. heater.

LASKY'S PRICE 49/6
Carr. & Insur. 12/6.

FERRANTI 17in. type TR17/10. 6.3 v. 3 amp. heater. Brand new and unused.

LASKY'S PRICE £6.19.6
Carr. & Insur. 12/6.

18 in. METAL CONE, famous make, type T901/A. 6.3 v. 0.3 amp. heater. **£6.9.6**
Carr. & Insur. 21/-.

17in. 90 degrees G.R. TUBES

Seconds but in perfect working order and guaranteed.
Carr. & insur 12/6. 79/6

RE-GUNNED G.R. TUBES

GUARANTEED FOR 12 MONTHS

Type	Price	& Ins.	Carr.
13in. round	£6 10 0	12/6	
14in. rect.	£6 10 0	12/6	
16in. & 16 round	£6 19 6	12/6	
17in. rect.	£6 19 6	12/6	
21in. rect.	£7 19 6	21/-	

TRANSISTORS

P.N.P. Junction types.

AUDIO, suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliamps. Double spot—yellow and green. Each **5/-**

R.F. suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.). Double spot—yellow and red. Each **7/6**

Type TS1. Suitable for all audio applications. Each **3/6**

One dozen 35/- post free.

Special prices quoted for large quantities.

OC44 15/-; OC45 15/-; OC70 8/6; OC71 8/6; OC78 15/- (Matched Pair 30/-); OC73 14/-; OC16 54/-.

EDISWAN MAZDA TRANSISTORS. The very latest types. XB/102 10/-; XB/103 10/-; XC/101 12/6; XA/101 15/-; XA/102 17/6.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102, XB/103, 2 matched XC/101. Price 79/6.

CRYSTAL DIODES. General Purpose GEX00, each 1/- Per doz. 9/- All other types in stock.

"GOLDTOP" POWER TRANSISTORS

All types in stock. Example:—V15.10P. Ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/- post free. Suitable Output Transformer for above, correct ratio, matched to 3 ohms. 9/6. Post 1/-.
Driver Transformer, 9/6. Post 1/-.

RESISTORS. The largest stocks of all types, high stability, wire wound, carbon, vitreous enamel, miniature and submin. Millions in stock. Why buy unwanted assortments? We will send you the types and values you actually want.

SUB-MIN RESISTORS. 1/16th watt, most values available. Each 3 1/2d. Per doz. 2/6.

5 millamp METER RECTIFIERS. Special offer of limited number at only **8/6** Post 9d.

TRANSFORMERS

Complete ranges in stock, mains and output, by Partridge, Gilson, Parmeko, Elbison, Elstone, Douglas, etc., etc. Let us quote you for the one you require.

CONDENSERS, RESISTANCES. High stability Resistances, Electrolytics. All values and sizes stocked.

SPEAKER COVERINGS. Large stocks of Tygan and "Some weave." Any size piece cut. Samples and prices post free.

12-CHANNEL TURRET TUNERS

Large selection, many by famous makers such as Cyldon, Brayhead, Plessey, Cossor, etc., all I.F.S. New and unused. Let us quote you for the model required. Examples: 33-33 mc/s., 37/6, 6-9 mc/s., 59/6, 9-14 mc/s., 59/6, 14-25 mc/s., 59/6.

TWO ADDRESSES FOR PERSONAL CALLERS

207 EDGWARE ROAD, LONDON, W.2

Few yards Praed Street
PADDington 3271/2

42 TOTTENHAM COURT ROAD, W.1

Nearest Station: Goudge Street
MUSEum 2605

Both Addresses
OPEN ALL DAY
SATURDAY
Close
Thurs. 1 p.m.



AVOMETER MODEL D
£8.19.6 (P. & P. 3/6)

D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
105 mV.	7.5 V.	15 mA.	75 mA.
300 mV.	15 V.	30 mA.	150 mA.
1.5 V.	75 V.	150 mA.	750 mA.
3 V.	150 V.	300 mA.	1.5 Amps.
15 V.	300 V.	1.5 Amps.	7.5 Amps.
30 V.	600 V.	3 Amps.	15 Amps.
150 V.	750 V.	15 Amps.	
300 V.	1.5 KV.	30 Amps.	
1.5 KV.		0-10 K ohms	
		0-10 K ohms	

Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 19/6. Post 1/6.
MATCHING TRANSFORMER (for Hi impedance), i.e. for HRO, CR100, etc., with standard jack plug, 4/6.

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. A.C. input 45 v. RMS. D.C., output 30 v. 10 amps. BRAND NEW. Boxed. 45/-. Post 3/6.

MARCONI IMPEDANCE BRIDGE. Type TF373. Measures, L, C & R at 1,000 Cycles. Accuracy 1%. 0-100H; 0-100uF; 0-1MΩ each in 5 ranges. Power Factor and "Q." First-class condition. £35. Carr. paid.

HALLICRAFTER VIBRAPACK. Input 6 v. output 300 v. at 170 mA. Designed for SX28 or S27. Size 6½ x 7 x 7in. BRAND NEW, BOXED. A real bargain at 29/6. Carr. 3/6.

ADMIRALTY HT TRANSFORMERS Pri. 230 v. 50 c/s. Secs. 620-550-375-0-375-550-620 v. (620 and 550 v. 200 m/amps., -375 v. 250 m/amps.), plus two 5 v. 3 amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25lb. Made 1953. BRAND NEW. Original boxes. 45/-. Carr. 5/-.

INSTRUMENT TRANSFORMERS. 230 v. A.C. input. Outputs 0-65-130-195 v. 85 m/amps., 6.3 v. 5 amps., 6.3 v. 0.3 amps. Shrouded. Size 3¼ x 3¼ x 3¼in. high. 15/- Post FREE.

AR88D MAINS TRANSFORMERS. Input 110-240 v. Output 345-0-345 v. 125 m/amps., 6.4 v. 4.5 amps., 5 v. 2 amps. 4½ x 4½ x 5½in. high. Wt. 12lb. Potted. Tag ends. RCA BRAND NEW. Boxed. 29/6, post 3/6.

TRIPLETT METER MOVEMENT

This article consists of a basic 400 microamp meter movement mounted on a bakelite panel 5½ x 2½. The dial is scaled as a 15 range Testmeter. A circuit and parts list of the original instrument is supplied.
BRAND NEW. Boxed. 35/-. post paid.



V.H.F. RECEIVER

(R1392D)

Covers 95-156 Mc/s. Those we offer are in very good condition, complete with all 15 valves, 1 mA. tuning meter and AIR TESTER. Circuit diagram is included. Power supply required 240/250 volts at 80 mA. and 6.3 v. at 4 A. (Type 234A was used.) 79/6. Carr. 10/6.

SEARCH RECEIVER

Type AN/APR4. Covers 38 to 1,000 Mc/s. with 3 Plug-in R.F. Heads. TN 16 (38-95 Mc/s.), TN 17 (74-320 Mc/s.) and TN 18 (300-1,000 Mc/s.). Self-contained power supply for 115 v. 50-2,600 c.p.s. Thoroughly reconditioned as new. In absolutely 100 per cent mechanical and operational order. £100.

RECEIVER R206

A highly efficient communications receiver covering 550 Kc/s. to 30 Mc/s. in 6 ranges. Though rather bulky (cf R107) the design incorporates many unusual features such as Turret Tuning, Crystal filters, Vernier oscillator tuning, etc. Less external power supply, with circuit diagram, completely realigned and air tested. £17/10/0. Carr. 35/-.

MARCONI CR100

Completely overhauled. In perfect working order. LOOK LIKE NEW. £21.
Later model with Noise Limiter, £25.
Carr. Eng. and Wales 30/-. Send S.A.E. for full details.

RECEIVERS R-1155B

A first-class 10-valve Communications receiver, covering 75 Kc/s. to 18 Mc/s. (16.2-4,000 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy and the R.F. stage and 2 I.F. stages ensure world-wide reception. All the receivers we sell have been thoroughly overhauled, completely realigned and are in first-class working order. ONLY £9/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE. In handsome black crackled steel cabinet to match the R-1155. Fitted with RCA Bin. speaker. Just PLUG IN and switch on! Only the finest quality components are used and we guarantee OUR power packs for 6 months. ONLY £6/10/-. Deduct 10/- when purchasing receiver and power unit together. Send S.A.E. for further details or 1/3 for 10-page illustrated booklet giving technical data and circuits etc. (FREE with each receiver). Add 10/6 carriage for receiver, 5/- for power unit.

RCA AR-88 SPEAKERS

A high quality 3 ohm unit fitted into heavy gauge black crackled steel cabinet, size 10½ x 11½ x 6in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker. CR 100, etc. In original cartons. BRAND NEW. 45/-. Post 3/6.

MINIATURE 373 IF STRIPS. For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 and 1 of EB91. A fresh release enables us to offer these once again. BRAND NEW. Complete reprint of conversion instructions and circuit supplied free. 35/-. OR less valves, 12/6. Post, either, 2/6.

LOUD-HAILER EQUIPMENT

IDEAL FOR CROWD CONTROL, FACTORIES, FETES, ETC. CONSISTS OF 4 SPEAKER UNITS AND CONTROL UNIT. COMPLETE WITH MICROPHONE, HEADPHONES AND SPARES. OPERATES FROM 12 VOLTS D.C. OR 6 VOLTS A.C. WITH SLIGHTLY REDUCED OUTPUT) CONSUMING ONLY 3 AMPS. OUTPUT POWER 8 WATTS. ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARGAIN. £4 19/6. CARRIAGE 25/6.

T.C.C. VISONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1½ x 5in. high. BRAND NEW. Boxed. 8/6 each, post paid.
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MINIATURE RELAYS (ALL BRAND NEW and BOXED)
G.E.C., sealed, wire ends, 670 2M2B H/D M1095..... 8/6
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GIANT COMPONENT PARCEL

Contains 100 j and 1 watt resistors, 50 Hf Stub resistors, wire wound resistors, carbon and W/V pots, 100 capacitors (mica, paper, Sprague, elec. variable, etc.), valveholders, tag strips, metal rectifiers, sleeving, etc. All components are unused. GUARANTEED VALUE, 25/- plus 2/6 post.

CHARLES BRITAIN (Radio) LTD.

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A crystal controlled heterodyne wave-meter covering 500 Kc/s. to 10 Mc/s. (Harmonics up to 30 Mc/s.) Requires 300 V. 15 mA. and 12 V. 0.3 a. D.C., but can be easily modified for 120 V. and 1.4 V. working. Size 7 x 7½ x 4in. Good condition, complete with valves, crystal, instruction manual and circuit. ONLY 59/6. Post 3/6. This item available complete as above. BRAND NEW and with spare set of valves. £4/10/-, post 3/6.

CANADIAN CRYSTAL CALIBRATOR. Uses double crystal and multiplier circuit to give "pips" at 1 Mc/s., 100 Kc/s. and 10 Kc/s. Incorporates Modulator. Handbook supplied. 79/6. Post 2/6.

ELECTROSTATIC METER. Dia. 6½in. reads 5-18.5 Kv. Manufactured 1953. Contained in wooden case 10 x 10 x 9in. high. £9/19/6. Post paid.

SANGAMO WESTON ANALYSER E772. A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. £7/10/-. Carr. 4/6.

MARCONI TF987/I NOISE GENERATORS. Range 100 Kc/s. to 200 Mc/s. Determines noise factor of AM and FM receivers. Fully stabilised H.T. supply A.C. mains operation. Brand new and in original boxes. £15. Carr. 7/6.

HEAVY DUTY SLIDER RESISTORS. 1.25Ω 20 A., 12/6, post 3/6. 1Ω 12 A., 8/6. **PRECISION RESISTORS.** 1 Megohm. 1% 1 watt wire wound, Ex-U.S.A. BRAND NEW. 10/6 per dozen.

D.C./A.C. CONVERTERS. Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2½in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order. £9/19/6. Carr. 10/6.
24 v. Input 230 v. A.C. 50 c/s. 100 watts output. In grey metal case. BRAND NEW. 92/6. Carr. 7/6.

RADIATION METERS. Portable dose-rate meter, containing modern type rectangular 50 micro-amp. meter, CVX494 electrometer valve, etc. BRAND NEW. In canvas carrying case, £3/19/6. Post 2/6. For details of other equipment, see our previous adverts.

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R.C.A. 0-500 microamps. 2½in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. BRAND NEW. Boxed. 15/-.
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0-300 volts, 25-100 c/s. Moving iron, 6in. scale. Ft. mtg. Hermetically sealed, grade IN. Made 1955. BRAND NEW. Boxed. 79/6. Post 3/6.



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SELENIUM L.T. RECTIFIERS. Full wave, bridge connected. 12/18 v. 1.5 A. 4/3; 12/18 v. 2½ A. 6/9; 12/18 v. 4 A. 9/9; 12/18 v. 5 A. 12/6; 12/18 v. 6 A. 13/6; 24/36 v. 1 A. 12/6; 24/36 v. 4 A. 22/6; 24/36 v. 15 A. 62/6. Please add postage.

L.T. TRANSFORMERS. For charging or models. All 200/250 v. primaries. 3.5, 9 or 17. 1 A. 9/9; 3.5, 9 or 17 v. 2 A. 14/3; 3.5, 9 or 17 v. 4 A. 16/6; 9 or 17 v. 6 A. 26/-; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 v. 2 A. 18/6; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 v. 4 A. 30/- P/P 1/3.

1 Megohm 1% **WIREWOUND RESISTORS.** 10/- per doz.

6 VOLT AC/DC BUZZERS. 3/6 ea. P/P 6d.

CV. 320. 1in. C.R.T. 4 v. heater, 600-1 kv. anode. Boxed, 19/6 ea. P/P 1/6.

MARCONI TF. 340 OUTPUT METERS. Reconditioned, perfect order. £9/19/6 ea. P/P 7/6.

MARCONI TF. 373 UNIVERSAL IMPEDANCE BRIDGES. Reconditioned to maker's spec. 0-100H., 0-100 mfd., 0-1 megohm, 0-100 Q. each on 5 ranges at 1,000 c/s., £35 ea.

MARCONI TF. 329 "Q" METERS. Range 0 to 500 Q. Frequency 50 kc/s to 50 mc/s. Reconditioned to maker's spec., £65 ea.

CERAMIC SWITCHES. 1 pole 6 way, 2/6; 2 pole 3 way, 2/6; 4 pole 3 way, 2/6; 2 pole 12 way, 2B., 5/6; 3 pole 12 way, 3B., 7/6; 8 pole 5 way, 4B., 7/6. P/P extra.

DEAF-AID EARPIECES. ER.100, 250 ohm imp. 4/6; ER.250, 1,000 ohm imp. 7/6. P/P 6d.

PAINTON MINIATURE JONES PLUGS AND SOCKETS. All new. 2 pin 2/6 pr.; 4 pin 3/6 pr.; 6 pin 4/- pr.; 8 pin 4/6 pr.; 12 pin 5/6 pr.; 18 pin 7/6 pr.; 33 pin 10/6 pr.

MINIATURE PYE COAXIAL PLUGS AND SOCKETS. Available male or female cable, per 2/6 pr.

7.5 K.V.A. AUTO TRANSFORMERS. 115/230 volts. Brand new, boxed, ex-U.S.A. £15 ea. Plus carr.

POST OFFICE TELEPHONE HANDSETS. Standard type, 12/6 ea. P/P 1/6.

A.R. 88 WAVECHANGE SWITCHES. 8 banks, 6 positions, complete with all screens. New, boxed, 17/6 ea. P/P 2/6.

AMERICAN HS-30 LIGHTWEIGHT HEADSETS. Res. 50 ohms. Extremely high quality. Brand new, 15/- pair. P/P 1/3.

AMERICAN SPRAGUE/MICAMOULD CONDENSERS. Highest quality, .1 mfd, 500 v. .01 mfd. 1,000 v. 6/- per doz. P/P 9d.

AMERICAN H.T. BATTERIES. Brand new. Tapped 90 v., 67½ v., 45 v., 22½ v., 5/- ea. P/P 1/6.

24 VOLT D.C. PUMPS



Self lubricating, capacity 60 g.p.h. at 30 lb./sq. in. Will operate O.K. on 12 v. ¼ BSP inlet/outlet union. Only 15/6 ea. P/P 2/6.

FIELD TELEPHONES TYPE F.

Ideal for all intercom. systems, house, office, building sites, etc. Generator bell ringing, 2 line connection. Supplied complete with batteries and wooden carrying case, fully tested. 39/6 ea. per telephone. 3/6 P/P.



1,000 WATT MAINS ISOLATION TRANSFORMERS

230 v. primary. 230 v. secondary. Ex-Admiralty heavy-duty type. New boxed, £5 ea. P/P 10/-.

R.1155 COMMUNICATION RECEIVERS

Standard Model B. Frequency coverage 75 kc/s to 1,500 kc/s and 3 mc/s to 18 mc/s on 5 bands. New improved geared slow-motion drive fitted. All receivers overhauled, aligned and tested. £8/19/6 ea. P/P 7/6. Combined A.C. mains power pack and audio output stage supplied 85/- extra.

BRAND NEW MEDRESKO HEARING AIDS

Supplied fully tested and complete with earpieces, leads and battery pouch. Incorporates 3 sub-miniature valves and sensitive crystal mic. Only 32/6 each. Batteries 5/- extra. P/P 1/-.

BC.221 HETERODYNE FREQUENCY METERS

125 kc/s - to 20 mc/s. As new condition. Supplied complete with valves and crystal but no calibration charts. Only £14/10/- ea. P/P 7/6.

FIELD TELEPHONES TYPE H.

Ideal for all intercom. systems. Generator bell ringing, two line connection. Supplied complete with batteries, ready to operate, 62/6 each, P/P 3/6.

SPARES KIT FOR CR.100 RECEIVERS

Contains 15 valves: 2-U50, 2-DH63, 2-KT63; 2-X66; 7-KTW61. Condenser and resistor packs, pots, toggle switch, output transformer, etc. All brand new. 57/6. P/P 3/6.

R.C.A. LOUDSPEAKERS

High-quality 3 ohm speaker housed in black crackle metal case to match AR-88 or H.R.O. receivers. Supplied brand new and boxed, 45/- ea. P/P 3/6.

COLLARO STUDIO TAPE TRANSCRIPTORS

Latest 1960 model. 3 speeds, 1½, 3½ or 7½. Fitted with 3 separate motors, digital counter, press-button switching, provision for fitting extra stereo head. Supplied brand new and guaranteed complete with spare 7in. spool, £12/10/- ea. P/P 3/6.

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Ideal for all intercom. systems. Buzzer calling, 2 line connection. Housed in metal carrying case. Supplied complete with batteries, fully tested, 39/6 ea. P/P 3/6.

R.C.A. PLATE TRANSFORMERS

Primary 200/250 v. 50 cycles. Secondary 2,000/1,500/0/1,500/2,000 v. 500 milliamps. Supplied brand new and boxed, £6/10/- ea. P/P 10/-.

PARMEKO TABLE TOP TRANSFORMERS. Input 230 v. 50 c/s. Output 620/550/375/0/375/550/620 v. 250 mA. 5 v. 3 amp, 5 v. 3 amp. Size 6½ x 6½ x 5½in. Brand new, boxed, 45/- ea. P/P 5/-.

12/24 V. D.C. MODEL MOTORS. Reversible. Brand new, 8/6 ea. P/P 1/-.

200/230 V. A.C. MAINS MOTORS. Made for hair dryers. New, 12/6 ea. P/P 1/3.

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SPEAKER BARGAINS

2½in.	Perdio	3 ohm	17/6
2½in.	Perdio	15 ohm	17/6
3in.	Plessey	5 ohm	15/6
3in.	Rola	3 ohm	17/6
4½in.	Plessey	3 ohm	15/6
5in.	Goodmans	3 ohm	15/6
6½in.	Plessey	3 ohm	17/6
8in.	Elac	3 ohm	19/6
10in.	R.A.	3 ohm	27/6
12in.	Plessey	3 ohm	32/6
12in.	Plessey	15 ohm	42/6
6 x 4in.	Plessey wafer	3 ohm	12/6
7 x 4in.	Plessey	3 ohm	15/6
8 x 6in.	Rola	3 ohm	17/6
10 x 7in.	Plessey	3 ohm	27/6
12 x 8in.	Plessey	3 ohm	49/6
8 x 2½in.	Goodmans	3 ohm	17/6

All brand new. Please add postage.

AMPHENAL 15 PIN UNITERS. Brand new 3/6 pr., ditto 18 pin, 3/6 pr. P/P 6d.

4 POLE 11-WAY METER SWITCHES, 4 bank, 6/6 ea. P/P 9d.

LEACH 12 V. DOUBLE POLE AERIAL CHANGE-OVER RELAYS. 7/6 ea. P/P 1/-.

SOUND-POWERED TELEPHONE HANDSETS. Just connect with twin flex or complete telephone system. No batteries required, 15/- ea. P/P 1/6.

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CONTACT-COOLED RECTIFIERS. 125 v. 85 mA 3/9. 250 v. 50 mA 5/6; 250 v. 85 mA 9/-; 250 v. 150 mA, full-wave bridge, 12/6. P/P 6d. ea.

HOOVER ROTARY TRANSFORMERS. Input 12 v. D.C.; output 310/360 v. 30 mA. New, boxed, 12/6 ea. P/P 1/3.

PORTABLE PRECISION VOLTMETERS.

Brand new moving iron instruments by famous manufacturer. Housed in polished teak case, 8in. mirror scale. 2 ranges, A.C. or D.C. 0 to 160 v. or 0 to 320 v. Accuracy within 2%, £5/19/6 ea. P/P 3/6.





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BRAND NEW Boxed 100 MICROAMP METERS. Standard 2 1/2 in. flush panel mounting. Scale calibrated 0-100 microamps. 42/6 each. P/P 1/3. Also available 3 1/2 in. panel mounting 62/6 each.

MAINS PANEL NEON INDICATORS. Chrome escutcheon, flying lead connections. Available red, green or clear. 3/6 each. P/P 6d.

ALUMINIUM CHASSIS. 18 swg four sided, reinforced corners. All sizes 2 1/2 in deep. 6 x 4 in. 3/6; 7 1/2 x 5 1/2 in. 4/6; 10 x 7 1/2 in. 5/3; 11 1/2 x 7 1/2 in. 6/-; 13 1/2 x 9 in. 6/9. Post extra.

PARMEKO MAINS TRANSFORMER. Fine heavy duty job. Primary 0/110/230 volts. Sec. 350/0/350 volts 150 ma. 6.3v. 4 amps 5 volts 4 amps. New, boxed, 32/6. P/P 2/-

PRECISION WIREWOUND POTENTIOMETERS. Linear track. 3 1/2 in dia. Available, 100 ohm, 500 ohm; 1k, 2.5k; 5k, 10k; 25k, 50k and 100k ohms. All 10/6 ea. P/P 1/-

750 WATT AUTO TRANSFORMERS. Fine heavy Admiralty type. Tapped from 110 to 230 volts to give any spot voltage. 69/6 each. P/P 5/-

POTTED "C" CORE CHOKES. 16 H. 150 ma., 20 H. 100 ma., 16 H. 120 ma.; 20 H. 80 ma.; 100 H. 30 ma. All 10/6 ea. 5 H. 500 ma 17/6; 10 H. 500 ma. not potted, 25/- ea. Post extra.

FERRANTI POTTED FILAMENT TRANSFORMERS. Primaries tapped 200/250 volts. 1. 6.3v. ct. 5.6 amp; 6.3v. ct. 4.8 amp; 6.3v. ct. 1 amp; 19/6 ea. 2. 6.3v. ct. 3.3 amp; 6.3v. ct. 1 amp; 6.3v. ct. .9 amp; 6.3v. ct. 6 amp; 15/6 ea. P/P 2/-

GERRARD VARIABLE SPEED GRAM MOTORS. 20J/250 volt A.C. Adjustable from 0 to 45 r.p.m. by arm. 22/6 ea. P/P 2/6.

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HEAVY "C" CORE TRANSFORMERS. 230 volt primary. 725, 700/675; 0/675/700/725 volt 500ma. 6.3v. 6 amp. 6.3v. 1 amp. 5v. 6 amp. New boxed, 72/6 ea. P/P 5/-

FERRITE CORED LOOP AERIALS. Operative up to 2 mc/s. New boxed, 22/6 ea. P/P 2/6.

ADMIRALTY SLOW MOTION DRIVES. 180°, scaled 0 to 100. Fast and slow knob with lock and also flick mechanism for setting to fixed frequencies. new 7/6 ea. P/P 1/3.

24 AMP. VARIAC TRANSFORMERS. Primary 230 volts Adjustable sec. from 185 to 250 volts. 24 amps. £12/10/0 each. P/P 10/-

"C" CORE POTTED L.T. TRANSFORMERS. Primaries all 230 volts. 1. 6.3v. 3 amp. 6.3v. 3 amp., 6.3v. 3 amp., 6.3v. 1.5 amp. 21/- ea. P/P 2/-; 2. 6.3v. 5 amp., 6.3v. 4 amp., 2 x 6.3v. 3 amp. 6.3v. 2 amp., 6.3v. 1.5 amp. 6.3v. 1 amp. 35/- ea. P/P 2/6.

12 VOLT ROTARY CONVERTERS. Input 12 volt D.C. Output 230 volts A.C. 50 cycles, 150 watts. Housed in wooden case and fitted with voltage control resistance and 300 volt A.C. output check meter. Supplied fully tested, £9/19/6 ea., P/P. 10/-

MINE DETECTORS NO. 4A. Complete equipment comprises search head, amplifier, headset, control box, telescopic rods for search head, search head test unit, test measure and haversack. Operation is from standard 67 1/2 v. battery. The unit will detect ferrous or non ferrous metals to a depth of 24 ins. giving maximum signal but can be used at greater depths giving lower output. Ideal for tracing underground pipes or cables and any hidden metal objects. Fully waterproof. Complete equipment supplied brand new in original transit cases complete with operating instructions. Price 99/6 ea. Carriage 10/- extra.

HALLICRAFTER 6 VOLT VIBRATOR POWER SUPPLIES. Magnificent units housed in grey metal case and supplied with all necessary connectors, etc. Made for SX28, S27, S36 receivers etc. Output 300 volts 170 ma. fully smoothed. Supplied new boxed, 29/6 each P/P 3/6.

AVO SIGNAL GENERATORS. Frequency coverage 95 kc/s. to 40 mc/s. Ideal for all general radio work. Supplied fully tested and checked £7/19/6 each. Operation is from 2 v and 60 v. batteries but original Avo mains units can be supplied at 19/6 ea. P/P 3/6.

FIELD TELEPHONES TYPES L. Ideal for all intercom systems. House, office or building site. Generator bell ringing. Two line connection. Supplied complete with batteries, fully tested. As new, 59/6 ea. P/P 3/6.

8 RANGE SUB-STANDARD D.C. AMMETERS
Ranges 1.5, 3, 7.5, 15, 30, 60, 300 and 450 amps. 8 in. mirror scale. Housed in polished teak case. Supplied complete with all shunts and leather carrying case, £15 each. P/P. 7/6

PHOTO VOLTAGE AMPLIFIERS
These special units contain a 1 microamp. Tinsley mirror galvanometer and a double selenium photo electric cell. Brand new, £9/19/6 ea., P/P. 7/6.

HIGH FIDELITY RECORDING TAPES
BARGAIN PRICES
3in. spool 225 ft. L.P. 6/-
5in. spool 600 ft. std. 12/-
5in. spool 900ft. L.P. 17/-
5 1/2 in spool 1200ft. L.P. 19/6
7in. spool 1200ft. std. 29/-
7in. spool 1800ft. L.P. 29/-
SPARE PLASTIC SPOOLS, 5 1/2 in. 2/3; 7in. 3/6. New, Boxed. Guaranteed. Post extra.

COSSOR 339 DOUBLE BEAM OSCILLOSCOPES.

Operation 110 / 200 / 250 volts A.C. Time base frequency sweep 6 cps. to 250,000 cps. Amplifier bandwidth 10 cps to 2,000,000 cps. Supplied in perfect working order fully tested, £15 ea., P/P. 10/-

METER BARGAINS
20 microamp D.C. M/C flush rd. 2 1/2 in. 69/6
25 microamp D.C. M/C proj. rd. 2 1/2 in. 59/6
50 microamp D.C. M/C proj. rd. 2 1/2 in. 49/6
100 microamp D.C. M/C flush rd. 2 1/2 in. 42/6
100 microamp D.C. M/C flush rd. 3 1/2 in. 62/6
200 microamp D.C. M/C proj. rd. 2 1/2 in. 29/6
300 microamp D.C. M/C flush rd. 2 1/2 in. 29/6
1 milliamp. D.C. M/C flush sq. 2in. 22/6
1 milliamp. D.C. M/C flush rd. 2 1/2 in. 25/-
1 milliamp. D.C. M/C flush sq. 4in. 69/6
30/0/30 millamp. D.C. M/C flush 2 1/2 in. rd. 9/6
15 amp. D.C. M/C proj. rd. 2in. 8/6
120 volts D.C. M/C flush rd. 3 1/2 in. 32/6
300 volt A.C. M/C rectifier flush rd. 2 1/2 in. 25/-
300 volt A.C. M/I flush rd. 2 1/2 in. 25/-
500 volt A.C. M/I flush rd. 2 1/2 in. 25/-
1,500 volts electrostatic. proj. rd. 2 1/2 in. 25/-
Postage extra.

NEW BLOCK PAPER CONDENSERS. Nitrogol, Visconol types. .25mfd. 4kv 3/6; .25mfd. 7.5kv 10/6; 25mfd. 10kv. 15/-; 1 mfd. 600v. 1/9; 1 mfd. 1kv. 3/6; 1 mfd. 2.5kv. 6/6; 1 mfd. 5kv. 15/-; 2 mfd. 400v. 2/6; 2 mfd. 600v. 4/6; 4 mfd. 400v. 3/6; 4 mfd. 600v. 4/6; 4 mfd. 1,000v. 5/6; 4 mfd. 1.5k. 8/6; 8 mfd. 400v. 6/6; 8 mfd. 800v. 8/6; 8 mfd. 1.5kv. 15/-; 10 mfd. 1.5kv. 17/6; 32 mfd 500v. 17/6. Post extra.

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Operates from 12 volt D.C. or 200/250 volts A.C. 10 watts push-pull output. Mic. or gram input. Output matched to 7.5, 15 or 500 ohm. Supplied in working order, £9/10/0 ea. P/P. 7/6.

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8 mfd. 500v.	2/6
16 mfd. 450v.	1/6
16 mfd. 500v.	3/3
32 mfd. 350v.	2/6
32 mfd. 500v.	3/6
32 mfd. 60v.	1/-
32 mfd. 12v.	1/3
60 mfd. 12v.	1/-

TUBULAR	
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100 mfd. 25v.	1/3
200 mfd. 8v.	1/3
500 mfd. 8v.	1/3
8 x 8 mfd. 450v.	3/6
8 x 8 mfd. 500v.	4/3
8 x 16 mfd. 450v.	3/6
16 x 16 mfd. 450v.	3/6
16 x 16 mfd. 500v.	4/3
32 x 32 mfd. 350v.	3/6

CANS	
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32 x 32 mfd. 450v.	4/3
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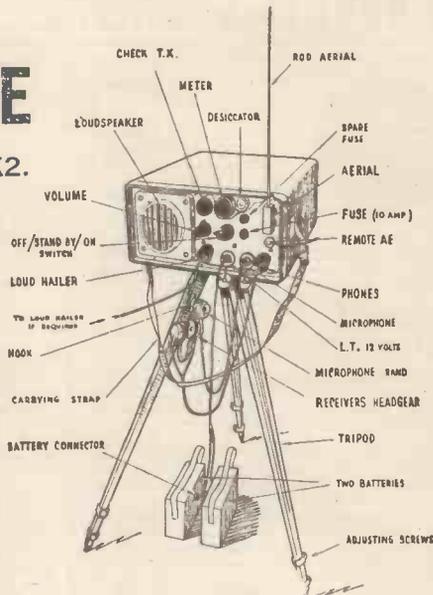
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3½in. Square—800 ohms resistance. 4 Scales operated by lever "Set-zero"—"0-3"—"0-30"—"0-300." Easily coupled to rotary range switch by cord or lever. Ideally suitable for transistor tester, output meter, volt-milliammeter. Adjustable to work as centre-zero 25-0-25 µA.

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Weight 2.1 ozs. Motor dimensions 1½in. long. 1½in. dia. Spindle 0.4in. long. .077in. dia. Consumption 0.72 watts off load. 7.68 watts on load. Speed 7,000 r.p.m. Switch. Centre off reverse by switching either side. General specification. These motors have a tremendous power-weight ratio, are extremely efficient. Can be used on 6 volts without great loss in power. Precision built in polythene housing. Self lubricating. With sintered bronze bearings. Easily mounted. Supplied Brand New and Guaranteed, 15/6, p.p. 1/6. Special price for quantities over 50.

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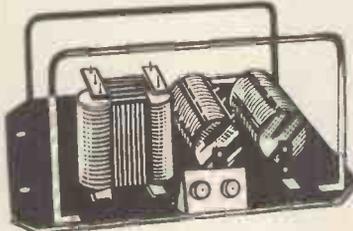
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Five 1.2 v. cells crated and connected to give 6 v. Brand new and fully guaranteed. Size of crate 15½in. x 12 x 6½in. £7/10/- Carr. 15/-.

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BRAND NEW TELEPHONE CABLE.

Twin D.8, one-mile drums £7/10/- Carr. 15/- Single D.3, one-mile drums, 85/- Carr. 7/6. Also 1/3rd-mile drums, 27/6. Carr. 5/-. Commando Assault Cable, P.V.C. covered, 1,000-yd. drums, 8/11, carr. 4/-. Cartons of five drums, 42/6. Carr. 7/6.

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(3 & 4)

Our very popular three valve plus rectifier mains T.R.F. receiver is now available with a new Deluxe cabinet with polished Walnut finish and Cream trimming (as illustrated). Brief Spec.: Valve line-up 6K7, 6J7, 6V6, and contact cooled rectifier. Ready drilled chassis, good quality 5in. loudspeaker, Special Denco Coils Covers Medium and Long Wavebands. Overall dimensions: 12in. x 6in. x 5in. high A.C. 200/250 v. Simple construction with guaranteed results. Easy to follow practical and theoretical diagrams supplied. All necessary components, down to the last nut and bolt, are offered at a **SPECIAL INCLUSIVE PRICE OF £5/10/-**, plus 5/- p. & p. Instruction book available separately 1/6, post free. Also available with plastic cabinet in **IVORY** or **BROWN** if preferred at **ONLY £5/5/-**, plus p. & p.

THE "SUPERIOR FOUR"

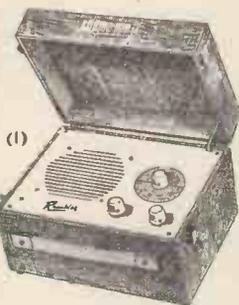
Our superior four-valve receiver A.C. mains 200/250 v. M. and L. o n g waves. As with our very successful "Economy Four" (6)



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This wonderful little Medium and Long wave battery superhet incorporates IR5, IT4, IS5, 3V4 miniature valves, 5in. speaker and frame aerial. Housed in smart two tone Red/Grey cabinet. All required components at the **NEW LOW PRICE OF £6/19/6**, plus 2/6 p. & p.; or with the latest low consumption "96 range" valves at the **NEW LOW PRICE OF £7/7/0**, plus p. & p. Uses all-dry batteries AD35 (1/6), B126 (9/-). Full descriptive instruction book, itemised price list, diagrams, etc., available separately at 1/6d. post free.



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A recent addition to our comprehensive stocks of quality equipment for the constructor. This is an exceptionally sound and robust instrument of the most versatile type, that will be a boon to the seriously minded amateur, serviceman or constructor. Specifications: 8-Range Time Base, switched from 20 c/s to 160 Kc/s. Y-Plate Amplifier has a sensitivity of 50 mV, and frequency response of 20 c/s to 600 Kc/s with a gain of 150. A calibrating voltage of 6.3 v. 50 c/s is provided. Employs ECR30 2 1/2 in. Cathode Ray Tube and 4 valves; 2/ECF80, 1/EF91, 1/6X5. Controls: X-shift, Y-shift, Focus, Width, Brilliance. ON/OFF. Time Base Frequency (Fine), Time Base Frequency (Coarse), Sync Selector, Sync. Amplitude, Y-input Selector, X-input Selector, Amplifier Gain Operates from 200/250 v. A.C. Mains. All required components for the construction of this wonderful instrument, including comprehensive assembly instructions, available at a **SPECIAL INCLUSIVE PRICE OF ONLY £12/19/6**, plus 5/- c. and p. Attractive engraved Ivorine Front panel: optional extra at only 10/6. Just arrived 1 Portable carrying case at 45/- extra.

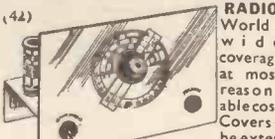


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Compare the advantages. Treble base AND middle controls. For crystal or magnetic pick-up. A C Mains 200/250 v. Valve line-up: 6V6GT, 6S7 metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1 1/2 in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at **£4/5/-** only, plus 2/6 p. & p. or Instruction Book fully illustrated for 1/- post free. This amplifier can be supplied assembled, tested, and ready for use at **£5/5/-** plus p. & p.

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This highly efficient unit is simple to assemble, extremely sensitive and may be installed in a matter of minutes. Completely **SAFE** employing a double wound mains transformer. Attractively finished in Red and Grey (washable) "Lionide" with cream plastic escutcheon. Size only 7 1/2 in. x 3 1/2 in. x 6 1/2 in. Supplied in kit form complete with mike at **ONLY 72/6** plus 2/6 P. & P. or assembled and tested 89/6 P. & P. 2/6. Suitable mike flex available at 3d. a yard. Instruction book and price list separately 1/- post free. A.C. 200-250 v.



Covers 40-100 metres with the coil supplied. Can be extended to cover 10-100 metres. Provision is also made for the addition of two extra valve stages. Employs the famous Acorn-type 954 valve. All necessary components can be supplied complete with full assembly instructions at **ONLY 35/-** plus 2/- p. & p. Send 2/- for point-to-point wiring diagram and price list.

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(21) MULLARD 510 as above plus input selector and spare power supplies	£9 9 0	3/6	1/6	1/6
(22) "DE-LUXE" Printed Circuit Superhet	£11 10 0	3/6	2/6	2/6
(23) "DE-LUXE" with New Look Cabinet	£7 19 6	3/6	1/6	1/6
(24) JASON J.T.V. 2 Tuner	£8 4 6	3/6	1/6	1/6
(25) RADIO JACK	£13 19 6	3/6	2/6	2/6
(26) MULLARD TYPE "C" Tape pre-amp.	19 6	1/6	6d.	6d.
(27) JASON Will Wobblulator	£12 9 6	3/6	2/6	2/6
(28) JASON Valve Voltmeter EM10 (23 ranges)	£14 19 0	3/6	3/6	3/6
(29) NEW JASON F.M. TUNER FMT2 with built-in power supplies and cabinet	£18 10 0	3/6	2/6	2/6
(30) NEW JASON FRINGE F.M. TUNER FMT3, as above	£8 19 6	3/6	2/6	2/6
(31) PULLIN Series 90 TEST METER	£10 19 6	3/6	2/6	2/6
(32) R.C. Super Personal Portable 1-valve (phone extra)	£5 19 6	2/6	1/6	1/6
(33) R.C. Super Personal Portable 2-valve (phone extra)	£1 15 0	2/6	2/-	2/-
(34) R.C. TRANSETTE 2-Transistor Personal Portable	£2 1 0	2/6	2/-	2/-
(35) JASON EVEREST 6-Transistor 2-wave Portable	£3 9 6	2/-	2/-	2/-
(36) JASON EVEREST 7-Transistor 2-wave Portable	£13 19 9	3/6	3/6	3/6
(37) CLYNE Cathode Ray Oscilloscope	£15 18 9	3/6	3/6	3/6
(38) Compact Multi-range Test Meter	£12 19 6	5/-	10/-	10/-
(39) CAR RADIO, Printed Circuit, 5-valve S'het.	£2 19 6	1/6	1/6	1/6
	NEW LOW PRICE			
(40) JASON Audio Generator AG10	£11 19 6	3/6	2/6	2/6
(41) JASON Oscilloscope OG10	£14 5 0	3/6	2/6	2/6
(42) Super SHORT WAVE RADIO, 1 valve	£22 10 0	5/-	3/6	3/6
(43) "WAVEMASTER" 7-Transistor Luxury Portable	£1 15 0	2/-	2/-	2/-
(44) "GOLD STAR" De-luxe 1-valve Portable	£10 19 6	3/6	2/6	2/6
(45) "PAGEBOY" 2-Transistor Pocket Portable ('phone extra)	£1 17 6	2/6	1/6	1/6
	£1 12 6	1/6	2/-	2/-

Instruction Books which contain full description, easy-to-follow practical wiring diagrams theoretical diagrams itemised price lists, etc. are free of charge with all parcels but may be purchased separately as shown above.

PLEASE NOTE:—A selection of the above items are described more fully in this advertisement!!

THE "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

400 MILLIWATTS OUTPUT

To build yourself Medium and Long Waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6in. x 4in. at base tapering to 4in. at top. Very attractive two-tone grey Vynid covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. ★ Weight—complete with long-life 7½ volt battery—4½lb. ★ Mazda high-grade transistors throughout. ★ High-Flux 7in. x 4in. Elliptical Speaker. ★ Slow motion tuning. ★ Co-axial socket at rear for direct connection to Car Radio Aerial. ★ Improved reception by use of seven-section plated telescopic aerial disappearing into Cabinet when closed, 34in. above Cabinet when fully extended.

Construction simplified by Bakelite chassis board with the following components already mounted: I.F. Transformers (3). Oscillator Coil, Trimmer Bank, Output Transformer, Interstage Transformer, Aerial Brackets and Earth Bar. SPECIAL INCLUSIVE PRICE for all required components, full assembly instructions—nothing more to buy—is £10/19/6 plus 3/6 P. & P. Alignment service available. Full assembly Instructions and Individually priced parts list, all of which are available separately, 2/6, post free.



(43)

PRINTED CIRCUIT CAR RADIO (for Home Construction).

We are proud to be able to offer this New type Car Radio employing up-to-the-minute circuitry, special 12 volt valves and transistorised output stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. NO VIBRATOR PACK IS REQUIRED. This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor at a Special New Low inclusive Price of Only £11/19/6 plus 3/6 P. & P. Instruction booklet with itemised price list, full description dimensions, etc., available separately at 3/6 post free.



(39)

"FAMILY FOUR" (5)

Our supersensitive T.R.F. Receiver for home construction. Covers Long and Medium Wavebands, is housed in very smart plastic table cabinet in Brown or Black. For A.C. mains 200/250 v. Comprehensive assembly instructions provided, including practical and theoretical diagrams, which are easy to follow and will enable you to complete this receiver which will be the envy of your friends. ALL NECESSARY COMPONENTS ARE BEING OFFERED FOR LIMITED PERIOD ONLY AT THE REMARKABLE PRICE OF ONLY 79/6, plus 2/6 P. & P. Instruction book available separately if you wish to study before purchase at 1/6 post free.



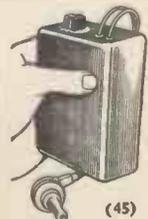
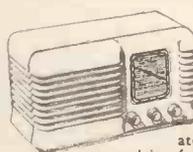
SUPER PERSONAL PORTABLE. (32) & (33)

A wonderful little set that you can take anywhere. Ideal for camping, picnics, etc. Detachable aerial rod supplied. Covers Medium waveband 200-500 metres. Can be built in approx. 1 hour. All necessary components available at the following SPECIAL INCLUSIVE PRICES: 1-valve version ONLY 35/- plus 2/- P. & P. Super 2-valve version ONLY 41/- Plus 2/- P. & P. Send for point-to-point wiring diagram and parts price list 2/- post free. Extra for use with the above DLRS balanced armature headphones, 7/6 pair.



THE CLYNE RADIO "DE LUXE" PRINTED CIRCUIT SUPERHET

A new two-wave band (L and M) Superhet using the latest miniature valves: ECH81, EF85 and ECL80, plus contact cooled Rectifier. Incorporates Ferrite Rod Aerial and is of unit construction. Exceptional sensitivity and selectivity. Outstanding performance and quality T.C.C. condensers throughout. Easily constructed in one evening. Brown or ivory Bakelite or wooden Walnut finish cabinet. A.C. mains 200/250 v. All necessary components at special inclusive price of £7/19/6 plus 3/6 P. & P. Instruction Book with itemised price list available separately at 1/6 post free. Also available in De Luxe Cabinet (as "Economy Four" at 5/- extra).



(45)

NEW "PAGEBOY" 2-TRANSISTOR POCKET PORTABLE. Completely portable—NO EXTERNAL AERIAL OR BATTERY REQUIRED. This is an amazing little receiver with built-in aerial and small enough to be held in the palm of the hand. Medium wave reception at wonderful volume. No fiddly tuning—condenser tuned! Supplied with drilled chassis and colour coded components. Easily assembled with the aid of the easy-to-follow assembly instructions provided. Total cost of all necessary components, including transistors, wiring wire and even solder ONLY 32/6 plus 1/8 P. & P. Battery 3/- extra. Ardente type deaf-aid earpiece complete with cord and plugs extra at 12/6. Parts price list and Easy Lay-out Plans 2/- post free. Callers welcome to hear this set demonstrated at any of our branches. Our reputation is your guarantee.

TURN OVER FOR MORE CLYNE BARGAINS

CLYNE RADIO LTD.

THE COMPONENT SPECIALISTS

18 Tottenham Court Road, London, W.1.
162 Holloway Road, London, N.7.
99 Chapside, London, E.C.2.

★ MORE CLYNE RADIO BARGAINS ★

CABY UNIVERSAL TEST METERS

These pocket-size multi-range test meters are of excellent quality and cover all the most useful ranges (A.C. Volts, D.C. Volts, resistance and current). Supplied complete with test prods, instruction book and batteries. Model A.10 (2,000 ohms per volt) £4/17/6

Model B.20 (10,000 ohms per volt) £6/10/-
Plus P. & P. 3/6 on each.
Fully detailed and illustrated leaflet available on request.

RECORD PLAYERS

Full range at usual competitive prices. Interesting H.P. facilities B.S.R. TU9. 4-speed single-record unit with separate lightweight pick-up fitted with T.C.B.H. crystal insert and sapphire styli. An ideal unit for a small portable gramophone. Brand new and fully guaranteed. SPECIAL PRICE: 75/- plus 2/6 P. & P. or motor and turntable only at 52/6 plus 2/6 P. & P. or Pick-up only at 27/6 plus 1/6 P. & P.

E.M.I. 4-SPEED STEREO/MON- AURAL SINGLE RECORD UNIT. Complete with Stereo Head and Sapphire Styli. Brand New and Fully Guaranteed. ONLY £6/19/6 plus 3/6 P. & P.

JUST ARRIVED! LATEST GARRARD MODEL 210. Four-speed manual or automatic. 10in. and 12in. records of same speed can be mixed in any order, wired for stereo, attractive white colour scheme. Price 10½ gns., plus 3/6 P. & P.

LATEST B.S.R. UA14. 4-speed. Attractive appearance. Wired for stereo. Fully guaranteed. £7/19/6, plus 3/6 P. & P.

B.S.R. UA8 STEREO/MON- AURAL. Few only at £7/19/6, plus 3/6 P. & P. Brand new Guaranteed.
COLLARO CONQUEST. Four-speed, wired for stereo. Brand new. £7/19/6. P. & P. 3/6.

No. 38 AFV WALKIE-TALKIE. A wonderful offer. This famous trans-receiver unit, with relay operated SEND/RECEIVE switch covering 7.4-9 Mc/s band, range approx. 5 miles. Good condition. ONLY 22/6 plus 2/6 P. & P. per unit (less accessories). Quantity export inquiries welcomed.

AERIAL TUNING UNIT ZA0841. This well made ex-W.D. unit contains a host of useful components including: 1 mA. 2in. flush round M/C meter, 1 mA. Westinghouse full-wave meter rectifier, 5-pole 5-way heavy-duty silver plated wavechange switch, 3in. dia. silver plated rotary tuning indicator, 350 pF tuning condenser with insulated coupler and 3in. calibrated dial (0-180 deg.) etc. etc. Contained in strong metal carrying case 9in. x 9in. x 8in. with hinged lid. ONLY 27/6 plus 5/- P. & P.

A CONSTRUCTOR'S MUST
The latest "Pifco" Instrument Bit Soldering Iron
With integral Stand and built-in Spot-light for illuminating work 200/250 v. ONLY 22/6. P. & P. 1/6.

SOLDER. New boxed 1 lb reels, 16 S.W.G. 50/50 at 8/6 only, plus 1/- P. & P.

12in. BAKERS SELHURST LOUSPEAKER. 15 ohms, 15 watt. 30-14,000 c.p.s. Brand new, £4/10/- P. & P. 3/6.

12in. RICHARD ALLAN P.M. LOUSPEAKER. 3 ohm speech coil. Brand new. Only 32/6 plus 2/6 P. & P.

SUPER MAGNETIC RECORDING

TAPE SPECIAL!!! Trade enquiries invited. First delivery famous American Ferrodynamic Acetate Base High Quality Recording Tape. An enthusiast's "must." Brand new (NOT SUB-STANDARD), 5in. 600ft. 16/-, 5in. 900ft. 18/6, 5½in. 1,200ft. 23/6, 7in. 1,200ft. 25/- 7in. 1,800ft. 35/-. "Professional quality" MYLAR Du Pont 5in. 1,200ft. 37/6. 7in. 1,800ft. 44/- 7in. 2,400ft. 60/-, each on plastic spool. P. free.



DECCA PORTABLE AMPLIFIER. As supplied in famous DECCA-MATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3½ x 8½in. Only 59/6 plus 2/6 P. & P. **SPECIAL CELESTION 8 x 6in.** elliptical high flux loudspeaker 30/- plus 1/- P. & P. to fit.

VERY ATTRACTIVE PORTABLE CABINET in two-tone rexine covering for accommodating the above items and ancillary equipment 75/- plus 5/- P. & P.
Note. If the above three items are purchased together they will be supplied at the special inclusive price of £72/6 plus 6/6 P. & P.

EXTRA SPECIAL OFFER !!

A small three-valve PORTABLE RECORD-PLAYER AMPLIFIER mounted on baffle 12 x 7in., with High Flux 6½in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, £5/12/6. P. & P. 3/6.

NEW STYLE CABINET finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13½ x 8½in. Fitted with carrying handle, £3/9/6 plus 5/- P. & P.

NOTE. If both items purchased together they will be supplied at a special inclusive price £8/7/6 plus 6/6 P. & P.



ANOTHER PORTABLE CABINET BARGAIN! Ex leading manufacturer's battery portable attache type case. Attractive two-tone grey rexine finish. Size closed 13½in. x 9½in. x 3½in. Complete with fittings and handle. Including Medium and Long Wave frame aerial which fits in lid. On/off switch on lid stay. Limited quantity only at bargain price of 19/6 plus 2/- P. & P. Brand new.

TAPE RECORDER CONSTRUCTORS

LATEST COLLARO STUDIO TAPE TRANSCRIPTION. 3 motors, 3 speeds. 1½, 3½, 7½ i.p.s., takes 7in. spools. Push-button controls. £12/19/6 plus 5/- P. & P. Usual H.P. facilities.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5½in. spools—3½ i.p.s. At only £8/19/6 plus 5/- P. & P.

TAPE RECORDER AMPLIFIER—MANUFACTURER'S SURPLUS: Suitable for use with either of the above Tape Decks, and most other types. For A.C. mains, 4 watts output. 40-12000 CPS at 7½ ips ± 3 db. Facilities for superimpose. Valves: ECL82, 12AX7, EM84 and contact cooled metal rectifier. Radiogram input, microphone input, volume control and separate treble and bass controls. Chassis measurement 11½ x 3 x 4½in. Supplied complete with attractive grey/blue escutcheon plate finished in black and gold. Circuit diagram and connecting instructions included. Price £10/10/- only, plus 3/6 P. & P. Limited quantity. If purchased with either of the above decks, both items post free!

ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE Suitable for above amplifier and Collaro, Studio deck. Limited quantity only at 72/6 plus 3/6 P. & P.

MIC 45-1 Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. OUR PRICE 29/6 plus 1/- P. & P.

ACOS MIC 39-1. Crystal stick microphone. List price 5 gns. Our price 39/6 plus 1/6 P. & P.

MIC 40. General purpose crystal microphone with desk stand. Our price 25/- only plus 1/6 P. & P.

M.C.24. ANOTHER HAND MIKE BARGAIN: Imported, crystal, attractive streamlined polished metal case, incorporates muing switch. List price 63/- OUR PRICE 42/- only 1/- P. & P.

NEW! AN INEXPENSIVE TV AERIAL!!

THE HANDY BURKE AERIAL. For B.B.C. and I.T.V. Patent applied for 17109/59. Tried and proved in most areas up to 25 miles from a transmitter. "Astounding in its simplicity." "Why didn't somebody think of this before?" "Not a 'gimmick'—but scientifically right." Television signals are elusive, particularly indoors, with this aerial you have a much better chance of catching them! Descriptive leaflet available includes technical report from "Wireless World," March 1960. Featured in "Daily Express" article May 12th, 1960. Trade enquiries invited. Send for leaflet.

ONLY Plus P. & P. 7/6 1/-

CLYNE RADIO LTD.

18 Tottenham Court Road, London, W.1.
162 Holloway Road, London, N.7.
99 Cheapside, London, E.C.2.

THE COMPONENT SPECIALISTS

ALSO SEE PREVIOUS PAGES

— TRANSISTORS !!! —

SURPLUS P.N.P. RED SPOT (Audio/Experimental Application) 3/6 ea.
WHITE SPOT, R.F. up to 2.5 Mc/s 5/- ea.
Attractive discounts for bulk purchases. The above is a selection only. Full range in stock by all leading manufacturers. Let us have your enquiries. (ALL POST FREE)

FRUSTRATED EXPORT. Not repeatable! L., M. and S.W. SUPERHET RECEIVER. Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free.



Valve line-up: 6K8G, 6K7G, 6Q7C 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8in. P.M. Speaker, 4 watts output, P.U. socket Ext. L.S. socket, etc. Tone control. Fitted in polished wood cabinet, size 21½in. x 10½in. x 10½in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price £5/19/6 only plus P. & P. 7/6, plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

12 CHANNEL TV TURET TUNER

(By famous manufacturer). Brand new, NOT surplus or ex-equipment. 35 Mc/s. I.F. PCC 84 and PCF 80 valves. Complete with coils. Band I Channels 1 to 5. Band III Channels 8 to 11. In manufacturers original carton. Fully guaranteed at only 39/6 plus 2/6 P. & P.

JUST ARRIVED !! PICK-UP CARTRIDGES

ACOS GP73-2A: Turnover cartridge for Stereo and Monaural Standard and L.P. Few only at 29/6 plus 9d. P. & P.

ACOS GP67-3. Latest Monaural turnover cartridge for standard and L.P., only 18/- plus 9d. P. & P.

Both of above absolutely complete, ready to fit, with two styli.

DEAF AID TYPE EARPIECES. Standard magnetic type complete with lead and plug. As new. ONLY 12/6, plus 1/- P. & P.

DLRS BALANCED ARMATURE HEADPHONES. Complete with headband and leads, 7/6 pr., P. & P. 1/6.

HIGH IMPEDANCE LIGHT-WEIGHT HEADPHONES. Brand new imported type finished in cream. Complete with leads, 15/- pr., P. & P. 1/6.

AT LAST! A really miniature speaker of quality. The LORENZ 1½in. overall diameter—¾in. depth from front to rear including magnet. 10,000 lines. 150-15,000 cycles. Price 25/- only, including P. Tax, plus 1/6 p. & P. ideal for miniature transistor receivers!

LOUDSPEAKERS. EX. CHASSIS. As new guaranteed perfect, by leading manufacturers. 6½in. 10/6; 8in. 13/6; also 10in. with O/P transformer (5,000 ohms), 17/6.

All 3 ohm speech coil, also 8in. available, in attractive cloth covered cabinet, ideal for extension speaker, 22/6. Each item plus 1/6 p. & p. Complete list of new speakers on request.

10,000 OHMS PER VOLT TESTMETER

This latest Caby model is a handy pocket sized tester 5 1/2 in. x 3 1/2 in. x 2 1/2 in. Reads low D.C. voltages at 10,000 ohms per volt, up to 1,000 v. A.C. and D.C. at 4,000 o.p.v. Resistance to 20 megohms, D.C. current to 250 milliamps, and also Decibels. Complete with Test Leads, Batteries, and Instruction Book. ONLY £6/10/-.



UNIVERSAL AVOMETER 34 RANGE MODEL D

Ex-Air Ministry, but thoroughly reconditioned and checked. Supplied with internal batteries and instructions. Covers ranges as follows:

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mV.	7.5 v.	15 mA.	75 mA.
300 mV.	15 v.	30 mA.	150 mA.
1.5 v.	75 v.	150 mA.	750 mA.
3 v.	150 v.	300 mA.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	15 amp.
300 v.	1,500 v.	30 amp.	Resistance
1,500 v.			1,000 Ω
			10,000 Ω



ONLY £9/19/6 (Postage, etc., 3/6).

OSCILLOSCOPE No. 11 by Cossor. A First Grade L.F. Oscilloscope incorporating a Hard Valve Time Base with speeds of 1-5-40 milliseconds but easily converted for a few shillings to produce 3 c.p.s. to 30 kc/s. Has High Class Amplifier with Fine and Coarse Gain controls, Brightness and Focus controls, X and Y shifts. A.C. mains pack for 115 v.-230 v. nominal, fully fuse protected. Employs 2 1/2 in. Tube ACR 10. Front panel 19 in. x 7 in. for rack mounting, depth 12 in., or can be used in Steel Transit Case on bench. Complete with suggested Modification data. BRAND NEW AND UNUSED. ONLY £12/10/- (carriage 16/-).

RCA 8in. P.M. SPEAKER in heavy black crackled metal case, size 11 1/2 in. x 10 1/2 in. x 8 in. Designed for use with AR88 Receiver or any set with 3 ohms output. BRAND NEW IN MAKER'S CARTONS. ONLY 45/- (Post 3/6).

CANADIAN MOVING COIL PHONES. Low-resistance, fitted noise-excluding chamois ear muffs, and leather covered head-band. Lead terminates to jack plug. BRAND NEW. ONLY 13/6 (Post 1/6).

CARRYING CASES, solid leather. SLIGHTLY USED. Internal dimensions 8 1/2 in. H x 8 1/2 in. W x 4 1/2 in. D. Fitted lock and key, and shoulder strap. Ideal for Test Instrument, Camera and accessories, etc. ONLY 25/- (postage 2/-).

BO 342 RECEIVERS. A few only of these famous American sets covering 1.15-18.0 Mc/s. in six bands. Internal 115 v. A.C. Mains pack. A super receiver in first-class condition and perfect working order. ONLY £25 (carriage 15/-).

HRO MAINS POWER UNITS. A.C. input 115/230 volts. Output D.C. (fully smoothed) 230 volts 75 mA., and 6.3 volts 3.5 amps. Complete in black crackled case. ONLY 59/6.

12-WAY SCREENED CABLE. In 10ft. lengths, fitted with plugs, originally made for No. 19 Wireless Set. UNUSED. ONLY 15/- per lead.

P.M. SPEAKERS. 3in. 19/6, 6 1/2in. 17/6, 8in. 21/-, 12in. 29/6.

SPRAGUE CONDENSERS. Metal cased wire ends. New. 0.1 mfd. 1,000 v. and 1 mfd. 500 v. 7/6 per dozen. Special quotes for quantities.

HETERODYNE FREQUENCY METERS TYPE LMI4



Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy Model of the well-known BC221 Frequency Meter but has many additional features which increase its usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy, and in addition it is fitted with an Internal Modulation switch to allow use as a Signal Generator. Size only 8 1/2 in. x 8 in. x 8 1/2 in. Full information on request.

RI155 RECEIVERS

The famous Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges: 18.5-7.5 Mc/s., 7.5-3.0 Mc/s., 1,500-600 kc/s., 500-200 kc/s., 200-75 kc/s., and is easily and simply adapted for normal mains use, full details being supplied. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Fitted with latest type Super Slow Motion tuning assembly. Have had some use, but are in excellent condition. ONLY £9/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 3in. P.M. speaker. £9/10/- DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

RCA AR88 RECEIVERS. Thoroughly re-conditioned, AS NEW externally and in perfect working order. "D" Model covers 500 Kc/s-31 Mc/s. ONLY £45. "LF" Model covers 75-140 Kc/s. and 1.2-30 Mc/s. ONLY £35. (Carriage 25/-).

DOUBLE BEAM OSCILLOSCOPE TUBES

Type CV 1596 equivalent to Cossor O9D as used in oscilloscopes by Cossor (339 series). Hartley and Erskine (13 series). Listed at £12/10/-.

Our price £2/19/6 (carriage 5/6)
Brand New in makers' crates.

W 1191A WAVEMETER

Crystal controlled heterodyne frequency meter covering 100 kc/s to 20 Mc/s. in 8 switched bands and is virtually the British BC221. Power requirements 2 v. L.T. and 40-60 volts H.T. Complete with Calibration Book, Crystal, Operating Valves and full set of spares. BRAND NEW IN ORIGINAL TRANSIT CASES. ONLY £9/19/6 (carriage 15/-).

METERS

F.S.D.	SIZE AND TYPE	PRICE
25 microamps	D.C. 2 1/2 in. Proj. circular	59/6
50 microamps	D.C. 2 1/2 in. Flush circular	59/6
50 microamps	D.C. 3 1/2 in. Flush circular	80/-
100 microamps	D.C. 2 1/2 in. Flush circular	39/6
1 millamp	D.C. 2 1/2 in. Flush square	22/6
1 millamp	D.C. 2 1/2 in. Flush circular	30/-
1 millamp	D.C. 2 1/2 in. Flush circular	25/-
1 millamp	D.C. 3 1/2 in. Flush circular	50/-
200 millamp	D.C. 2 1/2 in. Flush circular	12/6
30 amps	D.C. 2 in. Proj. circular	7/6
40 amps	D.C. 2 in. Proj. circular	7/6
5 amps	D.C. 2 in. Flush square	12/6
300 volts	A.C. 2 1/2 in. Flush circular	25/-
500 volts	A.C. 2 1/2 in. Flush circular	25/-

V.H.F. RECEIVER TYPE R.1392. A superb 15-valve superbet receiver covering 95-150 Mc/s. (2-3 Metres), being fully tunable over that range, with provision for Crystal Control. Has 2 stages of R.F., 3 of I.F., BFO, AGC, etc. Fitted with 2in. square meter for Oscillator and Audio Signal checking. Size 19 in. x 10 in. x 10 in. Used but in very good order, thoroughly air tested before despatch. Power supply required: 240-250 volts at 80 mA., and 6.3 volts at 4 amps. Complete with valves and circuit diagram. ONLY 79/6 (carriage, etc., 10/6).

HIGH FREQUENCY A.C. VOLTMETER. A first-grade moving iron instrument with 6in. Mirror Scale reading up to 150 volts A.C. at 400 and 1,200-2,400 cycles. In substantial oak case with removable lid, overall size 8 1/2 in. x 8 1/2 in. x 5 1/2 in. Recently made for the Air Ministry by Everett Edgcombe Ltd. and in perfect order. Brand new and unused. ONLY £27/10/- Can also be supplied for 60 cycles use, either 0-150 volts or 0-300 volts, same price.

POWER UNIT TYPE 3. Primary 200/250 volts A.C. 50 cycles. Outputs of 250 volts 100 mA., and 6.3 volts 4 amps. Fitted double smoothing and 2 meters to read H.T. current and voltage. For normal rack mounting (or bench use) having grey front panel size 19 in. x 7 in. BRAND NEW. ONLY 79/6 (carriage 7/6).

INTERCOM. TELEPHONE SET. Two pairs of Brand New Headphones connected to Breast Microphones, with leads, etc., in fitted carrying cases. Supplied with 4 1/2 volt battery, 10 yards twin flex, and full instructions for connecting to make super intercom. ONLY 27/6 (Post 3/6). Extra flex 3d. per yard.

AMERICAN HALLICRAFTERS 6 VOLT VIBRATOR PACK. Output 300 volts D.C. at 170 mA. Designed to run Communications Receivers from 6 volt car battery. In grey metal case size 6 1/2 in. H x 6 1/2 in. W x 7 1/2 in. D. Complete with 2 valves type 6X5, and full instructions. BRAND NEW IN MAKER'S CARTONS. ONLY 29/6 (Carriage 3/6).

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 mA. Size 6 1/2 x 3 1/2 in. diameter. Ideal for running Radio and Electric Shaver, etc., from car battery. ONLY 32/6.

MARCOMI SIGNAL GENERATOR TF 1440/7. Coverage 85 kc/s.-2.5 Mc/s. and 8 Mc/s.-70 Mc/s. Complete, and in AS NEW CONDITION. ONLY £95.

AMPLIFIER N24



Utilises 4 valves, 1 each 6Z4G, 6V6G, 6J7G, 6J5G and high quality components such as "C" Core Transformers and Block Paper Smoothing Condensers. A.C. Mains Pack for nominal 110x230 volts. Provision for 600 ohms or High Impedance Input. Output to 600 ohm Line. For normal use only requires changing Output Transformer. Output approximately 4 watts. Designed for Standard Rack Mounting, having grey front panel size 19 in. x 7 in. All connections to rear panel, front having "On/Off" switch, Gain Control, Indicator Light, Fuse and Valves Inspection Panel. BRAND NEW IN MAKER'S PACKING. ONLY £4/9/6 (carriage 10/6).

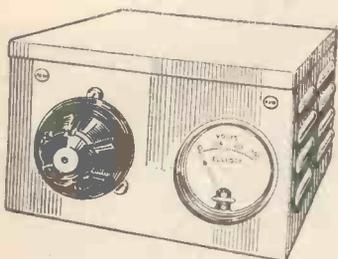
Cash with order please, and print name and address clearly
PLEASE ADD POSTAGE OR CARRIAGE COSTS ON ALL ITEMS

HARRIS ELECTRONICS (LONDON) LTD.

Radio Corner, 138 Gray's Inn Road, London, W.C.1. Phone: TERMINUS 7937

Open until 1 p.m. Saturdays.

We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.



BRAND NEW VARIABLE VOLTAGE TRANSFORMER. 230 volt A.C. input. Fitted in steel hammer finish case complete with 0-300 volt M.C. A.C. Meter, fuse and neon indicator light. Output constantly variable from 0-270 volt A.C. Type 1. 2.2 amp. Price £8/10/-, carriage 10/- Type 2. 5 amp. Price £12, carriage 10/-.

BRAND NEW VARIABLE VOLTAGE TRANSFORMER. For 230 volt A.C. input. In cases exactly as above with meter, fuse and indicator light. Output constantly variable from 0-230 volt A.C. Type 15. 15 amp. Price £22/10/- Carr. 15/-.

W. W. RHEOSTAT. New. 3.5K or 5K. 25 watts. Price 7/6. P. & P. 1/6.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohm. 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

EX P.O. MAGNETIC COUNTER. 500 ohm type for 24 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

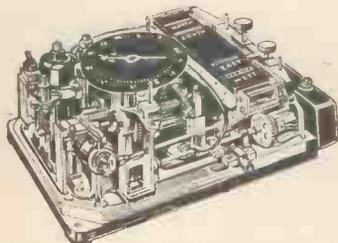
AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6.

HEAVY DUTY L.T. TRANSFORMER. Very conservatively rated for continuous duty. New. In manufacturer's cases. Input 110-260 volt multi-tapped. 50 cycles, single phase. Output 28-29-30-31 volts at 21 ampere. Price £5/15/-, carriage 10/-.

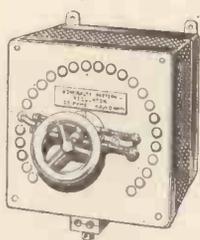
NEW GALVANOMETERS. Solid brass, 3in. dial, in polished wooden case. 70 degree scale, 35 mA either side. 100 ohm coil. Price 12/6 each. P. & P. 1/6.



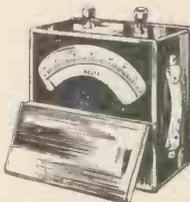
EX R.A.F. AIR POSITION INDICATOR. containing 3 ball and plate infinitely variable resolving gears, miniature spur bevel and worm gear drives, also toggle, push button and rotary switches, repeater motor, 4 mechanical counters, miniature lamp holders and lamps etc. As new. Illustration below. Price 22/6. P. & P. 3/6.



ROTARY SWITCHREGULATOR. 25 ohms, very conservatively rated at 4 amp., will handle 8 amp. Overall size 7 x 8 x 6in. Price 15/- P. & P. 2/6.



EVERSHED AND VIGNOLES "WEE MEGGER." 500 volt in brand new leather case. Guaranteed perfect. Price £13/15/- P. & P. 2/6.



LABORATORY PRECISION VOLTMETER. Brand new in polished teak case. Moving Iron instrument reading D.C. or A.C. 0-160 volt on Bin. mirror scale. Accuracy 2% £4/19/6 each. P. & P. 3/6.

BRAND NEW FREQUENCY METERS manufactured by **Calder & Thompson Ltd.** Calibrated 45 cycles to 55 cycles per second. 6in. dial. Panel mounting type. In original manufacturers' boxes. **PRICE £10/15/- ea. Postage 3/6.**



20 WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 11 x 3½ x ½in. New. Price 15/- each. P. & P. 1/6.

10 WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing 1 gramic Jack Plugs. New. Price 10/- P. & P. 1/6.

19-INCH RACK MOUNTING 20-WAY P.O. JACK STRIPS with 40 terminals at rear. Price 25/- P. & P. 3/6.

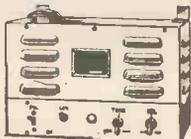
19-INCH RACK MOUNTING 20-WAY P.O. LAMP STRIPS. Price 25/- P. & P. 2/6.

LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES. As illustrated. Brand new, low impedance. Price: 10/6 plus P. & P. 1/6.



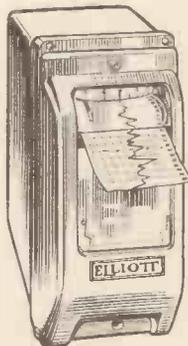
NEW MOVING COIL HEADSETS. Complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price: 12/6 each, plus P. & P. 2/-.

12 v. D.C. AMPLIFIER, as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram. input, tapped output 7½, 15, 62, 100, 250 or 500 ohms. £9/17/6 each. Carr. 15/-.



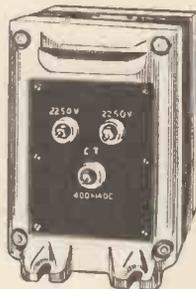
PYE LEVER OPERATING MICRO SWITCHES. Single pole change over. Brand new. 4/- each or 42/- dozen, p. paid.

VARIABLE VOLTAGE TRANSFORMER "BERCO." Brand new in manufacturer's boxes. For 110 volt A.C. Input. Constantly variable from 0-135 volts. 2.2 amp. type. £4. P. & P. 3/-, 5 amp. type £6/10/- P. & P. 3/6.



ELLIOTT SWITCHBOARD MOUNTING PEN RECORDER. 2½in. chart. 1 mA. movement. 2 speed mechanism. Complete with pen, and charts. Reconditioned as new and guaranteed. Limited quantity. Price £55, carriage 10/-.

PLATE TRANSFORMER of very best U.S.A. make, brand new, original manufacturer's cases. Input tapped at 190/210/230/250 v. Output 2250-0-2250, centre tapped 400 mA. Nett weight 76lb., size 13in. x 9in. x 6½in. Price £6/10/- each, plus carr. 10/-.



NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6 x 2 v. separate cells connected by terminal strips. 6 x 5½ x 4½in. over terminals. Price 19/-, plus P. & P. 2/9. Wooden carrying case for same with lid and strap price 3/6.

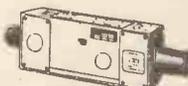


245 AMP. 2 VOLT ACCUMULATOR. Admiralty type in wooden casing. Size 15 x 7½ x 7½in. Weight 60lb. Unfilled, uncharged. New. Price £4. Carriage 10/-.



MINIATURE P.M. MOTOR. 12/24 volt, reversible. 1½in. dia. New. Price 10/6 each. P. & P. 1/-.

AIRCRAFT CINE CAMERA G45B Mk. III. Fully modified, fitted with f/3.5 triple anastigmatic lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing, £4/10/- each. P. & P. paid.



SLIDER RESISTANCES. 2 amp. 500 ohms, size 14in. x 6in., plus handle 6in., 27/6. P. & P. 3/6.



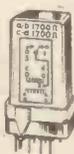
SOLENOID OPERATED MAGNETIC RELAY.

Type 5CW/3945, 4 pole changeover 10 A contacts 24 v. operation. Brand new 13/6. P. & P. 1/6.

NEW CARPENTER'S TYPE POLARISED RELAYS. 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-.
Carpenter's similar to above, but type 5A4B. Coils 1 x 3200 turns at 100 ohms and 1 x 2000 turns at 145 ohms, 22/6 each. P. & P. 1/-. Bases for same 2/6.

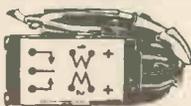


SIEMENS H.S. RELAY. Very latest type, sealed. H96E, 1,700 ohms plus 1,700 ohms, single C.O. contacts. Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.



Siemens sealed similar relay to above, but 2.2 ohms plus 2.2 ohms. Minus clips, 12/6 each. Plus 1/- P. & P.

SUPERIOR BRAND NEW RELAY. 7,000 ohms coil. Will pull in at 750 microamp, and out at 450 microamp. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2 1/2 oz. Price 18/6. P. & P. 1/-.
MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each. Operating current minimum 140 microamp., nominal 400 microamp, maximum 8 milliamp. One pole two way, or centre stable. Two way contact current 100 mA. at 50 V. A.C. or D.C. Size 1 1/2 x 3/4 x 2 1/2 in. Price 22/6 each.



G.E.C. SEALED RELAY. Type M.1090. 180 ohms coil. 6/12 volt. 4 C/O. Brand new, 18/-. P. & P. 1/-.
G.E.C. SEALED RELAY. Type M.1092. 680 ohms coil. 12/24 volt. 4 C/O. Ex new equipment. Unused. 10/-. P. & P. 1/-.
G.P.O. 600 TYPE RELAY. 400 ohms coil. 24 volt. 2 C/O plus 2 M. New 7/6. P. & P. 1/-.
MINIATURE OPEN TYPE RELAY. 700 ohms coil. 24 volt. 2 C/O. Ex new equipment. Unused. 7/6. P. & P. 1/-.
ROTARY RELAY. 12 volt. Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price 7/6. P. & P. 1/6.

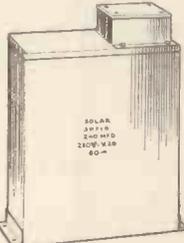


MINIATURE UNSELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohm coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. As illustrated.



HIGHLY PRECISION MADE GEARED MOTOR BY DRAYTON REGULATOR CO., for 230 volt 50 cycles S.P. A.C. **TYPE R.Q.R.,** reversible. 37 r.p.m., overall size 5in. x 4in. x 5 1/2in. Weight 4 1/2 lb. Ex. brand new equipment. Unused. Price £3/17/6. P. & P. 3/-.
SOLAR OIL-FILLED CONDENSER. 240 mfd. for 230 W. V.A.C. Overall size 14in. x 9in. x 5 1/2in. plus feet. Weight 46 lb. Brand new. Guaranteed perfect. Manufacturer's packing. Price £7/10/-. carriage 10/-.

DIAL THERMOMETER. Made by Short & Mason. Calibrated 0-160 degrees Fahrenheit. 4 1/2in. dial. 6in. rim for flush mounting with 6in. long rod protruding at the back. Brand new. Manufacturer's packing. Price 22/6. P. & P. 3/-.



SPECIAL OFFER. LIMITED QUANTITY. GENERAL PURPOSE CATHODE RAY OSCILLOSCOPE
The famous model 160-B C.R. 'Scope, manufactured by R.C.A. of U.S.A. Best general purpose instrument of its kind, complete with 6in. cathode ray tube. Unused, guaranteed perfect. For operation on 110 v. A.C. Price £22/10/-. Carr. 10/-.
Step-down transformer to enable the above to operate on 230 v. Price 19/6.

BRAND NEW SOUND POWER OPERATED EX-ADMIRALTY HEAD AND BREAST SETS. Two such sets connected up will provide perfect intercom., no batteries required. Will operate up to 1/2 mile. Original manufacturer's boxes. Price 17/6 each, plus P. & P. 2/-; or 32/6 per pair. P. & P. 3/-.



MUIRHEAD PRECISION. 1 bank, 1 pole, 25 position Stud Switch. Brand new. Price 12/6. P. & P. 1/-.
MIDGET ROTARY TRANSFORMERS 2 1/2in. dia. x 4 1/2in. Input 11.5 volt. 2 amp. Brand new.

Output 310/365 volts at 30 mA. Brand new. Price 12/6 each, P. & P. 1/6.
MINIATURE INSTRUMENT RECTIFIERS. Bridge Type 1 milliamp. Guaranteed perfect, 7/6 each.
S.T.C. RECTIFIER. 36 plates by 120 mm. Bridge connected. Maximum A.C. input 60 volt, D.C. output 15 amp. New, perfect. Price 60/-. P. & P. 3/6.

8-day clockwork Time Switch. Contacts 2 1/2 amp., 230 volt, 24 hour phase, 1/2 hour divisions, allow setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.



METERS GUARANTEED PERFECT

Charging Types

2 1/2 amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2 1/2in. fl. rnd.	11/6
7 1/2 amp. D.C. M.I. 3 1/2in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2 1/2in. fl. rnd.	6/6
15 amp. D.C. M.C. 2in. rnd.	10/6
30 amp. D.C. M.C. 2in. fl. sq.	12/6
100 amp. A.C. M.I. 4 1/2in. fl. rnd.	32/6

Voltmeters

12 v. D.C. M.C. 2 1/2in. proj. rnd.	8/6
20 v. D.C. M.C. 2in. fl. sq.	9/6
25 v. D.C. M.C. 2in. fl. rnd.	7/6
30 v. M.I. 3in. proj. rnd.	10/6
40 v. M.C. 2in. fl. sq.	9/6
300 v. A.C. M.C. 2 1/2in. fl. rnd.	27/6
300 v. A.C. M.I. 2 1/2in. fl. rnd.	22/-
400 v. A.C. M.I. 4 1/2in. rnd.	35/-

Milliammeters

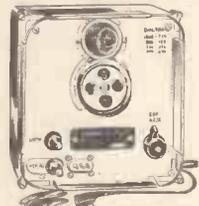
1 mA. M.C. 2 1/2in. fl. rnd.	25/-
200 mA. M.C. 2 1/2in. fl. rnd.	12/6
500 mA. M.C. 2 1/2in. fl. rnd.	9/6

Microamp

50 microamp, scaled 0-100, M.C. 2 1/2in. fl. rnd.	42/6
50 microA. 2 1/2in. square, side fitting scales	35/-
500 microamp., M.C. 2in. rnd. F.L. scaled 15/600 volt.	16/6

Postage on all meters 1/- each.

Miniature latest type moving coil 0-5 millamp meter, 1 1/2in. diameter, flush fitting complete with fixing clip. Price 17/6. P. & P. 1/-.
CRYSTAL CALIBRATOR No. 10. A crystal controlled 4-valve high-grade instrument in the same category as the famous B.C. 221. Directly calibrated, does not require cross reference or charts - functions as follows: (1) A crystal controlled oscillator which provides fixed frequency signals of 500 KC and all harmonics of 500 KC to beyond 10 Meg. and up to 30 Meg. (2) A variable oscillator from 250 KC to 5 KC, this enables all intermediate frequencies between 250 KC/s. and 30 Meg. to be produced and modulated. Supplied complete with 3 spare valves, all leads and maker's instruction book in carrying haversack. The complete outfit is brand new—repeat NEW. Price: £4/19/6. Carr. 3/-.



TWELVE PLATE F.W. BRIDGE CONNECTED RECTIFIER mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.



R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only
Can be assembled in 1/2 hour.

25 1/2 GNS. Carr. 17/6.

OR DEPOSIT £5/7/6 and 12 monthly payments of 42/-.
Cash price if settled in 3 months.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR, THE LINEAR LT45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 x 4in. LOUDSPEAKER, Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 16 x 13 x 9in., finished in durable and attractive duotone Poliorome, and connection diagram for wiring amplifier to transcriber.

FEATURES INCLUDE

- ★ 3 SPEEDS. ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FREDBACK EQUALIZATION FOR EACH SPEED. ★ OUTPUT 4 WATTS. ★ MAGIC EYE RECORDING LEVEL INDICATOR. ★ 3 MOTORS. Fast rewind. ★ TAPE MEASURING AND GALIBRATING DEVICE. ★ TAKES FULL 7in. DIAMETER REELS OF TAPE. ★ NEGLIGIBLE HUM. ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.
- Full descriptive leaflet supplied on receipt of S.A.E.



HI-FI 10 WATT AMPLIFIERS 6 GNS.

BRAND NEW BUT IN SLIGHTLY SOILED CONDITION

A REMARKABLE OPPORTUNITY Carr. 7/6
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 8 ohm or 15 ohm loudspeaker. Guaranteed, tested and in perfect working order. Please state speaker matching required when ordering.

VALVES! Full range at really competitive prices. All guaranteed!

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (especially suitable for use with any of our Amplifiers). A 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. input depending on Ae location. Only 250 v. 15 mA. H.T. and L.T. of 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 is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

RE-ENTRANT LOUDSPEAKERS

For factory or outdoor use.

Tannoy 7.5 ohms 8 watts 25/9.

Parneko horn type, highly efficient. Handles up to 10 watts. 15 ohm and 200 ohm matching 59/6.

R.C.A. 20 watt rating, 3 ohm, 15 ohm, 200 ohm and 600 ohm matching 6 gns.

ACOS HI-FI CRYSTAL 'MIKES'

Mic 40 hand or Desk type

27/9 (Listed) (45/-)

39-1 Stick type **39/6** (Listed) (5 Gns.)

Limited number.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5 1/4 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 1/2 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 H.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 59/6.



BUILD A PORTABLE BATTERY OPERATED RECORD PLAYER FOR ONLY £5/19/6. Portable Cabinet, Garrard 45 r.p.m. motor and pick-up unit, all parts for transistor amplifier, and circuit diagrams. Parts sold separately.

THE SKY FOUR 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. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, 6F6 and is especially 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 cabinet. Available in brown or cream bakelite or veneered walnut.

EXTENSION SPEAKERS. Handsome walnut veneered cabinets. All standard 2-3 ohms. 6 1/2 in. 29/9; 8 in 35/9.

R.S.C. A12 STEREO AMPLIFIER KIT

4 GNS.

A complete kit of parts to construct a good quality 3+3 watt (total 6 watt) stereo amplifier providing stereo Carr. and packing 7/6. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Prest. balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value. Supplied assembled ready for use at £5/19/6.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves E281, EC083, EC083, EL94, EL84. Separate Bass 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 ohm speakers. Point-to-Point wiring diagrams and instructions. Carr. 7/9.

8 Gns.

SELENIUM RECTIFIERS

We can quote special prices for quantities of 12 to 10,000 of most types. Special types made to order.

L.T. Types	H.T. Types H.W.	
2/6 v. 1 a. h.w.	120 v. 40 mA.	3/9
6/12 v. 1 a. h.w.	250 v. 50 mA.	3/11
Following F.W. (Bridge)	250 v. 60 mA.	4/11
6/12 v. 1 a.	250 v. 80 mA.	6/11
6/12 v. 2 a.	250 v. 250 mA.	12/9
6/12 v. 3 a.		9/9
6/12 v. 4 a.		12/3
6/12 v. 5 a.		14/6
6/12 v. 6 a.		15/6
6/12 v. 10 a.		25/9
6/12 v. 15 a.		35/9

Contact Cooled
250 v. 80 mA. 6/11
250 v. 75 mA. 10/11
F.W. (Bridge)

JUNCTION TRANSISTORS. R.F. Type 11/6. Audio type 5/9. Power type Goltop V15/10P 9 watts, 17/9. OCT1 10/-, OCT2 16/9. XB102 10/-, XB104 10/-, XA101, XCI01 17/6, XA102, XA103, XA104 12/9 and many other types.

RECORDING HEADS. Baird Record Playback and Erase (housed in one container) 9/6 pair.

Battery Chargers and Kits for 200-230-250 v. 50 c/s. A.C. Mains

COLLARO STUDIO TAPE TRANSCRIPTORS

Incorporating 3 motors. Provision for extra head for stereo. Speeds 1 1/2, 3 1/2, 7 1/2 per sec. 31 Gns.

HEAVY DUTY CHARGER KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0.7 amp. meter, multi-position switch with knob, fuses, fuse-holders, panels, plugs, and circuit. Only 59/6. Post 4/6.

ASSEMBLED CHARGERS

6 v. 1 a.	19/9
6 v. 2 a.	29/9
6/12 v. 1 a.	29/9
6/12 v. 2 a.	38/9

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. & pkg. 3/6.

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.	
0-9-15 v. 1 1/2 a.	12/9
0-9-15 v. 2 1/2 a.	15/9
0-9-15 v. 3 a.	16/9
0-9-15 v. 5 a.	19/9
0-9-15 v. 6 a.	23/9

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.

6 v. or 12 v. 1 amp.	24/9
As above, with ammeter	32/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 2 amps.	42/9
(inclusive of ammeter)	
6 v. or 12 v. 4 amps.	53/9
6 v. or 12 v. 4 amps. with variable charge rate selector and ammeter	59/9

CHARGER AMMETERS

0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp.	8/9
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D.C. SUPPLY KITS. Suitable for electric trains. Consist of mains trans. 200-250 v. 50 c.p.s.; 12 v. 1 amp. selenium rect. (F.W. Bridge); 2 fuseholders 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, 33/9.

REPANCO TWINETTE TRANSISTOR PORTABLE RADIO DESIGN. Constructional Envelope and parts list 1/3. Built-in Ferrite Aerial, 7in. x 4in. speaker, Long and Medium waves. Size approx. 7 x 4 x 3in. Total cost of all parts 5 GNS.

REPANCO 3 DEE 3 TRANSISTOR RADIO. Constructional envelope 1/3. Total cost of all parts 23/6/6.
REPANCO ANISEVEN 7 TRANSISTOR POCKET PORTABLE. Constructional data 1/3. All component parts 29/19/6.

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. 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. Only Carr. 3/9. **49/9**
As above, but for 3 amp. charging. Only 59/6. Carr. 3/9

ASSEMBLED 6 v. or 12 v. 4 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. Carr. 5/- Or Deposit 13/3 and 5 monthly payments of 13/3. As above, but for 6 amp. charging 4 GNS. Carr. 5/- Or Deposit 16/- and 5 monthly payments of 16/-. The 6 amp. model only is slightly store soiled and is being offered at well below usual price.

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 2/3 ohm speaker. Three miniature Mullard valves. Size only 6 x 5 x 3 1/2 in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5.19.6** Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.

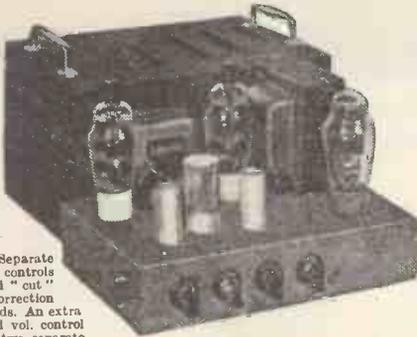
POWER PAOK KITS. Only 18/11. Fully smoothed H.T. output of 250 v. 60 mA. and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing Choke. Double Electrolytic Condenser. Aluminium Chassis and Circuit.

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TWETERS, 4in. Plessey, 3 ohms, 18/9. R.A. 15 ohms 25/9.

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC88, 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 BEST ABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "Hi" and "cut" with ample tone correction for long playing records. An extra input with associated 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. 80 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams.



ONLY 11 Gns. Or Factory built with 12 months' guarantee £13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 12 monthly payments of 24/9.

As illustrated Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 80 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-200,000 c/s Tone Controls ± 12 D.B. at 50 c/s. ± 12 D.B. to -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 12x9x9in. approx. Power consumption 350 watts. For A.C. mains 200-250v. 50 c/s. Outputs for 3 and 15 ohm 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.

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R.S.C. A7 3-4 WATT QUALITY AMPLIFIER. Spec. exactly as A5 below with exception of output voltage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 3/6

R.S.O. A5 4-5 WATT HIGH GAIN AMPLIFIER

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250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9	66:1 for 3S4, etc.	3/9
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ELIMINATOR TRANSFORMERS.		Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15 Ω	47/9
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90 v. 15 mA., 6-0-6 v. 250 mA.	9/11	120:1 High quality, clamped	6/9
FILAMENT TRANSFORMERS		120:1 High quality Mu metal screened	8/9
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6.3 v. 2 a.	7/9	250 mA., 5 H., 100 Ω 11/9	80 mA., 10 H., 350 Ω 5/6
0-4-6.3 v. 2 a.	7/6	150 mA., 7-10 H., 250 Ω 11/9	60 mA., 10 H., 400 Ω 4/11
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AUTO (Step Up/Step Down) TRANSFORMERS		PARMECO MAINS TRANSFORMERS. Fully shrouded.	
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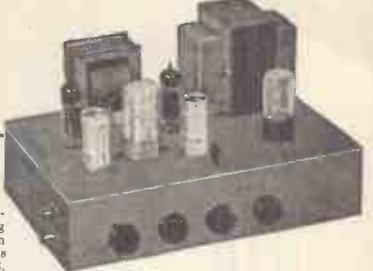
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HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram, as in A10 High sensitivity. Includes 5 valves: ECC83, ECC83, EL84, EL84, 5Y3. 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 ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. ONLY 25 millivolts 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. 12.9-7in. For A.C. mains 200-250 v. 60 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last out. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra.) **ONLY 8 Gns.** If required louvered metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 18/9 and 12 monthly payments of 18/9.** Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones, etc., with cash and credit terms.

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JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Flux 8in. 1/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly inside cabinet (size approx. 14 x 14 x 7in.) Finished in eggshell polychrome and fitted carrying handle. **£8/19/6** Carr. 7/6. Or Deposit £1 and nine monthly payments £1. Send S.A.E. for leaflet.

SENIOR 10 WATTS. High-Fidelity Push-Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated, a 12in. P.M. for Bass notes and 1 7 x 4in. elliptical for Treble. Cabinet and finish as Junior model. Size plus 10/- carr. H.P. TERMS. DEPOSIT 26/9 and 12 monthly payments 26/9. Both models for 200-250 v. A.C. mains.

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8.9 to 300 megacycles. Output 1 micro-volt to 10 millivolts. Five position switched attenuator. Variable multiplier 1 to 10, calibrated 0-20 db. C.W. square wave and sine wave outputs. Vernier tuned, 6 Band Coil Turret, Potted "C" core Transformers. Stabilised H.T. All voltage supplies including mains, B.F. filtered. External mod. by sine wave from 50 c.p.s. to 10 kc/s. or pulses down to 1/4 sec. Complete with all valves and charts.

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500 Micro-amp. Scaled in Decibels. Diameter 3 1/2 in. Flush mounting. 50/6. 250-0-250 Micro-amp. Diameter 2 1/2 in. 14/9. 0-50 micro-amp. Diameter 2 1/2 in. approx. Scaled 0-100. Flush mounting. 39/6.

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Incorporating the B.S.R. Monardeck Tape Deck (as used by most leading Tape Recorder manufacturers). A high quality T/R Amplifier providing 3 watts output, 7in. x 4in. R.A. loud speaker, Portable Cabinet finished in veneered walnut. Reel of Best Quality Tape, and spare 5in. spool. Amplifier is ready wired and therefore complete unit. CAN BE ASSEMBLED IN 1 HOUR. Inputs for "mike" and, Radio, or Gram. Visual Recording level indicator, variable Tone control. Attractive Perspex. Facia Plate. Carr. 12/6 GNS. TERMS: Deposit 23/15/- and 12 monthly pmts. of 23/3. PRICE 159/6. CASH SETTLED IN 3 MONTHS

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"ZENITH" SEMI-FIXED WIRE-ROUND RESISTANCE, 25 ohms., 4 amps. Length 10 1/2 in., diam. 2 1/2 in.—new 15/- each.

SANGAMO MOTOR UNITS, Model 7. Final speed one rev. per seven days—200/250 V.A.C., 50 cycles—new 30/-. T.M.C. MINIATURE CARPENTER HIGH-SPEED POLARISED RELAYS, Type 5c/9-1685+1685 ohm coil. Overall size in screening can 3 1/2 in. x 1 1/2 in. x 1 1/2 in. Unused, but dismantled from apparatus. 27/6 each.

EX-AIR MINISTRY 12-VOLT D.C. DOUBLE-POLE MAKE 3-AMP CONTACT RELAYS. Ref. 5CW/4120, fitted with cover an terminal block, overall size of relay 2 1/2 in. x 1 1/2 in. approx.—new 7/6 each.

SOLENOID OPERATED MAGNETIC RELAYS, type "S", ref. 5CW/4944, with 4 make contacts, 3-amp. contacts D.C., coil resistance 160 ohms, 24 volts operation, housed in metal screening can 2 1/2 in. x 1 1/2 in., made by Pullin Ltd., Hendry Relays Ltd., etc.—new 7/6 each.

CONTACTING FLOAT SWITCHES, ref. 5CW/4642, comprising float in wire mesh container, 3in. diam., 4 1/2 in. long, operating make or break seal, contact, ideal for all types of non-corrosive liquids. 15/- each.

"PARMEKO" L.T. TRANSFORMER. Primary 110/117 volts A.C., 50/60 cycles. Secondaries 12 volts, 6 amps. C.T. 6.3 volts 1 amp. 6.3 volts 6 amps. In makers' packing—unused. 35/- each.

HORSTMAN GEAR CO. 9-DAY NINE-JEWELLED LEVER MASTER CLOCKWORK MOVEMENTS. Admiralty pattern A.3235, final speed 1 rev. in 3 mins., with contacting point once per minute, in metal case 3 1/2 in. diam., 2 1/2 in. deep, stop and start device, with winding key—unused—ex-equipment. 65/- each.

HEAVY-DUTY CANTILEVER SOLENOIDS, 24 volts D.C., Ref. 8A/2128, diameter of coil unit 2 1/2 in., height 3in., weight 4lbs.—store sold. 22/6 each.

SOLENOID OPERATED OIL DILUTION VALVES, ref. 5U/3013, 24 volts, with terminal block, suitable for air, oil, water, etc., maximum air pressure 40lbs. p.s.i., overall size 3 1/2 in. long, 1 1/2 in. diam., approx. 7/6.

"VENNER" CLOCKWORK RELAY TIME SWITCHES, variable 10 to 30 secs., fitted 250-volt A.C. 5-amp. and 24-volt D.C. 5-amp. contacts, make or break, panel mounting, size 2in. diam., 2 1/2 in. long. 14/- each.

"BERCO" SLIDING RHEOSTATS, twin former 26 ohm, 6 1/2 amps., length 14in., width 7in., ideal for stage dimming, charging etc.—new 48/6 each.

G.E.C. L.T. RECTIFIER UNITS. Input 200/240 volts A.C. 50 C.P.S. Output 24 volts D.C. 13 amps. Continuous rating. Built in perforated metal case. Size 20in. x 15 1/2 in. x 10in. In original packing, very useful supply indicator for laboratory and test gear—condition new, 212/10/0.

Precision made PERMANENT MAGNET 200/240 volt D.C. Motors, geared output 500 r.p.m., approx. Overall size 3in. x 1 1/2 in. x 1 1/2 in. Weight 6 1/2 lbs.—ex-equipment. 20/- each.

"BRAY" 240-VOLT A.C. MAINS CONTACTORS, 20-amp. A.C. 5-pole contacts, fitted on bakelite-panel with terminal connectors, size 9in. x 4 1/2 in.—unused. 32/6.

"PARMEKO" SEACORE PATT. STEP-DOWN TRANSFORMERS. Prim. 230 V.A.C. 50 c.p.s. sec. 24 volt 2 amps. Fitted fuses, Neon indicator etc. 40/-.

"ROTAX" LINEAR ACTUATORS, 24 volts D.C. Travel 3in. 60 secs. Load 30 lbs. max. Overall length 12ins., diam. 2 1/2 in. 65/-.

"GASCOIGNE" ELECTRONIC CONTROLLERS, Input 200/240 V.A.C. 50 c.p.s. Output 12 volts D.C. 8 amps., fitted Relay panel incorporating Electronic Time Delay Timer, lead valve. Fitted in Metal Case 12 x 12 x 6ins. Ideal for I.T. Charging. Bench work etc. 85/-.

"TEDDINGTON" AIR THERMOSTATS, MODEL IT. 4 1/2 in. Stem. Range 25/105°C. Contacts 5/10 amp. A.C. 35/-.

"GRESHAM" 75 WATT. AUTO TRANSFORMERS. Prim. 220/240 volts sec. 110 volts 20/-.

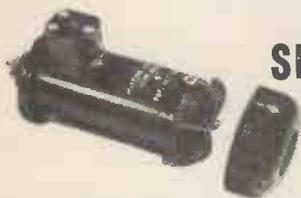
12 VOLT D.C. MINIATURE GOVERNOR CONTROLLED GEARED MOTORS. Final output speed 1 r.p.m. approx. Fitted Electro-Magnetic Clutch. 35/-.

"ASPEC" (LONDON) LTD. 12-VOLT D.C. ELECTRICALLY ACTUATED VARIABLE TIME CONTROL UNIT. 4 hours on, 3 hours off, 24 volts, 6 amp. contacts, fitted in brass case, 3 1/2 in. diam., 3 in. deep. Unused. 50/- each.

PROOPS Walk-around Store

and MAIL ORDER SERVICE

52 Tottenham Court Rd., London, W.1 • Open 9-6, including Sats., Thurs. 9-1 • LANgham 0141



SMALL HIGH-SPEED MOTORS

Robust, high-quality, fan-cooled motor built to aircraft standards by English Electric.

Continuously rated for 11,000 r.p.m. from 115 volt 3 phase 400 cycle supply. Only 4½ × 2 inches dia. with ¾ in. dia. fibre gear pinned to 3/16in. dia. shaft which protrudes ½ in. from end face. Substantial terminal block.

Brand New **30/-** each, post paid.



LOW INERTIA MOTORS

Precision servo system tool comprising Electro Methods high efficiency 24 volt D.C. motor unit mounted to robust aluminium face plate. Lightweight fibre and brass reduction gear to double ball bearing spindle terminating in miniature bevel gear.

Adjustment for varying speed. Jewelled bearings. Gold brushes. Brand New, post paid.

£4.10

POST FREE SNIPS

Double pole knife changeover switch on porcelain base. 2 for 5/-. G.P.O. 230 volt mains, twin six inch gong, outdoor bells. 33/6. Siemens high-speed relays. 1,000-0-1,000 ohm coils. 8/6. Pyrex Aerial Insulators. Four 3in. OR two 8in. 7/6. U.S.A./British co-ax. adaptors. Four for. 5/- T.C.C. oil filled 4mF condensers. 2,500 volt working 15/6. Neons. Ten 115 volt for 12/6; Six 80 volt for. 7/6 G.P.O. mechanical counters. 0-9999. 7/6

PORTABLE POWER

Neat, lightweight but really sturdy petrol engine. Completely self contained, air-cooled pedestal-based unit with 5in. dia. × ½ in. Vee pulley for driving generator, pump, etc. Made by Lauson Engines in the U.S.A. for easy transport in a special lightweight container. Developing 1.8 h.p. at 2,700 r.p.m., this very fine unit is only 17in. high × 14in. × 12in. and can be carried in one hand. It has stellite valves to suit any petrol, a totally enclosed carburettor with air filter and a mechanical fuel pump with glass bowl filter. Flywheel cord start. Push-button stop. Adjustable throttle. Butterfly choke, etc. Standard 14 mm. spark plug with screened H.T. harness. Crankcase oil bath. Supplied complete with 3ft. flexible exhaust pipe and detachable 9 × ¾ in. dia. silencer, driving belt and 10ft. of high-grade flexible fuel hose. A genuine quality engine offered at the remarkable price of



only **£17.10.0** carriage paid (inland only).

200 AMP D.C. GENERATORS

These relatively small but really heavy duty generators were designed for a continuous output of 200 amps at 29 volts and are very successfully employed as a portable welding plant when driven from a tractor take-off pulley or separate engine as required. Guaranteed fully serviceable.

Only **£6** carriage paid.

CLASS D WAVEMETERS

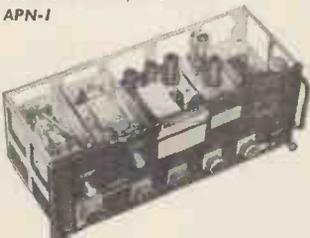
Popular, neat, heterodyne wavemeter with 1 Mc/s and 100 kc/s. reference crystals for zero setting directly calibrated illuminated dial covering two switched basic ranges of 1,900-4,000 kc/s. and 4-8 Mc/s. with appropriate harmonics and 100 kc/s. and 1 M/c.s. reference points. Press-button shifts frequency a few cycles for positive identification of signal heard. Phone monitoring through output transformer

and aerial output terminal for receiver alignment. Vibrator, power supply through selenium bridge rectifier from 6 v. supply. In good condition, straight from Service use and complete with twin crystal. Guaranteed serviceable. Operating instructions, circuit and component **£5** carriage paid. values supplied.



This is the attractive lightweight American Radio Altimeter that superseded the British version. A complete 14-valve radar set covering 420-460 Mc/s it is ideal for conversion to radio control of models or 70 cm. work. It embodies three self-contained sub-units in separate detachable aluminium cases, as follows:

TRANSMITTER/RECEIVER APN-1



TRANSMITTER

A push-pull feed-back oscillator tuneable either side of 445 Mc/s., frequency modulated at 100 c/s by a particularly robust moving coil transducer. Two 955 high frequency acorn valves. Case size only 3½ × 6½ × 2in. plus 2 × 2½ in. dia. for transducer.

RECEIVER

Tuneable to transmitter frequency. Size 3½ × 6½ × 2in. Two 9004 acorn valves.

AUDIO AMPLIFIER

Self-contained RC coupled 12SH7, 12SH7 and 12SJ7. Size 3 × 5 × 1½ in. Amplifies the received signal which is passed to detector circuit giving a D.C. voltage proportional to the difference between the transmitted and received (reflected) signal to operate internal relays which pass appropriate correction signals to autopilot and supply external indicator (5 mA meter).

MAIN CHASSIS

The main chassis carries the 3 sub-units and has a further three 12SH7 one 12SJ7, two 12H6 and one VR150 regulator, three 1% wire-wound resistors, one 4-pole changeover relay, two SPCO relays, three twin-ganged pre-set potentiometers, trimmers, fuses, etc. Power supply is derived from a 27-volt dynamotor (charging rate for 24 v. supply) delivering 285 volts at 75 mA.

BRAND NEW, a very useful buy indeed at only **£2** plus 7/6 carriage.

DEAF AID AMPLIFIERS

Special offer of the last few which are minus earpiece. Three modern low-consumption miniature valves in a very sensitive hi-fidelity circuit fed direct from the built-in crystal microphone. Brand new in original pack. Ideal for experimentation as pre-amplifier, audio signal tracer, etc., at the reduced price of 17/6, post paid.

SPECIAL VALVE OFFERS

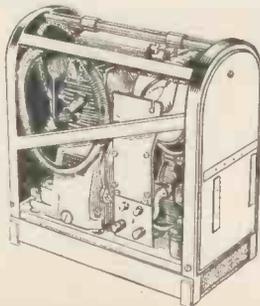
Five 25SN7's for £1.
Four 6AM6's for 10/-.

Four 1L4's for 5/-.
New, by return of post.

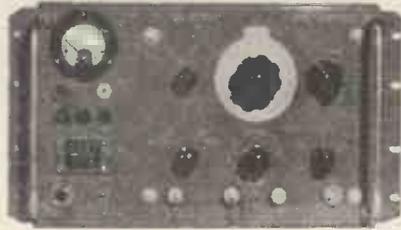
PORTABLE AC/DC GENERATING SET

Self-contained 80 watt unit on compact chassis delivering 12 to 18 volts D.C. Size only 14 × 15 × 8in. Weight 46 lb. Spring mounted air cooled petrol engine with fuel tank in base driving integral generator that has heavy duty bridge rectifier feeding D.C. terminal board. Miniature sparking plug. Filtered air intake.

Guaranteed serviceable. **£9** plus 10/- carriage.



PRECISION SIGNAL GENERATOR CT53. A modern laboratory standard instrument still in current use



A few with superficial damage offered unguaranteed and less cables, etc. for £12.10.0 plus 15/- carriage.

FEATURES

- Vernier tuned, Triple screened, 6-Band-coil turret covering 8.9 to 300 Mc/s with 72 ohm output from 100 mV down to 1µV.
 - Precision decade ladder and silver slide wire attenuator calibrated in voltage and 0-90db.
 - Variable carrier level monitored by cathode follower and VTVM.
 - CW or modulated 30% by 1,000 c/s Sine or Square wave (variable mark/space ratio).
 - External mod. by sine wave from 50 c/s. to 10 kc/s. or pulses down to ¼µ Sec.
 - Seven B7G Valves, Potted "C" core transformers, Paper capacitors, Stabilised HT.
 - Selected spare oscillator, pre-aged spare monitor, 100µA meter.
 - Mains, HT, Bias and Filament supplies fully RF filtered.
 - Combined cabinet/rack mounting case, Pressure sealed, Desiccator, Panel Mains voltage adjustment, Triple fused, in fact, "the lot"
- Offered straight from Service use, complete with calibration book, cables, circuit diagram and principal technical information, checked serviceable and fully guaranteed
- £17.10.0**
- Plus 15/- for careful packing and carriage.

I-30-A SIGNAL GENERATOR 100-156 Mc/s

Modern, portable, battery operated, 5 valve Signal Generator with alternative crystal or master oscillator, either optionally modulated by 1,000 c/s Hartley oscillator. Large directly calibrated dial with precision slow motion drive. Five step and variable attenuator. Supplied with matching black crackle carrying case for 6 and 135 volt batteries with 10ft. supply cable, and metal cased 1 mA. test meter for checking crystal resonance, etc. Brand new. £2/17/6 plus 7/6 packing and carriage.

I-95-A FIELD STRENGTH METER 100-156 Mc/s

Self-contained, tunable-input, valve-voltmeter with telescopic aerial and battery-fed diode rectifier and pentode amplifier for measuring field strength, presence of modulation, and approximate frequency of transmitter. Compensating circuit for state of 1¼ and 45 volt batteries. In attractive black crackle case. Brand new.

£2/15/- plus 5/- packing and carriage.

ROTARY RELAY.

Superb, fast acting, brand new precision unit made by Price for RCA. Nominally 12 volt, but mightily lively on 6-volt supply. Two heavy duty single pole changeover contacts and one low current for external circuits, plus one break set that extends coil winding to reduce initial energising current to 50 mA. (at 6 v.) for holding. Solid milled armature, laminated steel frame, 2¼ x 2½in. ½in. thick, moulded insert dielectric block. A highly recommended spares box buy at 7/6 each, post free.

AMERICAN 400 CYCLES INVERTER.

30/- post paid.



Very neat unit indeed, only 2½ dia. by 4in. long on 1½in. high pedestal base containing suppressor. Ball bearings. 24 volt D.C., input for 26 volt single phase output. Instrument quality—as used with Bendix Magnesynt compass system.

VARIABLE SPEED HYDRAULIC GEARBOX

This specially made oil-filled casing houses a hydraulic torque conversion unit originally precision made by Westinghouse from high quality materials for the U.S. Government at an acquisition cost exceeding £150 each. Highly suitable for lathe head drive, workshop variable speed power take-off, etc. Basically the unit is a back-to-back mounted, oil submerged, variable displacement hydraulic pump (input shaft) feeding a reversible hydraulic motor (output shaft) so that variation of the pump displacement by manual control gives very fine selection of output speed from zero up to 6% below input speed while a changeover valve in the supply lines to the motor provides instantaneous reverse at any speed. Recommended input speed 500-1,000 r.p.m., maximum power 1½ h.p. Both shafts ½in. dia. with Woodruff key. Tested and fully guaranteed, supplied complete with technical data and performance curves for the remarkable price of £16 only, carriage paid.

D.C. LINEAR ACTUATOR

Precision heavy-duty 24-volt linear actuator by Airesearch of Arizona. Rated loads over 5½in. piston rod travel, Static 2,800 lb. Tension 1,750 lb. Compression 850 lb. Size 13½in. x 4in. dia. Incorporates adjustable limit switches and thermal load protection.



Brand New £4.10.0 carriage paid.

£10 GEIGER-COUNTER

Circuit embodies U.K.A.E.A. patent. Specially moulded case. Currently being supplied throughout the world. Three ranges—highly sensitive—light—portable—visual and audible response—plus output socket. Ideal for introduction to radiation measurement and nucleonic circuitry. Specially written 40-page instruction manual supplied. Batteries £2/15/3 extra.

KIT OF PARTS £4/17/6

Identical parts. Guaranteed performance. Manual and printed circuit plates for battery pack supplied (assembled pack £2/15/3 extra). Fully illustrated assembly instructions. Spares and service permanently available.



NOMOTRON DECADE COUNTER TUBES

STC Type G10/241 latest type cold cathode, gas-filled, single pulse, uni-directional decade counter which illuminates numerals on tube face. Operating range -20 kc/s. Cathode output 40 volts, 3.7 mA. HT supply 310 v. plus. Applications include: tachometers, counting and batching, frequency and time measurement, direct operation of electro-magnetic relays, sequential monitoring of up to 10 different waveforms, etc. Brand New, complete with special base and instructions. 32/6 post paid.

BC.929 SCOPE UNIT

Neat, modern indicator unit especially suitable for quick conversion to attractive general servicing scope. (Suitable circuit diagram and all component values supplied.) Contains fully metal screened 3BP1 tube, intensity and focus controls, 3-position rotary switch and 8 pre-set, potentiometers, plus 2 x 6SH7, 2 x 6H6, 6G6, 6X5 and 2X2 valves. Designed for 24 v. D.C. or 400 c/s A.C. input. Size 14 x 8½in. square. Well known and deservedly popular buy. Offered new, less (unwanted) motor driven aerial switching unit, for post paid. 50/-



EVERETT EDGUMBE SYNCLOCKS

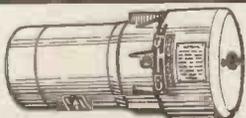
Grade 1 industrial process timer with 3 inch dial covering ¼ to 10 minutes in one tenth divisions. Driven by a 16 volt 50 c/s synchronous clock. A metal rectifier provides D.C. to pull in a relay that engages the drive until the time set on the dial elapses. As it reaches zero heavy duty contacts snap shut to close the external circuit (at the same time other contacts break to arrest the clock). Switching off the power trips the relay and the spring loaded dial returns to the time set ready for the next cycle. Whole totally enclosed in a heavy cast wall mounting case, stove enamelled black, size 6½ x 7 x 4 inches. Brand new in original packings 55/- post paid.

VENNER TIME SWITCHES

Type T.S.2, first grade precision time switches as supplied to G.P.O. Comprises absolutely silent self starting 250 volt 50 c/s synchronous clock, mechanism totally enclosed in heavy gauge brass case. Central drive takes detachable dial that revolves to operate sensitive on and off trips for external mains operated circuit. Self contained clock is easily detachable from rear mounting panel (self starting down to 80 v. and keeps running down to 15 v.). Brand new, in original packings, and with dial and adjustable stops, 37/6 post paid.

AMERICAN COWL GILL MOTORS

Smaller and neater than British counterpart. Split-field, reversible, 12-24 volts. £2 carr. paid.



PROOPS

BROTHERS LTD., 52 Tottenham Court Road, London, W.1.
 Head Office and mail order enquiries LAngham 0141
 Shop hours 9 a.m. to 6 p.m. Thurs. 9 a.m. to 1 p.m. OPEN ALL DAY SATURDAY

Each Model incorporates the highly successful HF/TR3 Amplifier (described opposite), thus ensuring truly "Hi-Fi" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1-200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them send S.A.E. for fully descriptive leaflets.



Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

- MODEL CR2/S. Incorporates the new COLLARO "STUDIO" TWIN TRACK 3-speed Deck..... **£39.10.0**
- H.P. Terms: Deposit **£7/18/-** and 12 months of **£2/17/11.**
- MODEL CR3/T. Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIPTOR" Deck which has both upper and lower tape tracks..... **£47.10.0**
- H.P. Terms: Deposit **£9/10/-** and 12 months of **£3/9/8.**
- MODEL TB3 Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck..... **£49.10.0**
- H.P. Terms: Deposit **£8/18/-** and 12 months of **£3/12/7.**

TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

MODEL HF/G2A-D

A complete self-contained Tape Recorder chassis incorporating Loudspeaker and comprising the Model HF/G2A Amplifier connected to the Garrard Tape Deck. Operates at 3 1/2 in./sec. speed and supplied fully tested and ready for immediate operation designed for easy fitting into a portable case or cabinet, only four fixing screws being required.



Price **£25.0.0**
Complete working unit containing 4in. spool of Long Playing Tape.

H.P. TERMS: Deposit **£5** and 12 monthly payments of **£1/16/8.**

Alternatively we offer—Complete Kit of Parts to build the HF/G2A Amplifier with the ASSEMBLED AND TESTED GARRARD TAPE DECK for H.P. Deposit: **£4/8/-** and 12 months of **£1/12/3**

The Amplifier, Model HF/G2A is available separately for:

- (a) Complete kit of parts **£11.0.0**
- (b) Assembled **£12.15.0**

MODEL HF/G2P-D

THE IDEAL "LINK" TO ADD FULL TAPE RECORDING FACILITIES TO HIGH QUALITY HOME INSTALLATIONS, RADIOGRAMS, etc. Comprises the HF/G2P Tape Pre-amplifier fitted to the Garrard Tape Deck, operates at 3 1/2 in./sec. speed, connects into the tape input or pick-up sockets of existing amplifier or Radio Chassis.



COMPLETE WORKING UNIT, containing 4in. spool of Long Play Tape. Price **£23.15.0**
Hire Purchase Terms: Deposit **£4/15/-** and 12 monthly payments of **£1/14/10.**

Alternatively we offer—Complete Kit of Parts to build the HF/G2P Pre-amplifier with the TESTED GARRARD DECK for Deposit, **£4/3/-** and 12 months at **£1/10/5**

The Pre-amplifier Model HF/G2P is available separately for:

- (a) Complete kit of parts **£9.10.0**
- (b) Assembled **£11.5.0**

MODEL HF/G2E Contains the Model HF/G2A-D UNIT (described opposite). A small robust recorder with outstanding performance. Truly portable, weighs only 22lbs. Twin Track operates on 3 1/2 in./sec. speed. Price **£29.15.0**
H.P. Terms. Deposit **£6** and 12 months at **£2/3/7.**

MULLARD TYPE "C" TAPE-PREAMPLIFIER ERASE UNIT

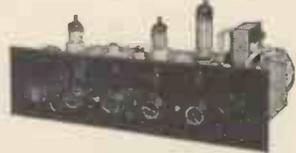
The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FERROXUCUBE POT CORE PUSH-FULL OSCILLATOR and 3-speed treble equalisation by FERROXUCUBE POT CORE INDUCTOR. FOR WEARITE — COLLARO — TRUVOX — BRENNELL or MOTEK TAPE DECKS. Includes separate Power Supply Unit. Price **£14.0.0** or ASSEMBLED..... **£17.0.0**



KIT OF PARTS **£14.0.0** or ASSEMBLED..... **£17.0.0**
(Excluding Power Unit **£11/15/-** and **£14/10/-** respectively).

MODEL HF/TR3 TAPE AMPLIFIER

(Mullard Type "A" design) A very high quality Amplifier incorporating 3-speed treble equalisation, using the latest FERROXUCUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENNELL WEARITE or MOTEK Tape Decks, has GILSEN Output Transformer. Includes separate Power Supply Unit.



KIT OF PARTS **£12.15.0** or ASSEMBLED..... **£16.10.0**
H.P. **£3/6/6** Deposit and 12 months at **£1/4/2**

FOR THE HOME CONSTRUCTOR SPECIAL "COMBINED ORDER" PRICES

- (a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit assembled and tested **£29.10.0**
- H.P. Terms: Deposit **£5/18/-** and 12 months at **£2/3/3.**
- (b) As above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts **£26.10.0**
- (c) The COLLARO Mk. IV TAPE DECK and the MULLARD Type "C" PRE-AMPLIFIER and Power Unit assembled and tested..... **£35.0.0**
- H.P. Deposit **£7** and 12 months **£2/11/4.**
- (d) As above but the Type "C" supplied as complete Kit of Parts **£32.0.0**
- (e) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" PRE-AMPLIFIER and Power Unit..... **£40.0.0**
- H.P. Deposit **£8** and 12 months **£2/18/8.**
- (f) As above but the Type "C" supplied as complete Kit of Parts **£36.10.0**
- (g) The BRENNELL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and Power Unit **£46.0.0**
- H.P. Deposit **£9/4/-** and 12 months at **£3/7/6.**
- (h) As above, but the Type "C" supplied as complete Kit of Parts **£43.0.0**
- (i) The WEARITE 4A DECK with Type "C" assembled and tested **£56.0.0**
- H.P. Deposit **£11/4/-** and 12 months **£4/2/1.**
(Carriage and Insurance on above quotes 10/- extra)
- (a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK... **£25.10.0**
- (b) As above but HF/TR3 ASSEMBLED and TESTED **£29.0.0**
- H.P. TERMS: Deposit **£5/16/0**, 12 months of **£2/2/6.**
- (c) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIPTOR" DECK (£1 extra if we are required to wire up Deck Banks) **£30.15.0**
- (d) As above but HF/TR3 ASSEMBLED and TESTED..... **£34.10.0**
- H.P. Terms: Deposit **£7**, 12 months at **£2/10/5.** (£1 extra if we are to wire up Deck Switch Banks)
- (e) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK..... **£36.0.0**
- (f) As above but HF/TR3 ASSEMBLED and TESTED..... **£39.10.0**
- H.P. Terms: Deposit **£7/18/-**, 12 months of **£2/17/11.**
- (g) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENNELL Mk. V TAPE DECK **£41.10.0**
- (h) As above but HF/TR3 ASSEMBLED and TESTED..... **£45.0.0**
- H.P. Terms: Deposit **£9**, 12 months of **£3/6/-.**
- (i) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc..... **£55.0.0**
- H.P. TERMS: Deposit **£11**, 12 months of **£4/0/8.** (Carriage and Insurance on each above is 10/- extra)

Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/ CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE —and 1,200ft. SPOOL E.M.I. TAPE—ALL FOR..... **£9.10.0**
(Carriage and Insurance 5/- extra)

STERN RADIO LTD. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E. AND STATE WHICH LEAFLET IS REQUIRED.

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification
MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS and NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko Output Trans.)..... **£10.00**
Alternatively we supply ASSEMBLED AND TESTED **£11.10.0**

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra

MULLARD'S 2-VALVE

PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EP86 valves and designed to operate with the Mullard MAIN AMPLIFIER, but also perfectly suitable for other makes.

Supplied strictly to MULLARD SPECIFICATION and incorporating:

- Equalisation for the latest R.I.A.A. characteristics.
- 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.

Price: COMPLETE KIT OF PARTS **£6.60** ASSEMBLED AND TESTED **£8.0.0**



COMPLETE MULLARD 5-10 AMPLIFIER

The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction.

Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformers.

Price: COMPLETE KIT, Parmeko Transformer..... **£11.10.0**
Alternatively we supply ASSEMBLED AND TESTED **£13.10.0**

Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 19/10.

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.



COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS..... **£7.10.0**

(Plus 6/6 carriage and insurance).

Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance)..... **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

STEREO "3-3" MAIN AMPLIFIER

Comprises two MULLARD 3-3 Main Amplifiers on one chassis. Operates with MULLARD STEREO PRE-AMPLIFIER. Output power 6 watts. Inputs for Crystal Pick-up and Radio Tuner.

KIT OF PARTS..... **£10.0.0** or ASSEMBLED..... **£11.15.0**

Mk. II "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

FOR THE CONSTRUCTOR..... **£10.10.0** or ASSEMBLED..... **£14.5.0**

SPECIAL CASH ONLY OFFER !!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER, ALL FOR ONLY **£8.7.6**

(plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey Colour Resin—WE ALSO SUPPLY SEPARATELY:—

- (a) The 2-stage (plus Rectifier) AMPLIFIER **£4 2 6**
- (b) The PORTABLE CARRYING CASE **£3 17 6** (Carriage and Insurance 4/- extra)
- (c) 6" H.P.M. SPEAKER..... **18 9**



"HI-FI" LOUDSPEAKERS

WE HAVE IN STOCK A COMPLETE RANGE BY

GOODMANS—WHARFEDALE—W.B.

ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

THE "ADD-A-DECK"

incorporating the NEW B.S.R.

"MONARDECK" & MATCHED PRE-AMPLIFIER

Thus providing full tape Recording facilities.

Carriage and Insurance 10/-.

Deposit **£3/12/-** 12 mths. **£17.17.0**

Designed to operate through the Pick-up Sockets of the standard RADIO RECEIVER or Small Amplifier which first-class results are obtained. It consists of a Twin Track Tape Deck, incorporating matched Pre-amplifier, and operates at 3 1/2 in./sec. speed. Supplied fully tested and only requires connections to the mains supply and the Pick-up Sockets, for which purposes "floating" leads are incorporated.



H.P. TERMS ARE AVAILABLE ON ALL EQUIPMENT OVER £9. FULLY DESCRIPTIVE LEAFLETS ARE AVAILABLE FOR ALL EQUIPMENT, BUT PLEASE SEND S.A.E.

PRICE REDUCTIONS

(a) The COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-Stage Pre-Amplifier Control Unit..... **£15.15.0**

(b) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested..... **£18.18.0**
H.P. TERMS: Deposit **£3/16/-** and 12 months of **£1/7/8.**

(c) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit..... **£21.10.0**

(d) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested..... **£25.0.0**
H.P. TERMS: Deposit **£5** and 12 months of **£1/16/8.**

(e) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit..... **£21.10.0**

(f) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested..... **£25.0.0**
H.P. TERMS: Deposit **£5** and 12 months of **£1/16/8.**

(g) COMPLETE KIT OF PARTS to build two "5-10" Main Amplifiers (incorporating Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit..... **£31.0.0**

(h) Two "5-10" Amplifiers (Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested..... **£36.0.0**
H.P. TERMS: Deposit **£7/4/-** and 12 months of **£2/12/-**. Carriage and insurance 7/6 extra.

Prices quoted are subject to **£1/6/-** extra for Partridge Trans.

MULLARD FOUR CHANNEL MIXING UNIT

Self powered with Cathode follower output. Incorporates Two Inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a Fourth for Radio or Tuner. KIT OF PARTS **£8.8.0** ASSEMBLED AND TESTED **£10.0.0**
Terms Deposit **£2** and 12 months at **15/-**. Model I.L. one microphone input matched for moving coil or ribbon mike **£1.17.0** extra.



COMPLETE STEREO AMPLIFIER

Meets the many requests for a low priced but good quality Stereophonic Amplifier. Output power is 4 watts. Inputs for Crystal Pick-ups and Radio Tuner.

KIT OF PARTS..... **£8.10.0** or ASSEMBLED..... **£10.10.0**

STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREO PHONIC and MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 mV.



Price: COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED AND TESTED **£15.0.0**

H.P. Terms on assembled unit: **£3** Deposit and 12 months of **£1/2/-**.

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The LATEST MODELS are in Stock. Many at REDUCED PRICES !!

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Autochanger with Crystal Pick-up **£7.10.0**

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The NEW COLLARO Model RP594, 4 speed Single Record Player, Studio Cartridge **£6. 9.6**

The COLLARO 4-speed Single Record Player, incorporating the Studio "O" Pick-up **£8. 7.6**

THE NEW B.S.R. Model UA12 is in stock. A 4" "SPEED" MIXER AUTOCHANGER **£10.10.0**

UA12 is also available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records. **£10.10.0**

GARRARD RC210 4-speed Autochanger fitted with latest Crystal Pick-up **£23.18.4**

The latest GARRARD TRANSCRIPTION MOTOR "301" with Stroboscopically marked turntable. **£18.7.6**

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HIRE PURCHASE TERMS available on all units **£8/19/6** and over. Carriage and insurance on each above 5/- extra.

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Designed by the W.B. STENTORIAN COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifiers, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screw driver is required.

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COSSOR "TRAVELLER'S FRIEND" 4 TRANSISTOR POCKET RADIO

Complete kit of parts to build this wonderful set. Size 6 x 3½ x 1½ins. Weight 17 ozs. Printed circuit, ferrite aerial, 2in. speaker. Original price 18 gns.

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"EASY SIX" PORTABLE TRANSISTOR RADIO

Printed circuit, ferrite aerial, 5in. speaker, push-pull output. Long and Medium waves. Complete kit of parts.

£9-15-0 P. & P. 1/6

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Build this wonderful meter in an evening. Two ranges: 25 mW-1W and 1 W to 10 W. Accuracy 5%. Complete kit:

£2-19-6 P. & P. 2/-

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COLLARO STUDIO TAPE TRANSCRIBOR 3 motors, 3 speeds 1½, 3½, 7½. Push button controls. **LIST PRICE 18 GNS.**

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17in. TUBE BARGAIN

Type CME/1702 90° BY MAZDA. Not Surplus. Heater (amps) 0.3, Heater (Volts) 12.8. Makers' Seconds.

SPECIAL PRICE £3-19-6 P. & P. 10/-
SCAN COIL AND E.H.T. Transformer for this Tube £1 extra.

STEREOPHONIC HI-FI EQUIPMENT AT "GIVE AWAY" PRICES

FREE DEMONSTRATIONS AT ALL TIMES WITHOUT OBLIGATION. ALL MODELS 100-250v. BRAND NEW IN MAKERS' CARTONS

PL6/21 10 WATT MONAURAL AMPLIFIER AND COMBINED PRE-AMPLIFIER CONTROL UNIT 5 inputs. Size 14½in. wide, 9in. deep, 4in. high. **LIST PRICE £29-8-0**

19 GNS. CARR. & INS. 7/6

SPA11 STEREO AMPLIFIER AND PRE-AMPLIFIER

Twin 10 watts output, 3-dimensional Monaural reproduction by combining both channels, 3 inputs for each channel. Size 14½in. wide, 4in. high, 8½in. deep. **LIST PRICE £29-8-0**

19 GNS. CARR. & INS. 7/6

STEP 11 STEREO PICK-UP PRE-AMPLIFIER UNIT Size 7½ x 4½ x 2½in. **LIST PRICE £6-16-6**

£4-19-6 CARR. & INS. 7/6

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B.S.R. U.A.3 complete with latest "ful-a" cartridge **£6-19-6**

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SPECIAL OFFER

COSSOR AM TABLE RADIO, MODEL 571. Brand New L/M Bands **LIST PRICE 13 GNS.**

12 GNS. P. & P. 3/6



DL7-35 POWER AMPLIFIER

54 watt peak output. Freq. response 5 c/s-30 Kc/s ±0dB. Two of these can be used in conjunction with SP21/2 Pre-Amp. Control Unit for stereophonic reproduction. Size 14½in. long, 9in. wide, 8½in. high. **LIST PRICE £31-10-0**

£16-19-6 CARR. & INS. 12/6



SP21/2

STEREO PRE-AMPLIFIER CONTROL UNIT Twin channel. Designed primarily for use with two DL7 35 Power Amplifiers. Six inputs for each channel. **LIST PRICE £28-10-0**

£16-19-6 CARR. & INS. 7/6

SPECIAL OFFER TO ALL OUR CUSTOMERS. Two DL7-35 Power Amplifiers and one SP21/2 Stereo Control Unit at a special price of **47 GNS.**

Ideal for use in clubs, halls, public performances, etc.

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MORSE KEY with buzzer, on board, wired for 4½ v. battery, 8/6 (p.p. 1/6). **TELE "F"** intercom. sets, good condition, pair 65/-, post free **GT. B. METERS** (100/4) with two centre-zero movements, 600 and 400 **µA**, 8/6. **RELAYS** 6/12 v. 2 heavy make contacts, on base, 3/6; or superior, bigger type, 7/6. **TRANSFORMERS.** Open, upright, input 200/250 v. Outputs:—250-0-250 v., 150 mA., 5 v., 3 A. and 6.3 v. 5 A., 25/-; Input 110/230 v. Outputs:—6 v., 2 A. twice, shrouded, 10/6. Potted, "C" core: Input 230 v. Outputs:—6.3 v., 0.3 A. (I.A. actual), twice, 8/6; Outputs: 510-0-510 v. 275 mA., 375-0-375 v. 83 mA., 5 v. 3 A., 6.3 v. 7 times (17 A.), 45/-. **CONDENSERS**, block, paper, 8 mfd. 250 Vw. 4/-; 600 Vw. 6/-; 4 mfd. 2 kWV. 7/6; 600 Vw. 3/6. Switch fuse splitter, DP 15 A. 15/-. Panel fusesolders, 1/3; Panel Lampholders (indicators), 1/6. **MONITOR 56**, triggered oscilloscope, comprising indicator 548 and Power Unit 675, 230 v. A.C. input, with cables and circuit. Cathode probe unit extra, 17/6. **£8/10/-** (Rail 15/-). **HEADPHONES, CLR. 7/6.** **CR100** Noise Limiter assemblies with valve, 3/6. **NEW M.C. METERS**, 3½in. round flush, 50µA, 70/-; 200 µA centre zero, 50/-; 1 mA., centre zero, 45/-; 1 mA., 55/-; 2½in. 1 mA., 22/6; 100 mA., 8/6; 2.5 300 mA., each 8/6; 2½in. M.I. 20 v. A.C., 8/6; 200 v. A.C. 2½in., 15/-; 100 v. A.C., 3½in., 45/-; 150 v. A.C., M.I., 6in., in case, 45/-. **VIBRATORS**, Mallory G834C 12 v. 4-pin, 7/6; 6 v. 5-pin reversible, 7/6. **R1155B**, good condition, tested, with handbook, **£8** (Rail 10/-). **DRIVES:** slow-motion Admiralty 200:1 ratio, scaled 0-100 5/6. **R1155 S.M.** "N" type, new, 10/6. **VIBRAPAK**, 6 v. D.C. to 250 v. 60 mA., smoothed case, 22/6. 12 v. to 250 v. 60 mA., 22/6 (p.p. 3/6). **DYNAMOTORS** (post 3/6). 12 v. to 230 v. 60 mA., 11/6, 6 v. to 250 v. 60 mA., 11/6. **CHOKES.** LF 10 H, 200 mA., 8/6; 100H, 60 mA., 8/6; 9H, 100 mA., 5/6; Potted 10H, 100 mA., 7/6; "C" 10 H., 250 mA., 12/6; 5H, 400 mA., 10/6. **R.F. 27**, good cond., 18/- (p.p. 3/6). **HEATERS:** Strips, enclosed, 220 v., 100 watts, 3/6; finned, 115 v., 200 w., 2/-; 230 v., 475 w., 5/-. Keys, morse, small, brass, 8 A., 3/-; covered, with plug, 4/6; large 7/6. **RELAYS**, co-axial, small, 12/24 v., with plugs, 10/6. **SWITCHES:** Wafer: 2 pole, 4 way, 4 bank, 1P8W6B, 2P5W4B, 4P2W2B, 1P7W3B, 1P11W2B, 4P2W5B, 3/6 each. Ceramic 2P4W1B, 1P5W3B, 1P11W, 3P3W2B, 3/6. **STUD.** 1P24W2B, 1P8W2B, 3/6; 1P19W2B, 5/6; 1P40W3B in brass case, 12/6.

SPECIAL OFFERS

TELE "F" intercom. sets, good condition, pair 65/-, del'd **GT. B. VALVES**, brand new, carboned: QOV 60 40 53; 815 50/-; 6BM6 £3; Q575/60. CV242, CV248, each 7/6; 6SK7G1 5/-; SP41 1L4. CV326 each 1/-

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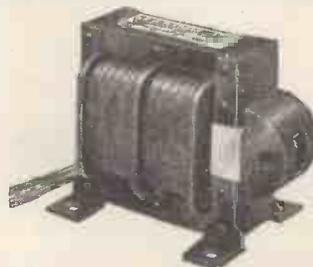
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Stock-taking Clearance. All new and unused. Prices post paid. Collaro Tape Motors, clockwise or anti-clockwise rotation. 18/-, 40-40 mFd. 150 volts, size lin. dia. by 2in. long. 1/-.
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 1mFd., 350 volt, metal tubulars, Sprague or Dubilier, 3/6 doz.
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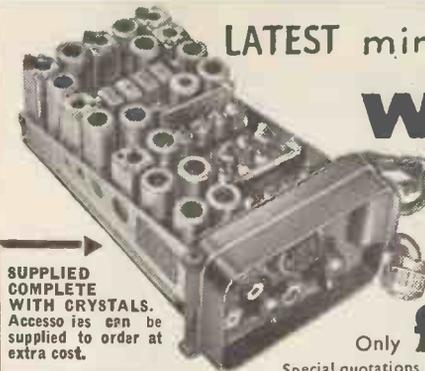


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 Continuous 3½ lbs. at 1' Instantaneous to 16 lbs.
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SUPPLIED COMPLETE WITH CRYSTALS. Accessories can be supplied to order at extra cost.

LATEST miniature

EXPORT ONLY

WALKIE TALKIE

"88" sets—just released by Ministry of Supply. Produced to exacting specifications by leading manufacturers E. K. Cole & Co. This Transmitter/Receiver weighs only 5½lb. (approx.) and measures 3½ in. x 5½ in. x 9½ in. It is a 4 frequency channel set, crystal controlled, 38-40/40-42 Mc/s.,

Only **£10** each.

Special quotations for quantities up to 3000 sets. "22" SETS ALSO—300 available only. New condition £10 each.



and operates from a Standard Dry Battery—HT/LT. 94/1. 3 v. (i.e. Ruben Mallory Type I). 14 of the current series of B7G valves are employed: 1-3A4, 6-1L4, 4-1T4, 1-1S5. 2-1A3. Each set is in first class condition.

7,500 YARDS!!
SCREENED WIRE FLEX
FOR ONLY 2d. per yd.



For Immediate Delivery—priced far below cost.
 Specification: Close braided 14/0048in. Covered .024 p.v.c. Tinned Copper. Screened. Assorted colours. Applications: Microphone leads, pick-up heads, etc. ON MAKER'S REELS. 220 yd. REELS (min. quantity) 36/8. P. & P. TEN REELS £17. Carr. Paid. 6/-.

Special Bulk Purchase makes possible this **UNIQUE OFFER**
 World Famous TELEPHONES "F" TYPE in Attractive Case

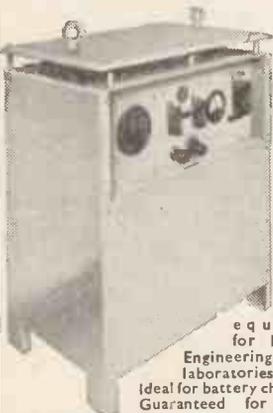
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TELE "F" HIGH POWER as above, but complete with amplifier. **£6.10.0**
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D3 STRANDED TELEPHONE CABLE.
 New Mile Drum 85/- Carr. 17/6.
ENGLAND'S LARGEST STOCKS OF TELEPHONE EQUIPMENT.

HEAVY DUTY 20 AMP. L.T. SUPPLY UNIT



by **S.T.C.**
 Normal cost over £100

Essential equipment for Electronic Engineering, research laboratories, schools. Ideal for battery charging etc. Guaranteed for 20 amps.

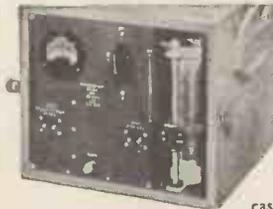
Output: D.C. Variable up to 20 amps and 24 v. or trickle charge 125/350/700 ampere hours.

Input: A.C. 100/260 volts 45/65 cycles. Size: 16 x 24 x 32in. high.

In attractive Grey Cabinet. **£22-10-0**
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(Circ. diag. and instr. loaned for 10/- deposit.)

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Input: 12 v. D.C.

Output: 230 v.A.C. 150 watts 50 cycles

Housed in wooden case and fitted

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FERRANTI 7½-KVA MOVING COIL Stabilized output voltage in the range 200-250 v. Plug-board tappings. The selected output voltage is constant with +1%, at all loads 0 to 30/37 amps. when the supply voltage is varying over the range +8% to -12%.

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- ★ Unused. Complete with spares and instruction book at a fraction of the normal cost.
- ★ A.C. MAINS STABILIZER. ONLY **£65**



AUTO TRANSFORMERS

3KVA Air Cooled (100% under-rated). GUARANTEED 230/250 tapped, 12 amps. 6 KVA 105/120 tapped 28.5 amps Made by well-known manufacturer and housed in strong metal case. Weight: 2 cwt. Brand new, in original maker's case.

PRICE **£15.0.0** Carr. 25/-



SUPER POWER AMPLIFIER

TODAY'S BEST PRICE —only **£40**, carr. paid.

Complete system with 4 speakers—saves over £100.

MADE TO STRICT GOVERNMENT SPECIFICATION. Will take up to 20 speakers. Ideal for INDOORS or OUTDOORS. Entire premises—Factories, Warehouses, Sports Grounds, etc. Output: 30 to 60 watts. Valves: Four 6L6, parallel push-pull. Input: 200-250 volts A.C. Leads, hand mic., plugs, spares, included. Robust wooden transit case 17½ x 15½ x 12in.

ORDER NOW—WHILE STOCKS LAST.
 Extra speakers 22/- each, carr. paid.

P.A. SYSTEM (EX GOVT.)

Complete with amplifier unit, 4 speakers, microphone, headphones and all spares, packed in wooden cases, 6 or 12 volts D.C. handling capacity 8 watts. Ideal for cars, boats, factories, etc. 15 gns. Carr. 30/-.

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IMPROVED TYPE 50 MK.II
36ft HIGH

Kits comprise—six 2½in. dia. Tubular Steel Sections of 6ft. length, top-section and base Pickets, Guys and Fittings. YOU can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take aerials for Tx., Rx. F.M. and TV (especially COMMERCIAL) and has many other uses. Extra 6ft. sections can be supplied at 17/6 per section.



£8.10.0 only Carr. 15/6.

U.S.A. Type 45ft. TELECOM AERIAL MAST. (7 sections, 6ft. 8in. x 2½in., guys, etc.). This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for £25. Carr. extra. British Manufacture only.

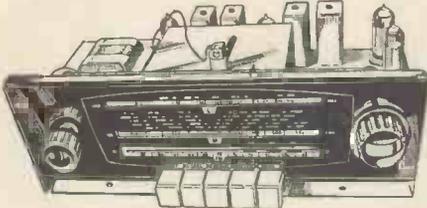
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Limited Quantity
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 Finest quality brass. Non-rusting. Base diameter 2½in. Complete with hand-winding winch for easy, rapid extension; and cable-wire bracing stays. One of the best masts ever produced. **£35** each Carr. £1/10. Windy down to 9ft.

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BRAND NEW AM/FM (V.H.F.) CHASSIS AT £13.6.8. (P. & P. 10/-)



Tapped input 220-225 v. and 226-250 v. A.C. ONLY.
Chassis size 15 x 6 1/2 x 8 1/2 in. high. New manufacture. Dial 1 1/4 x 4 in. in gold and black.
Pick-up, Extension Speaker, Ac., E., and Dipole sockets. Five "piano" push buttons—
OFF, L.W., M.W., F.M. and Gram. Aligned and tested.
With all valves & O.P. Transformer, Tone-control fitted.
Covers 1,000-1,900 M., 200-500 M.; 88-99 Mc/s.
Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. Speaker and Cabinet
to fit chassis, 57/6.
10 x 6 in. ELLIPTICAL SPEAKER, 20/- to purchasers of this chassis.
TERMS:—(Chassis) £5/8/6 down inc. carr.—and 6 monthly Payments of 30/-
or with Cabinet and Speaker £5/9/2 down and 7 monthly Payments of 32/-.
Some tarnished but fully working unused chassis at £10 (10/- carr.).

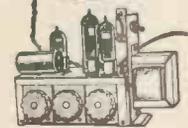
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Capable of giving 4 watts. Mains and output transformer. Valves ECC83, EL84, EZ80, 3 Controls, volume, bass and treble. On/Off switch. Fully guaranteed. Chassis size 6 1/2 x 3 x 2 1/2 in.; with 7 x 4 in. elliptical speaker or 6 in. round (Goodmans); state which.
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STUPENDOUS OFFER! 13-CHANNEL TUNER

L.F. 34-38 Mc/s. complete with valves PCF80 and POC84. Removed from chassis but in working order. Also 16-19 Mc/s.
15/- (2/6 P. & P.) Knobs 2/6 extra. Some tuners less valves 7/6.



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ALL NEW
NEW WAXED TUBULARS, 350 v. or above, 3 of each. .001, .002, .005, .01, .02, .05, .1 mF. Total 21 for 4/6, post paid.

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By well-known manufacturer for superhet TVs with 35-38 Mc/s. L.F. For all areas: covers all 13 channels. Switch gives BBC and two ITA selections. Suits G.E.C. sets BT45-43, 4544 5146, 5147, 5543, 5642 and 6641 without alteration. Easily adapted as aerial converter, and instructions can be provided free. Has ITA and BBC co-axial sockets and separate gain controls.
WITH VALVES PCF80 and POC84, 22/6 (P. & P. 3/-).
Some without valves at only 12/6 (P. & P. 3/-).



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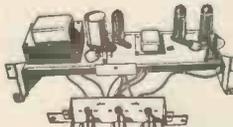
with 5 in. SPEAKER. On Fabric-covered Baffle 12 1/2 x 5 in. Mains and Output Transformers. EZ40 and EL41 Valves. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully Guaranteed. Two Knobs supplied. Ready to play. Useful for Stereo. ONLY 57/-, post 3/-.



PUSH-PULL AMPLIFIER 24/15/-

3/- P. & P.

Brand new 200-240 A.C. mains. Bass, treble and vol. controls flying panel. With valves EZ80, ECC83 and 2-EL84 giving full 8 w Chassis 12 x 3 1/2 x 3 1/2 in. With o.p. trans. for 2-3 ohm speaker.



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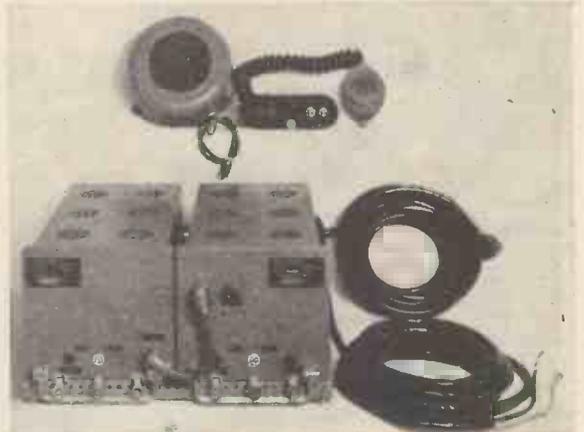
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30 Milliamp	2 1/2 in.	MC/FR	15/-
100 Milliamp	2 1/2 in.	MC/FR	15/-
200 Milliamp	2 1/2 in.	MC/FR	15/-
1 Ampere	2 1/2 in.	MC/FR	35/-
3 Ampere	2 1/2 in.	MC/FR	35/-
5 Ampere	2 1/2 in.	MC/FR	35/-
10 Ampere	2 1/2 in.	MC/FR	35/-
20 Volts	2 1/2 in.	MC/FR	35/-
30 Volts	2 1/2 in.	MC/FR	35/-
40 Volts	2 1/2 in.	MC/FR	35/-
500 Microamp	2 in.	MC/FR	25/-
1 Milliamp	2 in.	MC/FR	27/6
5 Milliamp	2 in.	MC/FR	27/6
10 Milliamp	2 in.	MC/FR	27/6
20 Volts	2 in.	MC/FR	27/6
30 Volts	2 in.	MC/FR	27/6
40 Volts	2 in.	MC/FR	27/6
15 Amps	2 in.	MC/FR	12/6
3 Amps	2 in.	MC/FS	27/6
5 Amps	2 in.	MC/FS	27/6
30-0-30 Amps	2 in.	MC/FR	15/6
50-0-50 Amps	2 in.	MC/FS	12/6
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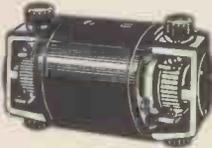
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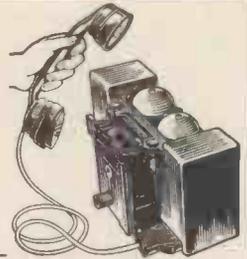
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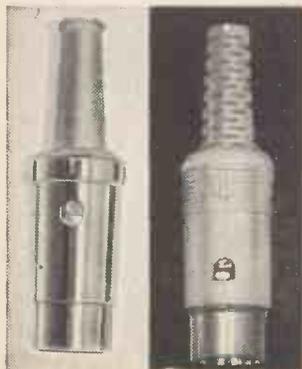
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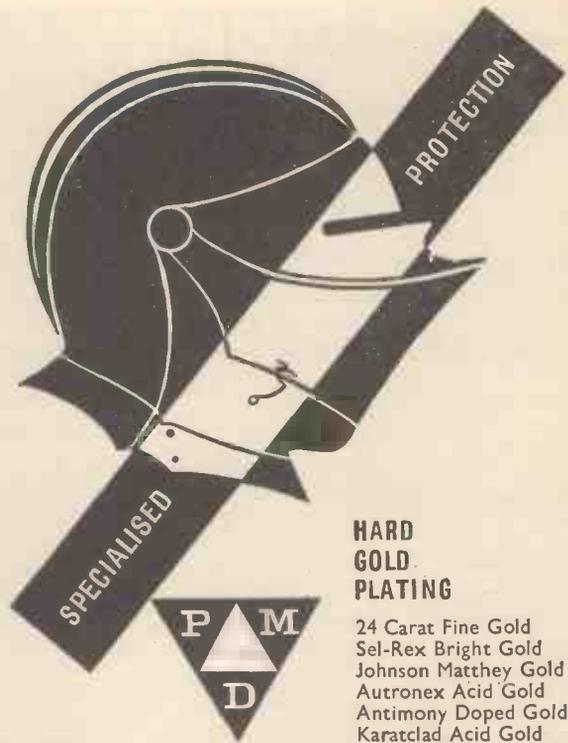
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Complete 17in. TUBE. VALVES—SPEAKER—KNOBS. Tuned ITV/BBC. Ready to use, fully guaranteed, TUBE 12 months, CHASSIS and VALVES 3 months. Cabinet to fit £11/11/6 if ordered with set. Salvage. Set—tube—cabinet despatched separately. Carr. and ins. on set £15/5/-; on Cabinet 12/6.

DELUXE TAPE RECORDER

List price 31 gns. our price 22 gns.

Beautifully styled rexine covered cabinet in Red/Beige, with carrying handle. Size: 14 1/2 x 13 x 9 1/2 in. Storage comp. in lid for tapes and mike. Playing time 1 1/2 hrs. Speed 3 1/2 in. per second. Compact set using latest 5 valve amplifier with 4-stage amplification and separate valve for Bias osc. 2 controls. Contains 7 x 4in. elliptical speaker and incorporating B.S.R. Tape deck. 5 1/2 in. standard tape. 3 months' guarantee. Ins. & Carr. 12/6. Deposit 28 plus Ins. & Carr. and 20 payments of 17/-.

COMPLETE TAPE RECORDER



LIST PRICE 29 gns. NOW ONLY 18 gns.

UNREPEATABLE VALUE

Famous manufacturer. Huge purchase allows us to offer at this amazing price. Beautifully styled, rexine covered cabinets. Colours: Red, Grey, Black. Storage space for 4 tapes, mike and lead. Incorporating the latest B.S.R. Deck. LOOK AT THESE EXPENSIVE FEATURES. Controls: Record/Playback switch and rewind with interlocking device to prevent accidental erasure. Tone and volume controls. Superimpose and electronic eye. Ample power output 3.5 watts. Small overall size 14 1/2 x 14 1/2 x 7 1/2 in. Lightweight, only 21lb. Playing time 1 1/2 hours. 5 1/2 in. standard tape. Terms: Carr. & Ins. 12/6. Microphone 27/6 extra. Tapes 19/9. Carr. & Ins. 12/6.

DELUXE TAPE RECORDER CABINET



ONLY 29/9

Beautifully made Tape Recording Cabinet. Size: 13 x 10 1/2 x 7in. Covered in two-tone coloured rexine cloth. Stylish design. Carrying handle with detachable lid. Easily adapted to Record Player Cabinet. Exceptional value at this very low price. P. & P. 4/6.

TELEPHONE SETS 7/9

X.W.D. Wireless remote control unit. E.MK.II (ZAI1954). Including Morse tapper, switched, lack plugs, etc. Less phone. Ins. and carr. 3/6.

DUKE & CO. (LONDON) LTD., 621/3 Romford Road, Manor Park, E.12. I.L.F. 6001/3

LIVERPOOL ST. TO MANOR PARK STATION Only 10 MINS.

T.C.C. "CATHODRAY" VISCONAL TYPES. 1 mid., 2 kV. wkg., 7/6 each. 0.25μF, 4 kV. wkg. 6/- each. 0.05μF, 8 kV. wkg., 7/6 each. 0.1μF, 5 kV. wkg., 6/6 each. 0.03μF, 5 kV. wkg., 6/6 each. 0.1μF, 6 kV. wkg., 7/6 each. 0.5μF, 2.5 kV. wkg. 6/6 each. 0.25μF, 2.5 kV. wkg. 6/- each. 0.0025μF, 6 kV. wkg., 5/- each. 0.0025μF, 5 kV. wkg. 4/6 each. 0.005μF, 6 kV. wkg. 5/- each. 0.0025μF, 3 kV. wkg. 4/- each. 0.025μF, 2.5 kV. wkg. 4/6 each. 0.0025μF, 2.5 kV. wkg. 4/- each. 0.005μF, 2.5 kV. wkg. 4/- each. 0.025μF, 3 kV. wkg. 4/6 each. All the above are tubular and mounting.

BLOCK PAPER TYPES. 10 mid., 1,500 v. wkg., 15/- each. post 3/6. 8 mid. 1,200 v. wkg., 11/6 each. 8 mid. 500 v. wkg., 5/- each. 6 mid. 500 v. wkg., 5/6 each. 4 mid., 500 and 750 v. wkg., 4/6 each. 4 mid. 1 kV., 5/6 each. 4 mid. 2 kV. wkg., 6/6 each.



POWER UNITS

100-250 v. A.C. input, 24 v. D.C. at 3 amps. or 12 v., twice at 3 amps. each winding. Continuous tropical rating switched and fused etc., in metal case that fits 19in. rack, size 19 x 7 x 7in. Brand new, £3/15/-, Carr. 7/6 (with circuit).



SMOOTHING UNIT

for the above power supply 2 chokes and 0.1 mA meter (grade 1) metal case, same as the p.u. £2. Carr. 7/6.

RANGE CONVERTOR

(part of R20 6 Rec.), 115-600 kc/s, on three bands, large dial with a Muirhead slow motion drive. Valves EP39, ARTH2, the set can be used with R107, R208, and many other types of receivers £32/6 each. Carr. 7/6.



GRAHAM GEARED MOTORS

115 v. A.C. 1/6th H.P., variable speed box 0-168. Size of unit 14 1/2 x 9 1/2 x 8 1/2. £8/10/-, Carr. 10/-.

INDICATOR UNIT Type 1-152-c (U.S.A.) 3in. tube 3DP1, 1 rectifier 2 x 2, and 3 x 6AG5, with controls, etc., in a neat metal box 11 x 6 x 6in. 50/- each. Post 2/6.

ROTAX CONVERTORS Type 8A, 24 v. D.C. input, 115 v. A.C. at 1.8 amps. 400 c.p.s. 3-phase. Just the job for the laboratory or experimenting. £8/10/- each. Carr. 7/6 ea.

MOTOR ASSEMBLY servo unit, C-1 II A G1020 26 v. auto pilot, new in cartons. £3/10/-, Carr. 7/6.

MODULATOR UNITS. MD 7/ARCS. 2 x 7L625, 12J5, VR150, Modulation transformer, 5 Relays, etc. £2/6 each. Post 3/6.

MOVING IRON METERS. 0-100 amps. 6in. scale, at £2; 90-180 v., 4in. scale at 35/-, Post 3/-.

AMERICAN L.T. TRANSFORMERS. Potted type, finished in black crackle and very conservatively rated. (1) 230 v., input 2 x 6.3 volts CT., at 3 amps. and 6.3 volts output, 18/3 each. (2) 230 volt input, 2 x 6.3 volts at 3 amps., and 6.3 volts CT., at 3 amps. output, 17/6 each. (3) 230 volts input, 28 volts at 2 amps. and 2 volts at 1 amp., 12/6 each. (4) 230 volts input, 3 x 0.3 volts at 3 amps. CT., 1, 6.3 volts 3 amp., 22/6 each. (All these transformers are new and boxed, please include postage 3/6 each.)

MODULATION TRANSFORMERS as used in the BC 640, 40 watts, modulate two 811's, 39/6 each, brand new, boxed. Post 3/-.

AMERICAN COMPUTERS AN-II-70A. Single parallax. Contains 8 relays 10 k., 2 change-over plat. contacts, 8 relays 300 ohms, 2 change-over silver contacts (all relays are small type), 9 x 6V6 small GT., 3 x 6X5 GT., and 2 6SN7. Seven small D.C. motors 27 v. 6 relays motors, 10 small micro switches. Plus gears, condensers, ball bearings and pots, etc. This unrepeatable bargain, £10 each.

DOUBLE PARALLAX AN-II-70-B. Similar to the above but larger etc., weight 140lbs. Brand new, £12/10/- each. Carr. £1.

DESK TELEPHONES (standard type No. 1) complete with the handset and cord ready to connect to line, £2/15/- each. Post 3/6, or £5 a pair.

DIPOLE AERIALS vertical H, span 72 inches easy fixing brackets and 25ft. co-ax cable, 37/6 each. Carr. 5/- each (new).

120 VOLT BATTERIES (Mines H.T. units) Cap 6 amps. made up from Nickel Iron Cells. Unused, 50/- each. Carr. 5/- each.

G.P.O. GENERATORS, as used for ringing 80 to 100 volts output Max., 7/6 each. Post 1/6. New.

VARIABLE RESISTORS, 3 ohms 10 amps. 18/6 each. Post 3/-.

25FT. AERIAL MASTS. Heavy galvanised steel tubes, four sections, tapered 2 1/2 to 1 inch. No guy ropes needed, £12/10/- each. Weight 2 cwt.

TRANSFORMERS (drop thro' type), 110 and 230 volts pri., 275-0-275 at 125 mls., 6.35 v., at 0.9 amps., 6.4 v. at 4 amps. Size 4 x 4 x 4 1/2in., £2/6 each. Post 3/-.

ROTARY CONVERTORS, 24 volts D.C., input 11 amps., 230 volts A.C., output at 80/100 watts D.C., regulated, voltmeter 0-300, starter and controls, also fuses on the front of the panel. Finished in grey, size 24 x 15 x 10in., £17/10/- each.

TRANSMITTERS. Type CWS 52244. Model YG.1. 115 v. A.C., 25 watts, Carrier 246 Mc/s. Beacon transmitter, £18/10/- each. (For export only.)

CANADIAN MIKES C3, with lead and plug, 7/6. Post 1/6.

INDICATOR UNIT, with two 5FP7 tubes, etc. £2. Post 3/6.

LIST AVAILABLE SEND 6d. IN STAMPS

PLEASE INCLUDE POSTAGE ON GOODS

TERMS C.W.O. All goods offered are ex-W.D. S.A.E. for enquiries.

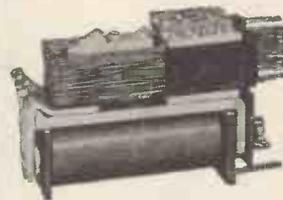
W. MILLS

3-B TRULOCK ROAD, TOTTENHAM, N.17

Phone: Tottenham 9213 & 9330

DEPENDABLE RADIO SUPPLIES LTD.

12a TOTTENHAM STREET, LONDON, W.1. (2 minutes Goodge Street Street. Opp. Heals in Tottenham Court Road.) Phone LANgham 7391/2 Hours of Business 9-6 (Mon. to Fri.) Callers welcome. Terms: Cash with order or C.O.D.



POST OFFICE RELAYS TYPE 3,000

BUILT UP TO YOUR REQUIREMENTS

Type 600 also available

COMPONENT PARTS ALL PLATED

Yokes, 4/- each. Top plates, 3d. each. Fixing Screws (with insulators), 2d. each. Armatures, 1/3 each. Bottom Plates, 3d. each. Buffer Blocks, 6d. Adjustable, 1/9 each. Armature Screws, each. Spindles, 1/6 each. Screws, adjustable, 4d. each.

BUILD UPS CONTACTS

	Silver	Platinum	
1. C/O.....	1/3	4/-	Up to
2. C/O.....	2/6	9/-	100 Ohms
3. C/O.....	3/6	12/-	500 "
4. C/O.....	4/6	16/-	1,000 "
6. C/O.....	6/6	24/-	5,000 "
8. C/O.....	8/6	32/-	10,000 "
			20,000 "
			40,000 "
			80,000 "

COIL VALUES

Single	Twin
3/-	5/-
4/-	6/-
5/-	7/-
6/6	8/6
9/-	—
14/-	—
16/-	—

Other build ups to order; all types of relays built to your specification. *Slugged coils extra.

SIEMENS HIGH SPEED C/O RELAYS

250+25p ohms Twin Coils 6/6 1,000+1,000 ohms Twin Coils 10/6
850+850 " " 8/6 1,700+1,700 " " 17/6
1/6 Post and Packing on all relays.

G.E.C. MINIATURE SEALED RELAYS

No.	Ohms	Build Ups	Voltage	Price
Z530005	2	2 C/O	1.3 v.	12 6
Z530008	670	2 C/O	24 v.	19 6
Z530010	40	2 C/O 2K	7 v.	17 6
Z530014	2	1 C/O	1.3 v.	10 6
Z530015	40	1 C/O	6 v.	12 6
Z530016	180	1 C/O	12 v.	19 6
Z530018	2,500	1 C/O	48 v.	£1 2 6
Z530019	2	2 C/O 2K	1.3 v.	14 6
Z530020	2	4 C/O	1.3 v.	16 6
Z530021	2	2M	1.3 v.	10 6
Z530022	2	1M 1B	1.3 v.	12 6
Z530023	2	2B 2M	1.3 v.	12 6
Z530024	40	2M	6 v.	12 6
Z530025	40	1M 1B	6 v.	12 6
Z530026	40	2B 2M	6 v.	15 0
Z530027	180	2M	12 v.	17 6
Z530028	180	1M 1B	12 v.	17 6
Z530030	670	2M	24 v.	17 6
Z530031	670	1M 1B	24 v.	17 6
Z530034	2,500	1M 1B	48 v.	£1 2 6
Z530480	670	2B 2M	24 v.	19 6
Z530430	5,000	2 C/O	48 v.	£1 9 6
Z530429	2,500	2 C/O	48 v.	£1 2 6

S.T.C. MINIATURE SEALED RELAY

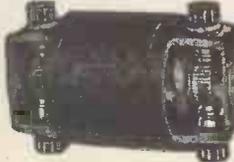
4184GD	700	2C	24	19 6
4190HC	170	2C	12	17 6

1/6 Post & Packing on all relays.

SEND FOR LISTS

ROTARY TRANSFORMERS

Delivery ex stock. Quotations on application.



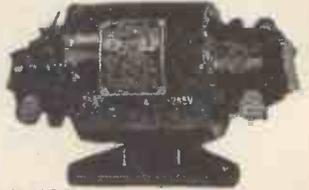
H.T. 31
Input 11.5 v.
Output 250 v. at 120 mA.

H.T. 32
Input 11.5 v.
Output 490 v. at 65 mA.

AS SUPPLIED TO GOVERNMENT DEPARTMENTS AND LEADING MANUFACTURERS. NEW AND BOXED.

ROTARY TRANSFORMERS

Made by DELCO
TYPE 1, 27/6. P. & P. 3/6.
TYPE 2, 37/6. P. & P. 3/6.
Type 1. Dual voltage 12 or 24 v., input 265 v., 120 mA. output; 500 v., 26 mA. output.
Type 2. 12 v., input 275 v. 110 mA. output; 500 v., 50 mA. output.
Both types dual output. Made in U.S.A.



OTHER DYNAMOTORS IN STOCK, SEND FOR LIST

TRANSFORMERS

POTTED C CORE

ri: 230 v. 50 c/s.
 ec.: 450-0-450 v. 220 mA. 5 v. 3 amps., 6.3 v. amps., 6.3 v. 3 amps. £2/10/- Carr. 5/-.
 ri: 230 v. 50 c/s. E.S.
 ec.: 500-0-500 v. 500 mA. 6.3 v. 500 mA., 6.3 v. amps., 5 v. 6 amps. £3/10/- Carr. 5/-.
 ri: 230 v. 50 c/s.
 ec.: 6.8 v. 5 amps., 6.3 v. 1 amp., 6.3 v. 3 amps., 3 v. 1.5 amps., 6.3 v. 2 amps., 6.3 v. 3 amps., 3 v. 4 amps. £1/12/6. Carr. 5/-.

MAINS ISOLATING TRANSFORMER
 Gresham). Pri. 230/250 v. Secs. 240-0-240 v. 5 amps., 5 v. 12.5 amps. Potted. Size 7in. x 4in. x 10 1/2in. Weight 50 lb. Ideal for obtaining W/O ISOLATED 240 v. lines at 360 watts each. Perfect condition. 80/- Carr. 10/-.

T. TRANSFORMERS for Battery Chargers etc. All Pri.: 200/250 v. 50 cycles Tapped. type 048B. Sec. 24, 30, 36 v. 6 amps. 4 x 4 x 4in. 2/9/6. Carr. 3/6.

type 066A. Sec. 18, 24, 30, 36 v. 8 amps. 4 x 4 x 4in. £3/19/6. Carr. 3/6.
 type 053A. Sec. 12, 24, 30 v. 10 amps. 4 x 5 x 4in. £4/4/- Carr. 3/6.

LUTO TRANSFORMERS. 0-110, 205, 25, 245 v. Fully shrouded. Terminal block connectors.

type 063A. 500 w., 4 x 5 x 5in. £3/7/6. Carr. 3/6.
 type 064A. 750 w. 4 x 6 x 5in. £3/17/6. Carr. 3/6.
 type 065A. 1000 w. 4 x 7 x 5in. £4/17/6. Carr. 5/-.

kV/A. AUTO-TRANSFORMER. 250/110 v. 0 cycles (fully tapped primary and secondary). Tapable of 25% over actual rating. Brand new unused, £12/10/- Carr. 20/- Also 6 kV/A. 5 above, £18. Carr. 20/-.

0 kV/A. AUTO-TRANSFORMER. 230/115 v. 50-60 cycles, by Jefferies Transformer Co., U.S.A. Perfect condition, £20. Carr. 20/-.

CONSTANT VOLTAGE TRANSFORMER
 90-260 v. primary, sec. 115 v. at 1 1/2 kV/A. (listed at 2 kV/A.). Brand new and unused. £25 or £45 per pair. Carr. 10/- each.

H.T. TRANSFORMER. 8,000-0-8,000 at 00 mA. Primary 230 v. 50 cycles. Oil filled. New and in original crates. £25. Carr. 10/-.

H.T. TRANSFORMER. 1,800-0-1,800 at kV/A. 230 v. 50 cycles primary. Fully tropicalized. New and boxed. £6/10/- Carr. 10/-.

H.T. TRANSFORMER. 1,100-0-1,100 at 50 mA. plus 4 v. L.T. Pri. 200/250 v. at 50 cycles. 5. Carr. 10/-.

CONDENSER, oil filled. 240 mfd. 230 v. A.C. 600 v. D.C. Made in U.S.A. Size 2 1/2in. x 5 1/2in. x 1in. Brand new in original cases. £7/10/- Carr. 5/-.

ROTARY CONVERTER. 24 v. D.C. input. 130 v. A.C. output at 250 watts. Complete with starting switch. New and unused. £15. Carr. 7/6.

ROTARY CONVERTER. 24 v. D.C. to 130 v. A.C. 50 cycles, 150 watts. Brand new and unused. £8/10/- Carr. 7/6. Ditto, 100 vatts £6/9/6. Carr. 7/6.

ROTARY CONVERTER. Ex-Govt. 12 v. D.C. input, 230 v. A.C. output 50 cycles at 35 watts. Complete in carrying case with lid. Voltage control, sliding resistance, mains switch and 0-300 v. A.C. flush meter. In good condition. £10. Carr. 10/-.

Motor only, without case, etc. Brand new and unused. £8/10/- Carr. 5/-.

T.C. SELENIUM METAL RECTIFIERS. B. FOR BATTERY CHARGERS.

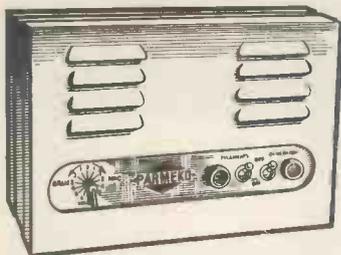
3 or 12 v. 1 amp. 5/-;	24 v. 1 amp. 10/-;
1 v. 2 amp. 7/6;	24 v. 2 amp. 15/-;
1 v. 2 amp. 12/6;	24 v. 3 amp. 25/-;
1 v. 4 amp. 15/-;	24 v. 4 amp. 30/-;
1 v. 6 amp. 20/-;	24 v. 6 amp. 32/6;
2 v. 10 amp. 35/-;	24 v. 10 amp. 70/-;

NEW AND UNUSED ACCUMULATORS

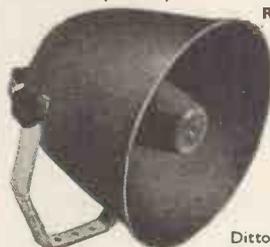
12 v. 25 A.H. (as illus.) 45/- Carr. 7/6. (Ideal for use with our Amplifier in centre column).
2 v. 100 A.H. 75 actual (ex-Govt.) with carrying handle. Size 6 1/2 x 6 1/2 x 3 1/2in. 15/- each. Carr. 3/6.
2 v. 16 A.H., as above. 7 1/2 x 4 x 2in., 5/- each. P. & P. 2/- 6 for 24/-.

& P. 10/-.
 v. 14 A.H., as above (less handle). 7 x 2 1/2 x 2 1/2in., 5/- each. P. & P. 2/- 6 for 24/- P. & P. 10/-.

A SELECTION OF HIGH QUALITY P.A. SPEAKERS FOR INDOOR/OUTDOOR USE S.A.E. for full list



12 VOLT D.C. AMPLIFIER (Parmeko, Ardenre). As new. 15 watt output with 2-EL35's in push-pull. Mike and gram. inputs, tapped output transformer. £9/19/6. Carr. 10/6. (Suitable microphone for above 30/- extra).

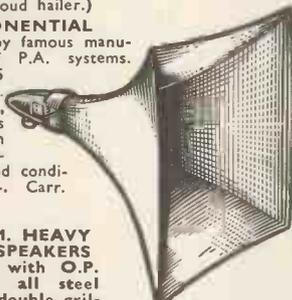


RE-ENTRANT LOUD HAILERS (Ex-Govt.) Heavy duty 20 watts all-metal 15 ohms. Diameter 15in., length 15in. (approx.) good cond. £6/10/- Carr. 10/- Brand new, £8. Carr. 10/-.

HEAVY DUTY ALL STEEL TRIPOD STANDS (as illus. Sept. issue). Adjustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage.) Suitable for outdoor speakers, public address systems, flood-lighting, etc., etc. OUR PRICE £3/10/- Carr. 5/-. (Ideal stand for the above loud hailer.)

EXPONENTIAL HORNS by famous manufacturer of P.A. systems.

15 watt, 25 in. long, 20in. square flare, 15 ohms s p e e c h coil. (Tan-nyoy.) Good condition. £7/10/- Carr. 10/-.



NEW P.M. HEAVY DUTY SPEAKERS

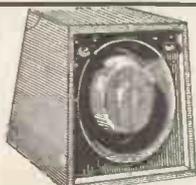
Complete with O.P. trans., in all steel blue-grey double grided cabinet. 6in. 30/- 8in. 32/6. Carr. 3/6 each. 10in. SPEAKER in wooden cabinet, size approx. 14 x 16 x 8in. with padded interior and volume control, 50/- Carr. 3/6.

BAKER'S SELHURST SPEAKERS SPECIAL NEW ARRIVAL!!!

"15in. VISCOUNT AUDITORIUM" 15 ohms at 400 c.p.s. 35 watts, Flux density 18,000. £15.
 "12in. P.M.", 15 ohms, 15 watts, 30-14,000 c.p.s. Our price £4/10/-.
 "AUDITORIUM" 12in., 15 ohms, 12 watts, 35-16,000 c.p.s. Flux density 14,500. OUR PRICE £7/10/-.
 "SUPER HI-FI 25" 12in., 15 ohms, 25 watts 25-20,000 c.p.s. Flux density 17,600. OUR PRICE £9/9/-. All are brand new and full descriptive specification is available.

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. Brand new 25/- Carr. 4/6.



QUALITY TEST EQUIPMENT

RECORD MEGGERS. 500 v. insulation tester, 0-20 megohms. In leather case. Perfect order £10.

EVERSHED AND VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). 2 ranges 0-3, 0-30 ohms. The perfect meter for continuity and polarity testing, complete with test leads and ready to use. Brand new. Only £4/17/6. P. & P. 3/-.

BRIDGE MEGGERS. Evershed and Vignoles. Series 2 in perfect condition. 250 v. £22. Carr. paid. Leather case available at 20/- extra.

MARCONI SIGNAL GENERATOR. TYPE TFS17-F/1. Covering 10-18 Mc/s. 33-58 Mc/s. 150-300 Mc/s. In very good condition. Complete with full technical data and instructions. Unrepeatable at only £12/10/- Carr. 20/-.

BRAND NEW CRYSTAL CALIBRATOR No. 10. (Battery powered 1.4 v. valves.) Complete with full working instructions, circuit diagram, carrying haversack, connecting lead and spare valves. Frequency range: 1.5 to 10 Mc/s. (nominal) but can actually be used up to 30 Mc/s. Weight 5lb. Size 7 x 7 1/2 x 4in. A miniature B.C.221 in every respect. A must for every laboratory, etc. ONLY £4/19/6. P. & P. 2/6.

MULLARD BRIDGE. Type GM. 4140/1. Mains operated from 100-250 v. A.C. Will test resistances from 0.1 ohm to 10 megohms and condensers from 10pf. to 10mfd. Good condition and complete with instruction booklet. £6/19/6. P. & P. 2/6.

TAYLOR VALVE TESTER Model 47A. Input 200-250 v. A.C. Will test all types of English and American valves with filaments from 1.1 v. to 117 v. Perfect condition. Complete with full instruction manual, £12/10/- Carr. paid.

10-LINE TELEPHONE SWITCH-BOARDS. For the complete control of 10 extensions (Tele. "F" etc.). Complete with jacks, leads and operator's hand set. Good condition. £9/19/6. Carr. 10/6.

TELEPHONE SETS (TELE "F") Housed in Bakelite cases, complete with built-in ringing generators and batteries. Ideal between two or more positions up to practically any distance. Tested before despatched. ONLY 70/- P. & P. 3/6. 2 sent for £6/10/- Carr. paid.

TELEPHONE CABLE. Twin one-mile drums (Don 8), £5. Carr. 20/- Single one-mile drums (Don 3), 50/- Carr. 7/6.

COLLARO "STUDIO" TAPE TRANSCRIBATORS. Brand new in original cartons. 3 speeds, 1 1/2, 3 1/2, 7 1/2 i.p.s. 3 motors, digital counter, etc. Complete with 7in. spool, instructions and fixings. A.C. 200/250 v. operation. SPECIAL PRICE £12/10/0 only.

RECORDING TAPES. Super quality P.V.C. 1,800ft. L.P. 7in. spools, 30/-; 1,200ft. Std. 7in. 19/-; Empty 7in. spools 3/9 each. Send S.A.E. for current Tape Bargain List.

A.C.-D.C. RECTIFIER POWER SUPPLY UNITS

110/230 v. A.C. 50 cycles input, 100/110 v. D.C. output max. 2 1/2 amp. Brand new and unused, £4/10/- Carr. 7/6.

230 v. A.C. 50 cycles input, 200/220 v. D.C. output at 3/4 amps. approx. Good condition. £10. Carr. 10/-.

200/250 v. pr., 110 v. sec. at 4 amps. max. Brand new and unused. £8/10/- Carr. 10/-.

TRANSMITTER TYPE T.1945. As used for Air-Sea Rescue. This transmitter is a non-directional sono-buoy. Freq. band 62.9 Mc/s. to 71.7 Mc/s. spaced 800 kc/s. apart. (Most channels available.) Brand new in tropically sealed packing. Enquiries invited.

AIRBORNE TRANSMITTER RECEIVER TYPE 1986. A mobile 10-channel crystal controlled V.H.F. Tx/Rx. covering 124.5/156 Mc/s. I.F. band width 23 kc/s. Complete (less external attachments) in metal case, with all valves and 24 v. rotary power unit. Used but in first-class condition. ONLY £8/10/- Carr. paid. Also, complete with control box and all necessary connecting leads, £12, carr. paid.

G.P.O. RACKS

19in. Heavy duty all steel Standard drilling. 5ft. 6in. angle uprights. £3/10/- Carr. 15/- 6ft. channel uprights. £5. Carr. 15/- 7ft. channel uprights. £6. Carr. 15/-.

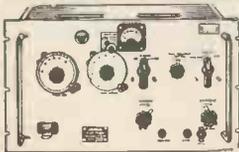
GEE BROS. (RADIO) LTD.

15 LITTLE NEWPORT STREET, LONDON, W.C.2. GER. 6794/1453
 ADJOINING LEICESTER SQ. TUBE STATION—Open 9-6 Weekdays. 9-1 Sat.

VARIABLE TRANSFORMERS

● Input Voltage 230 v. continuously variable output from 0-260 v. ● GOOD REGULATION. Output voltage is substantially independent of load. ● SMOOTH CONTROL. Can be set closely to any output voltage within its range. ● HIGH EFFICIENCY. Very low losses under all load conditions. ● LONG LIFE. The same as that of any standard fixed-ratio power transformer when operated at rated loads. ● SMALL SIZE. Smaller than any other type of control of equal power rating. ● LINEAR OUTPUT VOLTAGE. Continuously adjustable from zero to 30% above line voltage by a 320-degree rotation of the knob. The dial is calibrated to read directly in output voltage at rated line voltage. ● DIRECT-READING DIALS. All models are supplied with reversible direct-reading dials. Large white figures, easy to read at a distance. ● MODERATE TEMPERATURE RISE. Less than 50 degrees C. for continuous use. ● ADVANCED MECHANICAL DESIGN. Rugged construction—no delicate parts—protected with a strong, iron cover. ALL FULLY GUARANTEED. DELIVERY EX-STOCK.

- MODEL B.5**
Current rating
5 amps.
£9. 0. 0
- MODEL B.10**
Current rating
10 amps.
£18. 5. 0
- MODEL B.20**
Current rating
20 amps.
£32. 10. 0



V.H.F. COMMUNICATION RECEIVER 1392 15 VALVE SUPERHET

Frequency Range 95-150 Mc/s. (2 to 3 metres)

ONLY
£6.5.0
CARRIAGE 15/-

Gives reception of Police, Aircraft and Amateur transmissions. Valve line up: 1st and 2nd R.F. Amp. VR.136 (EF.54), 1st Local Oscillator; VR.65 (SP.61), 2 Oscillator Multipliers; VR.136 (EF.54); 3 I.F. Amp.; VR.53 (EF.39); A.G.C. 6Q7; Output 6J5; Muting VR.92 (EA.50); Noise Limiter VR.92 (EA.50); B.F.O. 6J7; Mixer VR.136 (EF.54); De Mod. 6Q7. Slow motion tuning, normally crystal controlled, or tunable over 95-150 Mc/s. Power supply required: 240-250 volts at 80 mA., 6.3 volts at 4 amps. Size 19in. x 10in. x 10in. Standard Rack mounting.

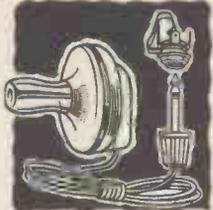
NEW TRANSISTOR RADIO KIT WITH MINIATURE SPEAKER Anyone can build it!!



This powerful yet tiny radio gives reception over the entire broadcast band. All parts including ★ 2 transistors ★ Ferrite rod ★ Miniature Speaker ★ Tuning condenser ★ Plastic case ★ Wiring diagram and step by step instructions ★ Size only 4 x 3 x 1/2 in. All parts available separately. ONLY 27/6 P. & P. 1/6. Battery 1/- extra. The best 2-transistor kit you have ever seen!!

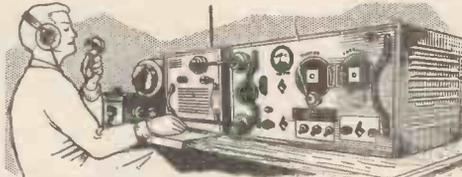
PRECISION 1% RESISTORS
Manufactured by Electrothermal, we offer the following values: 100K, 500K, all ±1/2% 1 watt, 1/9 each; 20/- per dozen.

NEW! SUPER MINIATURE EARPHONE FOR TRANSISTOR CIRCUITS



Here is a really sensitive dynamic earphone of exceptionally fine quality. This lightweight miniature earpiece is convenient and comfortable to wear. The practically invisible cord is connected to the earphone. Provides clear reproduction of music as well as speech. Fully Guaranteed and complete with transparent ear insert, 3 feet cord, sub-miniature plug and socket. Model CR.5 Crystal Earpiece, high imp. 8/- Model MR-4 Magnetic Earpiece, low imp. 7/- Post 1/-.

WIRELESS SET No. 19 MK. II



I.F. being 465 Kc/s., and a 6 valve transmitter designed for voice and C.W. operation. Incorporates test and tuning meter for voltages, aerial loading and current tests. Panel Controls: Frequency tuning, P.A. tuning, Gain control, MCW, CW, R/T switch, Het-tone, netting, off-on, Quench, aerial-AVC-LT-HT-Drive tests. Supplied complete with 15 valves and instruction book Complete station (as illus.), comprising: 19 set, Supply Unit, Control box, Headphones, Microphones, Morse Key, Variometer, Short Wave and V.H.F. Aerials and bases and full set of leads. All for only **£9.** Carr. 25/-.

SET 65/- Carr. 10/-

This most famous Army Trans/Receiver covers 2-8 Mc/s. (150-37 metres) in two bands and 230-240 Mc/s. V.H.F. Has an intercom. amplifier. Designed for 12 and 24 volt operation. Uses a 6 valve superhet receiver.

PORTABLE RADIOPHONES MODEL MK II

ONLY 60/- EACH
P. & P. 4/-
2 for £6 post free.

Batteries 20/- Per Set

Brand New British Army Portable Transmitter Receivers.

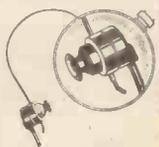
Designed for reliable voice intercommunication operating up to 10 miles depending upon obstructions and elevation. The combined Transmitter Receiver covers the whole frequency range between 7.4-9 Mc/s. and is fully tunable on both Transmitter and Receiver. Simple and a delight to operate as all controls are mounted on the front panel of the set and clearly marked. Operates from standard dry batteries 3 v. L.T. and 120 v. H.T. Incorporate 5 valves: R.F. Amplifier, I.F. Amplifier, Second Detector, Output and Power Amplifier.

All sets are supplied complete with all accessories comprising dynamic sound powered headphones, electro magnetic super-sensitive microphone, 4ft. aerial, junction box, battery connection details and full circuit diagram.

AMERICAN LIGHTWEIGHT HEAD SET

They're High and Low Impedance!

These H.S.30 phones are the smallest used by U.S. Air Force. 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality. Supplied free is a small transformer unit with cord and plug which steps impedance up to 4,000Ω. Only 15/- P. & P. 2/6



COMMUNICATION RECEIVER R.206

Frequency range 550 kc/s.-30 Mc/s. on 6 frequency ranges. Panel Controls: two speed, backlash free, tuning control. Frequency range selector. Very fine osc. vernier tuning control. Aerial trimmer. L.F. Gain, H.F. Gain, I.F. Bandwidth switch; 0.7, 2.5 or 8 kc/s. A.V.C. switch, B.F.O. control. 900 c/s. filter switch. Transient interference limiter. Aerial, earth, muting, phones and line inputs. Designed for use with an external A.C. or D.C. power supply. Receiver dimensions 25 x 13 x 13 1/2 in. Supplied complete with A.C./D.C. power unit with internal speaker. Original cost over £175. Very limited quantity offered at only £22/10/-, carr. 50/-

LEAD ACID ACCUMULATORS

(unspillable). 2 volts 16 A.H. Ideal for 6 volts and 12 volts supply. Brand new original cartons. Size 5/6 each. 4in. x 7in. x 2in. P. & P. 1/6. 3 for 15/- P. & P. 3/6. 6 for 27/6 P. & P. 5/-



POCKET VOLT TEST METER
Two D.C. ranges; 0-250 v. and 0-25 v. Complete with test prods. and leather case. Very limited quantity. Only 12/6. P. & P. 1/6.

R.F. UNITS
R.F. 24. 20-30 Mc/s. Switched tuning 22/6.
R.F. 25. 40-50 Mc/s. switched tuning, 8/6.
R.F. 27. 65-85 Mc/s. Variable tuning, 29/6.
Circuits supplied. P. & P. 3/6 on each.

POCKET MULTIMETER
Brand new. 2,500 o.p.v. Multi range 6/30/120/300/1,200 v. D.C. direct 0-1 k., 0-1 m e g o h m ; 400 micro - A., 12 mA., 300 mA. — 00 to +65 db., 1 1/2 in. Large clear dial. Leads supplied. ONLY 70/- P. & P. 2/6.

SPARE VALVE KIT.

Here's a gift for all 38 and 18 Set owners! Case containing 4 ARP12 & 1 ATP4 valves. Only 10/- P. & P. 2/6.



Callers: 87 TOTTENHAM COURT ROAD, LONDON, W.1
Mail Orders: (DEPT. W.) 32a COPTIC ST., LONDON, W.C.1. MUS. 9606

DOUBLE BEAM 'SCOPE'

For D.C. & A.C. APPLICATIONS



Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This "SCOPE" will appeal particularly to service Engineers and Amateurs. A high gain, extremely stable differential Y-Amplifier (80 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for measurement of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Push-Pull X amplifier; Flyback suppression; Internal Time Base Scan Waveform available for external use; pulse output available for checking T.V. Line Q/P Transformers, etc.; Provision for external X I/P and CRT. Brightness Modulation. A.C. mains 200/250 v. £19/19/- plus P. & P. 7/6, or 50/- deposit, plus P. & P. 7/6 and 12 monthly payments of 33/4.

FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE

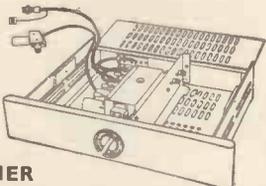
ALIGNMENT ANALYSER TYPE MC12

A.C. MAINS, 200/250 volts. Provides:—"WOBBULATOR" (SWEEP FREQUENCY) OPERATION, for FM/TV alignment line; frequency sweep up to 12 Mc/s. From 400 Kc/s—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0-60 pf. and 0—120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit L.F. transformer, etc. to be rapidly determined. Cash price £6/19/6 and 5/- P. & P. H.P. terms 25/- deposit and 5/- P. & P. and 6 monthly payments of 21/6



CHANNEL TUNER

Will tune to all Band 1 and Band II stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series) I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied). Complete with knobs.



32/6 Plus 3/6 P. & P.

HEATER TRANSFORMER

To suit the above, 200-250 v. 6/- Plus 1/6 P. & P.

B.S.R. MONARCH UA8 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: 12 1/2in. x 10 1/2in. Space required above baseboard 4 1/2in. below baseboard 2 1/2in. Fitted with Ful-Fi turnover crystal head. £6/19/6. Plus 5/- P. & P.

STEREO HEAD 27/19/6 Plus 5/- P. & P.

LINE E.H.T. TRANSFORMER

With built-in line and width control. 14 KV. Scan coil, 90° 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.

As above, but for 625 lines
 29/6 Plus 4/- P. & P.
 £2.10 Plus 4/- P. & P.

FOCUS MAGNET suitable for the above (state tube), 10/- 2/6 P. & P.

MAINS TRANSFORMERS

All with tapped primaries 200-250 volts.

0-160, 180, 200 v., 60 ma., 6.3 v., 2 amp., 10/6. 280-0-280, 80 ma., 6.3 v., 2 amp., 6.3 v., 1 amp., 10/6. 350-0-350, 70 ma., 6.3 v., 1 amp., 10/6. 250-0-250 70 ma., 6.3 v., 2 amp., 10/6. Postage and packing on the above 3/-.

SURFACE BARRIER TRANSISTORS

type SB 305, 15 Mc/s. 7/6 each.

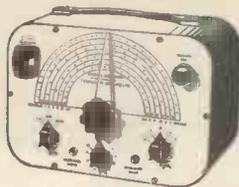
100% AUDIO TRANSISTORS

5/- each.

BATTERY RECORD PLAYER AND AMPLIFIER

Incorporating 45 r.p.m. "Start" motor, "Acos" crystal pick-up, 3 transistor push-pull amplifier complete with transistors. Output 500 milliwatts, 49/6 plus 3/6 P. & P.

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 6 1/2in. x 5 1/2in. 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 B.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%.

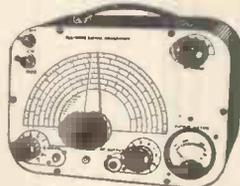
Or 25/- deposit and 6 monthly payments of 21/6. Post & Packing 5/- extra.

£6/19/6

SIGNAL GENERATOR

Coverage 120 Kc/s.—230 Kc/s., 300 Kc/s.—900 Kc/s., 900 Kc/s.—2.75 Mc/s., 2.75 Mc/s.—8.5 Mc/s., 8 Mc/s.—28 Mc/s., 16 Mc/s.—56 Mc/s., 24 Mc/s., 84 Mc/s. Metal case 10in. x 6 1/2in. x 4 1/2in. Size of scale 6 1/2in. x 3 1/2in. valves and rectifier. A.C. mains 200-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated B.F. Output continuously variable, 100 millivolts C.W. and mod. switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.

£4/19/6



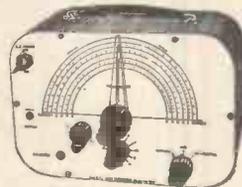
Or 25/- deposit and 4 monthly payments 21/6. P. & P. 5/- extra

SIGNAL & PATTERN GENERATOR

£6/19/6

P. & P. 5/-

Or 25/- deposit. P. & P. 5/- and 6 monthly payments of 21/6. Coverage 7 1/6 Mc/s.—210 Mc/s. in five bands all on fundamentals slow motion tuning audio output. 8 vertical and horizontal bars, logarithmic scale. In grey hammer finished case with carrying handle. Accuracy ± 1% A.C. mains 200-250 v.



CYLDON TURRET TELETUNER

I F 34/38 Mc/s. Brand new complete with biscuit for channels 2, 4, 8 & 9.

less valves 10/- plus 2/6 P. & P.
 (Valves required P.C.C. 84 & P.C.F. 80.)
 Pair of knobs to suit above, 3/6.

3-TRANSISTOR POCKET RADIO INCORPORATING MINIATURE SPEAKER

Plus GERMANIUM DIODE and PRINTED CIRCUIT

Size 3 1/2" x 4" x 7/8"

Incorporating Ferrite Rod Aerial. Two Surface Barrier Transistors and one Audio. Tunable over medium and long waves.

To build yourself 39/6 Plus 1/6 P. & P.

ALL PARTS SOLD SEPARATELY. Circuit diagram 1/6, free with kit.



All transistors guaranteed 100%

8 WATT PUSH-PULL AMPLIFIER

COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER

A.C. mains 200/250 v. Size 10 1/2in. x 6 1/2in. x 2 1/2in. Incorporating 8 valves, B.F. pen., 2 triodes, 2 output pens., and rectifier. For use with all makes and types of pick-up and mike. Negative feedback. Two inputs, mike and gram., and controls for same. Separate controls for Bass and Treble lit. Response flat from 40 cycles to 18 Kc/s. ± 2 db.; 4 db. down to 20 Kc/s. Output 8 watts at 5% total distortion. Noise level 40 db down, all hum. Output transformer tapped for 3 and 16 ohm speech coils. For use with Std. or L.F. records, musical instruments such as Guitars, etc.

£4.19.6 Plus P. & P. 7/6.



Or £1 deposit, plus P. & P. 7/6 and 4 monthly payments of 23/-.

PORTABLE AMPLIFIER on printed circuit for A.C. Mains 200/250 v. Size 4in. x 3in. with tone and volume control. Valves: ECL82 and E280, 39/6. P. & P. 2/6.

BUILT POWER SUPPLY UNIT, A.C. Mains 200-250 v., D.C. output, 250 v. at 75 ma., also 6.3 v., 2 amp. heater winding, 21/- Plus 3/6 P. & P.

RADIO AND T.V. COMPONENTS (ACTON) LTD.

23b, ACTON HIGH STREET, LONDON, W.3

GOODS NOT DESPATCHED OUTSIDE U.K. ALL ENQUIRIES S.A.E. TERMS OF BUSINESS C.W.O.



FOR VALVES, TUBES AND COMPONENTS—BY RETURN POST SERVICE

AIr-4	3/-	KT33C	8/-	VP41	8/6	6L7	7/6
AZ1	10/-	KT61	19/3	VR105/30	8/6	6L8	8/6
AZ31	10/-	KT63	7/-	VR116	4/-	6L9	3/6
B36	10/-	KT66	23/3	VR150/30	7/6	6N7GT	10/-
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D42	5/-	KT76	6/6	VU39 (MU)	6/6	6Q7G	3/6
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DF96	8/-	KTW61	6/6	VU111	2/6	6SA7GT	9/6
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DK95	8/-	KTZ41	3/6	W76	6/6	6SH7	4/6
DL63	9/-	MH41	7/9	W77	8/6	6S17	8/6
DL82	10/6	MHL4	7/6	W101	10/-	6SK7	6/-
DL96	8/-	MSP4/5	7/6	W729	10/6	6SL7GT	6/-
DM70	7/6	MSP4/7	7/6	W61	6/6	6SN7GT	7/6
DN41	12/6	MSP41	6/-	W61 (M)	8/-	6SQ7	9/3
EASO	1/6	MX40	12/6	X22 CI	24/7	6U4GT	12/-
EABC80	9/-	OZ4	5/6	X41M	12/6	6U5G	8/6
EAF42	9/6	P61	3/6	X101M	8/-	6U7G	8/6
EB34	2/-	PCC84	8/6	Y63	7/6	6V6G	6/-
EB41	8/6	PCC85	11/6	Z21 (4 pin)	5/-	6V6GT	7/6
EB91	4/-	PCF80	8/9	Z309	26/6	6X4	6/9
EBC33	6/9	PCF82	11/6	Z359	9/6	6X5G	7/-
EBC41	8/9	PCL82	12/-	IA7GT	12/6	6X5GT	7/6
EBF80	9/9	PCL83	13/6	AC2	11/6	6X0L2	12/-
EBF89	9/6	PL36	15/-	IC5GT	12/6	7B6	10/6
ECC81	7/6	PL81	11/-	IHSGT	9/-	7B7	8/6
ECC82	8/-	PL82	8/6	IL4	4/-	7B8	6/-
ECC83	8/-	PL83	8/6	ILD5	3/6	7C5	8/6
ECC84	10/-	PL84	12/7	INS	10/6	7C6	8/-
ECC85	9/6	PL820	18/7	IR5	7/6	7D6	13/6
ECF80	12/-	PX25	12/6	IS4	10/6	7H7	8/-
ECF82	10/6	PY80	7/6	IS5	6/6	7Q7	9/-
ECH42	9/6	PY81	8/6	IT4	5/6	7S7	9/6
ECH81	9/-	PY82	7/-	3A5	12/6	7Y4	8/-
ECL80	9/6	PY83	8/6	3A8GT	6/-	8D2	2/9
ECL82	10/6	PEN4VA	10/-	3D6	5/-	9D2	3/6
ECL83	19/3	PEN25	6/-	3Q4	7/6	10D2	12/-
EF22	8/6	PEN45	26/6	3Q5GT	9/6	10F1	15/-
EF36	4/-	PEN46	7/-	3S4	7/6	12A6	5/-
EF37A	15/-	PEN220A	4/-	3V4	8/-	12A8H	12/-
EF39	5/9	PEN4A	12/6	4D1	3/-	12A7	9/-
EF40	13/6	PM12M	8/-	5R4GY	9/6	12A7T	7/6
EF41	9/6	QP21	5/-	5U4G	6/-	12A6U	8/-
EF42	11/-	SP41	3/-	5V4G	11/6	12A6U7	8/-
EF50	4/-	SP61	3/-	5Y3G	8/-	12AX7	8/-
EF50SYL	7/-	SP45	10/6	5Y3GT	7/6	12BA6	9/-
EF54	6/-	SP47	10/6	5Z4G	9/-	12B6E	9/-
EF55	10/-	TP25	10/-	5Z4M	10/-	12C8GT	7/6
EF80	7/-	U10	9/6	6A7	10/-	12H6	3/6
EF85	7/-	U14	8/6	6A8G	9/-	12J5GT	3/-
EF86	12/6	M4	8/6	6AC7	4/-	12J7GT	10/6
EF89	8/9	M54B	10/-	6AG5	5/6	12K7GT	6/6
EF91	4/-	U16	12/6	6AK5	5/-	12K8GT	13/6
EF92	17/3	U22	8/-	6AL5	4/-	12Q7GT	6/6
EK32	7/-	U25	13/6	6AM5	4/-	12SG7	7/6
EL32	4/6	U26	10/-	6AM6	4/-	12SH7	6/-
EL33	14/-	U37	26/6	6AQ5	7/6	12SJ7	6/-
EL34	15/-	U45	15/6	6AT6	8/6	12SK7	6/-
EL41	9/-	U50	8/-	6AU6	10/6	12SL7GT	8/-
EL42	10/6	U76	7/-	6B8G	4/-	12SN7GT	10/-
EL84	9/-	U81	8/-	6BA6	7/6	14S7	17/-
EN19	4/-	U82	8/-	6BE6	7/6	15D2	7/9
EN34	9/6	U101	8/-	6BH6	9/-	25A6G	10/6
EN80	9/6	U191	16/7	6BJ6	9/-	25L6GT	10/-
EM81	10/6	U329	23/3	6BR7	12/6	25Z4G	9/6
EY51	9/6	U403	16/7	6BW6	9/6	25Z5	8/-
EY81	13/3	U404	11/4	6BW7	7/-	25Z6	8/-
EY86	10/-	UABC80	9/6	6C4	4/6	30C1	8/9
EZ40	7/6	UAF42	9/6	6CSGT	16/7	30F5	10/6
EZ41	7/6	UB41	9/-	6C6	5/-	30FL1	10/6
EZ80	7/6	UBC41	8/6	6D6	5/-	30P4	15/-
EZ81	7/6	UBF80	9/6	6CH6	8/6	30P12	12/6
EZ90	7/6	UCC84	10/11	6FG6	7/6	30P16	8/6
E638	26/6	UCC85	9/6	6FGM	7/6	30PL1	12/6
E1148	2/-	UCH42	9/6	6F33	7/6	35L6GT	10/-
FW4/500	10/-	UCH81	9/6	6H6	2/6	25Y5	9/9
GZ32	11/6	UCL82	11/6	6HG6GT	2/6	35V4	7/6
H30	5/-	UCL83	13/6	6J5G	3/6	35Z4GT	7/-
H63	8/6	UF41	9/-	6J5GT	5/-	42	8/-
HL23DD	8/6	UF80	10/6	6J5M	6/-	35Z5GT	9/-
KF35	8/6	UF85	9/-	6J6	5/6	30C5	11/6
KT2	5/-	UF89	9/-	6J7G	6/6	50L6GT	8/6
KT24	5/-	UL41	9/-	6K7G	3/6	75	10/6
KT32	14/-	UL84	9/-	6K7M	6/9	77	6/-

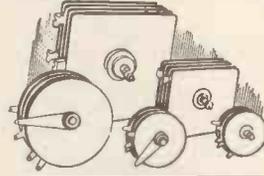
TRANSFORMERS

- T1** Standard, Primary 200/250 v., Secondary 250v.-0-250v. @ 80ma., 6.3v. @ 4a. tapped 4 v. and 5v. @ 2a. tapped 4v. 21/9 each.
- T2** Primary 200/250v., Secondary 350v.-0-350v. @ 80ma., 6.3v., @ 4a. tapped 4v. and 5v. @ 2a. tapped 4v. 21/9 each.
- Istone MR7** Multi-Ratio Output Transformer, Rating 10 watts, max. primary current each half, 80mA., 14 Single Ended Ratios, 11 Push-Pull 23/-

METAL RECTIFIERS

Alpha Range of Guaranteed Bridge Rectifiers suitable for Battery Chargers 6 and 12 volt output:

- 2 amp. 7/-
- 3 amp. 12/6
- 4 amp. 10/-
- 5 amp. 14/6



LOUDSPEAKER UNITS

All Brand New.

- 2 1/2 in. Square Rola C25 26/10
- 5 in. Round Plessey with O.P.T. 16/6
- 6 1/2 in. Round Celestion 17/6
- 8 in. Round Richard Allen 18/6

All Permanent Magnet.

- 10 in. Round Elac 25/-
- 12 in. Round Plessey 29/6
- 12 in. Round Plessey 15 ohms speechcoil 22/6
- 6 in. x 4 in. Plessey 19/6
- 7 in. x 4 in. Plessey 19/6
- 8 in. x 5 in. Celestion and Richard Allen 25/6
- 10 in. x 6 in. Celestion and Plessey 25/6

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MAINS DROPPER RESISTORS

Available in the following types:

- | Type | Amps | Ohms | Size | each |
|---------------|---------|-------|-----------------------|------|
| Midget Type | 1 amp. | 2,000 | 3/4 in. x 2 1/2 in. | 5/3 |
| | 15 amp. | 1,500 | 1 1/2 in. x 2 1/2 in. | 5/3 |
| Standard Type | 2 amp. | 1,000 | 1 1/2 in. x 2 1/2 in. | 6/- |
| | 3 amp. | 1,000 | 1 1/2 in. x 2 1/2 in. | 6/- |
| | 2 amp. | 1,000 | 3/4 in. x 2 1/2 in. | 6/- |
| Long Type | 2 amp. | 1,000 | 3 1/2 in. x 2 1/2 in. | 6/- |
| | 3 amp. | 1,000 | 3 1/2 in. x 2 1/2 in. | 6/- |

The above droppers have a fixed clip at each end and 2 slider clips.

SINGLE PLAYERS

GARRARD MODEL TA/MKII

4-speed single player. Diecast aluminium pick-up with GC2 cartridge. Automatic stop. 9 1/2 in. diameter turntable, £8/19/4.

COLLARO JUNIOR

4-speed, turntable and pick-up. Complete with crystal cartridge and sapphire stylus. Finish cream with maroon turntable mat and speed control. Price 75/- or turntable and motor only at 52/6. Pick-up only 27/6.

ACOS MICROPHONES

Acos Mic 39/1. Crystal Stick Microphones for use as a hand, desk or floor stand unit for high quality recording, broadcasting and public address work. List Price £5/5/-. OUR PRICE 39/6. With table stand 47/6. With floor stand adaptor 52/6. Postage 1/6.

Acos Mic 40, as supplied with most modern tape recorders with folding rest and 8ft. lead. Listed £11/5/-. Our Price 19/6.

COLLARO STUDIO

TAPE TRANSCRIBTOR

3 motors, 3-speed 1 1/2, 3 1/2, 7 1/2 l.p.s., takes 7 in. spool. Push button control. PRICE £15/15/-. Tape extra. Carriage and Insurance 5/6.

COLLARO MK IV

TAPE TRANSCRIBTOR

Four heads. Twin track operation. Pause control. Tape measuring and calibration device. Two motors. Fast re-wind. 7 in. tape spool. Three speeds: 3 1/2 in., 7 1/2 in., and 15 in. per second. Finish cream polystyrene cover plate with maroon control. Delivery from stock. £17/19/6.

"CABY" SUPREME MULTI-RANGE TEST METER

Solves your Problems with Speed and Accuracy.

Model A-10. Measurement Ranges: D.C. Volts 10 v. to 1000v. A.C. Volts 10v., 50v., 250v., 500v. 1000v.

Resistance ohm: 10K ohms. 1 megohm.

Size of Meter: 5 1/2 in. x 3 1/2 in. x 1 1/2 in. Price £4/17/6 (X) Inclusive of test prods, instruction book and batteries.

REPANCO ONE VALVE BATTERY RECEIVER

Includes metal chassis, headphones, battery, valve and all other parts. An ideal set for the beginner. Can be easily modified at a later date for output valve and speaker. Price 45/- each. Envelope with full details 9d.

AUTOMATIC RECORD CHANGER UNITS

BSR "MONARCH" UA8. 4-speed unit with B.S.R. FULFI cartridge, £6/19/6.

B.S.R. "MONARCH" UA8. As above but fitted with B.S.R. FULFI STEREO Cartridge £7/19/6.

B.S.R. "MONARCH" UA12. 4 speed unit in green and cream. £8/19/6.

B.S.R. "MONARCH" UA14. 4 speed unit in two tone grey, £8/19/6.

COLLARO "CONQUEST" 4-speed fully mixing changer, complete with studio "O" cartridge, £7/19/6.

GARRARD RC120 MK. 2. 4-speed unit with manual control to enable records to be played singly, fitted GC2 cartridge, £8/19/6.

SINGLE CABLES

All P.V.C. covered. In various colours:—Red, Black, Blue, Yellow etc. 7/18, 1/066, 1/044, 23/0076, 14/0076 etc., all 1 1/2d. per yard. Special price for quantities.

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**1 Watt
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High quality unit with neg. feedback giving 1 watt Audio output into 3 ohm Speaker.

AMP KIT only £3.19.6 Carr. 2/6.

Wired and tested, 17/8 extra.

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- 6 v. operation (2 E/R Type 800 batts.)
- 1 watt Push-Pull output
- 4 latest G.E.C. Transistors
- 3 ohm 7 x 4in. Quality Speaker
- Garrard Fidelity Gram. Unit

COMPLETE RECORD PLAYER KIT (3 Units) only **£7.19.6** Carr. 3/6.

Circuit diagram, full technical spec. and constructional details (free with kit), 2/6 post free.

Size: 11 x 9 x 5in.

Colour: Two-tone Red/White with Polka Dot Reel. Alternative Blue/Pawn with Polka Dot Reel.

★ **CABINET** incl. Motor Board and 7 x 4in. Speaker, 39/6. Carr. 2/6.

★ **GARRARD BA 1 Gram Unit**, 59/6. Carr. 2/6.



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RECORD PLAYER BARGAINS Latest 4-speed models

NEW RELEASE by E.M.L.—4-speed Single Player Unit fitted with latest stereo and monaural Xtal cartridge and dual sapphire styl. Auto stop and start. A fidelity unit and bargain buy at only 26/19/6, carr. & ins. 3/6.

SINGLE PLAYERS. B.S.R. (TU9) 90/-; COLLARO JUNIOR studio P.U. 24/10/-
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Model TA Mk. 2, 27/19/6. Carr. 3/6.
Model 4HF, £18. Carr. 3/6.

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Model RC210, 10 gns. Carr. 4/6.
All current 4-speed models. Brand new and boxed.

NEW BOXED VALVES ALL GUARANTEED

1T4	6/-	EABC808/6	EZ81	7/6
1R5, 1R57/8	8/6	ECC84 9/6	6X4	9/-
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SPECIAL PRICE PER SET
1R5, 1T4, 1R5, or 384 or 3V4, 25/-
DK96, DF96, DAF96, DL96, 35/-
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5, 32/6

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Cabinet Price **£3.3.0**
Carr. and Ins. 3/6



Contemporary style, reline covered cabinet in mottled red and white polka dot. Size 18 1/2 x 13 1/2 x 8 1/2 in. fitted with all accessories including baffle board and anodised metal fret. Space available for all modern amplifiers and auto-changers, etc. Uncut record player mounting board 14 x 13 in. supplied.

2-VALVE 2-WATT AMPLIFIER
Twin stage ECL82 with vol. and neg. feedback Tone control. AC 200/250 v. with knobs, etc., ready wired to fit above cabinet. 22/17/6 P. & P. 1/- 6in. Spkr. & trans. 22/- P. & P. 1/6.

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Designer-approved kits of parts for these quality and highly popular tuners available as follows:—

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MODEL JTV2. Self-powered Switch Tuned B1-B2-B3 AM/FM Unit. 5 preset stations, AFC and AGC circuits. Complete Kit incl. ready-built and valued Turret Tuner, £12/19/- post free. 4 spec. valves, 32/6 extra.

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MAINS TRANS. AND QUALITY OUTPUT TRANS. Mid. in our own workshops to top grade spec. Fully interleaved and impregnated. Enquiries welcomed for small production runs, prototypes or individual jobs.

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MAZDA	MULLARD	G.E.C.
XA101 14/6	OC70 9/6	GET114 9/6
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XA104 18/-	OC44 23/6	"Goldtop"
XB102 10/-	OC45 21/-	V15/10P
XC106 10/6	OC16 49/6	15/-
Germanium Diodes OA70 2/9; OA81 3/6; OEX34 4/-.		

RECORDING TAPE BARGAINS

EMI 1st grade. Brand new sealed boxes.			
	Standard	Long Play	
5in., 175ft.	7/-	250ft.	9/-
5in., 600ft.	19/-	850ft.	25/-
5in., 850ft.	25/-	1,200ft.	31/6
7in., 1,200ft.	31/6	1,800ft.	45/-

SPECIAL PURCHASE. Famous manufacturers, 1st grade tape, in sealed white boxes.

	Standard	Long Play	
5in., 600ft.	15/-	850ft.	19/6
5in., 850ft.	18/6	1,200ft.	22/6
7in., 1,200ft.	21/-	1,800ft.	32/6

Plastic Tape Reels, special offer. Manufacturer's surplus. 3in. 2/9, 5in. 3/-, 5 1/2in. 3/3, 7in. 3/6.

2 WAVEBAND CAR RADIO KIT Recommended Buy

Modern development of the famous Brimar Hybrid vibratorless car radio circuit. Five latest type Brimar low vol age valves and power transistor. R.F. stage and permeability pre-aligned Cydon Tuner Unit provide extremely good sensitivity and signal noise ratio. Printed circuit for easy construction and 7 x 4in. elliptical speaker for fidelity output. Self-contained in neat metal cabinet 8 x 7 x 2 1/2 in., with attractive calibrated dial Speaker and power transistor stage mounted separately approx. 8 x 5 x 3in. Instruction booklet and parts list available, 3/6 post free.



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New Improved types, low capacity small size and tag terminated, A.C. 200/250 v. Rect. out. 250v. +25%, +50% BOOST for 2 v., 4 v., 6.3 v., 10.5 v., 12 v. or 13 v. tubes. 2/6 each. P. & P. 1/6.

COAX 80 ohm CABLE

Now only 6d. a yard.

High grade low loss Cellular Air Spaced Polythene—in. diam.—Famous mfr.

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20 yds.	9/- P. & P. 1/6
40 yds.	17/6 P. & P. 2/6
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Coax. Plugs, 1/-; Coax Sockets, 1/-; Couplers, 1/3; Cable End Sockets, 1/6; Outlet Boxes, 4/6.

RE-GUNNED TV TUBES NEW REDUCED PRICES

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All tubes rebuilt with new heater, cathode and gun assembly—reconditioned virtually as new.
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7 VALVE AM/FM RADIOGRAM CHASSIS

Valve Line-up: ECC85, ECH81, EF89, EABC80, EL84, L:81, EZ80.

Three Waveband and Switched Gram positions. Med. 200-500 m., Long 1,000-2,000 m. VHF/FM 88-96 Mc/s. Philips Continental Tuning insert with permeability tuning on FM and combined AM/FM IF transformers, 460 Kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13 1/2 x 6 1/2 in. Height 7 1/2 in. Edge illuminated glass dial 1 1/2 x 3 1/2 in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation.



Aligned and tested ready for use, £13. 10. 0 Carr. & Ins. 5/-.
Complete with 4 Knobs—walnut or ivory to choice. Indoor FM aerial 3/6 extra. Three ohm P.M. speaker only required. Recommended quality speakers:
16in. Rola (Heavy Duty) 30/-
8in. Goodmans special cone 21/6

As previously announced fresh supplies are now being received, but we regret some slight delay may be experienced in fulfilling orders for this popular item.

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Terms: C.W.O. or C.O.D., post and packing up to 1/2 lb. 7d.; 1lb. 1/1; 3lb. 1/6; 5lb. 2/-; 10lb. 2/9.



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including Cabinet, Battery Transistors, Car Radio, AVC and all necessary items.

- ★ SIMPLE TO CONSTRUCT
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★ **RANGER—2** ★ (Supersedes the Major 2)
MEDIUM WAVE AND TOP BAND PERSONAL POCKET RADIO (120 metres to 500 metres coverage)
● LUXEMBOURG GUARANTEED ● (where normally receivable)
★ Full Station Separation ★ 9 Months' Battery Life ★
★ NO EXTERNAL AERIAL OR EARTH REQUIRED ★
★ Size 4½ x 3 x 1½in. ★ Weight only ½ ozs.

Total cost of all items with battery, transistors and personal earphone, etc. **65/-** P.P. 1/6.

All components sold separately and Fully Guaranteed.

EASY TO BUILD, SIMPLE TO USE

NO Reaction Controls.

Building Instructions and Prices FREE On Request

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FULL TUNING OF MEDIUM WAVEBAND AND AMATEUR TOP BAND (120 metres to 500 metres or 600 kc/s to 2.5 Mc/s coverage)
● LUXEMBOURG GUARANTEED ● (where normally receivable)

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- ★ 6 Months' Battery Life
- ★ Fitted Volume Control
- ★ No External Aerial or Earth
- ★ Size 4½ x 3 x 1½in.
- ★ Weight 4½ ozs.

TOTAL COST with Personal Earphone, Battery, Transistors, etc. **79/6** P.P. 1/6

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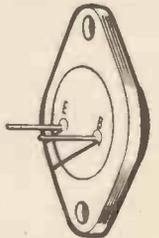
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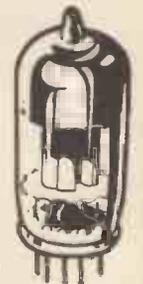
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"STEREO 3-D"

New high-gain circuit with full tone, balance and volume controls. Can be used with all types of records as well as stereo.

- ★ 2 WATTS PEAK PER CHANNEL
 - ★ ECC83; 2-ECL82 VALVES
 - ★ MAINS 110/250V A.C.
- Complete with speaker sockets, calibrated dials etc. **£5.7.6** P.P. 2/-
BUILT AND TESTED

- ★ ★ COLLARO 4-SPEED STEREO AUTO-CHANGER, ideal for use with above amplifier.....£7.10.0 P.P. 3/6.
- ★ ★ 9 x 6in. large magnet Elac speaker, for use with STEREO 3-D, 37/- pair. P.P. 1/6.

CRYSTAL MICROPHONES

- Acos 39-1. Stick microphone with screened cable and stand, 39/6. P.P. 1/6.
- Acos 40. Desk microphone with fold away stand and lead, 19/6. P.P. 1/6.
- Acos 45. New hand microphone with screened lead, 29/6. P.P. 1/6.

TRANSMITTER/RECEIVER Army Type 17 Mk. II

Complete with Valves, High Resistance Head-phones, Handmike and Instruction Book and circuit. Frequency range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120 v. H.P. and 2 v. L.T. Ideal for Civil Defence and communications. BRAND NEW



45/- P.P. 5/-



CRYSTAL MICROPHONE INSERTS

Fully Guaranteed

- ★ ACOS 43-1, 2½in. round 12/6, P.P. 6d.
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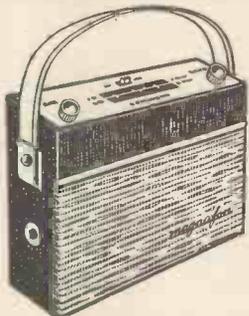
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Following the success of our recent Cossor transistor receiver, we are now introducing the new

MIGHTY SIX TRANSISTOR PORTABLE A NEW TRANSISTOR PORTABLE RECEIVER. Build this mighty six transistor superhet battery portable. Circuit description 6 Mullard transistors, OC44, 2-OC45, 1-OC81D, 2 matched OC81, 1-X1 diode, printed circuit, internal ferrite aerial, 5in. loudspeaker Assembled dial assembly, medium and long wave coverage, 500 M/W output, attractive blue/cream two tone cabinet, size 8 1/2 in. x 6 1/2 in. x 3 in. Weight approx. 3 lb. Detailed point to point and theoretical diagram, including all components for easy construction. Only £9/15/-, plus 3/- post and pkg. E/ready PPT battery 3/3. Instructions and circuit 1/6 post free.

THE NEW JASON range for CONSTRUCTORS

FMT1 FM Tuner. In kit form for cabinet mounting. One of the most popular tuners. Up to 60 miles normal range. Less valves £5/19/-. Power pack kit £2/14/9.
FMT2. In kit form with free standing case with power pack. Less valves £8/15/-.
FMT3. Variable tuner 88-108 mc/s. Variable AFC control dual limiters, approx. 80 mile range, less valves £9/19/-.
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MERCURY II switched FM/TV sound tuner in kit form for building into cabinet, less valves, £10/14/-. Power pack kit, £2/14/9. Valves for above kits extra.
EVEREST 6 s/het transistor portable, p/pull output, high quality speaker, matched transistors, neatly designed case, aerial input for use in car complete kit £13/19/9.
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A SNIP FOR CONSTRUCTORS

Build the Labgear Audio Output meter. Two ranges—25 milliwatts to 1 watt, 1 watt to 100 watts. Accuracy 5%. Input impedance 3, 15 and 600 ohms. Printed circuit. All components including 0-1MA moving coil meter and silver hammettone enamel case. Kit complete with instructions 59/6, post and pkg. 1/6.

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Due to the overwhelming demand, we are now approaching the end of our stocks of the famous

AVANTIC BEAM-ECHO EQUIPMENT

but can still offer the following amazing bargains of brand new Hi-Fi equipment in sealed cartons fully guaranteed.

AVANTIC DL7-35 Power Amplifier

An amplifier faultless in performance. 50W peak, intermodulation distortion 0.7% at 20W. Power response: 20W linear from 30c/s to 20Kc/s. Frequency response: 5 c/s to 30 Kc/s. ± ODB 4, 8 and 16 ohms switch selected load impedance. Sensitivity: 220 MV for 20W output. Maker's price of amplifier £31/10/-. OUR PRICE NOW £16/19/6. Post and packing 12/6.

THIS AMAZING STEREO COMBINATION OFFER.

47 Gns. for £90's worth of equipment.

2—DL7-35 POWER AMPLIFIERS AS ABOVE, AND SP21 STEREO CONTROL UNIT AS BELOW. THE 3 ITEMS AT 47 GNS. Plus 30/- Carriage and Crating.

SP21 STEREO PRE-AMP CONTROL UNIT

A twin channel pre amp. control unit, has 6 inputs for each channel INPUT SENSITIVITY for 250 M/V or 1.5V output TUNER 100 and 250 M/V. Tape 100 M/V flats 250 M/V. PICK-UP 5 and 50 M/V. Frequency response: 40 c/s. to 15 Kc/s. TAPE OUTPUT 50 M/V., continuously variable bass and treble controls, loudness control and stereo balance control. Power required 6.3 V. at 1.3 amp. A.C. 350 v. at 5 M/A D.C. Manufacturers price £28/10/-. OUR PRICE now £16/19/6. Carr. and packing 7/6.

AVANTIC PL6-21

High quality monaural power amplifier and pre-amp compactly housed and suitable for shelf mounting or cabinet. Two EL84, three EF86, one ECC83, one EZ81. 30 watts peak; speaker impedance, 4, 8 or 16 ohms. Sensitivity: 4MV on pickup, 3MV on tape, 100MV on tuner. Intermod distortion 1% at 10W equivalent Sinewave output. Maker's price £28/10/-. OUR PRICE 19 gns. Post and packing 7/6.

AVANTIC SPA11 Stereo Amplifier

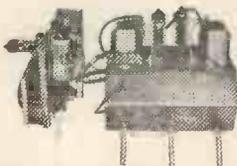
A twin channel amplifier and pre-amp., push-pull output, 10W peak each channel, rumble filter, speaker impedance 4, 8 and 16 ohms. Tape output: 100MV. Continuously variable treble and bass, stereo balance control. Input sensitivity: for 7W, 100MV radio: 100MV tape: 650MV pickup Manufacturer's price 28 gns. OUR PRICE 19 gns. Post and packing 7/6.

STEP II stereo pick up pre-amp. unit £4/14/6. P. & P. 2/6.

STEP 21 stereo tape pre-amp., £4/14/6. P. & P. 2/6.

A few only, Avantic Hi-Fi speaker cabinets slight blemish. Dimensions height 40 1/2 in., width 20 1/2 in., depth 14 1/2 in., baffle cut to house 1-15in., 2-5in. and 1-7 x 4 speaker, can be used with alternative speakers, porthole at base of cabinet. Nicely finished and well made. OUR PRICE £9/19/6. Carr. & Pkg. 20/-.

Limited number of this stereo offer

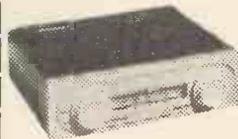


Compact stereo amplifier, 3 watts each channel using 2-ECL82 1-EZ80, separate balance and tone controls, volume and on/off switch, channel reverse switch, designed for crystal p/up, separate power pack, including 2-6 1/2 P.M. speakers in cabinets, finished imitation Rexine. Complete and ready for use. £8/19/6 P. & P. 10/-.

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Housed in two containers which are to replace AD35 and B126 Batteries. 37/6, Plus 2/- P. & P. only suitable for use with Dk96 Series valves.

LIMITED NUMBER



F.M. Tuner by the Ferguson Company. An attractive and compact unit in gold finish hammered metal case 10in. wide 7 1/2 in.

deep, 2 1/2 in. high. Neat escutcheon and tuning dial. Has own power supply. Uses two EF80, one ECF80, 2 Germanium diodes and metal rectifier. Coverage 87.6 Mc/s. to 98 Mc/s. (continuously). Will feed into any amplifier or radio. AT THE AMAZING PRICE OF

£12.19.6

2/6 Post and Packing.

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1 microvolt 0.1 attenuator
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23,500-24,500 mc/s. -40
to -80 dbm. power out-
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Receiver. Range 40-
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Sensitivity 85-60 µV.
This Receiver can be sup-
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and B.F. heads, 4 com-
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Condenser. Dual range.
35 pf.-615 pf. Nev. Un-
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We can quote for calibration.

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Many others for personal shoppers.
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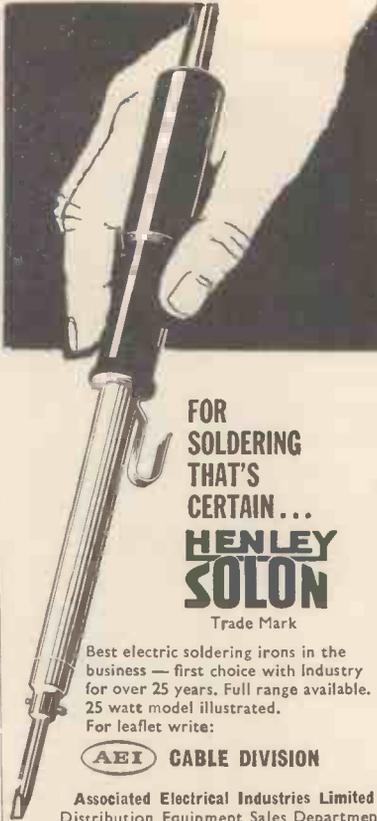
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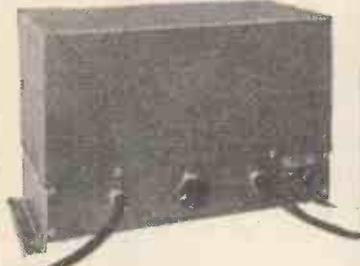
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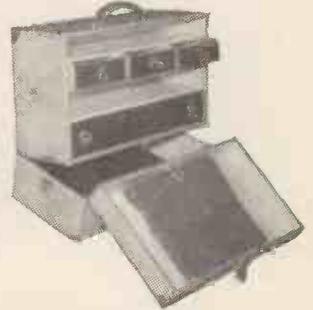
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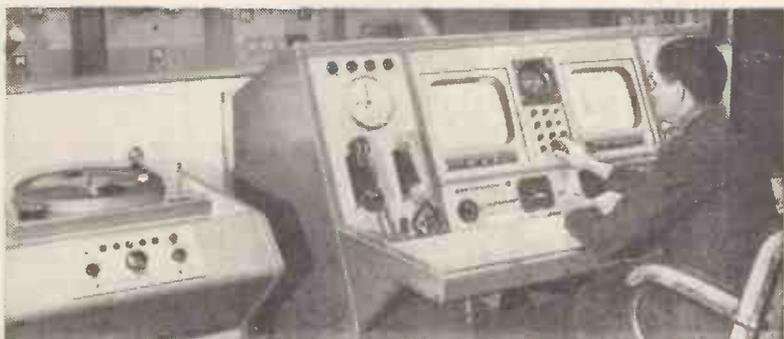
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required by the new Components Division of Elgar Laboratories (Elgar Trading Ltd.). H.N.C. Standard preferred, but a man with lower qualifications and previous sales experience in the field of electronic components, particularly resistors, will be considered. Please write in strictest confidence, giving details of experience and salary to:

**Managing Director,
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Opportunities exist at the Muswell Hill Factory of this old established Company for the following positions:—

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Applications should be addressed to Personnel Dept., Cambridge Instrument Co. Ltd., Sydney Road, Muswell Hill, N.10.

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**R. POWNALL,
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Applications are invited for the post of Digital Computer Maintenance Engineer for the Stantec-Zebra Computer now installed at Woolwich Polytechnic. Age 21-30. Applicants should have at least four years' experience in Radio or Allied Industry or Service training in Radio or Radar and be of O.N.C. (Electronics) standard.

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Application forms from Clerk to the Governors.

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Experienced circuit constructors are required at the Company's Works in Chelmsford, Essex to design and supervise the construction and maintenance of test equipment for the testing of specialised valves.

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Applications to:

Dept. G.P.S.
English Electric House
Strand, London, W.C.2.

quoting reference WW 1506H.

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Applications are invited for the following post in the **UGANDA GOVERNMENT, Information Department**. Appointment on contract for 1 tour of 30/36 months in first instance. Commencing salary (including Inducement Pay) according to age and experience up to maximum in scale rising to £1,566 a year. Outfit allowance of £30 payable in certain circumstances Free passages. Liberal leave on full salary.

BROADCASTING ENGINEER (TRAINING) (M2A/50941/WF)

Candidates, preferably under 45 years of age, must have teaching experience, ability to give theoretical instruction in telecommunication subjects and practical instruction in maintenance and operation of medium power broadcasting transmitters, studio control and recording equipment. A.M.I.E.E. an advantage.

BROADCASTING ENGINEER (M2A/50695/WF)

Candidates, preferably under 50 years of age, should possess Final C. & G. Telecommunications (with radio) or equivalent and have had wide practical experience of technical broadcasting equipment, including transmitters and control equipment. A.M.I.E.E. an advantage.

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He will have an overall responsibility for the testing and inspection of complex electronic units of prototype equipment in the development stages and will work in close contact with design engineers to ensure satisfactory performance standards can be adequately specified.

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Applicants should write, giving full details and quoting Ref. EL/9/A1 to:

Personnel Manager,
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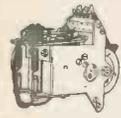
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Power approx. 5 watts at 7.000. R.P.M. dimensions 1 1/2in. long x 1 1/2in. dia. Shaft .077in. dia. x 4in. long. Centre of reversing switch integral with the motor. Self-lubricating sintered bronze bearings. PRICE brand new, 15/6 post free.

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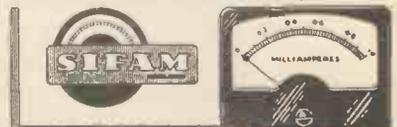
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- * Ferranti 7kVA Automatic Voltage Regulators £35 0
- * T-1131 Transmitters £35 0
- * Westinghouse 30 kV., 100 mA., Cabinet Rectifiers variable from 2 kV. £75 0
- * AM-8/TRA-1 250 watt Amplifiers £8 0
- * AN/FMD-1 Rawin £80 0
- * RCA 5-element Yagi Arrays, 420 Mc/s. £3 0
- * 75ft. Plywood Masts, 9in. dia. £35 0
- * RCA 25-watt Projector Speakers £14 0
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- * E.H.T. Power Supply, 3 kV. 0.5 amp. in cubicle £25 0
- * Power Supply Units, 1,200 v. 200 mA. 26 0
- * E.H.T. Power Supply, 7,500 v. 3.5 amps. in cubicle £250 0
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AERIAL EQUIPMENT. Whips, Beams and Microwave. Poles and Masts up to 150ft., 70 different types in stock.

RECEIVERS from 15 Kcs to 650 Mc/s., 60 kinds available.

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GP 35/A. 5ft wide. Control Panel 15x19in. Deck 17 1/2 x 13 1/2in., amplifier compartment and record storage. Price £16/10/6 or 66/6 deposit and 9 payments of 31/6 monthly.

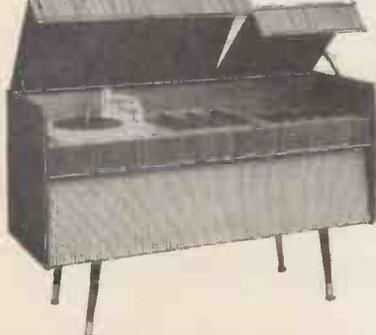
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SPEAKER repairs, cones fitted, fields and clock coils wound, guaranteed satisfaction, prompt service.—**L. S. Repair Services, Pluckley, Ashford, Kent.** [0223]

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THE ASSOCIATION OF PROFESSIONAL RECORDING STUDIOS, Ltd. To protect and encourage the interests of member studios engaged in electrical sound recording.—Write to the General Secretary, A.P.R.S., Flat 4, 34A, Arterbury Rd., London, S.W.20. [0173]

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RADIO/ELECTRICAL TV shop, with living accommodation, maintenance scheme just started; vast scope for expansion; rent £175, nett profit over £1,000; stock, goodwill, etc., £1,500 o.n.o. for quick sale. **BUSINESSSES** wanted.

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PART-TIME Electronic Engineer for mobile recording work with own equip. wanted in London; send details to—**Box 1579.** [0134]

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1H5GT	9/6	6SG7M	4/9	DF91	3/11
1L4	3/6	6SJ7M	5/-	DF96	6/11
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1R5	5/6	6U4GT	10/6	DK91	5/6
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3V4	6/9	7C5	7/6	ECC81	5/3
5Y3GT	5/9	7C6	7/3	ECC82	5/11
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6J5M	4/3	956	2/6	PCL82	7/6
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6J7G	5/-	9004	3/11	PY83	7/3
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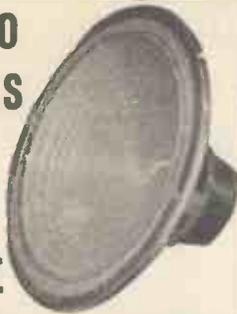
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For stereo to sound really right, one must make sure that both sound sources have integrated quality from lowest bass to extreme top. Duodes give this.

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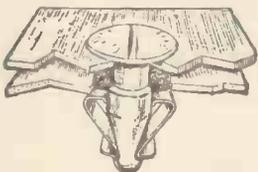
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ENGINEERS and Assistant Engineers with degree or H.N.C. and experience in the field of light electrical engineering, electronics, electro mechanical devices or semi conductors, to work on the development, installation and flight testing of automatic pilots. Salary commensurate with experience. Pension scheme.—Apply in writing, giving full particulars to: Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey. [0333]

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REQUIRED to control Electrical Production and Maintenance Sections. Applicants must be experienced in Relay Control Systems, Panel Wiring, Testing, Fault-finding, Estimating, and in the control of male and female personnel. A staff appointment offering excellent prospects in an expanding organisation.—Apply, stating age, education and experience, to Personnel Officer, W. E. Sykes, Ltd., Manor Works, Staines, Middlesex. [9288]

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PAINTON & Co., Ltd. MANUFACTURERS of high quality components for the Electronics Industry, are expanding their activities and wish to appoint an Assistant Chief Engineer. Applicants should be graduates in Physics or Electrical Engineering and should have experience in the design and development of Electronic Components for Industrial applications; this is a staff appointment with superannuation scheme.—Applicants to the Personnel Officer, Kingsthorpe, Northampton. [9285]

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AN Engineer is required to be responsible for the servicing and maintenance of an electronic business machine. Full training will be given at Farnborough, and the engineer appointed will assist in installation. Applicants should be responsible for the equipment at Liverpool H.N.C. or equivalent and practical electronic experience, preferably in systems, test or servicing is required. A four-figure salary will be paid.—Apply, Personnel Officer, The Solartron Electronic Group, Ltd., Farnborough, Hants. [9297]

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IS required by Pye, Ltd., for the design and development of domestic or car radio receivers; candidates should have spent at least 3 years on circuit development and hold a minimum qualification of C.N.C. level; previous experience of transistors would be an advantage. APPLICATIONS will also be considered from Junior Engineers who have development experience but who do not meet all the above requirements.

THE department works a 38½-hour, 5-day week; housing assistance may be given in approved cases. PLEASE write to the Chief Engineer, Pye, Ltd., Cambridge, quoting "RDL". [9288]

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The Council of the Radio Society of Great Britain invites applications for the post of senior administrative assistant from men below the age of 45 years; candidates should possess a sound knowledge of general office administration and have organizing ability; experience of amateur radio is desirable but not essential; salary initially will be in the range £750-2950 with a placing depending on qualifications; pension scheme available.

APPLICATIONS, including full references and all details, should be addressed to the General Secretary, Radio Society of Great Britain, 23 Little Russell St., London, W.C.1, marked "Confidential S.A.A." and must arrive not later than November 30, 1960. No application will be opened until after that date. [9311]

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A WELL-KNOWN company in the Midlands, manufacturers of radio and television equipment, has vacancies in its design and development laboratories for experienced:—

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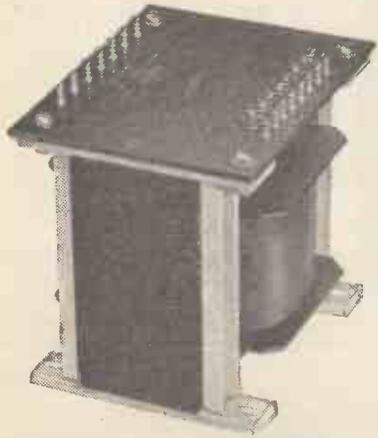
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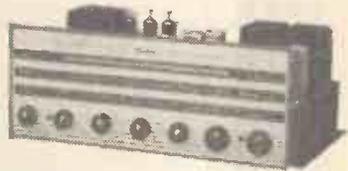
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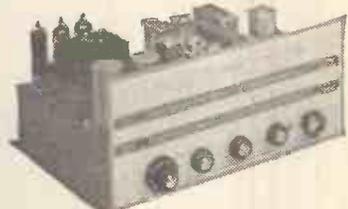
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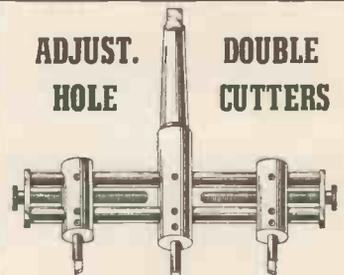
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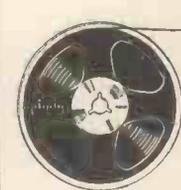
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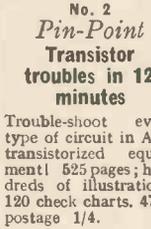
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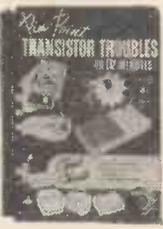
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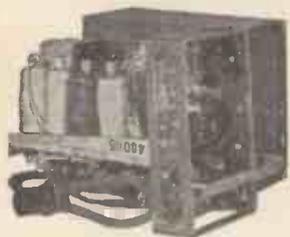
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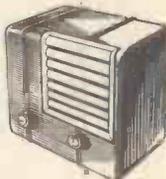
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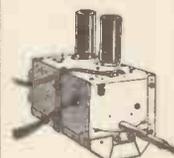
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