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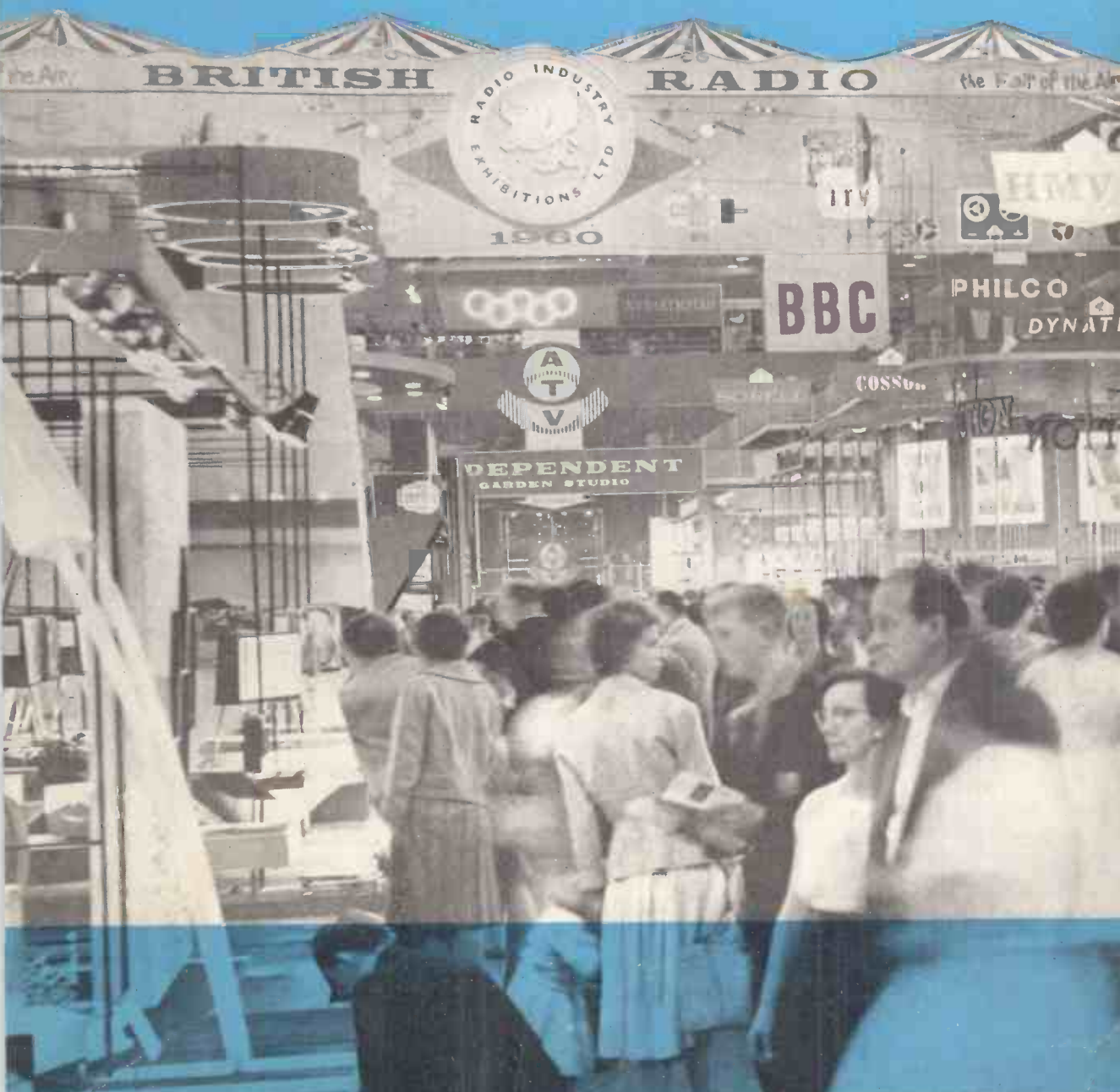
OCTOBER 1960 · TWO SHILLINGS

SHOW REVIEW

Wireless World

ELECTRONICS · RADIO · TELEVISION



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BRIEF SPECIFICATION		
Heater voltage (volts)	V_h	4·0 - 6·3
Heater current (amps)	I_h	0·72-0·6
Anode voltage, rating (kV)	$V_{a\ (max)}$	10·0
Anode voltage, typical operation (kV)	V_a	9·5

EDISWAN

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Wireless World

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Local Sound Broadcasting

COINCIDENT with the Postmaster General's appointment of a Committee on Broadcasting there has been another revival of activity among the advocates of commercial sound broadcasting for this country. With the example of independent television before them, there has been little hesitancy in trying to get in on the ground floor of any similar enterprise which may be started in sound broadcasting. In anticipation of the recommendations of the Pilkington Committee, the advice of the P.M.G. and the decisions of the Government—all of which must be made at the latest by 1964—scores of companies have been registered up and down the country to exploit the "new" medium if permitted to do so; new, that is, for this country.

In America and elsewhere commercial broadcasting, after many trials and tribulations, has found its level in national life. No doubt the spectacle of early chaos was the deciding factor when the decision was taken in 1927 to establish broadcasting in this country as a public service. Time has proved this decision to have been a wise one, and the quality and integrity of the British Broadcasting Corporation's work has compelled the admiration of the world. Its task has not been easy, and its purse strings have always been drawn tight by the necessity of keeping the licence fee at a reasonable level and, until recently, by the raids made by the Treasury on the available funds for purposes other than domestic broadcasting. Within these constraints it has progressively expanded the coverage of its service, and the range of programme material. It could and no doubt would have done even more if the funds had been available.

Regional broadcasting, as at present organized by the B.B.C., is administratively convenient, and it benefits the nation as a whole by originating in the regions new programme material which is of general interest. It is of value, too, in preserving racial traditions and language, as in Wales and Scotland, but in other respects it has failed in its attempts to provide a news service of regional interest. The reason is that the regions are too large. Even in large centres of population community interests seldom extend for more than a mile or two. The affairs of Harrow and Hoxton can seem as mutually remote as those of Redruth and Romsey.

It is, of course, possible to go too far in the opposite direction, and no one would suggest that interests should be narrowed to the extent that they are in the literally local broadcasting systems, circumscribed by inductive loops, which are to be found, for example, in hospitals and office buildings. The happy mean has probably already been established by the free play of supply and demand for local newspapers, and the areas served by these papers might well serve as a guide to the siting of local broadcasting stations. The provincial papers have in fact shown a shrewd interest in the proposals for local sound broadcasting, stimulated no doubt by the thought that if it is to be run on commercial lines, some proportion of advertisement appropriations will move in that direction.

There can be little hesitation in endorsing the principle of local as distinct from regional broadcasting, but we foresee plenty of scope for argument as to the best means of providing and running it. The B.B.C. has unrivalled professional experience, both on the engineering and programme sides, but would the money be forthcoming, and would administrative traditions be changed enough to give the degree of decentralization necessary for a truly local service? An "independent" service run on commercial lines would have no difficulty in finding money (frequencies might take a little longer); but should we then find ourselves with a lot of little Luxembourgs churning out "pop" records for the teenage owners of transistor portables? It has been said that anyone with a gramophone turntable and a pile of records could run a local broadcasting station. We do not necessarily endorse the implied sneer, for there is a wealth of first-class material in the record catalogues, quite often technically superlative, and provided that the selection of musical items is catholic in taste we cannot have too much of it. The B.B.C., even now, does not give us enough.

One manufacturer has already built and demonstrated a transmitting station costing £15,000 complete which could radiate a v.h.f. signal and a medium-wave signal, each with a 10-mile range (the medium-wave station would be restricted to daylight hours to avoid the long-distance propagation conditions of night-time). The problem of finding frequencies for large numbers of these stations would not be easy, particularly if, as seems logical, there should be competition between two or more stations within each community. The international common frequencies of 1484 and 1594 kc/s are hardly enough to accommodate the stations needed to cover the local subdivisions of the large centres of population and the B.B.C. already radiates from Barrow, Cardiff and Ramsgate on one of these frequencies (1484 kc/s).

We hope that the advocates of local sound broadcasting will keep their supporters informed of these future possible difficulties, and of the delays which may be involved in obtaining agreement to the use of other frequencies. Distribution by wire would remove frequency allocation and interference problems, but would still require the Postmaster General's sanction and a fundamental revision of the conditions under which licences to operate relay networks are at present granted.

Permeability Tuners for

PUSH-BUTTON CHANNEL SELECTION AND V.H.F/F.M.

THE basic requirements for a television tuner are that it should enable the required channel to be selected easily, should have reasonable freedom from local oscillator drift, and should provide a low noise factor. Further, it should satisfy these requirements while providing the maximum possible gain without seriously distorting the overall response shape of the receiver.

Types of Tuner

Permeability tuners are so called because they employ movement of a system of cores, made of iron dust or other suitable material, for the tuning of the radio-frequency amplifier and local-oscillator coils in a television receiver tuner unit by variation of effective permeability. Normally the whole of Band I is covered by one set of coils, and the whole of Band III by another set. Changeover from one set of coils to another is performed by a switch linked to whatever mechanism is provided for operation by the viewer.

Other types of television tuners are the turret and the switch, or incremental-inductance, tuners. In the turret tuner a separate set of tuning coils, on what is known as a "biscuit", is used for each channel, these biscuits being arranged on the periphery of a drum. The whole drum is rotated to select the required channel, and the coils corresponding to that channel are connected to the external circuit by a system of wiping contacts. Another form of turret tuner has the coil sets arranged like the spokes of a wheel. This type of construction saves space, but can raise layout problems.

The incremental-inductance tuner has the tuning coils divided into sections, and connected between contacts of a multi-position switch. The wipers of the switch, on operation, make contact with successive junctions of the coils, thus selecting the required inductance for a given channel. By suitable design, all Band-I and Band-III channels may be accommodated round a single wafer of a rotary switch.

Comparison of Features

Of the three types of tuner mentioned above, it is easiest to obtain good performance with the turret. The separate sets of coils enable conditions to be made optimum for each channel, and probably for this reason it has found the widest use of the three. There is, of course, a price to pay—literally, for the turret tuner is the most expensive of the three to produce. The operating mechanism tends to be heavy, and the operating control is virtually restricted to a knob with a good finger hold, or motor drive. The normal method of manufacture requires that both the wired tuner deck and the coil biscuits are carefully standardized, so that any coil biscuit can be fitted to any deck. Some set manufacturers, to reduce production costs, do not load fully the turrets with coils for all channels. The resulting distribution problem is minimized by despatching sets unloaded, and supplying dealers with coils for channels in use in their locality.

The incremental-inductance tuner, although having all channels available, is cheaper than a fully-loaded turret; but the multiplicity of switch contacts could be troublesome; it is not easy to align (in practice the Band-III inductors are usually preformed, permitting no adjustment for individual channels other than for oscillator frequency) and performance is to some extent a compromise. The operating mechanism can be made lighter than that of a turret.

The permeability tuner is as cheap as or cheaper than the incremental-inductance tuner, is easier to align, and the number of switch contacts is smaller. Its method of tuning lends itself easily to forms of channel selection other than a knob, such as push-button operation. It has not found very wide favour in the past due mainly to the lack of success designers have had in solving the key problem of finding a simple and effective means of ganging the tuning of the various coils. In the type of tuner to be discussed such a means has been found, and continued development has kept the performance abreast of modern requirements. A permeability tuner can provide all that is necessary for a high-performance television tuner; further, as will be described later, simple means are available of adding to the frequency ranges covered (as, for example, Band II) thus increasing its versatility. Like the incremental-inductance tuner, all channels are built in, and consequently no distribution or zoning problems arise.

Since the introduction of permeability tuners with push-button channel selection, some ingenious tuner designs offering push-button or piano-key channel selection have appeared.

Permeability Tuners for Bands I and III

The circuit (Fig. 1) employs the widely-used arrangement of a cascode r.f. amplifier followed by a pentode mixer having a triode oscillator in the same envelope. Two coils, one for Band I and one for Band III, are provided for each of the four circuit positions requiring a tunable circuit. All these coils are tuned by an assembly of iron-dust and brass slugs moving inside them, the physical arrangement of which will be described later. L_4 and L_6 are the r.f. grid coils, L_8 and L_7 the r.f. anode, L_{11} and L_{10} the mixer grid, and L_{13} and L_{14} the oscillator coils, covering Band I and Band III respectively. Changeover between the Band-I and Band-III coils is effected by the ganged switch, S_1. L_3 and L_5 are the aerial coupling coils, and these are also switched. This permits inclusion of the i.f. rejection filter L_1, L_2, C_4, C_5 in the Band-I circuit only, thus avoiding the degradation of noise factor which can occur when this filter has to be connected in the common Band-I/III input lead.

Television

By VIVIAN H. PIDDINGTON* A.M.Brit.I.R.E

RADIO FACILITIES

The r.f.-stage grid tuning capacitance is the input capacitance of V1a in series with C_6 on Band I, and C_{10} on Band III. C_9 provides neutralization of C_{ga} on Band III, but neutralization is not provided on Band I.

L_9 minimizes loss at Band-III frequencies due to the shunting effect of the output capacitance of V1a and the input capacitance of V1b, by forming a π network with these two capacitances, as shown in Fig. 2.

The output load of V1b is decoupled back to the earthed grid (which is connected inside the valve to the screen between the two triodes) and directly to the chassis by C_7 and C_{15}.

The r.f.-anode and mixer-grid tuned circuits are top-capacitance-coupled to form a bandpass pair. C_{17} is a common coupling capacitance, while C_{16} operates on Band I only. R_3 gives damping for the anode coils. The mixer grid coils are effectively damped by the mixer input impedance.

In circuits for PCF80 valves a very small inductance is included in series with C_{21}. This reduces the input damping of the mixer at Band-III frequencies by means of regeneration due to Miller effect. However this inductance is " built into " PCF86 valves.

L_{12} is the i.f. output coil, shown here arranged for bottom capacitance coupling to an i.f. amplifier, but any suitable coupling method could be used.

Oscillator output is capacitatively coupled to the mixer grid by C_{18}, connected in the Band-I position of S_1 only, and C_{19} which is common to both Band I and Band III.

Tuning and Ganging

The most important problems in permeability-tuner design are firstly: obtaining adequate frequency coverage with one set of coils, and secondly: ganging together the tuning of all the coils in the set. In the type of tuner being described maximum change of inductance is achieved by making the tuning core operating on each coil a combination of iron-dust and brass slugs. Attention must also be given to keeping tuning capacities small to enable the coil on which the tuning core operates to be of adequate length. This is the reason for keeping

*Bush Radio Ltd.

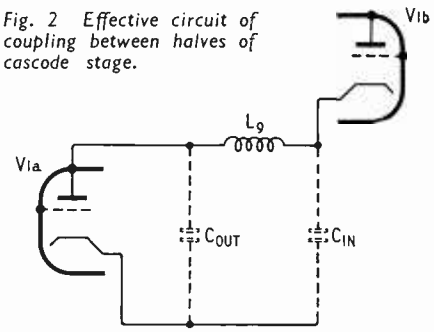


Fig. 2 Effective circuit of coupling between halves of cascode stage.

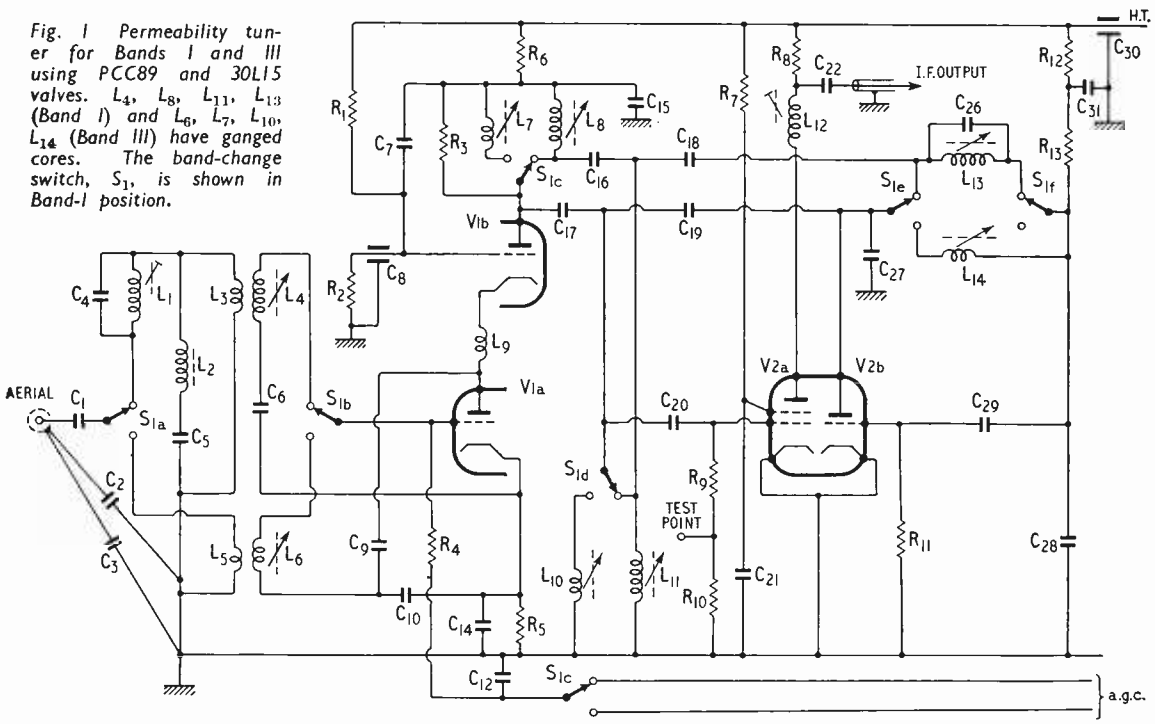


Fig. 1 Permeability tuner for Bands I and III using PCC89 and 30L15 valves. L_4, L_8, L_{11}, L_{13} (Band I) and L_6, L_7, L_{10}, L_{14} (Band III) have ganged cores. The band-change switch, S_1, is shown in Band-I position.

capacitors C_{10} in the r.f. grid circuit and C_{20} in the mixer-grid circuit low in value; these are effectively in series with the valve input capacities, thus reducing the total tuning capacitance. Ganging is achieved by winding each set of coils on one tubular former, and the combination of iron-dust and brass slugs for each coil is moulded into a complete assembly which slides inside the coil former. In operation a tappet pushes against one end of the core assembly and a return spring bears on the other end to ensure that the assembly remains in close contact with the tappet. The tappet is, of course, linked to whatever mechanism is provided for operation by the user.

Tracking.—Tracking is carried out by altering turn spacing of the appropriate coils rather than by differential proportioning of the core assembly. As the oscillator frequency is higher than the signal frequency, the oscillator circuits have a smaller percentage frequency change than the signal circuits for a given signal-frequency range. Thus the turns on the oscillator coils must be more widely spaced than those on the r.f. coils. This procedure makes it necessary to connect an additional parallel capacitor, C_{26}, across the Band-I oscillator coil, so that the length of this coil is not greater than the length of the tuning slugs. If this were not done the oscillator coil would have a different law of frequency against core movement from that of the r.f. coils. Wiring stray inductance must be kept small; where it is unavoidably larger than desirable in the Band-III circuits, layout is best arranged so that it comes in the r.f. grid coil, rather than in the other circuits. If this is done, tuning capacities can be arranged so that the r.f. grid coil has more turns than the other Band-III coils, so that the proportion of coil inductance to stray inductance is similar in all r.f. circuits. Having a large r.f. grid coil allows the aerial coupling coil to be larger, and so assists in obtaining good coupling.

Noise

It has been shown* that for minimum noise factor with an earthed-cathode triode:—

$$g_s^2 \text{ (optimum)} = \frac{a g_t + g_c + R_{sh}(g_c + g_t)^2}{R_{sh}}$$

but for correct impedance match,

$$g_s^2 = (g_c + g_t + g_f)^2$$

where: g_s = aerial conductance (referred to grid)
g_t = valve transit-time conductance
g_c = tuned-circuit conductance
g_f = feedback conductance
R_{sh} = equivalent shot-noise resistance of valve
a = constant

It is thus shown that the value of g_s for minimum noise factor does not involve g_f and this has lead to the technique of adjusting the aerial coupling transformer for minimum noise factor, and adjusting g_f for best obtainable impedance match. A convenient way of varying g_f is by C_9, the capacitor for neutralizing Miller effect on the earthed-cathode triode which operates on Band III. Neutralizing has not been provided for Band I, as it is generally considered that on this band the signal-to-noise ratio

*Tibbs, C. E., & Johnstone, G, "*Frequency Modulation Engineering*" (Chapman & Hall), second edition, pp 364-372.

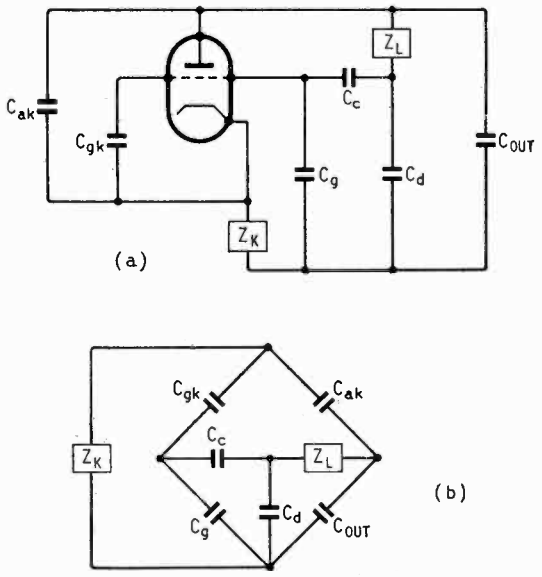


Fig. 3 (a) Effective circuit of earthed-grid stage and (b) its equivalent bridge form.

is more dependent on cosmic noise than upon receiver noise, and the aerial coupling transformer is adjusted for best impedance match. A small point to note in connection with Band-III performance is that the isolating capacitors, C_1 and C_2 with their leads look inductive at Band-III frequencies. The addition of a small capacitance, C_3, in parallel with C_2 neutralizes this inductance, and helps to avoid loss in connecting from the feeder socket to the coupling coil.

Earthed-grid Stage.— One of the important problems with this stage in any type of tuner is stability (freedom from self-oscillation), particularly with the high-slope frame-grid valves now available. The main feedback path is by anode-to-cathode capacitance, C_{ak}, including any wiring capacitance. The circuit of the earthed-grid stage is shown in Fig. 3(a), and the equivalent bridge form is given in Fig. 3(b), showing how neutralization of C_{ak} is obtained by connecting the anode load, Z_L, to the grid via C_c. The presence of C_1 complicates the bridge somewhat, but it is necessary on Band III to provide a lower-inductance chassis return path than would be obtained by way of $C_1 + C_g$; the tuning capacitance for Z_L being mainly to chassis. However, conditions for balance do exist and are:

$$\frac{C_{g_s}C_c}{C_cC_d + C_gC_d + C_gC_c + C_{gk}C_c} = \frac{C_{ak}}{C_{out} + C_{ak}}$$

It is not essential to obtain exact balance; partial balance gives a sufficient safety factor in most cases.

Physical Layout

Some idea of the disposition of components may be gained from Fig. 4. The Band-III (at right) and Band-I coil assemblies run parallel from front to back of the unit with the changeover switch between them on a plane nearer the chassis. The aerial input socket is at the top right-hand corner of the picture; the i.f. output coil can be seen at right centre,

and the i.f. rejector assembly is in the top left-hand corner.

The basic push-button mechanism for channel selection, as used on current designs, is at the bottom of the unit in the figure, and part may be seen. The mechanism consists of four spindles each with a return spring; and a latching plate for holding the selected spindle in the "in" position. Pushers on the end of each spindle operate on the core assemblies via the tappet mentioned earlier, by sliding in slots in the end plate casting. The position of these pushers relative to the spindles may be varied on turning the spindles which have a screw thread. The spindles also carry flanged blocks to move the rocker arm operating the changeover switch.

Adaptation for Three-band Working

There are applications where it is required to receive frequencies which are outside the normal Bands I and III whilst still using the television tuner. A particular case is Band-II v.h.f./f.m. sound radio in combined radio-television receivers. This case is particularly interesting since, for reasons of adequate adjacent-channel selectivity, a lower intermediate frequency is required for Band-II operation than is normally used for television sound; thus the i.f. output circuit (which is dealt with later) is required to respond to two frequencies.

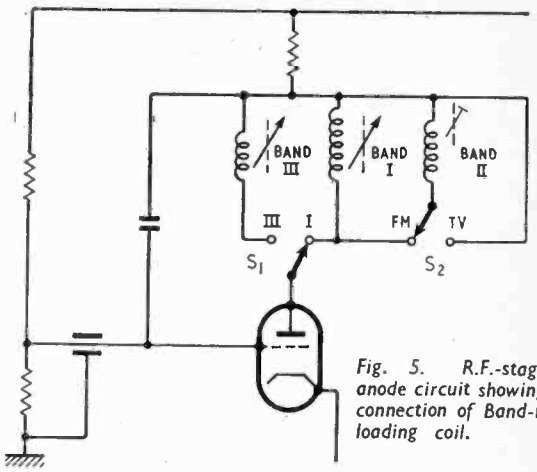
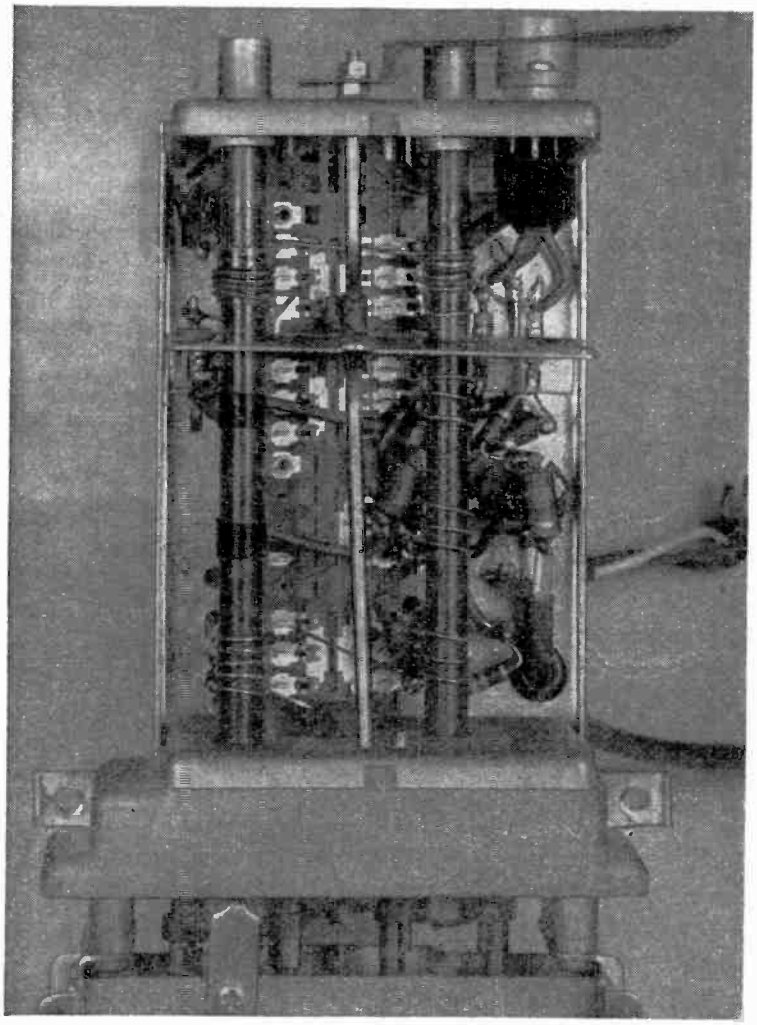


Fig. 5. R.F.-stage anode circuit showing connection of Band-II loading coil.

Fig. 4. View of underside of Band I/III permeability tuner. Here the unit is shown in plan, the push buttons are at bottom of picture.



The method adopted is to shunt the Band-I coils with pre-set inductors of such a value that tuning the Band-I coils covers the frequency range required for Band II.

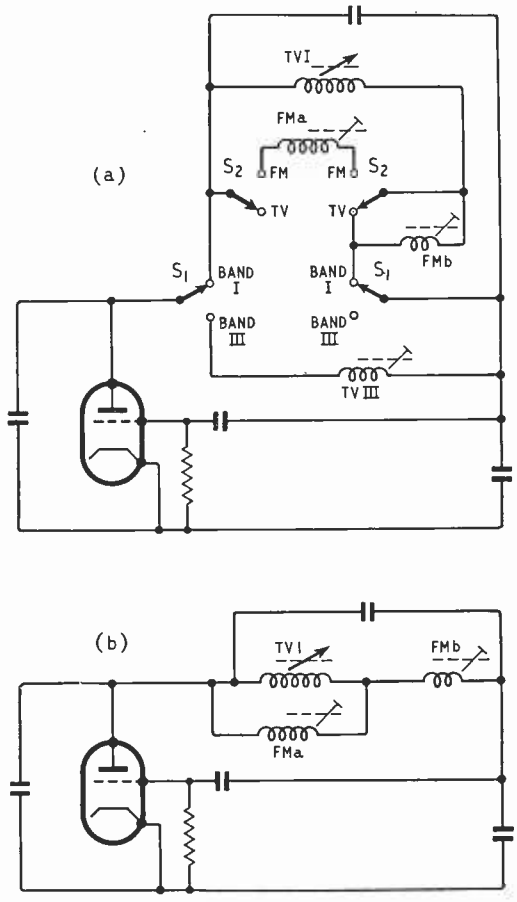
Circuit Description.—Fig. 5 shows the r.f. anode circuit to illustrate the method. The normal Band-I and -III coils, together with a section of the Band-I/III changeover switch, S_1, is shown here. A second switch connects the Band-II loading coil across the Band-I coil, and short-circuits the Band-II coil when not in use. It will be noted that the Band I/III changeover switch, S_1, must be in the Band-I position for Band-II operation, and S_2 must be in the TV position for Band I/III operation; these switching requirements are carried out by the push-button mechanism.

The oscillator coil presents an interesting problem. Table I on the next page gives the relevant details of the Band-I and Band-II oscillator frequencies, and it will be seen that in order to provide the preferred 10.7 Mc/s i.f. with the oscillator lower in frequency than the signal, the tuning range is halved but the mean frequency is of the same order. Thus the change of frequency with tuning core movement must be reduced without altering very much the mean frequency from that given by the basic Band-I coil.

The circuit used is given in Fig. 6(a) and shows how the required conditions are achieved by

TABLE I

Function	Intermediate Frequency (Mc/s)	Oscillator Frequency (Mc/s)				
		Relative to Signal	Minimum	Maximum	Range	Mean
TV (sound)	38.1	Higher	79.5	101.5	22	90.5
V.H.F./F.M.	10.75	Lower	78.5	89.5	11	84

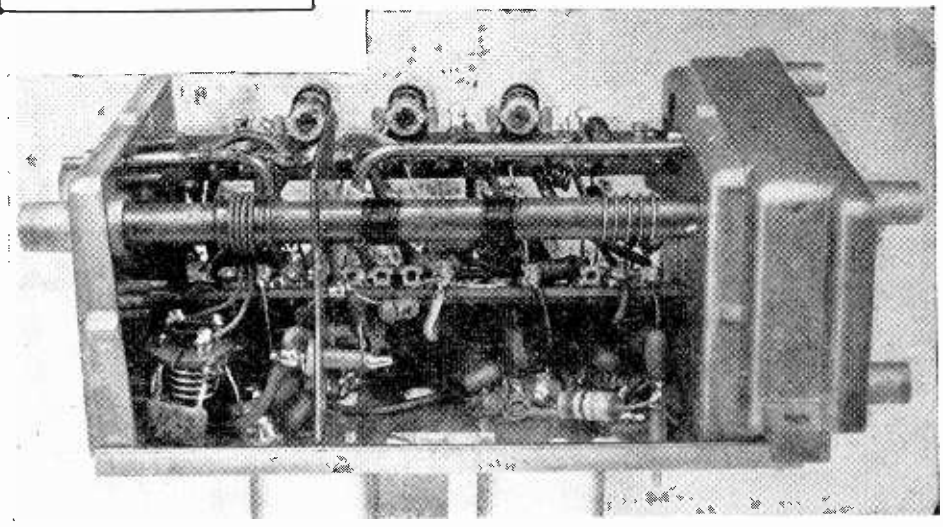


Above: Fig. 6. Simplified oscillator circuit showing (a) Band I/II/III switching and (b) components operating for Band II working.

connecting a loading coil. FMa, in parallel with the Band-I oscillator coil (TV I), lowering the resultant inductance; and a small coil, FMb in series with this combination, raising the inductance to the required value. The effective circuit without switching is show in Fig. 6(b); as the tuning core only operates on TV I, the tuning frequency range may be controlled by the values of FMa and FMb while keeping the mean inductance constant.

The loading-coil formers are mouldings with clip feet which enable them to be mounted on the additional changeover switch, S_2. Fig. 7 is a view of a tuner fitted with Band-II loading coils and switch. The three coils with screw core adjustment are the r.f. coils, and the coil on the right wound directly on an iron dust core is the parallel oscillator coil, FMa. Setting of the Band-II oscillator is carried out by altering the spacing of turns on FMb, which is the small air-cored coil seen in front of switch S_2, on the right.

I.F. Coupling Circuit. — It was mentioned earlier that on Band-II operation the oscillator frequency is arranged to give an i.f. of 10.7 Mc/s. Fig. 8 shows how this i.f. and the normal television i.f. of 34.65 to 38.15 Mc/s is coupled from the tuner to the i.f. chassis with only one cable connection. L_b, tuned by C_{out}, and L_c, tuned by C_{in}, are bottom capacitance coupled by C_c, and form a normal bandpass pair for television i.f.; L_a acts in this condition as a choke to feed h.t. to the mixer without appreciably modifying the coupling impedance, C_c. For operation at 10.7 Mc/s L_a is tuned by C_c. L_b and L_c are both small enough to present a negligible impedance at this frequency, and the



Right: Fig. 7 Permeability tuner with Band-II loading coils fitted.

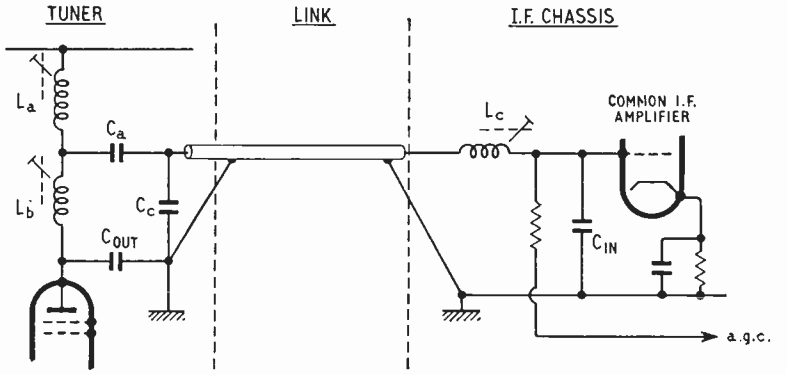


Fig. 8 Dual i.f. (television and 10.7-Mc/s f.m.) coupling circuit.

combination acts as a single-tuned-circuit coupling. Typical Band-II gain is 45 db. with a noise factor of 6.5 db.

Performance

Table II gives typical performance data for a production two-band permeability tuner with a 30L15 cascode amplifier, and a 30C1/PCF80 mixer and local oscillator. It is appreciated that the gain of a tuner is dependent on the design of the coupling circuit between the mixer and first amplifier. The figures given are typical of those actually obtained between aerial input and first i.f. amplifier grid, the i.f. coupling transformer having virtually no damping.

In Fig. 9 are given r.f. response shapes for various channels and Fig. 10 shows drift characteristics for Band I, Band II, and Band III.

Conclusion

One of the most important improvements to television receivers in recent years has been the introduction of r.f. amplifying valves with a lower equivalent noise resistance at Band-III frequencies, allowing a less noisy picture to be obtained in areas of low signal strength. These valves also provide higher gain, and with the higher-slope mixers now becoming available the design of tuners with a gain of about 60 db seems possible. With this order of gain it would be feasible to provide adequate fringe-area sensitivity with the same number of valves as was formerly used for strong signal areas. It is possible for permeability tuners to take full advantage of the improved qualities of these new tuner valves and produce a performance comparable with all other types of tuner.

TABLE II

Channel Number	Gain (dB)	Noise Factor (dB)	Input-impedance Modulus (Ω)
2	51	4.5	100
8	48	6.5	60

I.f. rejection >40dB over whole of vision and sound i.f. band.

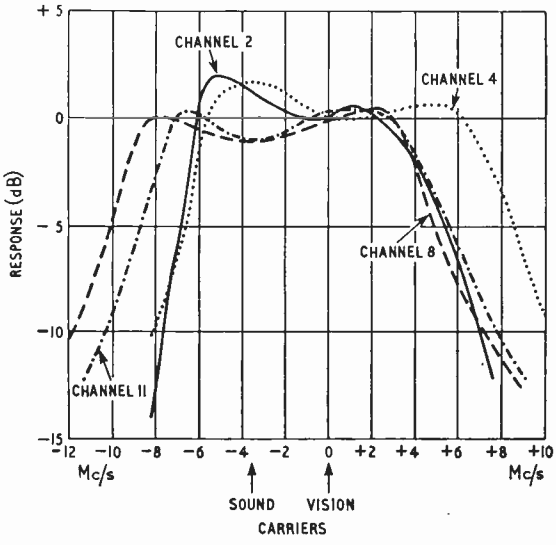


Fig. 9 R.f. response curves for tuner on Channels 2, 4, 8 and 11.

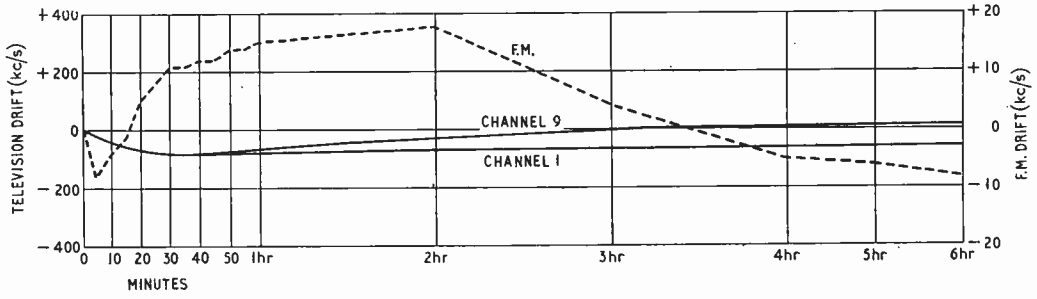


Fig. 10 Oscillator-drift characteristics for Bands I, II and III.

Airshow Electronics

REVIEW OF TRENDS AS SEEN AT FARNBOROUGH

ALTHOUGH not lacking in quantity, electronic equipment at the S.B.A.C. exhibition this year was sometimes quite hard to find—the small black box tucked away on the corner of a large stand replete with aircraft models and engines, for instance. One of these half-hidden black boxes was, however, the key to this year's show—its label said, succinctly, "Airborne Electronic Computer."

Automatic systems for aircraft control are not, of of course, new. But what is new is the widespread appearance of comprehensive systems linking many operations with little or no human intervention, whether on the ground, in the air, or between air and ground. One of the first of these was "Autoland"—the B.L.E.U. system that actually puts down the aircraft on the runway in any weather (rather than first placing it for the commencement of landing, as have other "blind" systems), which was demonstrated in 1958. Now, however, it is possible to see the emergence of a pattern of development—a tendency to take from man, whether he is pilot, navigator or air traffic controller, the tasks which resolve themselves into purely logical processes; but which either have to be performed over and over again, or at high speed, and give them to a computer. For instance, Decca have, with their Omnitrac digital computer, solved the problem of the conversion of the Decca Navigator hyperbolic system of presentation of information to cartesian co-ordinates without the errors inherent in an analogue system. This allows, for example, automatic flying "on Decca" with autopilot equipment, or "distance to go" and "on track" presentations.

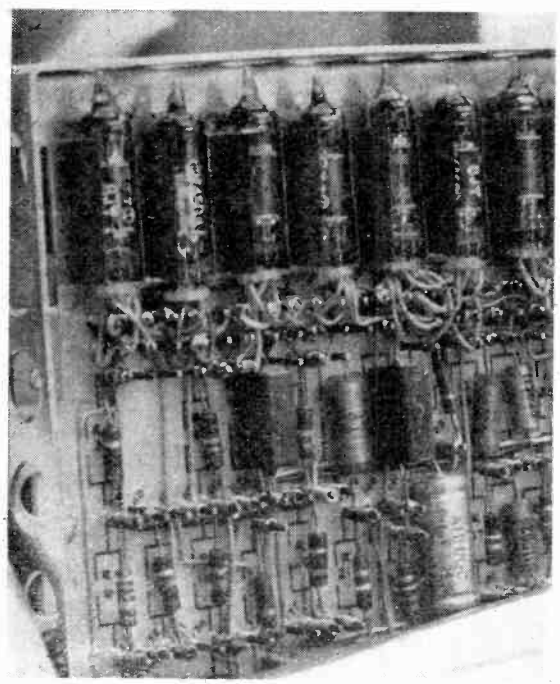
Computers are not used as aids solely for long-range or high-speed flying, though. The flying of a helicopter "by hand" is not an easy matter, and here the use of a computer helps by not only controlling the various engine parameters automatically but also by executing programmed manœuvres such as the change from forward flight to hovering at a chosen height, and, still more important, the stabilised automatic maintenance of this state (Louis Newmark).

Automatic reporting of flight data to the ground is another way in which work can be lessened for both air and ground operators. Cossor were demonstrating an experiment to assess the feasibility of doing this in digital code in the medium-frequency bands, the use of which would enable the system to be used on long-haul routes. Suitably adapted, this type of system could feed directly into an a.t.c. computer.

Automatic triangulation from d.f. stations is a most valuable aid to air traffic control, and this was shown last year by Marconi's, using time-sharing methods to give a display on one c.r.t. This year S.T.C. had on show their automatic triangulation equipment in which individual c.r.ts display the bearings resolved from several v.h.f./d.f. stations. The images from these are combined optically with each other and with a map transparency, and the whole is fed into a television camera: thus for each display only a monitor unit is necessary. The inherent flexibility in use afforded by television techniques is a great advantage: messages, for instance, can be "written into" the system.

Finally, on the ground, the major work-load of making the record of flight data and keeping it current can be taken over by a computer, as it is planned to do with the Ferranti "Apollo" at Prestwick. Of course, "Apollo" will have to be hand-fed with data, for the moment; but it will be able to work out on demand flight programmes and, what is more important, detect future possible convergences of aircraft.

Wire-wrapped joints in the Ferranti "Airpass" airborne interception radar as an aid to reliability.



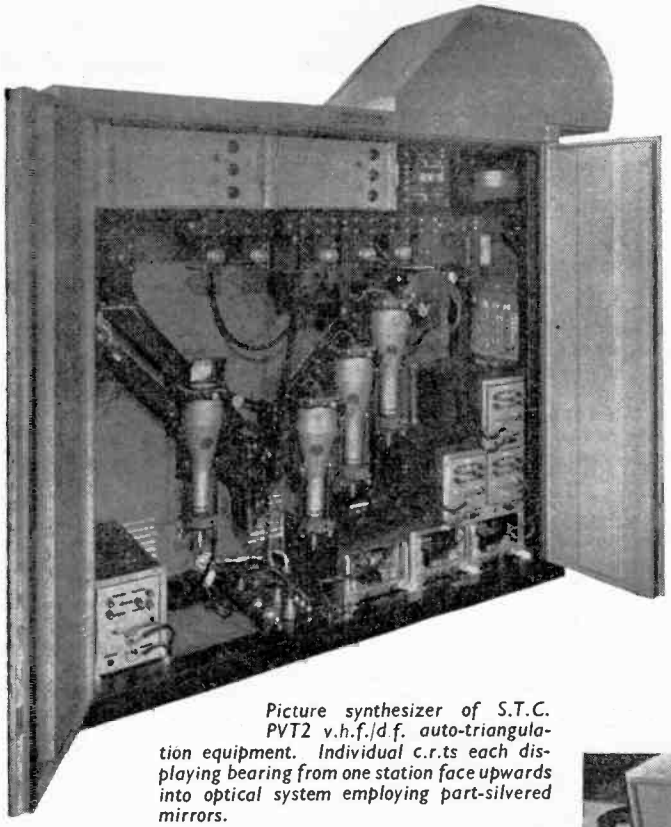
Although it can be seen that complete automatic control, which cannot make mistakes, may result from application of these techniques, this would be of little use if the equipment were not reliable. The efficiency and cool running of transistors can help in the attainment of reliability because they do not make the environment of other components so likely to cause failures—techniques for making connections without the use of solder (wire-wrapping, say) help. But even with these improvements, there remains the possibility of system failure and, to guard against this, redundancy, in the shape of multiplication of equipments, must be employed. One method suggested is to have three sets of equipment, whose outputs are compared. If one differs from the other two, it is switched out, and if further deviations then occur the system becomes unusable. Alternatively, two sets of equipment are carried and these two sets have their failure-prone portions duplicated. If a difference is detected between the "twins" of one set, then a changeover to the second set is made.

Perhaps the best course is that adopted in the case of "Autoland" and "Apollo"—the gradual introduction of automatic systems, piece by piece. Autoland's height-control system "Autoflare" is to be installed in civil DH121 and VC10 airliners and should be in use by 1960: later, as experience (and confidence) mount, the next steps towards completely automatic programmed take-off and landing may be taken.

Of course, none of these exciting possibilities can come to pass without improvements in techniques to make certain the acquisition of unimpeachable data:

there was evidence of these in plenty at Farnborough. Radar performance can be improved out of all recognition by the application of parametric amplifiers: Marconi plan to do this for their S264 series of 50-cm surveillance sets. An experimental amplifier shown used an Adler tube (fast-wave electron-beam type) and improved performance is achieved by locking the pump oscillator to the signal by means of the radar's crystal control. The gain of 20dB and low noise factor realized means that the noise contribution of following stages can be ignored.

Cossor, too, were showing an improvement for radar surveillance in the ground equipment to match the secondary-radar transponder shown last year. This ground equipment uses a double aerial array, one part having a narrow, high-gain beam and hence many sidelobes, and the other practically omnidirectional coverage which is at least +10dB in relation to the worst sidelobe. The transponder in the aircraft might ordinarily respond to sidelobes of the main array and thus give erroneous results; but with the Cossor system the transponder receives two pulses, the first from the omnidirectional array and the second from the directional aerial. Circuitry in the transponder does not allow a "reply" to be given unless the amplitude of the second, directional pulse is stronger than −9dB with respect to the first pulse. Coding of the transponder reply allows the automatic transmission of information.

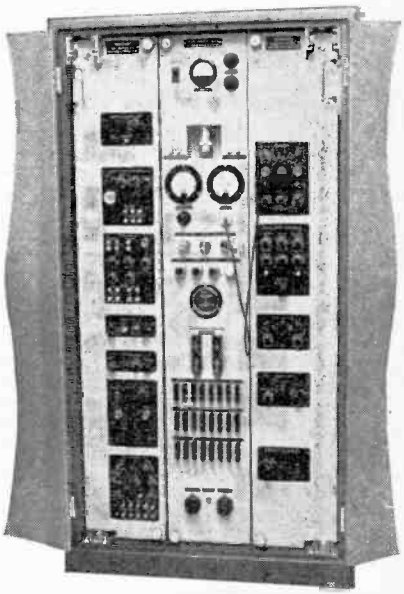


Picture synthesizer of S.T.C. PVT2 v.h.f./d.f. auto-triangulation equipment. Individual c.r.ts each displaying bearing from one station face upwards into optical system employing part-silvered mirrors.

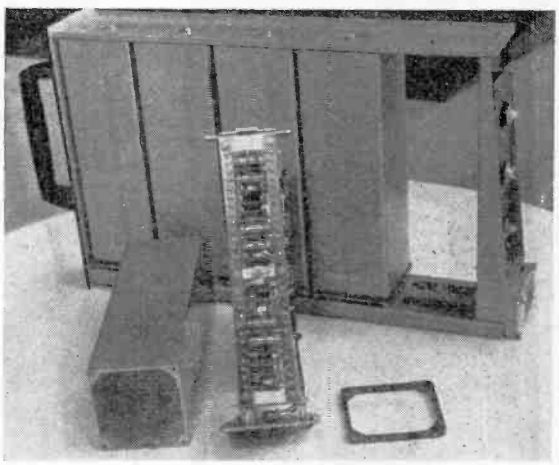
The recording of radar signals is something which has hitherto been confined to film. However, Decca were demonstrating the use of an Ampex video-tape recorder for radar recording. Bearing information from the aerial is recorded on the "cue" track of the tape and the radar sync and video are recorded on the video track. Viewing a replay of a tape made from the DASR1 radar at Arlanda airport, the reproduction was so realistic that the picture had all the immediacy of a live radar display.

New communications equipment showed even more startling results of concentrated development in the Marconi "Sixty" series of airborne v.h.f. radio and navigation apparatus. In this transistors are used in all stages except the 25-W transmitter output. Modular construction in which the modules are sealed and filled with inert gas (nitrogen) is employed and the complete R/T and navigation equipment seems no larger than some of the earlier valve v.h.f. R/T transmitter-receivers.

With the hope of providing a world-wide navigation aid using only relatively simple equipment in the aircraft, the Royal Aircraft Establishment is conducting a series of tests with a "flying laboratory" in a Comet to check on the long-range phase-stability of v.l.f. radio stations such as GBR Rugby (16 kc/s). In flight, the transmissions are compared with a stable crystal oscillator carried in the aircraft and the errors charted. If results prove satisfactory, a chain of, say, six ground stations could provide cover for the whole globe.



Cossor SSR 4 G ground-equipment racks for secondary radar.



Unit from Marconi "Sixty" series transistor v.h.f. radio and navigation equipment, with module removed and opened.

FIRATO 1960

The Amsterdam Radio and Electronics Exhibition

OF the many—some would say far too many—annual radio exhibitions in Europe the Dutch "Firato" can lay fair claim to being at the present time the most international of them all. It is strongly supported not only by native industry but by the British, German and American industries, either directly or through agents, and can claim at least token exhibits from many other countries, including for example East Germany and Japan. The public is admitted from 2 p.m. to 5 p.m. and again from 7 p.m. to 10.30 p.m. (at 5 p.m. the power is switched off and everyone takes time off for an evening meal), but traders are admitted at 10 a.m., and quite obviously it is primarily a trade exhibition. Not only is it a shop for Netherlands importers, but there is a good deal of export activity by firms such as "Aristona" which exports domestic receivers mainly to Scandinavia.

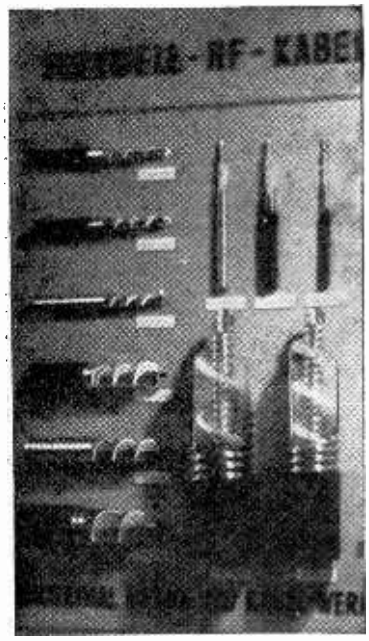
The exhibition covers industrial electronics, communications, measuring instruments, components and materials in addition to domestic broadcast receivers, and is unique in bringing together for direct comparison on the stands of the bigger agents most of the world's leading manufacturers of test and measuring equipment. Names like Advance, Cossor, Electronic Instruments, Epsylon, English Electric, van der Heem, Marconi, Sanders and Sullivan appeared together in the stand of ANRU (Algemeene Nederlandse Radio Unie), while on the stand of C.N. Rood the products of Felten and Guilleaume Hewlett-Packard, Rohde & Schwarz, Saunders-Roe, Tektronix and Varian Associates and more than twenty other firms could be examined side by side.

Philips have considerably extended their range of c.r. oscilloscopes for servicing, and new models include GM5601 (d.c.—5 Mc/s) with 18-step timebase (0.5μsec/cm—200 msec/cm) and improved triggering facilities; GM 5603 (d.c.—15 Mc/s) with differential input; and GM5639, an X-Y display with identical amplifiers having less than 2 degrees phase shift up to 1 Mc/s.

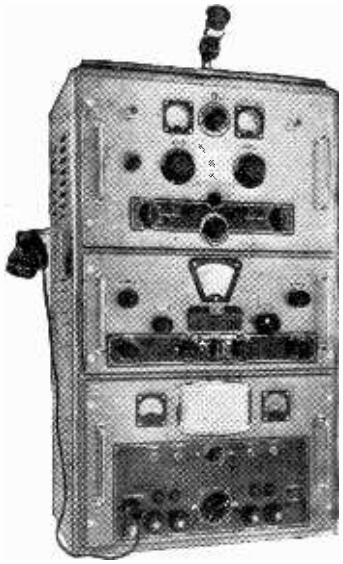
An interesting use of a TV set as an oscilloscope was seen on the Agfa stand. Using a sampling technique with vertical instead of horizontal scanning, waveforms from a tape recorder were shown in silhouette.

Communications were well represented by firms such as AEG, Siemens, Standard Electric, Racal and Radio Becker. The latter is a firm with branches in all the Dutch ports which specializes in short- and medium-wave transmitter-receivers and echo-sounding equipment for coasters and tugs.

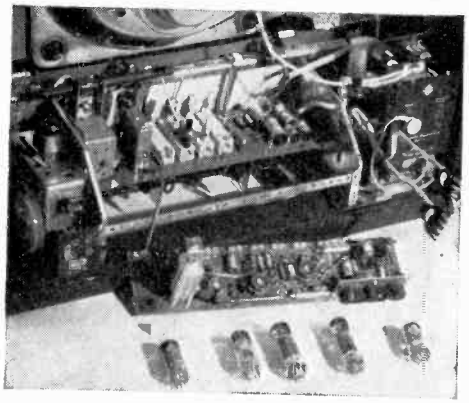
Domestic television receivers demonstrated at the show were notable for the uniform excellence of the line interlacing, which is accounted for not only by good design but also by the better synchronizing system inherent in the 625-line standard. The "new square tubes," as the 59-cm (23-in) sizes are referred to on the Continent, were available in sets by Baupunkt, Grundig, Nordemende, Philips and Telefunken. Fully automatic operation, including fine tuning, was general and there was a trend towards the "slim line" in cabinet design, led by Erres against a stand décor of *haute couture* (including fashion displays). Some of their sets use the short 110° tubes and have a depth of 27 cm (10½ in.). The rotary channel-changing switch at the side of Erres sets is set at an



Hackethal flexible coaxial cables.

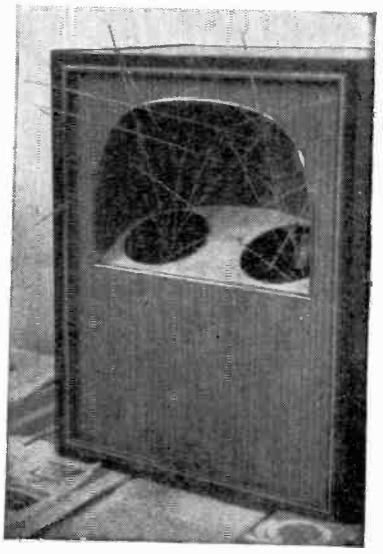


Radio Becker marine R/T transmitter and receiver Type HB-3/75-DSK. The transmitter (135W) operates on 33 channels between 17 Mc/s and 1,600 kc/s, and the receiver has a built-in auto alarm.



Above: Telefunken "servo-chassis" partly dismantled.

Right: Stereovox twin loudspeaker with double elliptical reflector.



Below: Philips AG456 stereo record player.

angle in its recess for ease of operation. All controls of the Rafena (East-German) TV sets are on the back panel, leaving the front and both sides of the cabinet completely clean.

The outdoor television aerial display in the street fronting the exhibition once again emphasized the complexity of Continental all-wave arrays. The mechanics of mounting presents a greater variety of problems than in England. Continental architecture makes use of a far wider range of roof pitches and chimney sections. Firms such as Pyros Antennetechnik and Schniewindt offer an amazing choice of galvanized ironmongery including gutter clamps, mast footings complete with tile flashings, etc., to meet all contingencies.

Flexible coaxial cables with spirally corrugated inner and outer tubular conductors and in diameters up to about 3 in. were noted on the stand of P. Regoort. They are made by Hackenthal Draht- und Kabel-werke A.G. of Hanover under the name Flexwell.

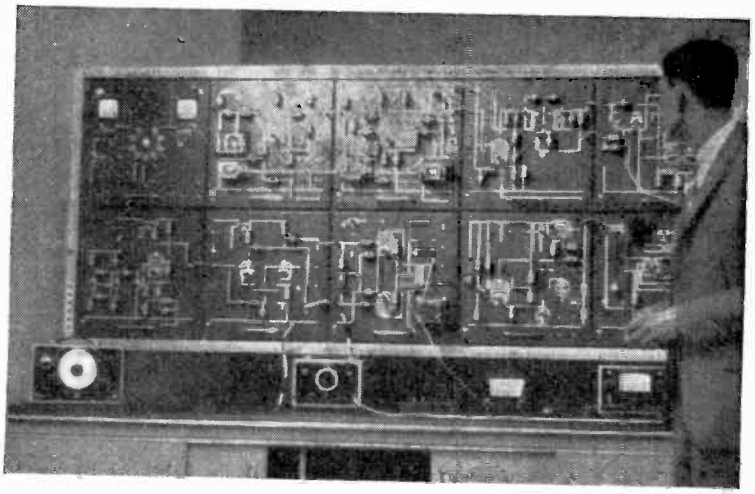
Among sound broadcast receivers the new Telefunken "servo-chassis" attracted a good deal of attention. This is of unit construction with printed circuit panels interconnected by snap contacts along the edges. It is quickly dismantled for easy servicing. The Siemens RB11 small table model with oiled teak cabinet made a welcome breakaway from the current trend of plastic cabinets. Philips made a last-minute addition of an artificial reverberation line in their F7X128 radio-gram. A reverberation time of 2 sec with 30 msec delay is provided. The "Freiburg Vollautomatic 125" table receiver with five loudspeakers, remote control station seeking, automatic tuning and every known refinement took pride of place on the Saba stand in their 125th jubilee year.

An interesting loudspeaker assembly giving, as the makers claim, an "almost stereophonic" effect is the Stereovox designed by a Dutch amateur, Mr. van Hedel, and marketed by Waller & Platte C.V. of Amsterdam. Two parallel-connected loudspeakers, tilted 55° from the vertical, project sound into a double elliptical reflector which diffuses the sound and removes the impression of a point source. The demonstration of this loudspeaker was convincing—even more so when two were used in a two-channel stereophonic system.

Among new Philips record reproducers the AG4156 stereo player was noted for its attractive appearance and for the loudspeaker arrangement which gives the possibility of varying the effective baseline of the sound sources by using reflections from the walls in a corner of the room.

Once again the keen interest of the younger generation in radio and electronics and the sympathetic understanding of the Netherlands firms like Amroh and Philips of their needs, first as hobbyists and then as serious students, were apparent. Both these firms have considerably extended the range of their "toy" constructional sets which are now available in attractive-coloured presentation boxes. Higher up the curriculum, Philips have now introduced an elaborate blackboard circuit system, for use in colleges and universities, known as "Elektronica Trainer". A range of hinged and quickly detachable panels with socket power supplies can be assembled to form most standard circuits. Plug-in component elements carry circuit symbols on their outside covers which can be removed by the student to examine the real components inside.

This year more than 190 firms took stands in the Firato and it is expected that next year it will be possible to move the exhibition to the new and much larger R.A.I. buildings in Amsterdam.



Philips "Elektronica Trainer" in use during a lecture.

WORLD OF WIRELESS

Scientific Radio

AT the closing session of the 13th General Assembly of the International Scientific Radio Union (U.R.S.I.) in London on September 15th Dr. R. L. Smith-Rose was elected president in succession to Dr. L. V. Berkner (U.S.A.). In introducing his successor Dr. Berkner paid tribute to Dr. Smith-Rose's lifelong dedication to radio science and to the fact that he had attended every triennial assembly since 1928.

The broad objects of the Union are to foster international co-operation in scientific radio investigation, to promote the establishment and use of a common nomenclature and measurement technique, and to undertake the comparison of standards used in scientific radio work.

Reports and resolutions were presented to the assembly by the chairmen of the specialist commissions. Of particular interest was the resolution from Commission V (radio astronomy) that it views with concern the proposals to eject from satellites quantities of resonant dipoles ("needles") to form orbiting "scatterers." It asks the Union to ensure that such schemes are not put into operation without due consideration being given to their effects on astronomical research.

All the commissions are collaborating in the present programme on space radio research and a special session of the whole assembly was devoted to this subject. We hope to deal with this and other aspects of the work of the Union in future issues.

As a follow-up to the International Geophysical Year, which came at a sunspot maximum period, it is proposed to plan a special programme for the sunspot minimum period of 1964/5.

The next General Assembly of the Union will be held in Tokyo in 1963.

"Echo" Tests

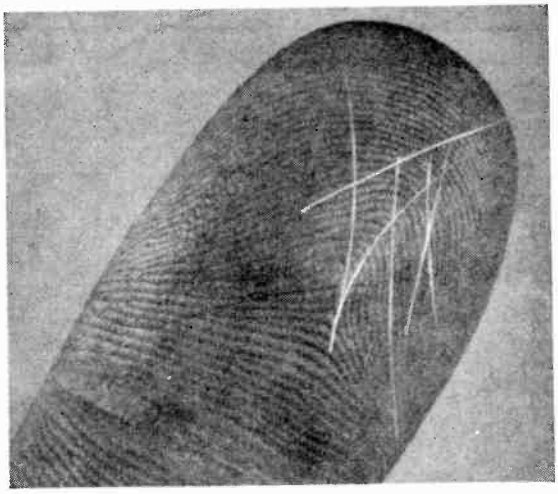
TRANSMISSIONS, both modulated and unmodulated, from the Bell Telephone Laboratories, New Jersey, and reflected from the American balloon satellite "Echo 1," were received at Malvern on August 29th. Although this was not the first occasion (the Jodrell Bank 250ft radio telescope had succeeded a week earlier) it was of particular interest, since the parabola used was only 20ft in diameter.

Amateur Television

Slow-scan equipment made by members of the British Amateur Television Club was the main attraction at the Club's fifth television convention held in London on September 10th. The attendance of almost 200 was rather greater than at the fourth convention held in 1958.

There were also demonstrated or displayed amateur-built image orthicon and vidicon cameras, pulse generators, teleciné equipment, oscilloscopes, distribution amplifiers and a colour bar generator (not to be confused with apartheid).

G. B. Townsend, of the G.E.C. Research Laboratories, is president of the club.



"Needles" on a forefinger.— An illustration from the paper on "Orbital Scatter Communication" presented by W. E. Morrow, of M.I.T., at the U.R.S.I. meeting on space radio research.

Pilkington Committee

ON September 8th the P.M.G. announced the thirteen members of the Committee on Broadcasting of which Sir Harry Pilkington is chairman. In announcing the members, the P.M.G. stated that the aim has been to pick a well-balanced team who would bring a wide range of experience to bear objectively on the Committee's work. The members, chosen for their personal qualities and ability, have been drawn from many sections of public life" are:—

Sir Jock Campbell, H. Collison, Elwyn Davies, Miss Joyce Grenfell, Peter Hall, R. Hoggart, E. P. Hudson, J. Megaw, J. S. Shields, Dr. R. L. Smith-Rose, Mrs. Elizabeth Whitley and W. A. Wright. The secretary is D. G. C. Lawrence, from the Post Office Radio Services Department.

New Post Office TV Link

AFTER 11 years the Post Office 900 Mc/s radio link between London and Birmingham has been withdrawn from service. This two-way link, which was built by the General Electric Co., was installed when the B.B.C. television service was extended from London to the Provinces in 1949. But since 1956 it has daily carried I.T.A. programmes networked between London and the north.

New equipment, also made by the G.E.C., has now been installed which provides two working and one stand-by channel in each direction. The new system works in the 2,000 Mc/s band.

VASCA

THE Electronic Valve and Semi-Conductor Manufacturers' Association (VASCA), formed last year to take over from the B.V.A. responsibilities for semi-conductors and industrial valves and tubes, now has fifteen members. It will be recalled that

the B.V.A. is now concerned only with domestic valves and television tubes. The present members of VASCA are: A.E.I. Electronic Apparatus Division, A.E.I. Radio & Electronic Components Division, Associated Transistors, Brush Crystal Co., English Electric Valve Co., Ferranti, G.E.C., M.O. Valve Co., Mullard, Plessey, Pye, Rank Cintel, S.T.C., Texas Instruments, and Westinghouse.

U.S.S.R.—Television receiver production in the Soviet Union during the first six months of this year totalled 796,000 which was a 36% increase on the same period last year. During the same period sound receiver production increased by 4% to 2.1M.

German Radio Show.—Next year's German Radio Show (August 25th to September 3rd) will be held in Berlin for the first time since 1939. The German radio industry had considered the possibility of making the show international, but as a reciprocal arrangement with other European countries has not been forthcoming it will remain a national exhibition.

Algiers is now linked permanently with the French television system. Two 500W tropospheric links operating in the region of 4kMc/s have been set up with an intermediate station on Majorca in the Balearic Islands.

N.E. Scotland is to be served by two I.T.A. stations which will be operated by a group called North of Scotland Television. One station, located between Stonehaven and Banchory, is planned to open towards the end of next year, and the other, on the Black Isle, about eight miles north of Inverness, during 1962.

Television Licences.—At the present rate of increase (some 50,000 a month) the number of combined television/sound licences in the U.K. should reach the 11M mark before the end of the year. The total at the end of July was 10,753,157. Sound-only licences totalled 4,380,994, including 449,463 for sets fitted in cars.

Technological Courses.—In order to publicize the many special advanced courses held in London and the Home Counties the Regional Advisory Council for Technological Education issues a Bulletin twice a year. The 127-page booklet for the autumn term, which costs 3s 6d, gives details of some 450 part-time courses and about 30 full-time courses in over 40 colleges. A large proportion of the courses cover electronics and associated subjects.

Transistors.—A course of 20 lectures on transistors and allied devices will be given at the Borough Polytechnic, London, S.E.1, on Tuesday afternoons from October 4th, and repeated in the evenings (fee 50s). The college is also conducting a laboratory course in basic transistor measurements and applications. This will be held on Tuesday or Wednesday afternoons or evenings and will extend from October 11th for eight weeks (fee 20s).

S.E. Essex Technical College, Dagenham, is providing a course of 12 evening lectures on electric circuit theory beginning on September 28th. Although complete in itself it will also serve as a preparation for a 12-lecture course on pulse circuit techniques which begins on January 18th. The fee for each course is 1 gn. An evening course of 20 lectures on the theory and applications of transistors starts on October 6th (fee 31s).

Sound Recording and Reproduction.—Peter Ford, honorary historian of the B.S.R.A., is giving a course of six evening lectures under this heading at the Hendon Technical College, The Burroughs, London, N.W.4, beginning on October 4th (fee 5s). The college is also conducting a course of 12 evening lectures on transistors and their applications on Tuesdays beginning September 27th (fee £1).

Interkama, the international congress and exhibition for instrumentation and automation, opens in Düsseldorf on October 19th for eight days. Prof. J. F. Coales, of Cambridge University, is one of the four speakers at the opening session. There will be sessions covering new components; measuring systems; control systems; and data handling.

Brian Rix, the well-known actor who is also a radio amateur (his call is G2DQU), has accepted the invitation to open the Radio Hobbies Exhibition at the Royal Horticultural Society's Old Hall, Westminster, London, on November 23rd. The Exhibition will be open for four days from 11 a.m. to 9 p.m., admission 2s.

Electrical Contacts.—The Institute of Physics and the Physical Society in collaboration with the I.E.E. are organizing a symposium covering recent advances in the study of the phenomena occurring at mating surfaces carrying currents used in light electrical engineering. It will be held in the Brunel College of Technology, Woodlands Avenue, London, W.3, from April 5th to 7th next year.

Television-Film Convention.—A joint convention on Television and Film Techniques is being arranged by the Television Society and the British Kinematograph Society for April 21st and 22nd next year. It will be held at the I.E.E. Non-members may obtain further details and registration forms from the Television Society, 166, Shaftesbury Avenue, London, W.C.2.

Cardiological Apparatus.—The 12th annual exhibition organized by the Society of Cardiological Technicians of Great Britain will be held at the Londoner Hotel, Welbeck Street, London, W.1, on October 14th and 15th. Free admission tickets are obtainable from the Cardiac Departments of St. Bartholomew's Hospital, London, E.C.1, and University College Hospital, London, W.C.1.

New Components is the theme of a two-day symposium to be held in London on October 26th and 27th by the Brit.I.R.E. The chairman will be G. W. A. Dummer, of R.R.E., and some 20 papers will be presented during the morning and afternoon sessions at the School of Pharmacy, Brunswick Square, W.C.1. There will also be an associated exhibition. Further details and registration forms (fee 2gn) are obtainable from the Brit.I.R.E., 9, Bedford Square, W.C.1.

Industrial Applications of Aviation Electronics is the theme of a two-day convention being organized in Bristol by the South Western Section of the Brit.I.R.E. for October 7th and 8th. Programmes and registration forms are obtainable from W. C. Henshaw, c/o The School of Management Studies, Unity Street, Bristol, 1.

"**Communications and Space Research**" is to be the subject of next year's Brit.I.R.E. convention. Details of the date and venue are not yet available.

Personalities

Sir Hamish MacLaren, K.B.E., C.B., D.F.C., LL.D., the new president of the I.E.E., has been Director of Electrical Engineering in the Admiralty since 1945. A graduate of Edinburgh University, he was with B.T.H. for two years before joining the Admiralty in 1926. After various appointments in the U.K. and abroad he was in 1940 appointed assistant director of the Electrical Engineering Department. Sir Hamish has been vice-president of the Institution since 1955.

Sir Hamish MacLaren

T. B. D. Terron

T. B. D. Terroni, B.Sc., A.C.G.I., D.I.C., M.I.E.E., the 1960/61 chairman of the I.E.E. Electronics and Communications Section, is manager and chief engineer of the transmission division of the Automatic Telephone and Electric Co. He received his engineering training at the City and Guilds Engineering College, where he completed a post-graduate course in heavy electrical engineering. After a further year as a demonstrator, he spent a year as junior transformer designer with Ferranti. He then went over to research and development in the telecommunication field with the International Telephone and Telegraph Laboratories Inc. for three years, and in 1931 joined A.T.E. Mr. Terroni's work has been mainly concerned with line transmission developments and in particular with multichannel carrier operation.

G. G. Roberts, M.Sc., has joined the board of Cossor Radar and Electronics, Ltd., as technical director. He was, until recently, on the board of S. Smith and Sons (England), Ltd., Aircraft Division, which he joined in 1954. For seven years from 1947 he was a senior principal scientific officer in the Guided Weapons Department of R.A.E., Farnborough, prior to which he was at R.R.E. In 1958 Mr. Roberts and Mr. J. E. N. Hooper, of the Ministry of Aviation, were awarded the Musik Memorial Trophy of the New Zealand Government for their work on cloud and collision warning radar at the Royal Radar Establishment, Malvern.

N. Elson, M.A., M.Sc., A.M.I.E.E., who during the war was at R.R.E., where he was concerned primarily with waveguides, has joined the Cossor Communications Company as technical director. Educated at Trinity College, Cambridge, he did research on radio-wave propagation at the Cavendish Laboratory and in New Zealand. Mr. Elson was engaged on guided weapon systems studies at Ferranti's prior to joining Racal six years ago as chief scientist in charge of research and development.

Air Vice-Marshal T. U. C. Shirley, C.B.E., M.I.E.E., is Deputy Controller of Electronics, Ministry of Aviation, in succession to **Air Vice-Marshal G. P. Chamberlain,** C.B., O.B.E., who has retired from the Royal Air Force. A. V-M. Shirley joined the R.A.F. as an aircraft apprentice in 1925. He took the specialist signals course in 1934 and in 1941 took command of No. 73 and 75 Signals Wings. In 1946 he was appointed Deputy Director of Signals (D). He became Director of Radio Engineering in the Air Ministry in 1951 and two years later went to Fighter Command as Chief Signals Officer. Since early 1959 he has been Senior Technical Officer Fighter Command.

Group Captain B. H. Boon, O.B.E., B.A., A.M.I.E.E., has been appointed Controller of R.A.F. Telecommunications at Headquarters, Signals Command, with the acting rank of Air Commodore. Air Commodore Boon, who is 47, recently took a guided weapons course at the R.A.F. Technical College, Henlow, and was previously Chief Signals Officer of Maintenance Command. He graduated from the R.A.F. College, Cranwell, in 1936 and in 1938 underwent a specialist signals course at Cranwell and has since specialized in signals and radio. He has held a number of signals appointments both in the U.K. and abroad and was Inspector of Radio Services for two years. He commanded the Radio Engineering Unit at Henlow before becoming Chief Signals Officer at H.Q., Allied Air Forces Northern Europe, in 1955.

Group Captain R. W. Hase has been appointed to the Signals Division of S.H.A.P.E. as Chief of Electronics Branch. He has been in signals throughout most of his Service career, which began in 1933 when he joined the Auxiliary Air Force. In 1956 Gp. Capt. Hase, who is 45, was appointed Deputy Command Signals Officer, Fighter Command, and since relinquishing that post has been in the Air Ministry.

F. S. Barton, C.B.E., M.A., B.Sc., M.I.E.E., who since 1955 has been in Canada, as Counsellor (Defence Research and Supply), Ministry of Aviation, retired from public service on August 31st and has joined the board of Mullard Equipment, Ltd. He joined the radio department of R.A.E., Farnborough, in 1922 and in 1936 became deputy head of the department. From 1941 to 1946 he was in Washington as director of radio engineering in the British Air Commission. He returned to this country in 1946 to become Director of Communications Development in the Ministry of Supply, and was later appointed Principal Director of Electronics Research and Development. Mr. Barton was a member of the Radio Research Board from 1947-1955.

F. S. Barton

C. J. Francis, who is 56, has been appointed to succeed F. S. Barton in Canada. He was for 13 years in the radio industry prior to 1939 when he joined T. R. E., where six years later he became a divisional head in charge of work on defensive ground radar. In 1946 he was made responsible for reasearch and development of ground radar, navigational aids and blind landing equipment. Mr. Francis joined the British Joint Services Mission in Washington in 1954 and three years later was appointed Assistant Director, Electronics Research and Development (Air) in the Ministry of Supply.

E. Eastwood, Ph.D., M.Sc., M.I.E.E., and **A. J. Young,** B.Sc., M.I.E.E., have been appointed to the board of Associated Transistors Ltd., operated jointly by A.T.E., English Electric and Ericsson. Dr. Eastwood, replacing **Sir Noel Ashbridge,** who retired some months ago, has been chief of research of Marconi's W/T since 1954. He joined English Electric in 1946 in charge of their radiation laboratory and two years later was transferred to Marconi's as deputy chief of research. Mr. Young, managing director of the English Electric Valve Company, joined Marconi's in 1934 and was technical adviser on valve production in Poland and Czechoslovakia until the outbreak of war. He has been associated with the E. E. Valve Company since its formation in 1947.

John Keir, personal assistant to the managing director of the Marconi International Marine Communication Co., has retired after 45 years service with the company which he joined as a sea-going radio operator. He was for some years managing director of the company's Brazilian associates, Companhia Marconi Brasileira.

Donald S. Reid, M.A., honorary secretary of the British Amateur Television Club since 1958, has joined the television development laboratory staff of Rank Cintel. On coming down from Trinity College, Cambridge, in 1954, he joined what was then the transmitter advanced development group of Marconi's. Since 1958 he has been in the electronics section of the physics research laboratory of Ilford Ltd., at Brentwood, Essex, where he has been working on the application of television techniques to photographic duplicating. His new address is: 21, Silverdale, London, S.E.26.

S. V. Williams has been appointed to the boards of two of the companies within the Derritron group, which was recently set up by V. G. P. Weake. The companies are Reslosound Ltd. and Chapman Ultrasonics Ltd. Mr. Williams was with Pamphonic for some years before joining Derritron in June.

E. C. Wayne has joined Aveley Electric Ltd. as a sales engineer and will be specializing in microwave measurement equipment and aerials. For five years prior to joining Aveley Electric he was in the aerial and filter development department of Marconi's. Before that he spent 15 years in the Post Office Engineering Department.

OUR AUTHORS

A. E. Crawford, M.Brit.I.R.E., S.M.I.R.E., chief engineer of the Brush Crystal Company, of Hythe, Hants., contributes an article on piezoelectric transformers in this issue. Since joining Brush in 1955 he has been responsible for the establishment of their ceramics and semiconductor division. He is a member of the Brit.I.R.E. Technical Committee and a founder member of the newly-formed Southern Section Committee.

V. H. Piddington, A.M.Brit.I.R.E., contributor of the article on permeability tuners in this issue, has been with Bush Radio since 1955 where for some time he has been responsible for television tuner design. After war-time service in Army radio workshops he spent some years with Furzehill Laboratories. Immediately prior to joining Bush he was with R.C.A. (Great Britain) as section leader responsible for the development of reproducing equipment. .

OBITUARY

Commander Christopher Michael Jacob, D.S.C., A.M.I.E.E., R.N.(Retd.), deputy technical manager of the Marconi International Marine Communication Co. since 1954, died in Chelmsford on September 2nd at the age of 54. He specialized in radio and radar during the greater part of his naval career, and in 1939 was appointed to the Home Fleet as Fleet Wireless Officer and Fleet Radar Officer. In 1942 Commander Jacob was transferred to the Admiralty for radar work with the Director of Radio Equipment. He was later Deputy Captain-Superintendent of the Admiralty Signal and Radar Establishment; was Naval Adviser to the Director of Communications Development in the Ministry of Supply, and immediately prior to joining Marconi's in 1954 was deputy chairman of the British Joint Communications-Electronics Board.

Jean Bishop, who died on August 1st after a long illness, had been in the radio industry for 40 years. She joined Marconi's in 1920 and a year later transferred to the Marconiphone Co., where she worked on technical press liaison and was for 14 years secretary to F. Youle. In 1943 she joined the B.V.A. as secretary to the technical secretary. Since 1947, until her health broke down at the beginning of this year, Miss Bishop had been secretary to E. M. Lee, managing director of Belling & Lee.

News from Industry

Phœnix.—The seven-company consortium—A.E.I., A.T.E., Ericsson, G.E.C., Marconi's, Plessey and S.T.C. —which sought to take over Temco (now in the Pye group) have obtained a controlling interest in Phoenix Telephone and Electric Holdings Ltd. The consortium is operating through a recently formed company—Combined Telephone Holdings Ltd.

Metal Industries Group, which includes Avo, Taylor Electrical and Brookhirst Igranic, had a trading profit of £1,722,715 for the year ended last March compared with £1,503,963 the previous year. With the acquisition of Lancashire Dynamo Holdings Ltd. the group has more than doubled in size—from 6,000 employees in 16 companies to 12,000 in 38 companies. A separate balance sheet for 1959 has been prepared for Lancashire Dynamo. It shows a trading profit of £863,273.

Colvern Ltd. report a 34% increase in their 1959/60 profits before taxation compared with the previous year—£221,615 against £164,646.

Telefusion.—A 63% increase in the trading profit of the Telefusion group is recorded in the report for the year ended last April; £1,144,285 compared with £702,838 the previous year. The net profit after allowing for depreciation (£778,975) and taxation was £297,483. Teleng Ltd. is the manufacturing subsidiary of the group which, through its various companies, operates a number of sound and television relay networks throughout the country. The group has recently registered a subsidiary company Radio Telefusion Ltd., with a view to entering the field of commercial broadcasting if the Government should introduce it.

B.R.W.—A trading profit of £2,474,606 for 1959/60, which is over £1M higher than the previous year, is reported by Sir Robert Renwick, chairman of British Relay Wireless and Television Ltd. Depreciation of equipment absorbed £1,677,107 and taxation £7,846, leaving a group profit of £676,769 against £273,148 the previous year.

Radio-Aids Ltd., of Watford, Herts., manufacturers of instruments and industrial electronic equipment, have been acquired by Contactor Switchgear Ltd., of Wolverhampton. E. L. Gardiner, the well-known amateur and past president of the Radio Society of Great Britain, will continue as managing director of Radio-Aids and has been joined on the board by two directors of Contactor Switchgear—H. Rayner and A. V. Lawry.

Gresham-Lion.—Gresham Developments Ltd., of Hanworth, Middx., and Lion Electronic Developments Ltd., of Feltham, Middx., have been amalgamated to form a new company, Gresham-Lion Electronics Ltd., Gresham House, Twickenham Road, Hanworth. (Tel.: Feltham 2271.) The directors are John P. Coleman, J. A. Clegg and Dr. C. B. Speedy.

Murphy Radio have received an order from the Ministry of Aviation for the supply of 15 ground installations of Autoland, their blind landing system. They are also supplying 150 installations for aircraft. Murphy have been working on this leader cable system for some years in collaboration with the Government Blind Landing Experimental Unit at Bedford.

S.T.C. have received a contract valued at approximately £1.8M from Cable & Wireless for the supply of a complete multi-circuit telephone cable system between the United States and Bermuda. It will be jointly operated by C. & W. and the American Telephone and Telegraph Co. The installation, which is scheduled for completion towards the end of next year, includes 750 nautical miles of submarine coaxial cable with 34 submerged repeaters and three submerged equalizers, together with terminal equipment at Manahawkin, N.J., and Flatts, Bermuda.

Livingston Laboratories have recently added three more American names to the list of companies for whom they are agents—Ballantine, Boonton and Moseley. The last two are in consequence of their becoming subsidiaries of Hewlett-Packard, for whom Livingston Laboratories are already sole representatives in this country.

Plessey Nucleonics, Ltd., have received an order from the U.K. Atomic Energy Authority for the supply of all the nuclear instrumentation for its advanced gas-cooled reactor at Windscale.

Franco-American Company.—Compagnie Européenne D'Automatisme Electronique has been formed jointly by Compagnie Générale de Télégraphie Sans Fil and the Société Intertechnique, of France, and Thompson Ramo Wooldridge, of the U.S.A., for the manufacture of digital computers for industrial control. The head office is at 8 rue Lavoisier, Paris.

Lancashire Dynamo Electronic Products have prepared a colour film "Invitation to Prosperity" for general distribution to film libraries this autumn. It exemplifies the wide variety of applications of their control methods in industry and public service.

General Radio's U.K. representatives, Claude Lyons Ltd., have notified us that G.R. have moved to a new plant in West Concord, Massachusetts.

Redifon in the U.S.A.—Redifon Ltd. have formed Redifon Electronic Inc. with offices at 5265 Watson Street, N.W., Washington, D.C.

Sifam Electrical Instrument Co. have moved to a new factory at Woodland Road, Torquay, Devon. (Tel.: Torquay 63822.)

EXPORT NEWS

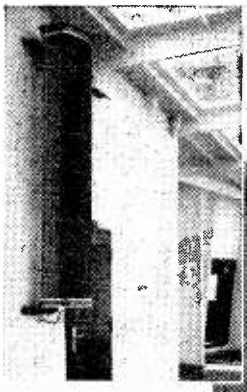
Radio-telephone Link.—A contract worth approximately £1M has been secured by Murphy Radio, Ltd., for an extensive v.h.f. radio telephone network in northern India. The system will follow the route of the new 700-mile pipeline of Oil India Private Ltd. between Nahorkatiya, Assam, and the refinery at Barauni, Bihar. At intervals of 30 miles or so, at each pumping house, a radio station will be installed to give 36 communication channels forward or back along the pipeline route. The frequency-modulated equipment operates in the 150-170 Mc/s band. The carrier equipment for the system is being provided by A.E.I. Telecommunications Division.

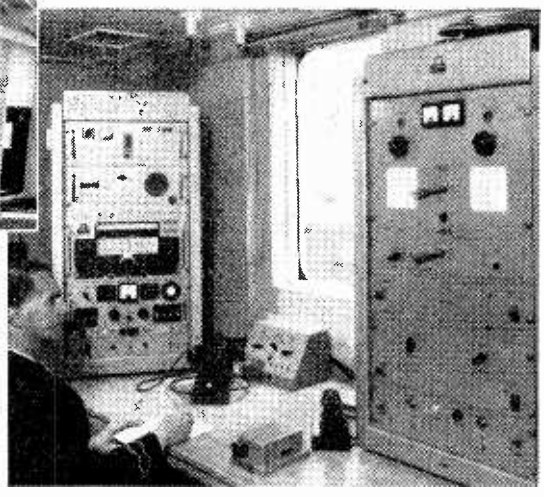
Vision and sound transmitters, as well as studio equipment, for three new television stations in New Zealand are to be supplied by Marconi's through Amalgamated Wireless (Australasia). The three stations, at Christchurch, Wellington and Dunedin, will operate in Band I using the 625-line 7-Mc/s standard. The existing experimental station in Auckland was equipped by Marconi's.

Travelling-wave tubes to the value of $2M have been ordered from Mullard's by the Radio Corporation of America. The tubes will be used in a new multichannel radio communication system to be manufactured by the R.C.A.

The paging system used at the recent U.S. Democratic National Convention in Los Angeles was made by Multitone Electric Co. of London and supplied by their Canadian subsidiary.

Ekco in Italy.—A new subsidiary company in Milan, with the title Ekcovision Italiana S.P.A., has been set up by E. K. Cole Ltd. For some years Ekco television chassis have been imported and fitted into locally-made cabinets by the company's distributor, Compagnia Commerciale di Cinematografia, whose general manager is a member of the board of the new company.





"Windsor Castle".—The radio office in the new Union Castle 38,000-ton liner Windsor Castle. *Her radio transmitters and receivers, radar, direction-finders and echometers were supplied by Marconi's. Inset is one of the specially designed line-source loudspeakers for the sound reproducing installation provided by Pamphonic Reproducers. These and the individual loudspeakers in many of the cabins are fed from three amplifiers with a total output of 1kW.*

NATIONAL RADIO SHOW REVIEW

ANALYSIS OF TRENDS SEEN AT EARLS COURT BY "WIRELESS WORLD" STAFF

TELEVISION

WHOLESALE introduction of the "short short" 110° tube (as the tripotential-gun c.r.t. has become known) has resulted in a "slimming-down" of last year's slim sets. Usually this has caused the "bulge" to disappear from the back of the cabinet. We were intrigued by the description "pencil-slim" applied to some receivers: this was found to be a comparison with the length of a pencil, not, as we had hoped, its thickness!

"Push-through" presentation of the c.r.t. continues, and reaches its logical conclusion with the new c.r.t.s which have the protective glass bonded to the tube face plate, so that no additional masking or protection is required.

The use of frame-grid valves in the i.f. stages as well as the r.f. has resulted in a reduction of the number of valves in a receiver, or the elimination of the necessity for separate "fringe" and "standard" categories. Mean-level a.g.c. seems to be on the way out and flywheel line synchronizing is increasing in popularity. The twin l.s. trend continues, particularly in models with v.h.f./f.m. Philco were showing receivers fitted with long and medium wave radio, rather than v.h.f. This was said to be due to the demand for reception of Radio Luxembourg.

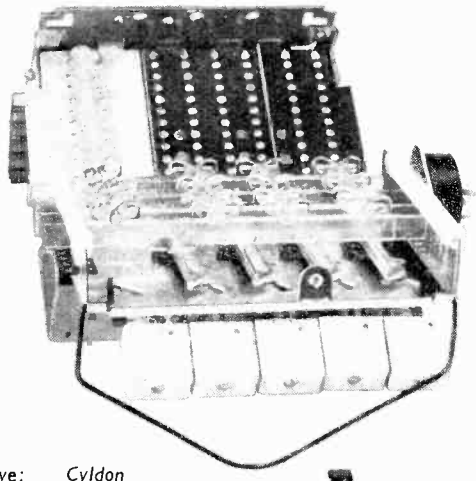
Tuners.—The first set without (as far as the user was concerned) a fine-tuning control was introduced by Murphy in June 1957 and was made possible by building a very stable local oscillator. This used a turret-type tuner and, last year, the principle was extended to f.m., when a.f.c. was applied with a point-contact diode. Bush introduced, two years ago, a push-button tuner using permeability tuning and having separate fine-tuning controls, for initial setting-up, associated with each button. Later this was modified to cover also f.m.

Many manufacturers were showing sets using push-button or modified forms of rotary tuner, all with preset fine-tuner controls. Alba call theirs "touch-tuning" and they use what is really a two-position incremental/permeability tuner. A rocker-arm mechanism moves a slide switch which, in one position, short circuits the Band-I coils, leaving in circuit the Band-III coils. Both sets of coils are mounted across the tuner and the cores of each set are ganged by plates whose positions are governed by threaded spindles. These latter project through the side of the receiver for adjustment. Thus, after initial setting-up, it is necessary only to touch the rocker switch to change from B.B.C. to I.T.A.

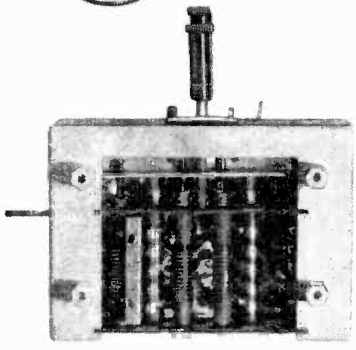
The Ferguson "Golden Glide" uses a modified disc tuner. Linear motion of the selector stud is converted to rotary motion of the spindle. Depressing the stud disengages the click, or detent, mechanism of the tuner and allows the stud to be slid to the desired channel number. The oscillator tuning for each channel is controlled by small gear wheels which are brought up to another gear on the fine-tuner spindle.

Many manufacturers use tuners made by specialist firms. One such is the A.B. Metal Products piano-key "turret" tuner noted first at the last I.E.A. exhibition, and used, for instance, by H.M.V. On this the mechanism allows one of four coil "biscuits" to rise into contact with the tuner circuit.

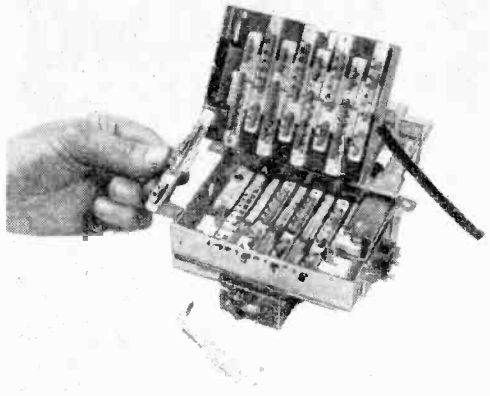
Called "Selectronic" by R.G.D., the Cyldon (made by Sidney Bird) tuner was also found to be used widely. This is of the incremental type and has printed coils on a flat board. The coil terminations are extended



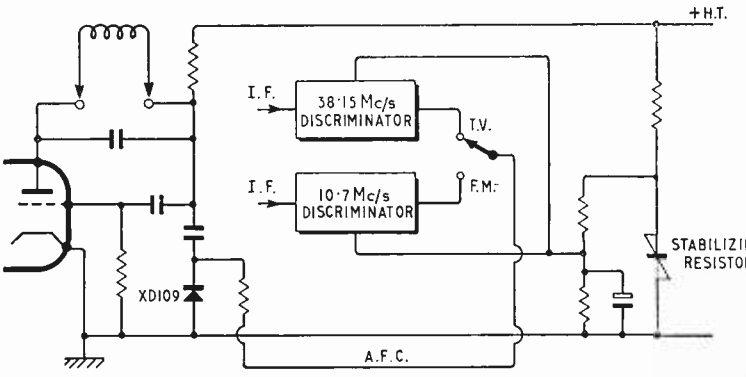
Above: Cyldon push-button tuner with coil panel folded back to show shorting contacts.



Underside of Alba "Touch-Button" tuner. End of Band-I/III slide switch can be seen at left, tuning spindles at top of photograph.

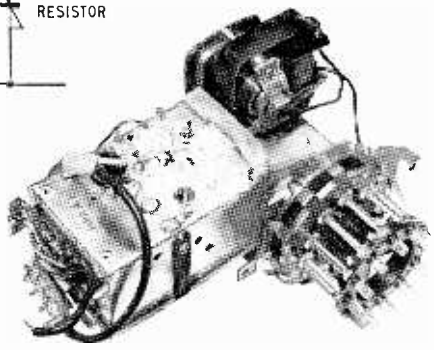


Piano-key switch tuner by A.B. Metal Products (in this case from H.M.V. receiver) has four coil biscuits inserted in the mechanism; those for other channels are housed in a cassette under the tuner.



Left: Simplified circuit of a.f.c. system in Dynatron "Autoview" sets.

Below: Motor-driven tuner from Ultra "Bermuda" receivers.



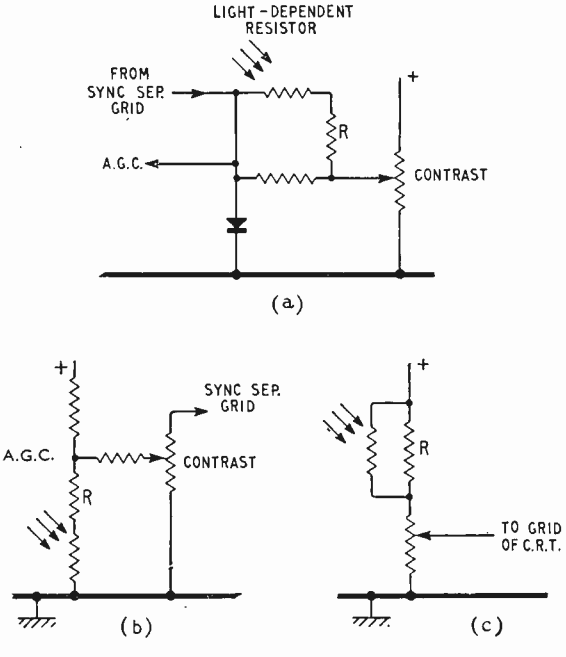
through the boards as contact studs and these are short-circuited by slide bars operated by the four channel-selecting push buttons. Thirteen slots, corresponding to the thirteen channels in Bands I and III, are provided for the slide bars, so choice of channels is accomplished simply by inserting the four slide bars in the appropriate slots. The fine tuner is a concentric capacitor which is set on each channel by a linkage from a captive nylon screw in each button. The whole tuner is shaped to fit the bell of the c.r.t., so that a compact chassis arrangement can be achieved.

Ultra feature yet another approach—motor drive—in their "Bermuda" range of receivers. Here the tuning control looks rather like a telephone dial with twelve push buttons projecting from it. On pressing one of the buttons the dial rotates until the chosen button reaches the top of the disc, when it springs out and the rotation stops. When a button is pressed, a hooked contact is forced over an insulating collar to make contact with an earthed disc, so completing the motor circuit. The drum then rotates until the depressed contact is lifted off by a nylon cam, when the motor stops. The fine-tuning is set on each channel by a linkage coupled to the button in the "at rest" position. V.h.f./f.m. positions are also provided on the tuner and the channel in use is indicated by optical projection of the number or letter on to a small screen in the centre of the "dial."

Remote Control.—Possibly the most convenient remote-control system allows one to change channels without waking completely from the physical torpor induced by television in a darkened room. At Earls Court three manufacturers were showing systems of this type and motor-driven remote-control tuners were found on Pye, Pam and Invicta receivers shown at the Royal Festival Hall. Pye have replaced the normal spring detent by a Geneva mechanism to give positive location without mechanical resistance.

The Dynatron "Autoview" system uses a motor-driven tuner to which is coupled a shorting-type wafer switch. On depressing one of the piano-key controls, the motor circuit is completed; then the turret is rotated until the circuit is broken when the blank on the shorting switch reaches the contact through which the circuit was completed. Fine tuning is carried out by an a.f.c. system using a junction diode for which the control is provided by two discriminators in the sound channel (one for f.m., one for TV). A voltage-dependent resistor stabilizes the diode back-bias (from the h.t. line) against mains fluctuations. One position of the key switch is labelled "remote"; when this is depressed an external control unit connected by a multiway cable is brought into operation, or, in the latest model, a supersonic system using a transistorized transmitter which is, in broad outline, similar to that in the Emerson set shown last year.

The H.M.V. Model 1920 also uses a motor-driven tuner but, unlike the Dynatron, the control unit does not contain batteries, valves or transistors. It is what might be termed a high-frequency "gong," tuned to about 45kc/s, which is struck mechanically when the button is pressed. The acoustical vibration is picked up by a crystal microphone, amplified and is used to operate a relay which starts the motor. On the tuner drum are mounted adjustable pegs which lift a pair of contacts and stop the motor. For switching off the set, a longer peg is inserted in an unused channel position, so lifting a second pair of contacts which allow a capacitor to discharge, over about 12sec, through the motor relay: if a second "ping" is not received during this time the set switches itself off. Of course, the trouble with such a small control unit is that it can



Lighting compensation circuits. Sobell and McMichael (a) and Philips (b) vary contrast whilst Defiant (c) varies brilliance. Resistor R limits effect of device in increasing [(a) and (b)] and decreasing (c) light.

be lost easily. Purchasers of the set need not worry: it has been reported in the daily press that an aerosol fly-spray works on some American receivers and WIRELESS WORLD changed channels quite effectively by rattling a bunch of keys.

The Bush push-button tuner has been modified for remote control too. This tuner has comparatively long push-in spindles and, by attaching armatures to these and putting a solenoid round them, the buttons can be pulled in very effectively. A large current is needed for this and it is provided by the discharge of a capacitor which is charged from the h.t. line.

Automatic Adjustment of brilliance or contrast to suit room lighting conditions was shown privately last year by Mullard and was found in receivers at this year's show. Some receivers have the photo-resistor connected so that it increases contrast when an increase of light reduces the resistance of the device, whilst Defiant use it to increase brilliance. These viewpoints are not as divergent as they seem, however, because over the normal operating range changing the tube bias will alter its *gamma* or contrast performance. Similarly, unless a black-level clamp is used, an increase of contrast simultaneously increases brilliance because the picture black level corresponds to the top of the sync pulses. Over the ORP60 cell employed in Philips sets a prismatic diffuser is used and a small preset vane covers part of the cell to bring it to its correct operating point: for this purpose K-B use a light-attenuating filter and a preset resistor.

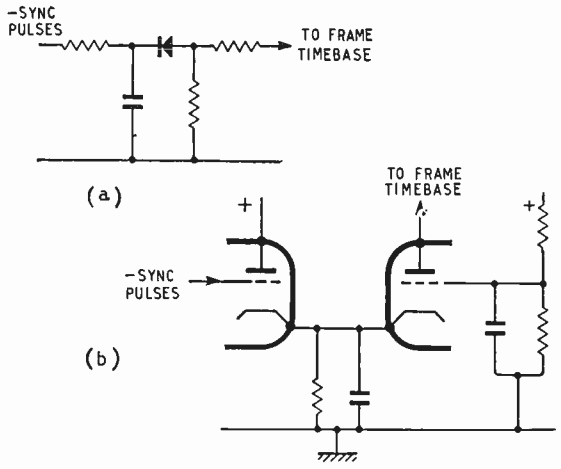
Interlace.—It has long been known that feed-through from line to frame timebase can destroy interlace; this can happen when mutual coupling exists between line and frame coils. With 110° c.r.t.s. the scan coils have to be of very high quality to give satisfactory performance. K-B, to avoid rejection of coils with excessive mutual coupling, fit a bucking coil in series with the line-scan coils. The coupling between this and the frame coils is adjusted on a bridge to cancel the imperfection. Thus it looks as if the introduction of the 110° c.r.t. has been responsible, through the high quality needed in its scanning yoke, for a general improvement in interlace.

However, a new method of ensuring interlace was found in Decca receivers. These sets use an integrator followed by a differentiator to separate the frame pulses. A rheostat is fitted in the frame oscillator circuit in such a position that it allows alteration of both the pulse width from the differentiator and the grid time constants of oscillator. Using this, an individual adjustment for correct interlace can be made on each receiver.

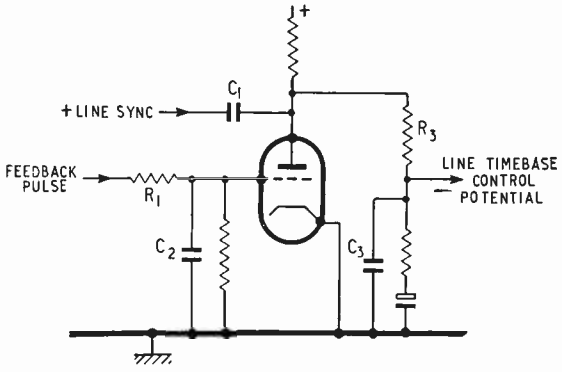
Flywheel Line-sync circuits are hardly renowned for their simplicity, but an extremely simple one has been developed by Philco (see diagram). Positive sync pulses are partially differentiated by C_1 and a positive flyback pulse is delayed by R_1 and C_2. Normally the valve is cut off by bias resulting from grid current, but the flyback pulse causes it to cut on, providing a low impedance at its anode and allowing C_3 to charge fairly quickly R_3. When the valve is cut off C_3 can only charge slowly through the high-value anode resistor. The potential to which the valve anode falls during the cut-on period, and the state of decay of the back edge of the partially-differentiated sync pulse thus largely determines the potential on C_3. If the timebase is running fast the flyback occurs when the lagging edge of the sync pulse is at a high negative value, thus the timebase is slowed down. If the flyback pulse occurs late (timebase slow), the trailing edge of the sync pulse has almost completely decayed: thus the control potential becames more positive and the timebase is speeded up.

Transistor TV.—Although experimental battery-operated transistor television receivers have been made before, 1960 sees the introduction, by Pye and Ferguson, of sets shortly to go into production.

One of the major problems in using transistors is that of obtaining a sufficient amplitude of video signal to modulate the c.r.t. Pye overcome this by using a special 14-in tube, made by Cathodeon, which has a drive re-

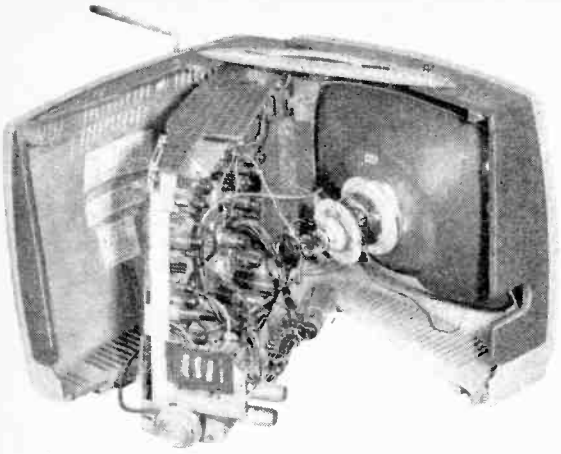


Well-tried simple (a) and relatively complicated (b) frame-pulse separator circuits found to be giving good interlace [(a) Ekco, (b) Peto Scott].

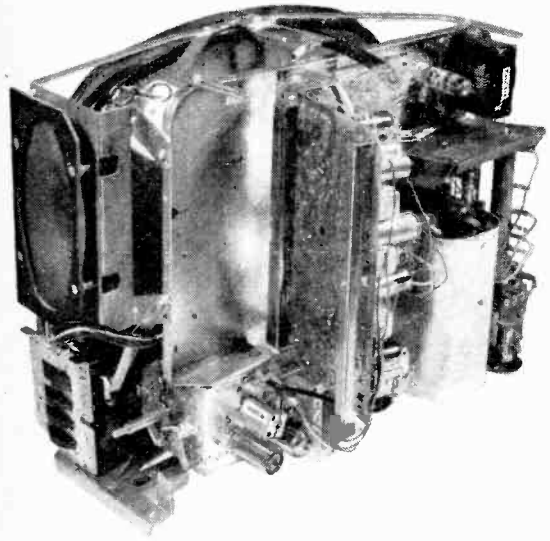


"Philcoloc" flywheel line-sync circuit.

Ferguson "Transvista" 7-in transistor TV weighs 20-lb and runs for four hours from its internal batteries. 24 transistors and 15 semiconductor diodes are used.



G.E.C. BT326 has book-form chassis and case.



Ekco receiver with its case removed and i.f. panel swung out. Slots allow chassis to slide back from bell of c.r.t.

quirement of 10-V, 2-V less than the 12-V "h.t." available. Ferguson, on the other hand, develop a 40-V supply for the video amplifier from the flywheel-synchronized line timebase and use a 7-in standard rectangular monitor tube. They also use a single switching transistor for the line-output stage, which is so designed that the transistor is projected from the pulse occurring on flyback. This pulse is stepped up to 5kV by a transformer and then voltage-doubled by thermionic diodes to give 10kV e.h.t. OC171 transistors are used for the five vision and four sound i.f. stages (at B.R.E.M.A. frequencies) and a.g.c. is applied to hold contrast constant.

Mechanical Features.—As in past years, the trend for easing servicing continues. Particularly notable were sets by Ekco, Philco, Peto Scott and G.E.C.

The Peto Scott chassis swings down in much the same manner as some metal window-frames open, so that the whole chassis is moved clear of the cabinet. The side-mounted tuner is held by two screws which, when loosened, allow the tuner to be slid inwards so that the control knob clears the escutcheon. Probably equally convenient is a G.E.C. arrangement, where the cabinet opens like the covers of a book (with the c.r.t. attached to one) leaving the "single-page" chassis in the middle.

Philco have introduced what they call the "Codenta" system. With this each section of the set has its own colour for easy identification, i.e., tuner, orange; sound, blue; sync, green; etc., and this code is used on every wire and major component—even the over-printing of the wires on the circuit boards and, for instance, the mains dropper (power supply, red). Not content with this the Philco designers have made the whole set clip together, so that it can be stripped down to individual sections in less than five minutes.

Ekco, on the other hand, favour keeping the receiver in one piece and their new sets can be fully exposed for servicing in a very short time. The back and bottom are held on by ¼-turn nylon "screws." After removing these it is only necessary to loosen two wingnuts, remove the tuner knobs and release a lever which closes the dust-seal between tube and mask, to lift off the cabinet and expose the whole "chassis." If access to any part close to the tube is required the release of the supporting struts allows the chassis to be pulled back several inches; but this is not necessary with the i.f. panel which hinges outwards.

TELEVISION AERIALS

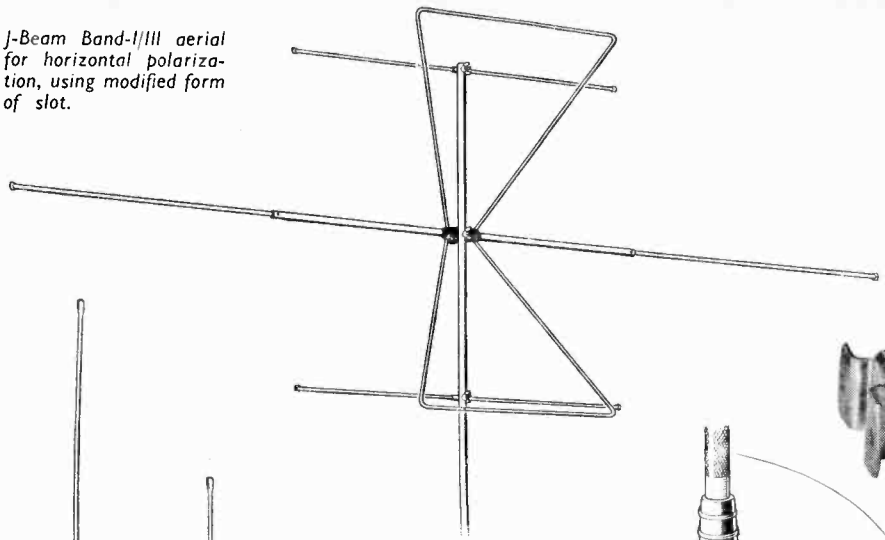
NEW developments tend to be sparse in the aerial field today; but Wolsey's "Collector-Combine" series certainly looks as if yet another method has been found for the inter-connection of Band-I and -III arrays. The aerial uses two half-wave end-fed co-linear radiators for Band III (next to Band III directors) and these are connected together by a half-wavelength-long loop, to maintain correct phasing. This loop is also used as a $\lambda/4$ transformer to step down the high aerial impedance to about 80Ω for connection of the feeder where the Band-I elements are attached. On Band I the inductance of the loop end of the $\lambda/4$ transformer and the capacitance of the Band-III elements and their connections resonate as a parallel-tuned circuit, so presenting a high impedance from the Band-III section to the Band-I dipole.

Antiference, in their "Cresta" in-the-room aerial, also use two co-linear end-fed $\lambda/2$ sections for Band-III reception. To aid matching, a decorative metal $\lambda/2$ section is placed near the fed ends of the aerials and the "Cresta" also performs better on Band-I than would a single Band-III dipole because the elements, due to their extra length, more nearly approach resonance.

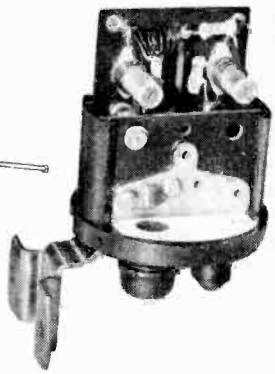
New outdoor aerials from J-Beam have been designed with a view to keeping their outline as compact as possible to reduce wind resistance and skyline "clutter." In the case of the higher-gain combined arrays this has been done by mounting the familiar J-Beam slot behind the Band-I dipole so that the directors do not project so far forward. This "cleaning-up" process has also inspired the design of the "New J-One." The effectiveness of this design can be judged from the fact that had we published a drawing of the aerial it would have been little more than a line down the side of this page. The basic construction is a centre-fed sleeve dipole for Band I (in which the feeder enters through the lower element) with its lower element shortened because the mass of the metal chimney clamp and lashing is used to load capacitively the short rod, so bringing the aerial to resonance. Band-III reception is achieved by two $\lambda/4$ sleeves concentric with the Band-I elements and connected to the feeder at the same point as the Band-I aerial. A new combined aerial for horizontally-polarized transmissions demonstrates the versatility of the skeleton slot by bending back the long sides to join the feeder connections at the Band-I insulator.

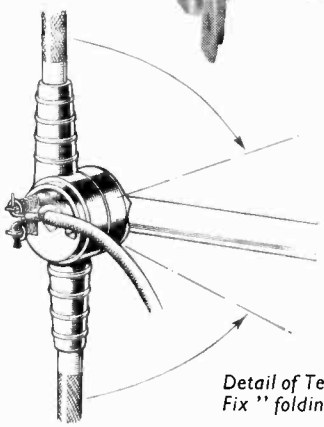
Telerection have designed a new folding Band-I insulator to ease erection and packing problems. This consists of three discs—one grooved to lock on the crossarm, the other two carrying the dipole elements. Locating pegs enable the unit to be used for both the "Paravex" (near "X" form) and plain dipole collectors and the feeder connections are simple and quick to fit.

J-Beam Band-I/III aerial for horizontal polarization, using modified form of slot.



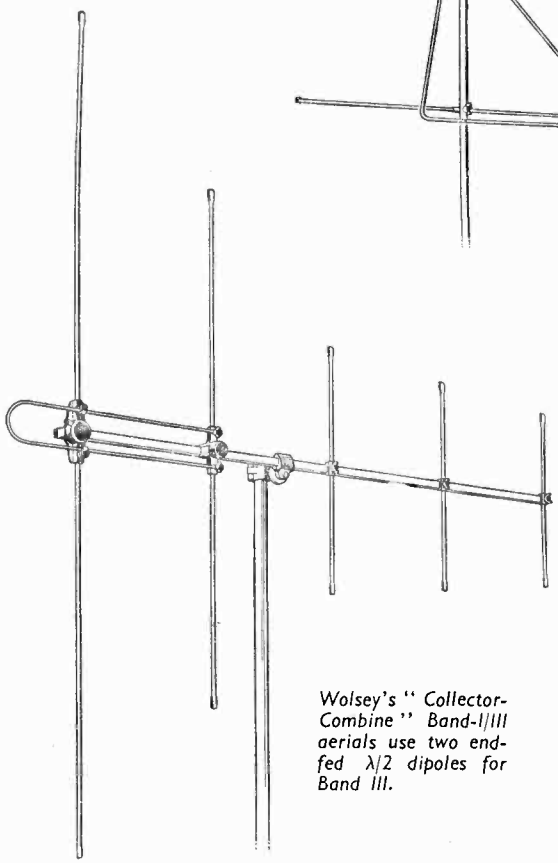
Antiference Y9 aerial feeder combining unit for C.C.I.R. Channels 5, 6 and 7, 8, 9





Detail of Telerection " Finger Fix " folding dipole insulator.

A new chimney clamp by Wolsey is of folding construction and although of seemingly light material, is extremely strong due to the use of bracing struts. It replaces three models of clamp from the existing range.



Wolsey's " Collector-Combine " Band-I/III aerials use two end-fed λ/2 dipoles for Band III.

Instead of the usual saddle and terminal arrangement needle-eyed posts extend from the insulator and a spring and washer on each post traps the bared ends of the feeder firmly in the eyes.

Andrew Sloss, a Scots aerial manufacturer, found that corrosion from sea spray, even 20 or 30 miles inland, was the cause of early failure of some aerials. Similarly the rigid clamping of the ends of parasitic elements caused, in high winds, the reflection of shock waves from the clamp with a resultant failure due to fatigue caused by the vibration standing-wave pattern. To provide protection from spray p.v.c. sleeves were shrunk on to the elements and boom and a standard resilient insulator of hard polythene was used not only for the radiator but also the parasitic elements.

Accessories.—Antiference were showing a 300Ω diplexer for export and combining units (75Ω) for C.C.I.R. channels 2 and 4 (Model Y8) and 5, 6 and 7, 8, 9 (Model Y9). Both are mounted in waterproof cans, and factory-adjusted tuned circuits are used to achieve satisfactory performance. (C.C.I.R. channels 6 and 7 are adjacent, at the l.f. end of Band III.)

SOUND RECEIVERS and REPRODUCERS

Transistor Receivers.—Improvements in the performance, cost and availability in large quantities of v.h.f. transistors have now allowed the commercial production of v.h.f./f.m. transistor receivers, and about half a dozen models were exhibited at this year's show. These receivers could nearly all also receive medium- and long-wave a.m. broadcasts.

F.m. sensitivities ranging from 2 to 5μV were generally achieved. This is high enough for use with the telescopic swivel aerial which was usually incorporated to allow for possible distortions of the plane of polarization of the signal near the ground.

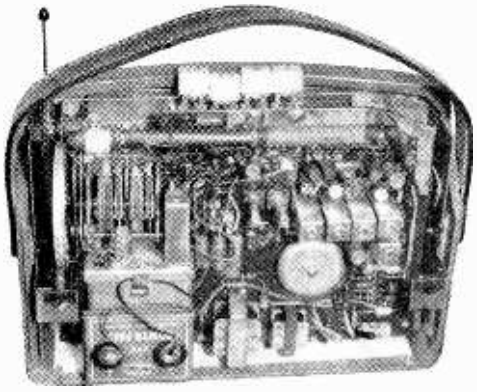
For f.m. reception the basic transistor functions were the same on all receivers—an r.f. amplifier, combined mixer and local oscillator, and three i.f. amplifier transistors being used. A ratio detector was also invariably employed. OC 171 transistors were popular for the r.f. amplifier and combined mixer/oscillator and OC 170's for the three 10.7Mc/s i.f. amplifiers. For a.m. reception, the first two f.m. transistors were disconnected in all the receivers, but two alternative methods of employing the three f.m. i.f. amplifier transistors on a.m. were noted. On most receivers these were used to make up a combined a.m. mixer/oscillator and two i.f. amplifiers; on the H.M.V. and Ferguson models, however, they were used to make up an r.f. amplifier, combined mixer/oscillator, and single i.f. amplifier. All receivers again used the same basic audio

amplifier consisting of a pre-amplifier, driver, and push-pull output pair.

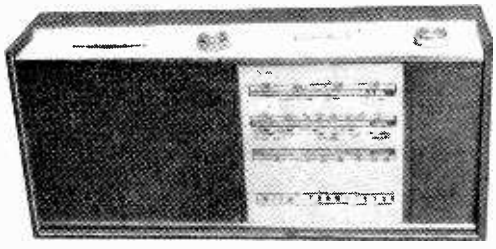
On f.m. often only the first (r.f.) stage was gain-controlled, the a.g.c. voltage being obtained by rectifying the signal at the output of the first i.f. amplifier. Such a.g.c is essential to reduce changes in the local oscillator frequency due to changing signal levels In the Ultra TR81 additional a.g.c. is applied to the second i.f. stage so as to operate the ratio detector at a more constant level and obtain consistently good a.m. rejection.

A special feature of the Ferguson Model 626BT receiver is the provision of a stabilized bias voltage for the three i.f. amplifiers on f.m. or the mixer/oscillator and i.f. amplifier on a.m. This reduces changes in the receiver sensitivity as the battery voltage falls.

Similar developments in transistors as have recently enabled v.h.f. receivers to be manufactured have also resulted in the production of short-wave receivers. Ferguson, H.M.V., Marconiphone and Pye showed export models: short-wave reception and independence



Perdio Model 95—one of the new a.m./f.m. transistor receivers.



Defiant Model AF54—another of the new a.m./f.m. transistor receivers. This model also illustrates the trend towards making transistor receivers look like valve table models.

from the mains supply can, of course, be particularly useful in foreign countries. Wavelengths down to 10 metres can be received by using two OC 170's as a separate mixer and local oscillator. An additional OC 170 tuned r.f. amplifier is provided in the Perdio Multi-band Model 91. This receiver is also somewhat unusual in providing complete coverage from 11 to 570 metres as well as the 750 to 2,000 metre long-wave band.

Last year the Perdio Continental a.m. receiver used a diode whose resistance is controlled by a signal voltage dependent bias and which is placed across a tuned circuit so as to damp this circuit and increase its bandwidth at high signal levels. Such a damping diode also alters the circuit gain, and this method was used in several of the receivers exhibited to apply a.g.c. to the i.f. transformer primary of the a.m. mixer/oscillator (the diode control signal voltage being obtained from a later i.f. stage). A very important use of such a.g.c. may be to avoid possible overloading in the i.f. stages.

In previous years we have noted the trend towards making transistor receivers more like valve table models by giving them an increased power output and a larger loudspeaker and cabinet. Looking at their cabinets alone, this year transistor receivers have in many cases become nearly indistinguishable from their valve counterparts. One obvious distinction—the absence of a mains lead—is referred to in the increasing use of the word "cordless" to describe such receivers. These trends are continued, for example, in the 1-W output and 8 by 5in loudspeaker of the Hacker "Herald". An unusual additional feature of this receiver is that low-frequency acoustic loading of the loudspeaker is provided by a number of slots in the back of the cabinet which are resistively loaded by foam polyurethane.

Last year in the Murphy B385 we noted a transistor receiver which, by the provision of alternative cabinets, could be used either as a table model or small portable. This year this idea was carried still further in the Perth "Home and Away" mains valve record reproducer and battery a.m. transistor receiver. Here the transistor receiver can either be used separately with its own output stage and loudspeaker, or alternatively be fitted into the record reproducer so as to feed the output from its detector into the record reproducer amplifier and loudspeaker.

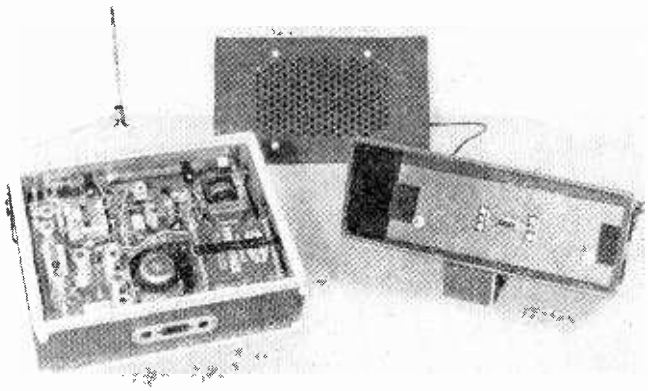
The trend towards dual-purpose portable/car-radio receivers was carried further in the Ever Ready car portable. When this set is plugged into its special container in the car, this automatically connects the car aerial, the car battery and an 8in × 5in loudspeaker in place of the internal aerial, battery and speaker. An ignition interference filter is also connected in the car and the container acts as an earthed metal screen. The increase in the supply voltage from the 9V of the internal battery to the 14V (approximately) of the car battery when on charge allows the available receiver power output to be increased from 400mW to 1W in the car.

Both Perdio and Roberts used output stages in which the load was split between the collector and emitter circuits so as to compromise advantageously between the high-gain but high crossover distortion of the grounded-emitter configuration and the low crossover distortion but low gain of the grounded-collector configuration. With this arrangement the battery can be used down to one half rather than two-thirds of its original voltage.

Transistor Radiogramophones.—These are no longer the comparative rarity they once were since about six companies showed new models. A compact arrangement with the receiver and record turntable on opposite sides of the cabinet was noted in the E.A.R. "Envoy". In the Bush "Top Ten", radio reception of only the light programme on long waves is provided, a simple t.r.f. circuit being used.

An interesting feature of the Dansette Model TRG/45 is that the radio is automatically switched off or on according to whether the record turntable is rotating or not. This is achieved by placing the motor field coil in series with the battery supply to the receiver, and the automatic turntable switch across this supply. When the motor is running this switch thus shorts out the supply to the receiver and thus also avoids any possibility of audio breakthrough from the receiver. As soon as the turntable stops, this switch opens and automatically reconnects the battery supply to the receiver.

Stereo Record Reproduction.—Stereo records have now been with us long enough for the rate of change in this field to have slowed down. However, there has been no decrease in the wide variety of solutions adopted for the three main problems of stereo as distinct from mono record reproduction—the relative positioning of the two loudspeakers, the relative balanc-



Ever Ready car portable transistor receiver.

ing of the two channels, and the design of a stereo pickup.

Normally for mono reproduction the two stereo amplifiers are still used independently or simply paralleled together to double the available power. In the Philco Models 92 and 94 a.m./f.m. radiograms, however, on radio reception the two stereo single-ended channels are switched to form a variety of push-pull amplifier. This is done by reversing the phases of both the input to one channel as well as its output transformer secondary, and then paralleling the two output transformer secondaries. This is claimed to provide the even harmonic distortion cancellation advantage of normal push-pull operation, though it does not, of course, provide the other advantage of push-pull operation of d.c. cancellation in the primary of the output transformer.

The Ferguson "Reverbersonic" Model 658RG a.m./f.m. stereo-gram is, as far as we know, unique in this country for incorporating artificial reverberation. This is produced by adding to the original sound a delayed version of it obtained from a mechanical spring delay line similar to that described in the Technical Notebook section of our September, 1960, issue. The degree of reverberation can be altered by varying the level of the delayed sound relative to the original sound, and only the right-hand channel is reverberated.

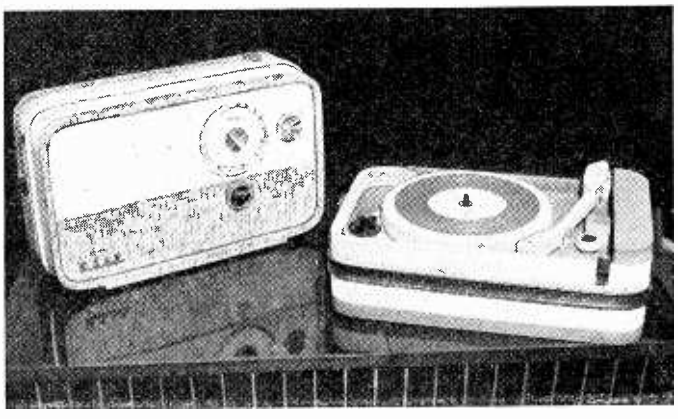
The G.E.C. demonstrated the use of a third centrally placed loudspeaker fed from both stereo channels. This was done to improve the definition of central sound sources and thus reduce the "hole-in-the-middle" effect noticeable with some recordings especially when widely-spaced loudspeakers are used. The central speaker was placed about two feet in front of the left- and right-hand speakers. With this arrangement simultaneous inputs to all three speakers are heard from the central speaker just before the left- and right-hand speakers. The precedence effect then increases the apparent loudness of the central speaker relative to the left- and right-hand speakers. In the central speaker the G.E.C. Periphonic two-speaker mounting system was used, each speaker being fed with about one-quarter of the power from one stereo channel. For non-central sources in which only one of these two central speakers is thus excited, the sound radiated by this speaker is increasingly reduced as the frequency is decreased below 1,000c/s owing to the coupling to the other unexcited speaker in the Periphonic system. Thus below about 1,000c/s non-central sources are only slightly apparently pulled in towards the centre.

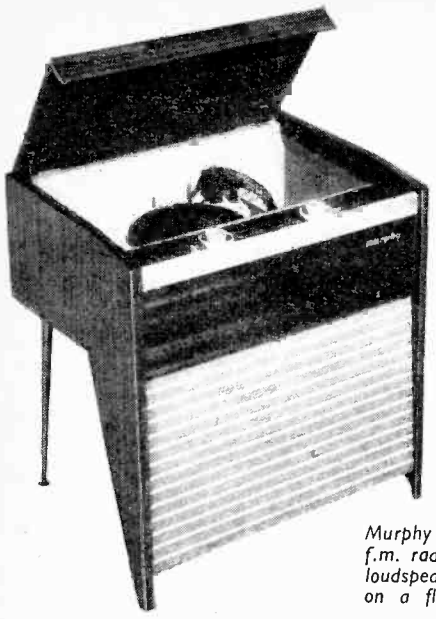
Loudspeaker Mounting.—In horn enclosures the expansion is usually made to follow a simple exponential law. To produce an adequate low-frequency response the horn must then be made unmanageably long unless it is folded, which in its turn introduces additional problems. A somewhat shorter horn can, however, be made by following a hyperbolic-exponential law, though in this case the radiation falls off rather more rapidly below the cut-off frequency. This fall is postponed to a somewhat lower frequency in a "hypex" horn design shown by Goodmans by means of an air chamber between the loudspeaker and horn throat. The chamber air volume stiffness is adjusted so that it resonates with the throat air mass just below the horn cut-off frequency.

Normally in multi-speaker systems the individual units are, at least not intentionally, acoustically coupled together. One exception to this rule is, of course, the G.E.C. Periphonic system in which two Metal Cone speakers are placed close together front-to-back and fed in antiphase to form a sort of acoustic push-pull system which considerably decreases the low-frequency distortion. Another exception is the Pye HF8BS in which a 12-in and 10 by 6 in unit are acoustically

Goodman's hyperbolic-exponential law horn loudspeaker removed from the room corner and viewed from one side to show one of the two horn mouths.

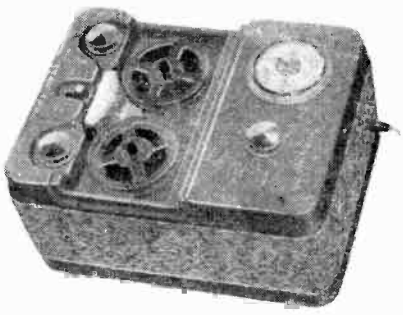
Two E.A.R. "Envoy" transistor radio-grams in which the radio and record player are on opposite sides.





Murphy A592R a.m./f.m. radio-gram with loudspeakers mounted on a flat baffle.

Casian Trav-ler Companion combined transistor tape recorder and a.m. radio.



coupled together to produce, it is claimed, reduced cone breakup and increased bass output.

A return to Murphy's old system of flat baffle loudspeaker mounting was noted in their Model A592R a.m./f.m. radio-gram.

Valve Receivers.—Design has now been stabilized for some time, but one unusual detail which we noticed was the heater supply system used in the K-B Gavotte. In this the heaters are fed in series with the rectified h.t. current. A shunt resistance across the rectified h.t. provides sufficient starting current for the heaters and, together with the reservoir capacitor ripple and h.t. currents, gives the correct heater current after the receiver has warmed up. With this arrangement the electrical heating power developed in the shunt resistor is considerably less than that developed in the resistance normally used to supply the valve heaters in series from the mains input.

A simple system of a.f.c. is used in the Dulci Model FMT/2 f.m. tuner shown by Lee Products. Here the frequency is controlled simply by varying the voltage across (and thus the effective resistance of) a germanium diode in series with an additional oscillator tuning capacitor.

A method of improving the action of the normal simple diode limiter is to add an i.f. third-harmonic rejection filter in series with the diode input. This method was used in conjunction with a Foster-Seeley discriminator in the Ferguson a.m./f.m. stereo-gram Model 658RG. It was also described by J. W. Head and C. G. Mayo on page 85 of the March, 1958, issue of *Electronic & Radio Engineer* (now *Electronic Technology*) and in the Technical Notebook section of the April, 1958, issue of *Wireless World.*

Other unusual details noticed in valve receivers were the attachment of the tuning indicator to the tuning-scale pointer for ease of adjustment in two Pye receivers, and in the H.M.V. Model 558 a.m./f.m. tuner the use of an "infinite-impedance" a.m. detector.

Tape Recorders and Accessories.—The continually increasing interest in tape recording was illustrated by the fact that about half a dozen more manufacturers have entered the field at this year's Radio Show by showing their first tape recorder. The main trend in this field which was exemplified at the Show was the increasing use of four rather than two tracks, new four-track recorders being shown also by about half a dozen manufacturers.

An unusual feature of the Sound "Master" four-track recorder is that the output from the replay head is initially amplified and suitably frequency compensated by means of two transistors. A circuit is used which remains accurately matched to the head impedance even if this impedance ceases to be predominantly inductive at low frequencies due to the head resistance. This recorder also features a push-pull erase oscillator, separate record and replay heads and amplifiers, a meter graduated in dB for indicating the recording level, and a ten-watt "ultra-linear" push-pull output amplifier.

Unusual features of the Reps Model R10 four-track recorder are that the input is first fed to a low output impedance amplifier before being connected to the record/replay switch, and that low-impedance tone controls are used. This is done so as to avoid capacitive coupling between the record/replay switch contacts and between the edge-on tone controls and the hand.

New transistorized recorders—both using d.c. rather than high-frequency erase—were shown by Walter and also by Casian. The Casian Trav-ler recorder is available in two versions, one with d.c. and the other with a.c. bias. The respective signal-to-noise ratios for these two versions of 30dB and >45dB thus allow a comparison to be made between these two methods of providing bias. This recorder is also available combined with a transistor medium- and long-wave radio as the Trav-ler Companion. Features of the Walter recorder are battery or mains operation facilities and an output as high as two watts. The tape noise obtained with the d.c. erase head is claimed to be within 3dB of that for unused tape.

Superimposition facilities are very frequently offered on tape recorders. A simple way of providing such a facility is, of course, to disconnect the erase oscillator. However, this can result in an increase in the distortion and a reduction in the amplitude of the original signal owing to interaction between the original and superimposed bias signals. Such effects are much reduced in the Sound range of recorders by reducing the amplitude and frequency of the bias when superimposing.

A tape reproducer designed especially for copying tapes was shown by Reflectograph. This uses their new deck fitted with a single (playback) head. A playback pre-amplifier and power pack are also incorporated.

A range of electronic d.c. to a.c. converters suitable for use with tape recorders was shown by Valradio. In these converters the output from an ECC82 double-triode flip-flop is amplified by four KT55 valves in class-C parallel push-pull. An L, C filter reduces harmonics in the square-wave output.

Kits for building a mono or stereo tape record/replay pre-amplifier were shown by Heathkit. These can be used with either high- or low-impedance heads, and a three-position bias level control allows optimum results to be obtained with any make of tape. A push-pull erase and bias oscillator is used.

An inexpensive version of their VR65 twin-ribbon stereo microphone—the VR65NS—was shown by Lustraphone. In this the angle between the two ribbons can be varied—contrary to what was unfortunately incorrectly stated in our Radio Show Guide.

LETTERS TO THE EDITOR

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

"1910 and all That"

IN his review of "Scrapbook for 1910" in your September issue, "Free Grid" complained that he could not make head nor tail of the morse signals used in the sequence covering the arrest of Dr. Crippin. "Could it be," he asks, "that the jumble of sound was sent by somebody who knew nothing of morse?"

No—it couldn't be. What *could* be, if the signal had been sensible, was possible confusion and alarm in the minds of radio operators who might have heard the signal by accident. It is for this reason that the B.B.C. does not allow genuine morse signals to be broadcast in dramatic productions.

The mention in the programme of 1910 as being "the first year of a new decade" was made by a young woman at a New Year's Eve ball. She was wrong, of course—but so, always, are many others on these occasions. And "Scrapbook" records the errors of the times as well as the truths!

London, W.1. VERNON HARRIS.

[Mr. Harris is the producer of the B.B.C. "Scrapbook" programmes.—Ed.]

Servicing in New Zealand

IN your July issue "Diallist" comments that in New Zealand only persons who have passed an official examination as radio servicemen may legally undertake the servicing of electronic equipment, and asks whether readers think this is a good thing.

Personally I do not think it has any very obvious advantages. So far as I can see the standard of radio servicing here is not as high as in the United Kingdom. No amount of compulsory certification can make a *good* serviceman, even though it can prevent completely untrained and incompetent people from attempting to service radio and electronic equiment.

In one respect the law has a big loophole in it. Any registered electrician may legally service radios, even though he has not the slightest knowledge of radio theory, while a radio technician employed in a Government Department, holding a First Class Certificate in Radio Technology, which requires a higher degree of technical knowledge than the Serviceman's Certificate, may not legally service any radio outside his place of work.

Until this year this led to the Gilbertian situation in which a Government-employed technician, fully employed on all kinds of electronic equipment, including high-powered transmitters, could be prosecuted for repairing his own domestic receiver, or indeed even changing a fuse in his house. (To give credit to the innate good sense of New Zealanders I must admit that I have never heard of any such prosecution being brought.) The law has now been amended so that everyone engaged upon radio or electrical work must pass both theoretical and practical examinations, to ensure that at the very least they are aware of the dangers of poor or faulty workmanship; and the Wiremans Registration Board conducts a very vigorous safety campaign. Whether this actually does result in a smaller proportion of electrical accidents than in the United Kingdom has never, to my knowledge, been studied.

I have been in New Zealand long enough to make one prediction. If this appears in print, *Wireless World* will be inundated with letters from infuriated representatives of the radio trade in this country, assuring you that the standard of radio servicing here is the highest in the world and denouncing me in the strongest printable terms. That's one of the things that makes life here such fun.

Wellington, New Zealand. F. W. ASHTON.

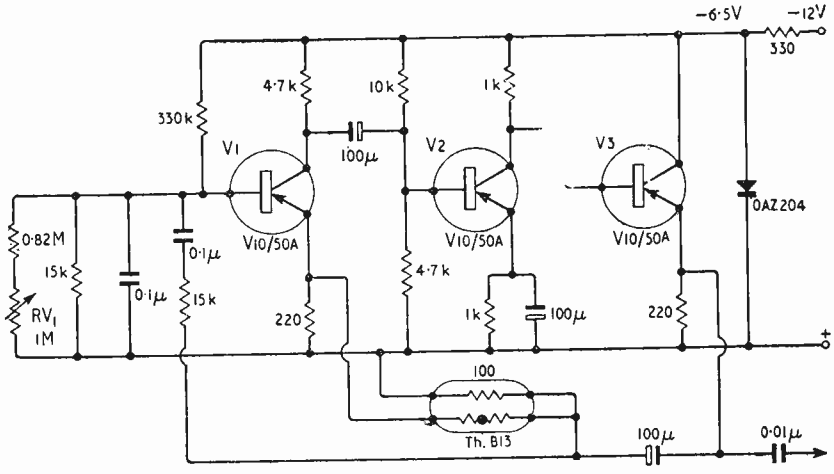
Transistorized Wien Bridge Oscillator

I WAS very interested to see the article by F. Butler in the August issue on the design of a transistorized Wien bridge oscillator. I have recently been developing a similar device for a rather different application, namely a 100c/s fixed-frequency oscillator to be used as a time standard in portable equipment. Good frequency accuracy and stability were needed—of the same order as can be obtained with a valve-maintained oscillator. The circuit of the oscillator we are now using is reproduced herewith, and it will be seen that I have attempted to deal with the difficulties described by Mr. Butler rather differently.

As it now is, my oscillator, when compared with a 1000c/s valve-maintained tuning fork, appears to have a stability, after the first five minutes, of better than 1 part in 1000; which is just about sufficient for our purpose. There appears to be a slow random irregularity, of a fraction of one part in 1000, as well as a slight variation from day to day, which may well be caused by differences of temperature. If any readers can suggest how these remaining small changes may be further reduced, I would be very grateful.

There appear to be three differences of principle between Mr. Butler's circuit and mine:

(a) The input circuit. Undoubtedly Mr. Butler's "super-alpha pair" is a better arrangement than my



conventional one, but I am afraid he takes too gloomy a view of the input impedance of the conventional circuit, in practice. As he himself says, negative feedback can make the input impedance more or less as high as is desired. In this case, the voltage gain of the whole amplifier is determined by the voltage feedback to the first emitter, and in the oscillating condition is approximately 3. The current gain however, is not restricted. If we take the output voltage as 1 volt, the collector signal current of V_2 is 1mA; and if we take the current gain of V_1 and V_2 to the 50 each, the signal base current of V_1 needed to maintain this output is 0.4 microamp. This, with a V_1 base voltage of $\frac{1}{3}$-volt gives an input impedance of little under one megohm. This method of calculation is undoubtedly oversimplified, but the circuit behaves as though it were at least approximately correct.

Nevertheless, with the present bridge values, to shunt the input base to earth through one megohm increases the frequency of oscillation by a half per cent, and indeed RV_1 is provided, in that position, as a fine adjustment. Variations in amplifier gain will certainly lead to a change in frequency, though the proportional change will be reduced by a large factor. Thus, reducing the gain to a half would increase the frequency by one quarter per cent.

(b) The emitter-follower, V_3 is used firstly to provide sufficient current for the thermistor B13, but also because of the need to keep the amplifier output resistance very much less than the bridge impedance. In this circuit the output resistance of V_3 is about 20Ω.

(c) Amplitude stabilization. In an earlier version of the circuit a type A13 thermistor was used and I agree with Mr. Butler in finding it "not ideally suitable" for the purpose. It was necessary to select the emitter resistance of V_1 with great care, and the resultant circuit was very sensitive to room temperature. The B13 now used is very much better in this respect, and although the 100-Ω heater coil shunts the emitter load of V_3, the output amplitude rapidly stabilizes at a value below that at which clipping occurs. It has one disadvantage, however, in that it has a longer time constant than the type A, and there is a tendency for the output amplitude to hunt. I look forward to trying the probably still more suitable type R.

Cambridge.

A. CARPENTER,
Applied Psychology Research Unit,
Medical Research Council.

WITH reference to F. Butler's article in the August issue, we find that we are in disagreement with several features of his design. Whilst it is difficult to criticize constructively his circuit (Fig. 4) without a complete redesign we would like to make the following comments.

(1) A current gain of 100, which Mr. Butler assumes, exceeds even the maximum quoted valve for the OC 71. His circuit defines the collector current of V_2 at about 400μA, making the current through V_1 only a few microamperes and under these conditions one would be surprised to measure a small signal current gain of 100.

(2) Mr. Butler assumes an input impedance of 5000Ω for V_2 and therefore uses a "super-alpha" stage to obtain an estimated input impedance for V_1 of 0.5MΩ. We have calculated that the input impedance of V_2 is about 250kΩ assuming a Beta of 40 for V_2 and V_3. This makes one question the need for V_1 anyway. Even in the absence of feedback from V_3 collector the input impedance for V_2 is about 25kΩ.

(3) The base current of V_2 is the emitter current of V_1. This base current changes direction, however, when $(B+1)i_{co}=400\mu A$. For this circuit, this condition may easily obtain even at temperatures of less than 30° C with the result that V_1 emitter junction would be reverse biased.

(4) We feel that an increase in the bias voltage across R_4 would be desirable and that there seems little point in including R_9 since V_3 is substantially current fed.

Hatfield, Herts.

G. S. EVANS,
B. G. WILLIAMS,
Systems Engineering Group,
de Havilland Propellers Ltd.

The author replies:

It is, of course, well known that the current gain and input impedance of a transistor amplifier are dependent on the signal amplitude, the supply voltage and the standing collector current. The small signal current gain certainly falls to an abnormally low value if the transistor is operated under very low current conditions. The figures for current gain (100) and input impedance (5000Ω) were not claimed to apply specifically to the OC 71 but were quoted as an illustrative example to show in an elementary way how any super-alpha stage comes to have a very high input impedance.

The next point concerns the input impedance of V_2 in Fig. 4 (p. 388, Aug. issue) which Messrs. Evans and Williams calculate to be 250kΩ with feedback and 25kΩ without feedback from the collector of V_3. Their computation apparently takes account of V_2 and V_3 only and ignores the effect of V_1 which, with its associated components (including the bridge elements), forms part of the overall feedback loop. For example, V_1 is connected directly between the collector and base of V_2 and thus contributes to the overall feedback. A really accurate analytical treatment would be so complex and the final expressions so cumbersome that it would be difficult to draw useful conclusions from them.

Turning next to the possibility of reverse biasing of V_1 at high temperatures, this point had occurred to the writer and in one version of the oscillator circuit a resistance was originally connected between the base of V_2 and earth so that the correct bias conditions on V_2 would require a substantial increase of collector current in V_1. Over the normal range of room temperatures there was a negligible difference in the oscillator performance so the resistor was omitted. Much greater temperature changes might call for the use of a silicon transistor in the V_1 position.

The resistance R_9 is not strictly necessary. It was included to provide some local feedback so that any OC 72 in the normal production range could be used in the V_3 position without special selection.

The base bias voltage across R_4 was set by trial to give least distortion in the output waveform. It can easily be increased by reducing the value of R_5.

One is left with the impression that Messrs. Evans and Williams are unduly prejudiced against the use of transistor amplifiers operating under what might be called current-starved conditions. The writer does not feel impelled to make a strong defence of the use of a low-current super-alpha pair in the present circuit since similar arrangements have been described in earlier papers. It would be different if one had claimed originality for the circuit. It was used in this case because its high input impedance exercised a negligible shunting effect on the Wien bridge elements and because it allowed oscillator tuning to be accomplished by resistance variation without seriously disturbing the base bias of the first amplifier stage. There may be better ways of achieving this object but it is doubtful if there is a much simpler approach.

If high-temperature operation is required there is clearly some advantage in using silicon transistors which are at last becoming available at an economic price. There still remains the difficulty of devising an amplitude control arrangement which will operate without distortion over a very wide temperature range.

F. BUTLER

Television Standards

NOW that the Television Advisory Committee Report is published there is much talk of television standards

changing and it seems clear that changes will be made.

It seems to this writer that a serious fundamental limitation to the present standard is the effect of flicker. As the brightness of pictures has increased so much in recent years, and with the arrival of fully portable television receivers, this flicker is becoming serious and will become worse. Note how poorly presented are receivers in shop windows, and how unbearable pictures are in sunlight. V. K. Zworykin and G. A. Morton in their book "Television" show that increasing the flicker frequency from 50c/s to 60c/s allows the brightness to be increased 7 to 10 fold so that one would expect American standards to be better than all others in that respect. I do not regard it as very important that we retain a standard locked to the mains. Unlocked systems are often used already, O.B.s for instance, and many well-designed receivers work perfectly well in Ireland and off unlocked power supplies. Perhaps if we are going to have a bit more bandwidth to "spend" some of it would be well spent increasing the frame frequency.

Northwood, Middlesex. C. H. BANTHORPE.

MAY I refer to your most interesting Editorial comment "Line Standards" in your July issue.

I do not know whether it was your intention to keep the scope of your article intentionally confined to "line" standards only and purposely to avoid reference to other necessary concomitants to the adoption of the so-called "C.C.I.R." or "Gerber" 625-line system; as a user of (and as a result, an advocate of the adoption of) the 625 line system, I feel it is only fair to compare the systems as a whole, and I would therefore like to suggest that some of the most far reaching advantages of the 625 line system *to the domestic viewer*, do not even involve the number of lines but are more strongly apparent in the following:—

(1) F.m. sound is specified, thereby bringing to the domestic TV receiver all the advantages of this system, already becoming well known in U.K. homes by means of the v.h.f./f.m. Band II service. This system is capable of providing improved signal-to-noise ratios, more effective noise limiters, less interference from passing motor vehicles, higher available fidelity at a given cost, and a greatly improved effective signal/noise ratio in fringe areas of reception.

(2) Picture modulation system—negative and not positive. A real advantage, especially in fringe areas, is gained in getting one's peak aerial power in the blacks and the all important synchronizing pulses. It is my experience with modern "C.C.I.R." receivers to be able firmly to lock pictures and enjoy reception in areas of low field strength, where man-made interference levels are very high, which would make a positive modulation a.m. sound signal, of similar e.r.p., quite unusable. Such interference as is seen is generally black in content and not white, which in my opinion is less disturbing to the eye.

I admit my experience of these matters has so far been mainly confined to Band I, therefore I would not like to be dogmatic as to the outcome of results of tests carried out between the two systems on Band IV and V; but I would hazard, however, that a low-end of Band I "C.C.I.R." transmitter, horizontally polarized, at comparable aerial height and e.r.p. to the present Crystal Palace installation would in fact give a considerably increased effective service area than the present 405-line installation, solely for the reasons I alluded to above. To return to the picture, as an engineer operating a "C.C.I.R." station, whenever I return to the U.K. on leave or business, for the first few days I imagine that all large-screen domestic TV receivers I chance to see in action are suffering from an acute form of line pairing!

M. W. HEFFERNAN,
Chief Engineer,
WNTV-NWBS.

Ibadan, West Nigeria.

Self-Balancing Push-Pull Circuits

MAY I suggest that the criticisms of the "triple" contained in my letter in the August issue, are equally relevant to the two-stage amplifier with controlled unbalance envisaged by Mr. May in his letter in the September issue.

In the second part of this letter Mr. May has attempted to prove that a signal applied to the common cathode connection of a cross coupled cascode has no influence whatever on the output voltage of the stage. Since this is a direct contradiction of my previous statement that "the measured error loop gain . . . is 150 times", I feel bound (if only in self-defence) to return the unexploded bomb!

We see from the figures on Mr. May's circuit that apparently a change in grid-cathode voltage of the lower triode of a cascode stage has no influence on the anode current of the upper triodes. We may note at this juncture that the current which we have called the anode current of the upper triodes in fact constitutes the anode current of the lower triodes. In order to accept the argument put forward, we have therefore first to accept that a change in grid-cathode voltage of the lower triode has no influence on its anode current. So far as I am aware the only conditions under which this is true are when (a) the valve heaters are not switched on, (b) the valve is not of reputable manufacture!

The fallacy in the argument which Mr. May has put forward lies in the assumption of a fixed voltage gain in the lower triodes, whereas the gain contributed by the lower triodes in a function of the input impedance of the upper triodes which changes very considerably between push-push and push-pull operation.

The equivalent circuit in my letter in the August issue shows that the lower triodes provide the major part of the error loop gain, whereas the upper triodes provide the major part of the signal gain.

Incidentally, the sixth line of type below this figure should have read "the middle triode will *now* provide more gain".

D. R. BIRT.

"Things Great and Small"

I WAS most interested to read the letter from F. T. Van Veen in the September issue, and of the new system of metric nomenclature proposed by A. P. G. Peterson.

As a student of language (as well as radio) I should like to point out that the reason Latin and Greek are used for the building of new technical terms, is that they are both *dead* languages. It is not merely a matter of "classical" snobbery.

The reason "dead" roots are used in preference to living ones is to avoid established connotations in the living language. Thus "television" is lisped out by the modern infant not long after it has mastered "Mamma"; it is a word in its own right like "cat" and needs no explanation. By contrast, the word "Fernsehfunk" sounds to German ears like "far-see-spark", with its obviously false connotations, especially the obsolete "spark" bit.

I have no quarrel with "kilo" and "milli" already well established in such words as "kilogram" and "millimetre". There is no confusion here. But the remainder of the prefixes in the fractional column (on the right) clash horribly with established English words. Thus, billi=one millionth, quadrilli=one billionth, sextilli=one trillionth, octilli=one quadrillionth, and decilli=one quintillionth. Mr. Van Veen finds this system "ingeniously simple" but is hurt by "nano", "giga", "terra", and "pico", which, being strangers to the English tongue, are ideal for building new words without introducing false notions.

As for the double capitals on the integral side of the table, my own logic, which I now suspect must be sadly perverted, makes DK=TR and 0K=zero by the ordinary (logical) rules of algebra.

Should Mr. Van Veen read these lines and fail to

follow the fourth paragraph (British readers will have no difficulty) I hasten to remind him that in Britain, Germany and elsewhere, the names of the very large numbers indicate *logically* the power to which a million is to be raised, whereas in France and the U.S.A. the terms employed are, I fear, merely "alogical absurdities".

Nottingham. D. B. PITT.

Rogue Equipment

HAVING read Mr. Himan's observations in the May issue on "rogue equipment" I find that I cannot agree that his theory is valid.

My experience on inspection and test of batch production is that exactly the reverse applies and that the early models suffer far more than the later ones. The reasons are fairly obvious. The assembly and wiring operatives are inexperienced with the equipment; a number of them are often new to the business completely; "Inspection" being keen to establish a fair standard as soon as possible is more severe than later; and "Test" have not yet learnt what portions of the specification they can afford to relax. So the resultant mauling these units receive in the shuttle between production and inspection leaves them basically unfit for sale, but by that time the clamour of "Sales" has made itself felt and away they go.

However, if Mr. Himan could take the records of all his instruments of which he has a large enough number to form a representative sample and then, having taken out all faults he can reasonably attribute to unfair use, divide the remaining ones by the operational life of the instruments and finally either list this result against the serial numbers or, better, graph the two numbers, a study of the results should throw further light on the subject.

If my ideas are confirmed it might well be a warning to these dealers who do all within their power to obtain new models as soon as possible after their announcement!

Hampton, Middlesex. L. CAMPBELL.

Circuit Conventions

WE have watched with keen interest the correspondence in your columns on the subject of graphical symbols.

Whilst agreeing that the proposed changes have certain advantages, they are not, in general, quicker to draw in rough sketches nor, with the exception perhaps of the inductance symbol, do they show any marked reduction in labour when drawn for reproduction. Moreover, we think the following points should be borne in mind.

1. That British Standards specifications are issued only after lengthy consideration by the parties concerned, and that in this case they follow reasonably closely traditional circuitry, being widely understood, if not always employed, both in this country, and, in general, overseas.

2. That changes as drastic as those suggested would render many circuits virtually incomprehensible to the uninitiated. In this connection, this committee has redrawn a number of quite simple circuits using the proposed new symbols, and has tried them out on engineers who were unfamiliar with the proposals. In every case difficulty was encountered in interpreting the diagrams.

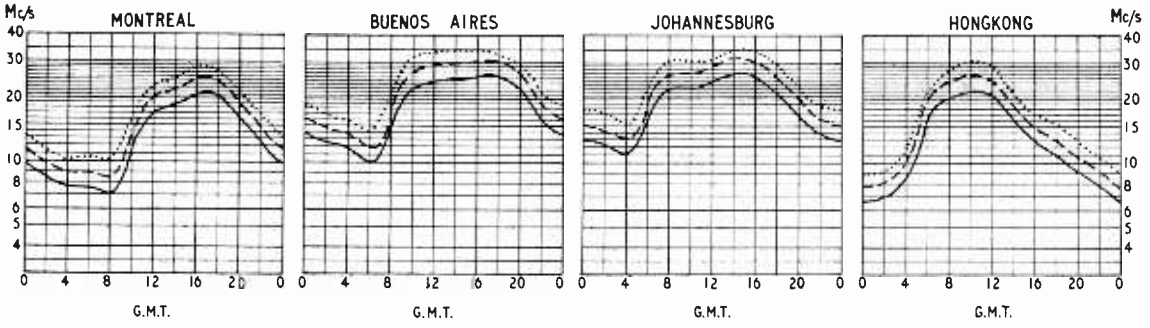
3. It is not always sufficiently realized that the primary purpose of a technical drawing or diagram is to convey information, and no diagrams, however low the cost of production may be, can be regarded as effecting an economy if they do not perform their intended function.

This committee is constantly studying problems concerned with standardization in the realm of technical publications, and whilst it welcomes innovations which simplify the task of the technical author or illustrator it emphasizes that in the presentation of technical information, the overriding consideration must be to present this to the reader in the clearest and most readily understood manner.

London, W.2. H. J. BATEMAN.
Chairman, Standards Committee,
Technical Publications Association.

SHORT-WAVE CONDITIONS

Prediction for October



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 October.

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

Equatorial Ionospheric Effects

POST-SUNSET FADING ON LONG-DISTANCE RADIO CIRCUITS

By T. W. BENNINGTON*

IN a region near the earth's magnetic equator there occur several magnetic and ionospheric phenomena which appear to be peculiar to that region alone. One of these is an effect which occurs in the F2 layer of the ionosphere soon after local sunset, and which appears to last for a few hours thereafter. Because the echoes obtained from that layer by vertical sounding become, during these hours, diffuse and of indefinite height, it is known as "equatorial spread F."

In 1938 Booker and Wells[1] reported that at Huancayo, Peru, there was, soon after sunset, a marked increase in the height of the F region and that the received echoes then became diffuse, as though they were due to scattering from electronic

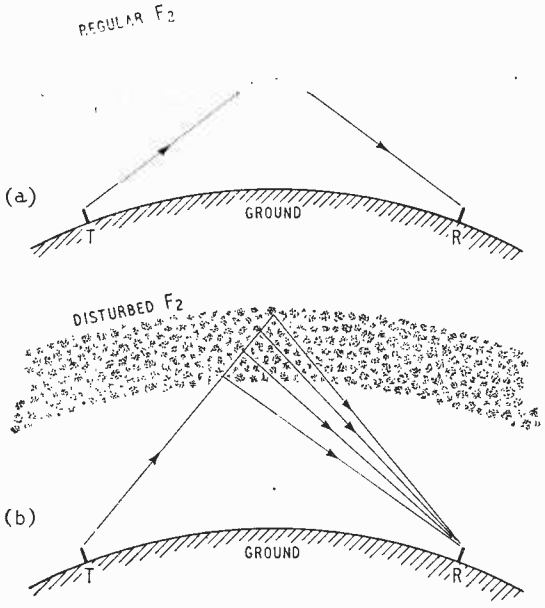


Fig. 1. Illustrating, for a single-hop transmission path, the mode of propagation of a single ray (a) via the normal F2 layer and (b) via the cloud-like structure occurring after local sunset.

clouds, rather than due to reflection from a stratified layer. Later in the night there was a decrease in the height, accompanied by a disappearance of the diffuse echoes. In 1951 Osborne[2] observed a similar phenomenon at Singapore, which, like Huancayo, has a low dip latitude. He stated that soon after local ground sunset the F2 layer virtual height rapidly increased, and the region, instead of preserving its layer-like structure, began to form "clouds" of ionization and that, by the time of ionospheric sunset, it frequently disintegrated entirely into such clouds. Soon after this the virtual height began to decrease again and, though the clouds often persisted for several hours, the layer gradually regained its normal structure.

Short-wave engineers soon came to associate these ionospheric occurrences with a peculiar fading of the signals received over trans-equatorial circuits soon after local sunset, and which they called the "tropical sunset fading effect." This was noticed at Singapore, in many parts of Africa and at several other locations, and observations made over several years have established the following general facts about it. The fading appears to occur more frequently at the equinoxes than at other times of year, though it does occur during other than equinoctial months. At most places where it has been observed it starts soon after local ground sunset and lasts for about four hours, after which conditions return to normal. (As we shall see there are exceptions to this.) It is generally worse during years of high than of low sunspot activity and appears to be brought about by conditions in the ionosphere in a zone lying near the magnetic equator, the northern and southern boundaries of which are not yet known. The fading is of medium or deep intensity, is at a rapid rate and often of the kind known as "flutter" fading. Such fading can be of serious consequence in various types of communication, for receiver a.g.c. systems do not deal with it effectively. In high-speed telegraphy the resulting distortion of the characters conveying the transmitted information often renders the received result unintelligible. In broadcasting, whilst speech usually remains intelligible, the fast fading destroys the programme value of music transmissions.

Cause of the Fading.—Fig. 1 is an attempt to illustrate the ionospheric effects upon an obliquely incident ray of radio energy. In (*a*) is pictured the situation before sunset, where the ray, at a given frequency, undergoes refraction and reaches the apex of its trajectory at a discrete height in the F2 layer, and then follows a downward path to the receiving aerial. When the layer breaks up into a cloud-like structure, as in (*b*), refraction is no longer a relatively simple process with apex of the trajectory at a discrete height: in fact the forward propogation of the radio energy is more in the nature of "scattering" than of refraction. This scattering takes place at and between numbers of different cloud formations lying at different heights, with the result that the energy reaches the receiving aerial from a whole range of heights and in the form of a number of "packets" of energy at different angles. The arriving rays will have traversed different paths and, furthermore, the path lengths will

*Research Department, British Broadcasting Corporation.

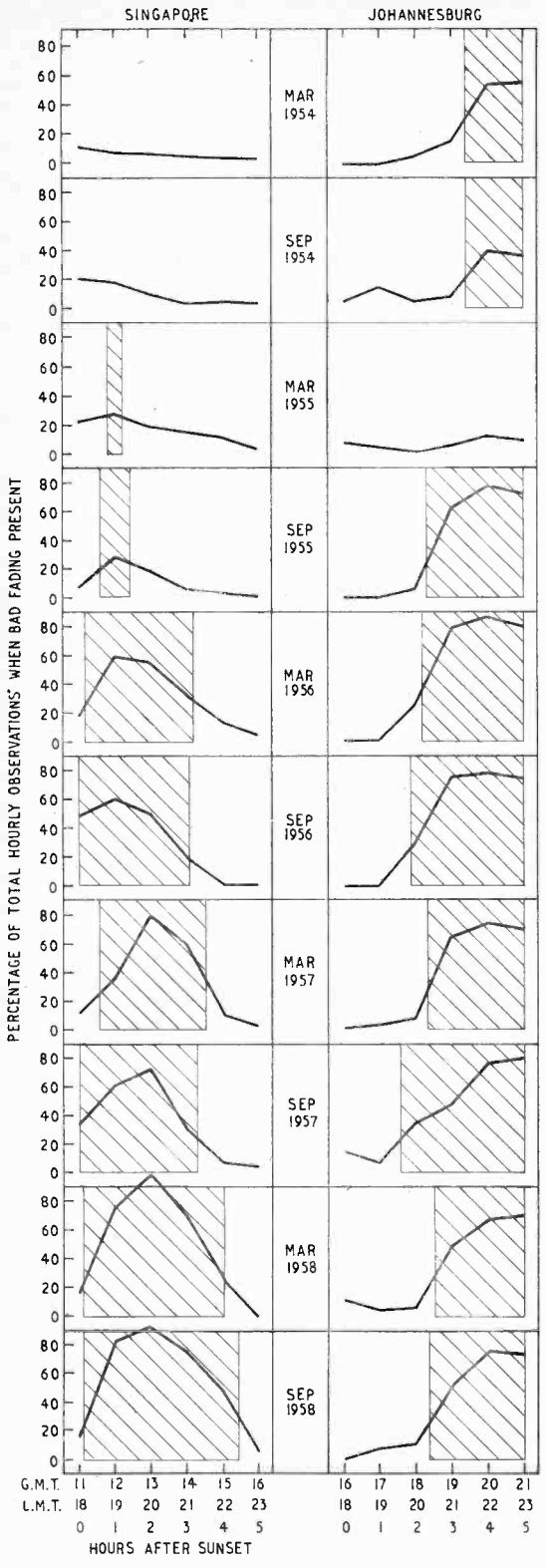


Fig. 2. Incidence of medium-rapid, or worse, fading in reception at Singapore and Johannesburg during 5 hours after sunset—equinoctial months 1954-1958.

constantly change with time as the clouds change shape and position. The received signal will therefore fade more or less rapidly with time.

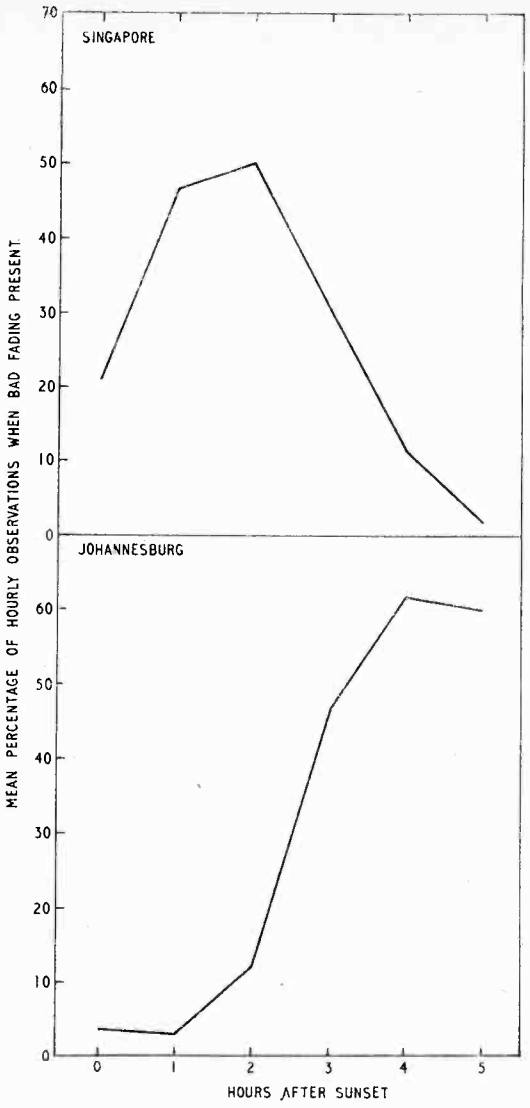
Fading at Johannesburg and Singapore.—In order to obtain some information on the incidence of the fading and of its variation during the hours following on sunset at different places, and also over the sunspot cycle, an examination was made of data received from Singapore and Johannesburg on the reception of h.f. broadcast transmissions from this country. The transmission paths from the U.K. to both these places traverse the region of the magnetic equator. The data examined were those for the five hours following on ground sunset at both places, namely 1100-1600 G.M.T. at Singapore, and 1600-2100 G.M.T. at Johannesburg, and this was done for the equinoctial months of March and September only. The period considered was that of the years 1954-1958 inclusive, and it should be noted that sunspot minimum occurred in April 1954 and sunspot maximum in March 1958. Observations made on all frequencies in use at a particular time were included, it having been first of all found that there was no significant frequency discrimination in the fading effect, this being observed on all frequencies in use when it was present.

The results are given in Fig. 2, the graphs of which show the percentage of the total hourly observations during each month when medium-rapid, or worse, fading was observed at Singapore and Johannesburg respectively. The shaded areas of Fig. 2 show the times during which the fading was present for 25% or more of the hourly observations, and thus give an indication of the severity and duration of the effect.

At Singapore, it is seen, very little fading was observed during the hours following on local sunset in 1954 and 1955, but from 1956 towards 1958 it increased in its rate of incidence with increasing sunspot number. The peak period for the fading was from one to two hours after ground sunset, and it was generally above the 25% incidence rate from sunset till three to four hours thereafter, but always reached a negligible level by five hours after sunset.

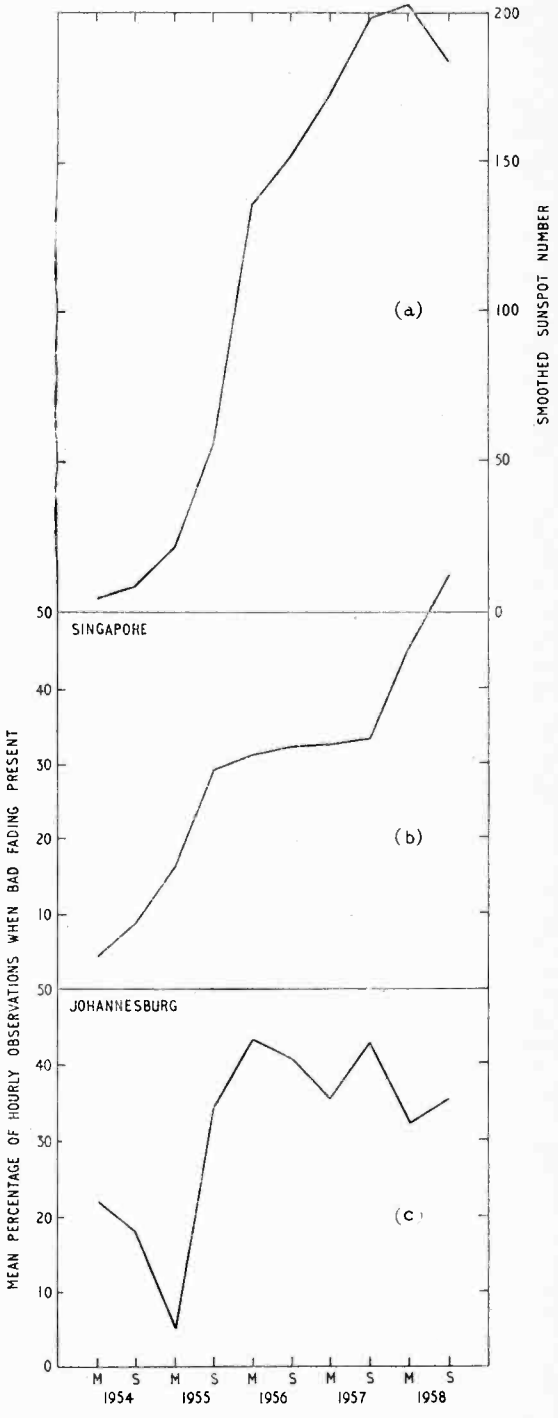
At Johannesburg the fading reached fairly high incidence rates even during sunspot minimum years, though the incidence rate was higher, and the high incidence rate of longer duration, after September 1955 than before that month. Thus the fading increased with increasing sunspot number. What is more peculiar, however, is that the diurnal pattern in the incidence of the fading was different from that at Singapore, for at Johannesburg it did not usually start till two hours after local ground sunset, and was generally above the 25% incidence level only from then onwards. But at five hours after sunset (after which time no data was available) it was still near the maximum incidence rate and showed little sign of clearing up. Fig. 3 gives the mean percentage of the hourly observations when the fading was observed for March and September of the whole 5-year period for both places, and illustrates the difference in the diurnal pattern for the two locations.

Fading Variations with Increasing Sunspot Number.—In Fig. 4 are shown the variations in the post-sunset fading at these two places over the sunspot



Left—Fig. 3. Incidence of medium-rapid or worse fading in reception at Singapore and Johannesburg during 5 hours after sunset. Mean values for 5 years 1954-1958.

Below: Fig. 4. Variation in the incidence of fading with sunspot number. (a) smoothed sunspot number (b) and (c) mean percentage of observations when fading present during first 5 hours after sunset at Singapore and Johannesburg respectively.



cycle, it being borne in mind that, since the sunspot number varies erratically from month to month, it is best to take the smoothed value appertaining to each month in order to show its general long period variation, as has been done in (*a*). The graphs of (*b*) and (*c*) do not show a detailed correlation with this, but they do indicate a general increase in the fading when the sunspot number is high, and vice versa. As is seen this increase in the fading continued at Singapore until September 1958, whereas at Johannesburg it did not further increase after March 1956.

Connection between Fading and Observed Ionospheric Phenomena.—It would seem fairly clear that the post-sunset fading observed on these and other circuits is due to ionospheric phenomena occurring in a region near the magnetic equator, through which the radio waves have to pass in reaching these places from the northern hemisphere. And it would also seem probable that the ionospheric phenomenon concerned could be the "spread F" which is ob-

served to occur after sunset at ionospheric observatories near to the magnetic equator. But to say this gives no explanation of several peculiarities in the fading; to mention only one, the difference in the local time of its onset as between Singapore and Johannesburg. It is interesting, therefore, to pursue the matter a little further by examining some of the ionospheric measurements.

In addition to the occurrence of spread F near the magnetic equator there is another well-known ionospheric phenomenon associated with this region. This is the existence of a permanent daytime belt of sporadic E, of high critical frequency, which breaks up and disappears near sunset, and it has been pointed out by Wilkins and Kift[3] that, since h.f. radio waves would be unable to penetrate this region and so reach the F2 layer, but would be reflected from it, it is logical to suppose that its sudden disappearance around sunset would lead to poor radio propagation for a time, until the F2 layer became effective as the reflecting medium. This leads them to suppose that the fading observed on h.f. transmissions may start with the break-up of the sporadic E ionisation and may, at a later time, be continued by the disintegration into "clouds" which then sets in in the F2 layer.

In Fig. 5 are plotted, against local time, for the months of March and September 1956 to 1958 inclusive the results of an examination of some ionospheric data obtained at Singapore (which is near the geomagnetic equator) and at Ibadan, Nigeria (a station near the great circle path U.K./Johannesburg and also near the geomagnetic equator). The dip latitude for Ibadan is, however, only 7°S, whereas Singapore is 16°S.

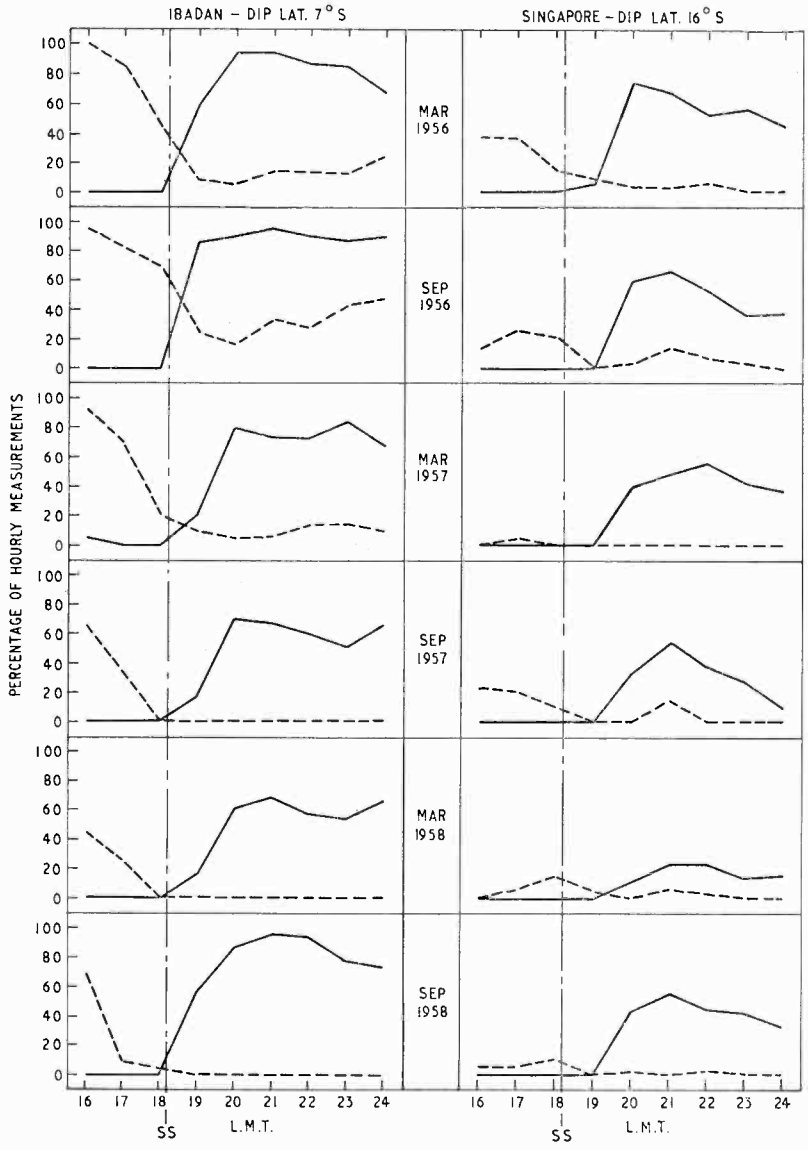


Fig. 5. Percentage of hourly measurements at Ibadan and Singapore. Full-line curves when "spread F" echoes were observed from the F2 layer and dashed-line curves when spradic E with critical frequency ⩾ 5Mc/s was observed.

The full-line curves give the percentage of the hourly (valid) measurements at each station when spread F echoes were observed, and it is seen that prior to local sunset no such echoes were observed at either station, but that after sunset a large percentage of spread F echoes occurred at both stations. The percentage of spread F echoes reached high values at Ibadan, however, somewhat sooner after sunset than at Singapore.

The dashed-line curves give the percentage of the hourly measurements at each station when sporadic E with critical frequency equal to or greater than 5Mc/s was observed. At Ibadan, it is seen, this was a permanent daytime feature (it should be noted that by 1600 local mean time it was already fast decreasing from its very high daytime incidence) but generally rapidly decreased to a negligible incidence rate at or just after local sunset. At Singapore, on the other hand, the occurrence of this intense sporadic E was not at all marked during the hours before sunset.

Consideration of these ionospheric measurements and of some from other stations (notably Huancayo, Peru) would lead one to the conclusion that the equatorial daytime sporadic E is confined to a very narrow belt along the magnetic equator, probably bounded by the dip latitudes 10°N and 10°S, which would thus include Ibadan and Huancayo but

(*Continued on page* 505)

TABLE 1

Month	Disturbed days	Quiet days	Percentage of total observations when spread F echoes observed		
			Place	Disturbed days	Quiet days
September 1957	14	16	Singapore	10.3	53.4
			Ibadan	29.8	90.3
September 1958	8	22	Singapore	25.6	52.0
			Ibadan	55.0	93.6

not Singapore. The equatorial spread F, on the other hand, appears to occur within a much wider belt, possibly from 40°N to 40°S dip latitude, and is thus observed at Singapore as well as at the other two places. This limit for the equatorial spread F is that suggested by Wright[5], who has studied both of these ionospheric phenomena in Ghana.

Possible Reason for Different Onset Times for the Fading.—The above considerations would appear to indicate the following as a possible explanation of the difference in the time of onset of the fading in terms of local time at Singapore and at Johannesburg. The greatest distance to the north of each place at which a ray emergent from a layer could reach the earth's surface at that place is about 1,100km in the case of the E layer, and about 2,000km in the case of the F2. A location on the great-circle path U.K./Singapore 1,100km north of Singapore lies in dip latitude 0°, where the daytime equatorial sporadic E would exist, whilst a similar point on the great circle U.K./Johannesburg would lie in dip latitude 50°S, where it would certainly not exist. Points 2,000km north of both places would lie in dip latitudes lower than 40° and thus within the spread F zone. We thus have the situation where a radio ray arriving at Singapore would be unlikely to escape reflection from the sporadic E, whilst it was in existence, but where a ray arriving at Johannesburg might well avoid the sporadic E, and reach that location entirely by way of F2 layer reflections. The sporadic E break-up (see Fig. 5) appears to have become well established by 1800 l.m.t., and a ray arriving at Singapore by way of sporadic E should begin to be poorly propagated as from shortly before that time. As is seen from Fig. 2 the fading has generally started at Singapore by 1800 l.m.t. After the sporadic E has disappeared and the wave begins to arrive at Singapore by way of the F2 the spread F has already set in, and this causes the fading to continue for some hours thereafter.

At Johannesburg, supposing the wave to be arriving all the time by way of the F2 layer, it remains unaffected until the spread F has set in, which, from Fig. 5, is seen to be at between 1900 and 2000 l.m.t. It is at approximately this time that the fading is observed to begin at Johannesburg.

As to the continuance of the fading beyond 2300 l.m.t. at Johannesburg but not at Singapore, the ionospheric data for Ibadan show that after this time the spread F still persists with a high incidence rate for several hours. That for Singapore shows far less observations of spread F after 2300 l.m.t. It may be supposed, from this, that, for some reason, the spread F over Africa persists for a longer period after sunset than does that over the equatorial region in the vicinity of Singapore.

Variations with Magnetic Disturbance.—It has been reported by Wright[5] that on days when magnetic storms are in progress the occurrence of spread F in equatorial regions is reduced, and that it is more frequently observed on magnetically quiet days. The Huancayo evidence suggests that the onset of spread F is *delayed* by the magnetic disturbance. The ionospheric data from Ibadan and from Singapore for the months of September 1957 and September 1958 were examined, and the number of spread F echoes observed during the period 2000-2400 l.m.t. counted separately for the magnetically disturbed days and for the quiet days. The daily character numbers for the geomagnetic field issued by the magnetic station of the Royal Greenwich Observatory were used in order to define the magnetically disturbed days, a day being considered disturbed when the character number was equal to or greater than 1.0, and quiet when it was less than this. The results are given in Table 1, from which it is seen that at both places the percentage of observations during the period after sunset when spread F echoes were observed was considerably greater during quiet days than during disturbed days. The mean percentage ratio of quiet-day spread F to disturbed-day spread F for the two months was approximately 2.9 for Singapore and 2.2 for Ibadan. It might therefore be expected that the fading observed at Singapore and Johannesburg would also tend to occur more frequently on disturbed than on quiet days.

Accordingly the h.f. reception data for Singapore and for Johannesburg were examined separately for the disturbed days and for the quiet days of these two months for the period 2000-2300 l.m.t. at both places (data not being available for a later daily

TABLE 2

Month	Percentage of hourly observations when bad fading observed		
	Place	Disturbed days	Quiet days
Sept. 1957	Singapore	30.9	23.4
	Johannesburg	33.8	81.3
Sept. 1958	Singapore	48.9	55.4
	Johannesburg	15.9	65.3

period), and the percentage of the total hourly observations when bad fading was present ascertained. The results are given in Table 2, from which it is seen that the post-sunset fading at Johannesburg was considerably more prevalent on quiet days than on disturbed days, but that this was not the case at Singapore. In fact the mean percentage ratio of quiet day fading to disturbed day fading for the two months was approximately 3.0 at Johannesburg, whereas at Singapore it was of the order of 1.0.

This result might be taken to indicate that the fading observed at Johannesburg is connected with an ionospheric phenomenon which is itself inversely correlated with magnetic disturbance, i.e. spread F, whereas that observed at Singapore is, at least partly, dependent upon an ionospheric phenomenon which is not so correlated. This latter might, in fact, be the equatorial sporadic E, as has already been indicated, which, so far as these two months are concerned, did not show a tendency to be more prevalent on quiet than on disturbed days. It is to be remarked, however, that Wright[5] found that the equatorial sporadic E, like the equatorial spread F, also decreased on magnetically disturbed days, and it has also been reported to disappear earlier on these days, so that the above indication is only tentative. The trouble is that during some of the equinoctial months examined by the present author the number of disturbed days so exceeded the number of quiet days that no clear-cut result emerged.

Further Questions.—It can hardly be considered other than significant that the equatorial sporadic E and the equatorial spread F both occur within zones lying near the magnetic equator, and that the disappearance of the former is followed so soon by the appearance of the latter. Though it may be pure speculation, one cannot but wonder whether, following on the disappearance at sunset of the intense E layer ionization in the equatorial zone there might be an upward movement in the ionosphere, resulting, not long after, in the appearance of the disturbed and inhomogeneous condition known as equatorial spread F in the F layer in an overlapping and somewhat wider zone.

There remain certain ambiguities about the equatorial spread F and the post-sunset fading which it would be unwise, as yet, to do more than mention. For instance, if both phenomena have an inverse correlation with magnetic disturbance why is it that they appear to occur with greatest frequency at the equinoxes when magnetic disturbances are particularly prevalent? And why, if such a correlation exists, does the fading increase with increasing sunspot number, when magnetic storminess does likewise? It is evident that a great deal of investigation will have to be done before these ionospheric and radio reception phenomena become fully explicable.

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Crystal-controlled Communications Receiver

THE Type HR120 general-purpose communications receiver recently introduced by the Marconi Company incorporates an unconventional tuning system consisting principally of decade switching. Four switches enable selection of any frequency within the band 2.1Mc/s to 30Mc/s to be effected quickly and accurately.

A double-superheterodyne circuit is used with one r.f. amplifying stage having three conventionally tuned circuits, followed by a crystal-controlled first oscillator adjustable in increments of 1Mc/s throughout. This is followed by a continuously variable second oscillator covering 1.1 to 2.1Mc/s.

The first i.f. amplifier is tunable over the range 1 to 2Mc/s and as its tuning system is ganged to that of the variable second oscillator a final intermediate frequency of 100kc/s emerges.

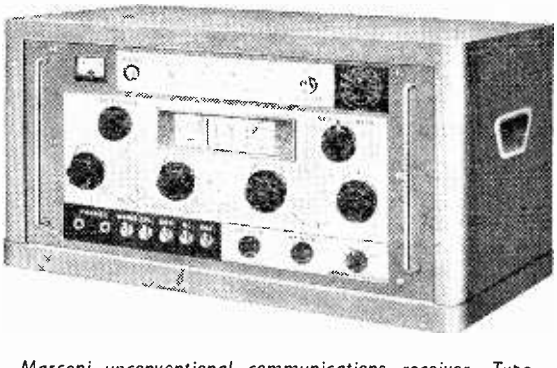
Coil switching in the aerial and r.f. circuits is automatic as it is linked with the crystal-oscillator's decade switching system.

Incorporated also is a crystal-controlled marker oscillator for checking the calibration of the signal-frequency circuits, which, with the inherently high stability and accuracy of the crystal-controlled first oscillator, provides, it is claimed, a receiver setting and reading accuracy of ± 200c/s at all parts of the frequency range covered.

I.F. bandwidths of 1.5, 3, 6 or 12kc/s, at -3dB points, can be selected and for c.w. telegraphy reception an a.f. filter, tuned to 1kc/s and having a passband of 100c/s, can be switched into circuit.

Provision is made for reception of single- as well as double-sideband telephony with the a.f. output fed into either a 2.5-Ω loudspeaker, headphones or a 600-Ω line.

Power consumption is 120W at 100 to 120V or 200 to 250V, 45/60c/s. Further details can be obtained from Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex.



Marconi unconventional communications receiver, Type HR120.

Transistor Inverters and Converters

3.—Modification of the Standard Push-pull Square-wave System

By M. D. BERLOCK*, Grad. I.E.E. and H. JEFFERSON*, M.A.

THE previous article described the standard push-pull square-wave oscillator widely used in inverters and converters. In its basic form it has the circuit shown in Fig. 1 and the practical form differs from this only by the addition of some biasing elements to facilitate starting. The natural state of the theoretical circuit is that one transistor, say Q1, is fully conducting and is held in this state by the positive feedback to the base: at the same time Q2 is held in a cut-off condition. This cannot go on for ever, because the magnetizing current in the transformer is rising steadily and a point is reached at which the transformer saturates. In all designs having high efficiency this saturation is made to take place very sharply by the use of special core materials, preferably with toroidal structures.

When the transformer core saturates there is a sudden change in the load line, the transistor collector current flies up and the loop gain drops. There is now nothing to keep Q1 conducting, but as conditions start to settle towards the natural symmetry of the circuits Q2 is brought into conduction and away the circuit goes on the other half-cycle. It will be seen that the battery line is presented with a very high current demand every half-cycle and this can lead to some very unpleasant pulling effects if several inverters of about the same frequency share a common line. Other equipment on and near the line is also liable to serious interference. The high current spikes in the transistor collector circuit produce correspondingly high transient dissipation and may also contribute to voltage spikes at the collector of the transistor which is cut off.

This circuit becomes even more mischievous where a reactive load is connected to the circuit. In one case which has been reported to us a nominally 50 c/s inverter jumped to about 200 c/s when offered a motor load. This state of affairs was not satisfactory to either inverter or motor.

Much greater reliability is obtained by the use of a circuit described by J. L. Jensen†. The trouble with the standard circuit is that the switching operation which breaks the feedback loop to initiate the reversal is in the collector circuit where the full power of the system is available and where the load is connected directly to the switch. Jensen has moved the switch to a lower-level part of the system. His basic circuit is shown in Fig. 2 and it can be seen that there are now two transformers, an additional transformer having been introduced in the base circuit. The collector-load transformer is now, however, a perfectly conventional non-saturating transformer which can be designed according to taste as a power transformer or an audio output transformer: the results should, of course, be the same. The transformer T2 is the saturable transformer. As long as T2 is not saturated the positive feedback holds one transistor fully on and the other in a cut-off condition. To do this there must be a constant voltage across the primary of T2 and the flux in the core will rise steadily until the core saturates.

At this point R_{FB} plays a vital part. The available current into T2 is limited to the current which can be driven through this resistance by the available feedback voltage. The base circuit of the conducting transistor and the magnetizing current of the transformer are sharing this and as the demand of the transformer rises the base current of the transistor must fall. The drive has been cut off but the resistor R_{FB} prevents the change of impedance of T2 from being apparent at the load. There is no current spike at the collectors, no sudden inrush from the battery, and no voltage spike on the cut-off transistor collector.

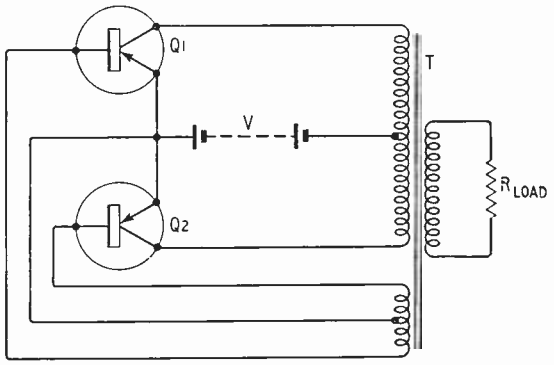


Fig. 1. Standard Uchrin-Royer circuit.

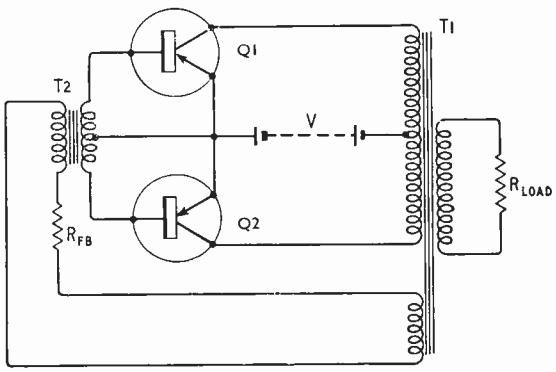


Fig. 2. Jensen introduced a small saturable transformer in the base circuits of Fig. 1.

*The Phoenix Telephone and Electric Works Ltd.
†*I.R.E. Trans. on Circuit Theory*, Vol. CT-4, p. 276 (Sept. 1957).

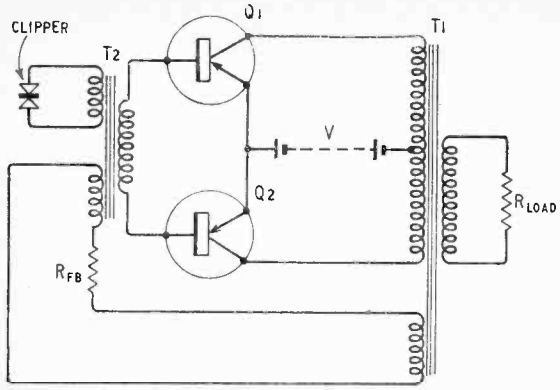


Fig. 3. The addition of a clipper diode pair to the basic Jensen circuit of Fig. 2 stabilizes the frequency.

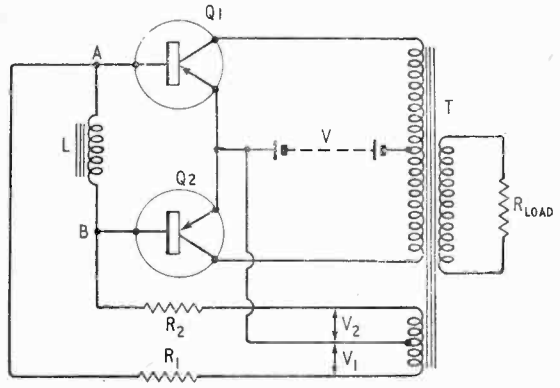


Fig. 4. In this new circuit even less square-loop core material is used and the frequency depends less on transistor properties.

This behaviour is especially noticeable when the circuit is being operated with a light load. The circuit described in the previous article still spikes up to the same saturation current while in this case we find an almost spike-free waveform of appropriately low level.

The economy of this Jensen circuit lies in the fact that T2 is a very small transformer. A 100-watt inverter may require about 1 watt of base drive power, and the expensive square-loop core material is used only for this relatively-low-power device. For the 100-watt transformer T1, which is very much bigger, we can use one of the silicon iron core materials which are very much cheaper. Moreover, we can operate at any flux density which seems appropriate to balance weight against power loss.

A very important variation described by Jensen is shown in Fig. 3. Both the standard and Jensen forms described so far have operated at frequencies which depend on the transistor input impedance and on the supply voltage. The circuit shown is provided with a clipper pair of symmetrical Zener diodes which fix the voltage across T2. Since the time taken to build up to saturation is directly proportional to this voltage the effect of fixing the voltage is to fix the half-cycle time and thus the frequency.

Although Jensen does not mention the starting problem it will be apparent that it differs in no way from the starting problem discussed last month, and the same solutions are applicable.

Further improvements in inverter circuits are possible. The Jensen circuit shows that only a small volume of the expensive switching core material need be used: the circuit to be described was introduced to provide economy in winding the transformers while retaining the advantages of switching in the base. On examination it was found that it also made the operating frequency much less dependent on transistor characteristics. It has been found to provide satisfactory operation in a wide range of inverters up to 250 watts, and details of some of these inverters will be given.

The new circuit is shown in Fig. 4. The base transformer of the Jensen circuit has been replaced by an inductor L and the positive feedback which makes the circuit oscillate is now derived from a separate feedback winding on the main transformer T. As the transformer already carries a number of windings there is some economy in labour to add to this number in return for the extreme winding simplicity of the inductor compared with the use of a base transformer.

The feedback winding is centre-tapped so that the voltages labelled V_1 and V_2 are in fact equal. Let us assume that the transistor Q1 is conducting. The point A will be at some negative potential with respect to 0, $-V_{be}$, and there will be a current into the base of the transistor which must be $(V_1 - V_{be})/R_1$. The assumption is, of course, that L takes no current at all. We know that this base current must be sufficient to give the required collector current and we can therefore write

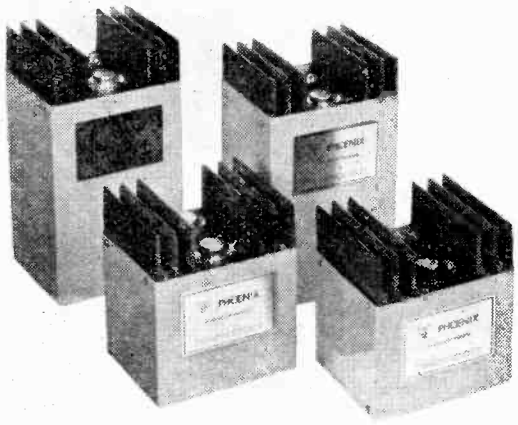
$$\frac{V_1 - V_{be}}{R_1} = \frac{I_c}{\beta(\min)}$$

where $\beta(\min)$ is the current gain of the worst specification transistor at a current I_c.

The other transistor, Q2, is cut off so that point B is at a potential V_2 with respect to 0. Across the inductor L, therefore, we have a voltage of $V_2 + V_{be}$. This can be sustained only for a limited time, after which there is a demand for a very rapid rise in magnetizing current. The available current is however limited, and the effect is to bring both A and B to about the potential of 0. Transistor Q1 is cut off and initiates the transition to the state in which Q2 is conducting.

In the unclipped version of Jensen's circuit the

Range of inverters based on the circuit of Fig. 4.



Distribution of power losses in four typical inverters based on the circuit of Fig. 4.

Nominal Supply (volts)	Input Power (watts)	Output Power (watts)	Efficiency at Full Load (%)	Nominal Frequency (c/s)	Losses in watts in					
					Transistor		Base Switching Inductor	Base Limiting Resistor	Transformer	
					Collector & Transient	Base Drive			Copper	Iron
24	240	212	89	400	6.0	1.25	0.1	3.75	8.5	8.0
12	120	96	80	400	6.0	1.25	0.1	3.75	7.5	5.0
12	72	55	76	400	6.0	0.3	0.1	2.0	5.5	3.0
12	36	28	78	800	2.5	0.2	0.2	0.2	2.8	2.0

voltage across the frequency-determining transformer is settled by the value of V_{be} in the conducting transistor. This is not a particularly stable or consistent quantity and it varies, as you might expect, with emitter current. Consequently the operating frequency is not particularly well defined. The main transformer must therefore be proportioned to suit the lowest expected frequency and we should expect considerable difficulties to arise in operating reactive loads, of which fluorescent lamps and their control networks are a special example.

This new circuit, on the other hand, has its frequency determined by the voltage $V_2 + V_{be}$. The size of V_2 has not yet been discussed but it is easily seen that if the transformer has the ratio $(N + N) : (1 + 1)$ we shall have

$$V_2 = [V - V_{ce}(sat)]/N$$

where V is the supply voltage.

The main source of variation in this will be the variations in supply voltage V. This can give us a criterion for the choice of V_2 and thus of N. Suppose that the circuit is to work reasonably well from 11 volts to 14 volts. For arithmetical simplicity we shall take a rather bad transistor, with $V_{ce}(sat) = 1$ volt. Then V_2 will range from 10/N to 13/N, a range of 3/N volts. Let V_{be} have a possible range from 0.5 to 0.8 volts. The frequency error contributions will be equal if $N = 10$, and the frequency error will be dominated by the supply voltage error if N is less than about 4 or 5. By this approach we fix one extreme value of possible N.

The dissipation in the resistors R_1 and R_2 is, for half the time in each, very nearly $(V1 \text{ or } V2) \times I_b$. As I_b is fixed by the maximum power condition we see that this source of loss is directly proportional to the feedback voltage. We can derive a relation for this loss in the following way. The input power is $VI_c = V\beta I_b \approx NV_2\beta I_b$, since in most practical cases $V \gg V_{ce}(sat)$. The loss of power in the resistors is therefore approximately $1/N\beta$ times the input power. Here is our incentive to keep N large.

Another reason for keeping N small, even if we are not worried about frequency stability, is that the base current is determined by $V_1 - V_{be}$. We have already noted that V_{be} varies from transistor to transistor and we must be certain that in our most unfavourable case there is sufficient base current and at the other extreme that the base current does not exceed the manufacturer's limit. It is a matter for the designer's judgment to balance these requirements.

The designer has another opportunity for exercising judgment in the design of the transformer. A small transformer will have substantial copper and iron losses: a large transformer will be expensive and, not surprisingly, large. The mechanical construction of the inverter may be such that transformer heat can reach the transistors and introduce problems of thermal stability. Where a cast or extruded aluminium fin structure has been adopted for transistor mounting it will usually be convenient to have one or two dimensions fixed for a whole range of inverters and these dimensions become important factors in extending a range of inverters.

A range of inverters based on this new circuit is shown in the photograph. These cover a power input range from 30 watts to 250 watts and as a matter of convenience use standard end castings throughout. The tabulated performance details show how the losses are distributed in the circuit. It will be seen that the individual losses do not add up to the indicated total. This is no doubt entirely a matter of experimental error. It will be realised that we are dealing here with losses attributable to waveforms which are far from sinusoidal and in consequence both calculation and measurement offer considerable difficulties.

CLUB NEWS

Cambridge.—The chairman of the Cambridge University Wireless Society for the 1960/61 academic year is D. E. Bowyer (G3NHB), Clare College, and the secretary M. H. Hallett (G3MDR), Emmanuel College. The Society will have a stand at the University Societies' Fair in the Corn Exchange during the early part of October when the club station, G6UW, will be in operation.

Clerkheaton.—The programme for the meeting on Septemper 28th of the Spen Valley Amateur Radio Society is being provided by Fane Acoustics. On October 26th A. R. Bailey (G3IBN) will deal with two-metre techniques. The club now meets in the Labour Rooms, Railway Street, at 7.30.

Dartford.—Readers in the Dartford, Kent, area may be interested to know that efforts are being made to form a tape recording club in the locality. Information is obtainable from E. H. Foreman, 117 Westgate Road, Dartford, Kent.

Mitcham.—"Colour television" is the title of a lecture being provided by the B.B.C. for the October 7th meeting of the Mitcham and District Radio Society. Lecture meetings are held on alternate Fridays at 8.0 at "The Cannons," Madeira Road.

Reading.—A lecture-demonstration on simple transistor portable receivers will be given to members of the Calcot Radio Society by their chairman, S. Woodward, on October 7th. Three weeks later J. A. B. Dunn, of Associated Transistors Ltd., will give a lecture-demonstration on transistor circuit applications. The society, which caters mainly for the employees of the U.K. Atomic Energy Authority, meets at 7.45 at St. Birinus Church Hall, Calcot.

Piezoelectric Voltage Transformers

AN ALTERNATIVE PRINCIPLE WITH USEFUL APPLICATIONS

By ALAN E. CRAWFORD*, M.Brit.I.R.E., S.M.I.R.E.

VOLTAGE transformers based on electromagnetic induction are widely used in all branches of electrical and electronic engineering. No satisfactory replacement for them has been proposed until the recent introduction of units based on piezoelectric effects.

Although the principle of operation is well known it has not been possible to apply them practically owing to the limitations of known piezoelectric materials. The development of solid solution lead zirconate-titanate ceramics[1,2] has enabled transformers to be constructed that can compete favourably with conventional types in certain applications

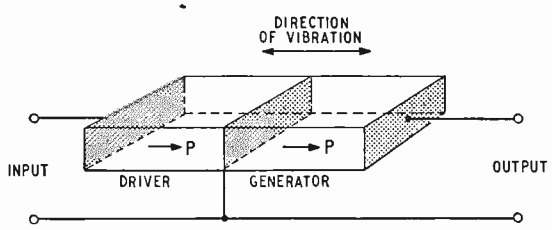


Fig. 1. Ring-type (longitudinal) piezoelectric transformer.

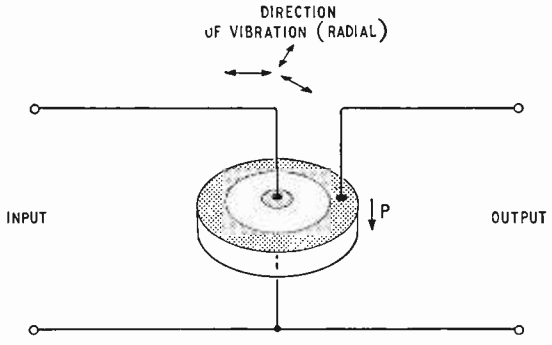


Fig. 2. Ring-type piezoelectric transformer suitable for use as an i.f. filter.

and this article outlines the principles of operation and design considerations.

When a piezoelectric material is subjected to mechanical strain an electric charge appears across selected electrode faces. Similarly, there is a motor effect when an electric charge causes an alteration to the physical dimensions of the material. The former is known as the "direct" piezoelectric effect and the latter is known as the "converse" effect.

All mechanical structures possess resonant modes of vibration corresponding to their physical properties and structural dimensions. At these resonances the strain produced by the applied vibrating force rises to a maximum due to the standing wave distributions. When a piezoelectric resonator is energized by an applied voltage of a frequency corresponding to a natural resonant frequency then the maximum mechanical deformation will be produced.

Considering these facts it will be seen that a system can be devised consisting of two piezoelectric elements physically coupled together in a form where strain can be introduced into one element by electrically energizing the other. The strain is converted back to an electrical output by the direct piezoelectric effect. The magnitude of the generated voltage will be decided by a number of fundamental factors, all of which can be specifically defined to give required characteristics such as voltage gain, output impedance and power output.

While it is possible to use single crystal piezoelectric materials like quartz and Rochelle salt the particular properties of polycrystalline piezoelectric ceramics enable practical transformers to be built with great simplicity of construction.

The piezoelectric polycrystalline ceramics possess the property of preferential direction of activity. This means that the direction in which the piezoelectric effect occurs is decided during manufacture by choice of electrode areas and the polarizing process.

Unlike a single crystal, which possesses an inherent polarization, the polycrystalline body of ceramic consists of a number of randomly orientated domains. These domains can be aligned by the application of an electrostatic field under certain controlled conditions. The effect is permanent and on removal of the field the polyarystalline mass acts as a single crystal so far as the piezoelectric effect is concerned.

This ability enables composite resonators to be built from one homogeneous piece of ceramic by preferentially polarizing separate sections of the structure. Similarly, complex shapes can be initially formed and then polarized in any preferred direction. The ceramic transformer uses this method of construction to produce large ratios of input to output voltage, and a number of types are possible.

Ring-type Transformer.—This is so termed from filter nomenclature, where the physical and electrical arrangement is symmetrical, but it could equally well be termed a longitudinal-type transformer. The construction is shown in Fig. 1 and consists of two bars of piezoelectric ceramic cemented end to end. The ends are provided with electrodes and the direction of piezoelectric activity (P) is lengthwise. Input connections are made to one end and the central electrode while the output is obtained from the other end and the common centre. The bar is energized in its fundamental length mode as

*Brush Crystal Co. Ltd.

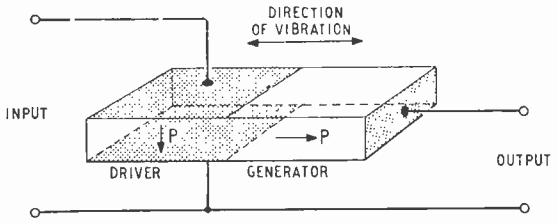


Fig. 3. Transverse-type piezoelectric transformer.

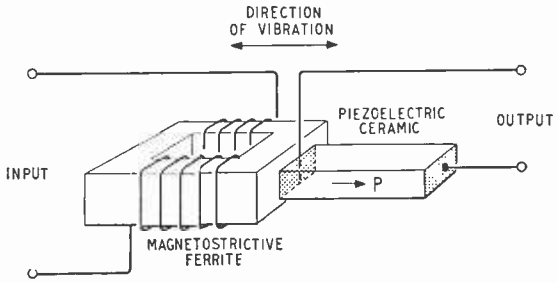


Fig. 4. Composite transformer.

a half-wave resonator and a suitable mounting position would be the central nodal point. Both ends would be free.

The open-circuit amplification of this type is independent of the geometry, being a function of the mechanical Q and the electromechanical coupling coefficient k_{33}. The latter is the efficiency of conversion in the length mode of operation.† The range of input impedance relative to the output impedance is limited by the symmetrical geometry, and the level of input impedance is high compared to other types of ceramic transformers.

A specific version of this type of element is found in the circuit device known as a "Transfilter"[3] and used as a replacement for an i.f. transformer in radio receivers, Fig. 2. The radial resonance is employed and mechanically adjusted to 465 kc/s. Energizing is carried out using the outer electrode ring, the centre dot electrode providing an output with a voltage gain of about 10 : 1. The Q of the system will decide the band-pass frequency.

Transverse-type Transformer.—Fig. 3 shows the construction of a transformer using transverse principles. A long bar of ceramic is coated with electrodes over half the length and polarized in the thickness direction. The remaining half is polarized transversely to the length by applying an end electrode and temporarily connecting the thickness electrodes in parallel.

By applying an alternating voltage between the thickness electrodes corresponding to the length resonant frequency the bar can be excited into mechanical length resonance. This produces a strain in the second half of the bar which in turn is piezoelectrically transformed into a voltage appearing across the end electrode. The waveform of the driving voltage is preferably sine wave, but a square or saw tooth waveform will also energize the bar. Single voltage pulses with a short rise time can be used to excite the resonator and produce amplified voltage pulses.

This form of transformer has many advantages over the longitudinal type. The geometry of the bar determines most of the design factors and power levels, voltage amplification factor, electrical termination characteristics can be specified. It is thus an obvious choice for a practical design.

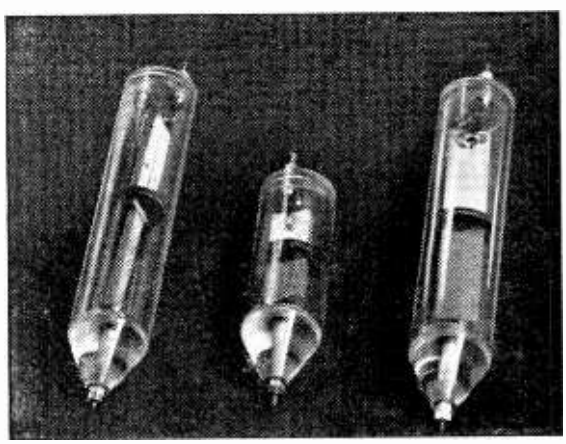
Hybrid Transformers.—The recent development of magnetostrictive ferrite materials has enabled a composite transformer to be constructed, Fig. 4. A suitably shaped and proportioned block of magnetostrictive ferrite is bonded to a length-polarized bar of piezoelectric ceramic. The necessary d.c. polarization of the magnetostriction element is supplied either by an insert permanent magnet, or by a d.c. voltage through the energizing winding. Alternating current energizes the magnetostrictor at its resonant frequency and thus introduces a mechanical strain in the piezoelectric bar. This in turn produces a voltage across the electrodes. The ability to provide a low-impedance input is somewhat offset by the lower mechanical efficiency and strain limitations imposed by the ferrite material. However the provision of a d.c. path on the input side rather than a capacitive input may be of use in some applications and the low impedance possible with the energizing coil would enable transistor circuits to be readily applied.

Design Considerations.—Of the three systems the transverse type appears to offer immediate promise and a number of experimental transformers have been constructed for study purposes.

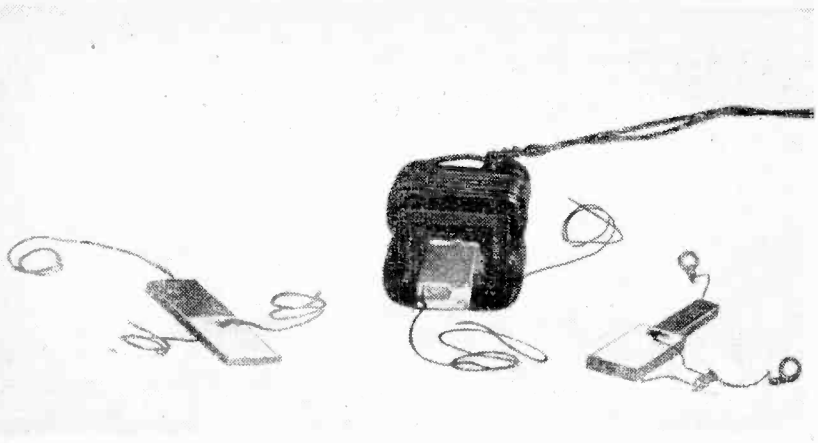
In the past a serious disadvantage has been limitations imposed by unsuitable piezoelectric ceramic materials. The development of the family of ceramics based on lead zirconate-titanate solid solutions by the Clevite Corporation in the U.S.A., and Brush Crystal Company, in England now enables practical transformers to be designed. These materials possess very high electromechanical conversion efficiencies, can be operated at temperatures up to 250°C without depolarization, have very low dielectric losses and high mechanical Q values.

Although it is possible to operate the transformer at harmonic modes the complications inherent in high-frequency operation generally limit the mode of vibration to the fundamental or second harmonic.

Ceramic transformers (left to right) stepped bar 20kc/s, parallel bar 40kc/s, parallel bar 20kc/s.



†The subscript 33 refers to the direction of polarization (or cut) and the direction of energization. It is referred to in Mason's "Piezoelectric Crystals" and also defined in the I.R.E. Standards on Piezoelectric Crystals, Measurements on Piezoelectric Ceramics, 1959.



Unmounted elements (left to right) parallel transverse, magnetostrictor hybrid, stepped transverse.

The lower frequency limit is dictated by the audio nuisance value and is therefore restricted to about 20 kc/s. The choice between fundamental or second harmonic operation is dictated primarily by the impedance level requirements for matching the driving source and electrical load.

Initially work has been concentrated on two fundamental frequencies of 20 kc/s and 40 kc/s. These frequencies give a bar length of about 3in and 1½in respectively, with other dimensions dictated by the various parameter requirements.

Theoretical Considerations.—The theoretical calculations for operating parameters are mainly based on equivalent circuit analysis, the circuit being shown in Fig. 5(a) and the mechanical parameters are defined in Fig. 5(b). It is not proposed to give the derivations as they have been fully covered in other papers (for example, reference 4).

It is assumed that certain design requirements can be initially stated and be given as load resistance R_L, voltage amplification A_v and r.m.s., output voltage E_2. The transformer is of transverse type operating at the fundamental frequency.

Minimum Length

The length L of the bar is decided by the required operating frequency but is influenced by the maximum safe operating voltage of the ceramic.

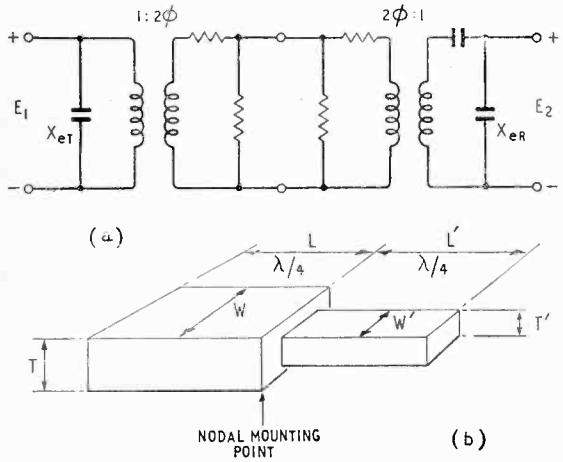


Fig. 5(a). Equivalent circuit and (b) dimensions of transverse transformer.

$$L = \frac{E_2}{V_{max}} \text{ centimetres} \quad .. \quad .. \quad .. \quad (1)$$

where V_{max} is r.m.s. volts per cm.

Thickness

The thickness T is determined from the no-load voltage amplification A_{vo} and the piezoelectric coefficients for the material. The conditions for maximum power transfer are defined by:

$$A_{vo} = 2A_v$$

then

$$T = \frac{4Q_m Y^E{}_3 g_{33} d_{31}}{\pi^2 (1 - k^2{}_{33})} \cdot \frac{L}{A_{vo}} \quad .. \quad .. \quad .. \quad (2)$$

where Q_m is the mechanical Q of the system, $Y^E{}_3$ is Youngs Modulus in the direction of polarization, g_{33} is the piezoelectric voltage output coefficient relating field to stress applied parallel to the polarizing axis, d_{31} is the piezoelectric charge output coefficient relative to stress applied perpendicular to the polarizing axis, k_{33} is the coupling coefficient for long bars with the length perpendicular to the polarizing axis.

Width

The width W is decided by the terminating factors and the piezoelectric and mechanical characteristics of the ceramic.

$$\frac{X_{eR}}{R_L} \simeq \frac{\pi^2}{4Q_m k^2{}_{33}} \quad .. \quad .. \quad .. \quad .. \quad (3)$$

where $X_{eR} = \dfrac{L}{\omega \xi^T{}_{33} (1 - k^2{}_{33})^2 \, TW}$ .. .. (4)

and $\dfrac{1}{\omega} = \dfrac{2L}{\pi c^E}$ .. .. (5)

Combining these equations and solving for W.

$$W = \frac{8Q_m k^2{}_{33}}{\pi^3 c^E (1 - k^2{}_{33})^2 \epsilon^T{}_{33}} \cdot \frac{L^2}{R_L T} \quad .. \quad .. \quad (6)$$

where $\xi^T{}_{33}$ is the dielectric constant, E is the velocity of propagation at constant field, L and T are determined from equations (1) and (2), R_L is specified.

Generator Dimensions

The section of bar comprising the generator requires modification to its physical dimensions to

(*Continued on page 513*)

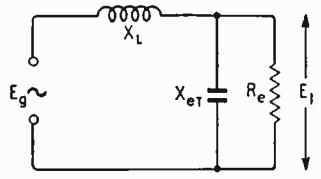


Fig. 6. Simplified circuit of transformer input with resonant inductance.

match the acoustic impedance of the two sections and also to ensure that each section is a $\frac{1}{4}$ wavelength. The difference is determined by the coupling k_{33}.

$$L' = \frac{L}{(1 - k^2_{33})^{\frac{1}{2}}} \quad .. \quad .. \quad .. \quad (7)$$

and $$W'T' = WT(1 - k^2_{33})^{\frac{1}{2}} \quad .. \quad .. \quad (8)$$

Operating Frequency

The resonant frequency is determined from the velocity of sound in the material and the length.

$$F = \frac{c^E}{4L} \quad .. \quad .. \quad .. \quad .. \quad .. \quad (9)$$

Input Impedance Parameters

The resistive and reactive components are calculated from the piezoelectric, electrical and physical characteristics of the bar.

$$X_{eT} = \frac{1}{\omega \xi^T_{33}(1 - k^2_{31})} \cdot \frac{T}{WL} \quad .. \quad .. \quad (10)$$

and $$R_e = \frac{\pi}{c^E Q_m Y^E_3 d^2_{31}} \cdot \frac{T}{W} \quad .. \quad .. \quad (11)$$

where k_{31} is the coupling coefficient for long bars with the length perpendicular to the polarizing axis.

Inductance at Resonance

The input represents both a resistive and reactive impedance. In practice it is desirable to neutralize the reactive part and this can be done by resonating it with an inductor. (Fig. 6). This usually results in an increased voltage amplification. The required resonating inductance L_e is calculated as:

$$L_e = \frac{X_L}{\omega} = \frac{1}{\omega} \cdot \frac{X_{eT}}{1 + (X_{eT}/R_e)^2} \quad .. \quad .. \quad (12)$$

Practical Design.—A number of ceramic transformers have been constructed based on the above design considerations. It will be realized that due to the high output impedance they are essentially voltage devices and are only capable of limited current. The ratio is input voltage to output voltage can be designed, to be between unity and about 500 : 1 in the case of transverse systems and considerably higher with hybrid systems. The limits on physical size decides a fixed frequency range between 20 kc/s and 100 kc/s.

Practical data have been obtained on a 40 kc/s fundamental transverse transformer with mechanically identical input and output sections. This is not the ideal form, but in view of the simplicity of construction it was considered desirable for initial evaluation.

The input impedance is approximately 750Ω at 40 kc/s and the no-load output was measured using a capacity divider input valve voltmeter. The voltmeter input capacity was 10μF and meter readings were corrected to give true figures, the output section of the transformer having a capacity of 40μF.

Working with the fundamental frequency over an input voltage range of 5 to 10 volts the voltage gain varied from 60 to 50. This can be attributed to the shape factor due to a parallel bar and greater linearity has been achieved with stepped bars approaching the optimum acoustic impedance match.

Fig. 7 shows the variation of efficiency with a varying output load and figures approaching 90% have been measured.

Fig. 8 gives the variation of gain with output load, the maximum gain being achieved under ideal no-load conditions.

The material used in the transformer was Brush LZ-4a ceramic and this possesses the following parameters.

k_{31}	= 0.30	d_{31}	= −130 × 10^{-12} coulomb/newton
k_{33}	= 0.76	g_{33}	= 28.3 × 10^{-3} volt metres/newton.
k_3	= 1200	Y^E_3	= 6.75 × 10^{10}; newtons/metre^2
tan δ	= 0.005	c^E	= 3000 metres/sec.
Q_m	= 500	ξ^T_{33}	= 1.2 × 10^{-8} farad/metre
Max. operating temp.	= 250°C.		

Conclusion.—Suggested applications of the ceramic transformer include cathode ray tube high-

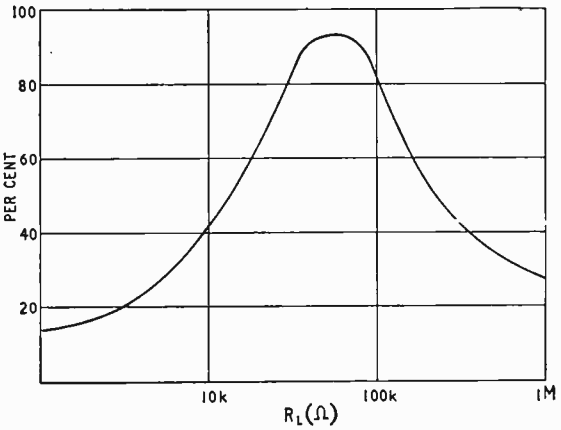


Fig. 7. Variation of efficiency with output load (40-kc/s parallel-element transformer).

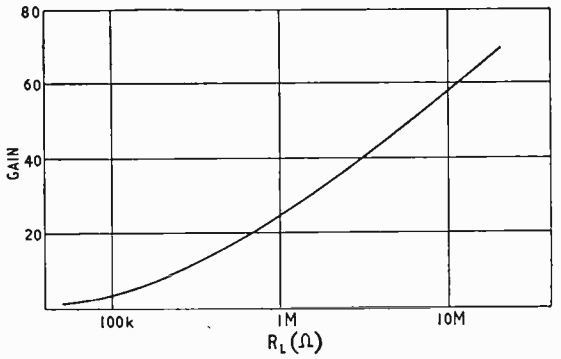


Fig. 8. Variation of gain with output load (40-kc/s parallel-element transformer).

voltage supplies, Geiger tube voltage sources, discharge tube power supplies, high-voltage pulse generation. The main advantages in the use of these devices are the absence of a magnetic field, elimination of insulation problems, light weight and simple high-frequency operation.

Development is still in an early stage but initial results show considerable promise.

The material used and certain aspect of the transformer design is covered by British and foreign patents or patents pending.

Acknowledgements.—The research staff of Brush Crystal Co. Ltd., assisted in the work, notably Mr. R. F. J. Orwell who made many of the calculations and Mr. C. Pearcey who carried out the practical measurements.

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[1]Jaffe B., Roth, R. S., and Marzulls, S. "Properties or Piezoelectric Ceramics in the Solid Solution series, Lead Zirconate—Lead Titanate—Lead Oxide." *J. Research Bureau of Standards*, Vol. 55, No. 5, November 1955.

[2]Crawford, A. E., "Lead Zirconate Piezoelectric Ceramics" *British Communications and Electronics*, July 1959.

[3]Lungo, A., and Henderson, K. W. "Application of Piezoelectric Resonators to Modern Band-Pass Amplifiers" paper presented at I.R.E. Convention, New York, March, 1958.

[4]Rosen, C. A., Chapter 5, in book entitled "Solid State Magnetic and Dielectric Devices," published by Wiley, New York, 1959.

INDUSTRIAL GROUPS

WITH the growing number of "take-overs," consortiums and amalgamations it is becoming increasingly difficult for those outside the groups concerned, and often for those within, to know what relationship exists between the various companies. We have, therefore, compiled an index, from which we propose to publish extracts from time to time.

It is not the size of the groups, but rather the fact that they have recently been in the news, that has governed our choice of the first "family," of which we give details below.

The Pye group made headline news in August with its acquisition of shares and a controlling interest in "Temco" in face of the take-over bid from a consortium of seven companies.

It may not be generally known that the group of over 60 companies, of which C. O. Stanley, C.B.E., is now chairman and managing director, started in Cambridge in 1896 as a small instrument-making firm—W. G. Pye & Co. After the first World War the company became interested in radio receiver production and in 1928 Pye Radio Ltd. was formed to look after that side of the company's interests, and it was then that C. O. Stanley became associated with the company.

So much for the beginnings of the group which now includes not only sound radio, television and electronics companies, but also firms making records, domestic electrical equipment, domestic oil heaters, etc.

The group's issued share capital in 1948 was £366,067 and now stands at £7,398,133. During this period the profits before taxation have risen from £262,807 to last year's record figure of £2,423,884.

Below is the list of the companies within the family, not in order of seniority, but with priority for those companies concerned most with radio and electronics.

Pye Ltd.
Pam (Radio & TV) Ltd.
Invicta Radio Ltd.
High-Definition Television Ltd.
Pamphonic Reproducers Ltd.
Pye Telecommunications Ltd.
Pye TVT Ltd.
Faraday Electronic Instruments Ltd.
W. Bryan Savage Ltd.
Labgear Ltd.
W. G. Pye & Co. Ltd.
Unicam Instruments Ltd.
The Telephone Manufacturing Co. Ltd.
Magnetic Devices Ltd.
Newmarket Transistors Ltd.
Cathodeon Ltd.
Cathodeon Electronic Ltd.
Cathodeon Crystals Ltd.
Pye Records Ltd.
L. G. Hawkins & Co. Ltd.
W. Watson & Sons Ltd.
Pye Electric Ltd.
The Lindley Thompson Transformer & Service Co. Ltd.

Overseas Companies
Deutsche Pye G.m.b.H.
Pye (Australia) Pty. Ltd.
Pye Canada Ltd
Pye Corporation of America
Pye (France) S.A.
Pye Proprietary Ltd. (Australia)
Pye Telecommunications (Pty.) Ltd. (South Africa)
Radio Corporation of New Zealand Ltd.
Radio Centre Ltd. (New Zealand)
Svenska Pye A.B. (Sweden)
Pye Ltd. (New Zealand)
The Akrad Radio Corporation Ltd. (New Zealand)
Green & Cooper Ltd. (New Zealand)
G. A. Wooler & Co. Ltd. (New Zealand)
Pye Radio & Television (Proprietary) Ltd. (South Africa)
Sciaky Australia Proprietary Ltd.
United Acceptance Corporation Ltd. (New Zealand)

Associated Companies
Pye Industries Ltd.
Bendix-Tecnico Pty. Ltd. (Australia)
Bendix-Tecnico (Automotive) Pty. Ltd. (Australia)
F. W. Davey & Co. Pty. Ltd. (Australia)
Tecnico Electronics Pty. Ltd. (Australia)
Pye (Ireland) Ltd.
Telecommunications Ltd. (Eire)
Electronic Industries Ltd. (Australia)
Television Engineering Pty. Ltd. (Australia)
Unidare Ltd. (Eire)
Pye Records Pty. Ltd. (Australia)
Five Star Finance Co. Ltd. (New Zealand)

In addition to the above there are several companies which have been set up to operate some of the group's factories.

The group also has a 9% holding in Associated Tele-Vision, the London and Midland television programme contractors.

Commercial Literature

Small Motors and Servomotors are used increasingly in control equipment and analogue computer. Leaflet listing no fewer than forty items—motors, synchros, servomotors and magnetic and transistor servo amplifiers—from R. B. Pullin & Co., Ltd., Phœnix Works, Gt. West Road, Brentford, Middlesex.

Spring Clips for a vast variety of functions including quick-release types for assembling and mounting coil formers and cans on printed wiring boards, retaining printed-circuit boards and fixing cabinet backs. Leaflet describing forty of 1,000 fastenings from F.T. Products, Ltd., Uxbridge, Middlesex.

Miniature Earphones including special driver units offering various response curves, complete stethoscope types and two models of individual ear clip. Leaflets from Amplivox, Ltd., Beresford Avenue, Wembley, Middlesex.

Telecommunications Equipment, including v.h.f./f.m RT, u.h.f., h.f., microwave link, marine and public address apparatus. Eight-section general catalogue (1960) from Pye Telecommunications, Ltd., Newmarket Road, Cambridge.

Gold-plated Frame-grid and nickel cathode used in the S.T.C. Type 3A/167M triode, which has a mutual conductance of 47±9mA/V. Forty-page applications report on this valve, designed for high performance and long life, from Standard Telephones and Cables Ltd., Special Valve Sales Department, Footscray, Sidcup, Kent.

Electrolytic Etching of panel markings, code numbers, etc., can be carried out easily and quickly on any metal surface by the Electromark process. A.I.D. and A.R.B. acceptance "as a means of marking metal" has been obtained and stencils cut with ordinary typewriter can be used. Leaflet from Electromark (G.B.), Ltd., Harlequin Avenue, Great West Road, Brentford, Middlesex.

KIRCHHOFF'S LAWS

By "CATHODE RAY"

IF we were asked what we knew about Kirchhoff, I suppose we would reply that presumably he was the "bod" who invented Kirchhoff's laws—the one about currents at a junction and the other about voltages around a loop. From the ordinary electrical textbooks one might well get the impression that this was his life's work. And certainly there have been plenty of life's works not half so helpful. Kirchhoff's laws are simple enough, yet enable one to calculate the most complicated circuits. But in fact they emerged in 1847, at the early age of 23, as a mere introduction to 40 years of much cleverer but less publicized work. One of the first items, incidentally, was to make clearer than Ohm did what Ohm's law meant.

Having gained considerably light on Ohm's law by looking up who Ohm was and how he came

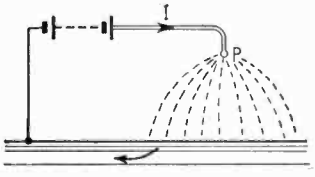


Fig. 1. Even if a "point" P is large enough to have appreciable capacitance, the very small transient current needed to charge it to any reasonable voltage has its counterpart as a displacement current in space.

to proclaim his law, I thought I would do the same with Kirchhoff. It seemed a good idea, but hasn't worked very well. Every book on electricity, pure or applied, states the laws—in a surprising number of different forms—but background information on them is notably scarce. Sir Edmund Whittaker, in his "History of the Theories of Aether and Electricity," refers to Kirchhoff a dozen times but doesn't even mention them. Perhaps they were too obvious to be taken seriously by such an authority.

If there are any hidden obscurities or complications we shall have to find them for ourselves.

There is general agreement about the way No. 1 is put: The algebraic sum of all the currents meeting at a point is zero. True, a few of the more unsophisticated works say that the sum of all the currents arriving at a point is equal to the sum of all the currents leaving it; but if anyone didn't already know what "algebraic sum" meant, the neater form of the law would be reason enough for finding out.

As for proof, I would base it on the axiom that current must go somewhere. It can't just suddenly vanish like a river in the desert. Nor can it come from nowhere. It is a movement of electric charges, and charges cannot accumulate at a point, because if they did an infinite p.d. would be created—remember $V = Q/C$, and the C of a point is zero. Even if the point were expanded a little from its mathematical definition of no magnitude to the size of, say, a soldered joint, the charging of it by a current flowing into it as in Fig. 1 would set up an electric field around it which would cause displacement currents in space, equal to I. It would be a transient affair, anyway.

And if the current flowed in the opposite direction it would "uncover" opposite charges in P, and the result would be the same in reverse. So although presumably the law was originally formulated for d.c. it applies also to a.c. too, provided these displacement or capacitive currents in space are recognized. A radio aerial is then no exception to the law.

Whether Kirchhoff's second law was for him an entirely separate mental operation I don't know. It needn't be for us, thanks to the principle of duality, which from time to time I try to sell you. The advertising slogan is "Two formulae for the price of one." All you have to do is replace each item in any formula or law by its opposite number in the two-column list provided. Current is replaced by voltage (and vice versa), and nodes (i.e. circuit junctions) by circuit meshes. Working on Kirchhoff's first law with this, one is rewarded by the news that the algebraic sum of the voltages around any mesh is zero. That is one form—the neatest, I think—of the second law, though probably not the one that Kirchhoff himself announced. In fact, many books even at the present day prefer to say that the algebraic sum of the potential differences is equal and opposite to the algebraic sum of the e.m.f s.

Besides being less neat and symmetrical, the latter form raises the vexed question of what is an e.m.f. —controversial enough to provide material for a whole article, in December 1950. While there may be no difficulty about applying the law in this form to d.c. circuits, how often nowadays does one want to? With a.c. circuits there would almost certainly be a lot of argument about whether the voltage across a capacitor was an impedance drop or an e.m.f. All totally unnecessary if one accepts the simple dual or analogy form of the second law.

Fig. 2 shows the two laws symbolically, Σ standing as usual for "the algebraical sum of terms of the kind . . ." As I explained not long ago in "Missing Signposts" (Nov. 1959), the directions of the arrows

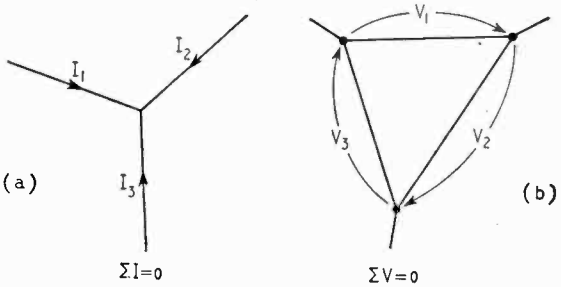


Fig. 2. Symbolic expression of Kirchhoff's two laws. They are duals of one another.

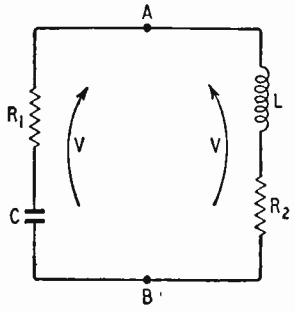


Fig. 3. The fact that the p.d. between two points is the same via any path implies the truth of Kirchhoff's second law.

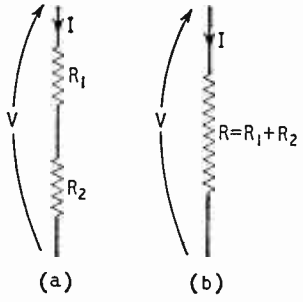


Fig. 4. The well-known principle of combining resistances in series follows from the first law.

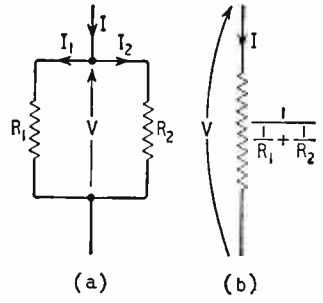


Fig. 5. And the combining of resistances in parallel follows from the second. But a dualist would work this in conductances.

are altogether arbitrary; they are not intended to show the directions in which the currents are actually flowing, but the directions I happen to have chosen as " positive." At least one of the values of current must then obviously be negative if the law is to be true. If you chose other directions for any of the arrows, the signs of those currents would be reversed and the result the same. Mathmatically, at least, a negative current from A to B is the same as a positive current from B to A.

For some reason that has never been made clear to me, most people (including authors of books on electrical engineering) draw voltage arrows pointing in both directions at once, thereby obliterating the somewhat important distinction between positive and negative. Awareness of the principle of duality would preserve them from this error, one would think.

Supposing you are fussy and would rather pay its own price for the proof of (b) than accept it as a gift under the duality special offer, that shouldn't be difficult. For if the second law were *not* true, then a single point would be at more than one potential at the same time, which on any definition of potential is absurd.

Another consequence of the nature of potential is that the difference of it between two points is the same along whatever path it is measured. If this were not so, it would be contrary to the law of conservation of energy. For the amount of p.d. between two points is defined as the amount of energy given or taken by unit electric charge moving from one point to another with or against the electrostatic force. If a charge were moved against it along the low p.d. path and released along the high p.d. path one would get energy for nothing and fulfil the old dream of perpetual motion. One therefore concludes that in reality all paths show the same p.d. For instance, if the voltage between A and B in Fig. 3 via C and R_1 is added up and found to be V, the same result is found via R_2 and L. So around the whole loop the two Vs cancel one another out to give zero, as stated by Kirchhoff's second law.

A reader who is a teacher sent me a formal algebraical proof of the second law based on conservation of energy. Actually, that was what suggested this month's title. Besides being perhaps a shade elaborate, this proof gives the law in the IR-drop versus e.m.f. form, and gets one into difficulties in a.c. circuits. I still think my axiom that no one point can be at two different potentials at once is simple and convincing, and leads at once to the second law in its most general form, the dual of the first.

The same two axioms, in conjunction with Ohm's law, lead to the familiar rules for combining resistances in series and parallel. If you know me you will be asking " Which Ohm's law? " I mean the one that says that the voltage across a dissipative part of a circuit is proportional to the current flowing through it, the constant of proportionality being the resistance; in short, $V = IR$. Where there are two such circuit parts in series (Fig. 4(a)), the first axiom implies that the current through both is the same, so the total voltage is $IR_1 + IR_2$, and, as this is equal to $I(R_1 + R_2)$, the resistance of the combination is $R_1 + R_1$. Similarly for more than two.

Where there are resistances in parallel (Fig. 5(a)), according to the other axiom (which is the dual of the first) the voltage across both is the same, and as $I_1 = V/R_1$ and $I_2 = V/R_2$,

$$I = I_1 + I_2 = \frac{V}{R_1} + \frac{V}{R_2}$$

The resistance of the combination is V/I; that is

$$\frac{V}{\frac{V}{R_1} + \frac{V}{R_2}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

Dualists, of course, would avoid these untidy reciprocals by seeing that Fig. 5 is the dual of Fig. 4 and accordingly substituting G (conductance) for R in the series formula, getting $G = G_1 + G_2$. Two formulae for the price of one, again.

While we are on this elementary level, we must remember that whereas we gaily but justifiably extended Kirchhoff's laws in their neatest forms to a.c. circuits, the series and parallel rules we have just reviewed can only be applied to a.c. impedances if the symbols are printed in heavy type. Well, of course, I don't mean literally. Heavy type is the accepted way of indicating that things are vector quantities and have to be treated rather more elaborately than by simple arithmetic or even algebra, and as long as that is understood they can be written in 2H pencil if one wants.

(*Continued on page 517*)

The reason for the difference is that the voltages across inductors and capacitors are not simply proportional to the current, as in the case of resistors. They are in fact proportional respectively to the differentials and integrals of the current, which tends to raise the level of the mathematics quite a lot; but by certain ingenious devices—and the assumption that the voltages and currents are sinusoidal—at least the forms of the d.c. circuit formulae have been preserved, and only the necessity to take account of phase has to be remembered.

Take Fig. 6. for instance. Kirchhoff's laws hold good for this just as much as for d.c. circuit. So the current (neglecting stray capacitances) is the same throughout, and at every instant the voltages across R and L add up to an amount that exactly cancels e. (In a.c. circuits, capital letters are reserved for r.m.s. current and voltage values, which apply only when certain assumptions are made; the small letters here are to indicate that instantaneous values, which apply generally, are meant.)

We know that the voltage across R is iR as in a d.c. circuit. The voltage across L is the inductance L multiplied by the rate at which i is changing. So the Kirchhoff equation is

$$e - iR - L\frac{di}{dt} = 0$$

Unless one knows how fast i is changing, or has enough data to find out, one is stuck.

If however e is known to be sinusoidal, as mercifully it so often more or less is, e and i can be replaced by E and I, which are constant values equal to $1/\sqrt{2}$ times the peak values; and a quantity analogous to R and measurable in ohms can be found—$2\pi fL$, often abbreviated to X_L and called inductive reactance. But although this ingenious mathematical technique allows the analogy to be pursued as far as knowing that the voltage across L is IX_L, the nature of things forbids its being added to IR just as if L were another resistor. The voltage IX_L is quarter of a cycle ahead of IR, so must be added vectorially at right angles. This can be done graphically, but it is usually more convenient to use the j technique. A prefixed j means addition quarter of a cycle in advance, and $-j$ means quarter of a cycle behind. Since j can be regarded as $\sqrt{-1}$, a.c. calculations are brought within the scope of algebra.

Fig. 7 is an example on which to demonstrate how Kirchhoff's laws are applied in practice to an a.c. circuit. Although there may be differences in procedure, depending on the conventions adopted, the basis is the same. For instance, one could mark currents as in Fig. 5(a), regarding the current in the generator arm as the total and those in the L and C arms as the parts. But in more complicated networks it isn't always as easy as that to pick out one current as being a total, and Fig. 7 shows the more civilized (because unprejudiced) convention for currents.

Kirchhoff's second law is applied to each mesh in turn, the first law being implied by reckoning the current downwards through R and L as $I_1 - I_2$:

$$E - (I_1 - I_2)(R + jX_L) = 0 \quad .. \quad .. \quad (1)$$

$$E - I_2(-jX_C) = 0 \quad .. \quad .. \quad .. \quad (2)$$

(Strictly, the first term in (2) is $(I_1 - I_2)(R + jX_L)$, but as we know from (1) that this is equal to E we can write E for brevity.)

Here we have two simultaneous equations, so if I_1 and I_2 are the only unknowns we can find them. I_2 comes straight away from (2):

$$I_2 = -\frac{E}{jX_C}$$

As can be found by multiplying above and below by j and remembering that $j^2 = -1$, this is equal to jE/X_C. Also X_C is $1/2\pi fC = 1/\omega C$, so

$$I_2 = jE\omega C$$

This can then be substituted in (1) to give I_1; at the same time we might as well write ωL for X_L:

$$E = (I_1 - jE\omega C)(R + j\omega L)$$

$$I_1(R + j\omega L) = E + jE\omega C(R + j\omega L)$$

$$I_1 = E\frac{1 + j\omega C(R + j\omega L)}{R + j\omega L}$$

$$= E\left(\frac{1}{R + j\omega L} + j\omega C\right)$$

That is not quite so simple as it looks, because

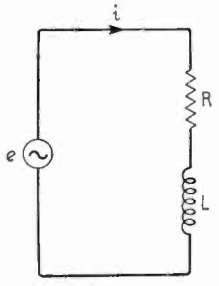


Fig. 6. Simple a.c. circuit for studying how Kirchhoff's laws apply.

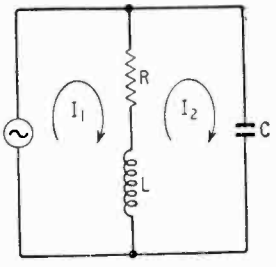


Fig. 7. Analysis of a simple a.c. network by Kirchhoff's laws.

even when the appropriate numbers for any particular circuit have been substituted for E, R, L, C and ω, the two terms in the bracket can't be just added together. The denominator of the first one is a mixture of "real" (no j) and "imaginary" (with j) numbers, such a mixture being called (rather confusingly) "complex." Just try it and you will see what I mean. It is necessary to "rationalize" it, and the trick is to multiply above and below by $R - j\omega L$ (known as the conjugate of $R + j\omega L$), with the result

$$I_1 = E\left(\frac{R - j\omega L}{R^2 + \omega^2L^2} + j\omega C\right)$$

$$= E\frac{R - j\omega[L - C(R^2 + \omega^2L^2)]}{R^2 + \omega^2L^2}$$

$$= E\frac{R - j\omega[L(1 - \omega^2LC) - CR^2]}{R^2 + \omega^2L^2}$$

The whole thing that E is multiplied by—a complex number, as we see—being I_1/E, is the admittance of the circuit as seen by the generator. The im-

pedance is of course the reciprocal of this. To find it in more manageable form we had better go back a few steps:

$$Z = \frac{1}{\frac{1}{R + j\omega L} + j\omega C}$$

$$= \frac{R + j\omega L}{1 + j\omega C\,(R + j\omega L)}$$

$$= \frac{R + j\omega L}{1 - \omega^2 LC + j\omega CR}$$

$$= \frac{(R + j\omega L)\,(1 - \omega^2 LC - j\omega CR)}{(1 - \omega^2 LC)^2 + \omega^2 C^2 R^2}$$

$$= \frac{R + j\omega[L\,(1 - \omega^2 LC) - CR^2]}{(1 - \omega^2 LC)^2 + \omega^2 C^2 R^2}$$

The resistive part of this impedance is of course the "real" part—R divided by the denominator. The reactive part is the rest of it, governed by j.

Of the several possible ways of arranging these not very inviting formulae, my choice has been such as to bring the term $(1 - \omega^2 LC)$ into the picture. Fig 7 is of course a parallel resonant circuit, and at the frequency of resonance, when $X_L = X_C$, or $\omega^2 LC = 1$, this term goes out. I should have said "*one of* the frequencies of resonance," for in a parallel tuned circuit with resistance there are several ways of defining resonance (see "Resonance Curves" in the Jan. 1953 issue).

But this is not meant to be a lesson in either complex algebra or tuned circuits; the object of the exercise on Fig. 7 is firstly to show how Kirchhoff's laws are applied to the solving of a.c. circuits, and incidentally to show that even a simple looking example can turn out to be fairly involved. In principle the laws are quite easy to apply to even the most complicated networks, but in such cases one quickly becomes bogged down in a morass of algebra. In the interests of paper economy if nothing else, people who have to do much of this sort of thing find it necessary to learn the special mathematical short-cuts that have been devised for the purpose; viz., matrix algebra.

A "Kiwi" at Earls Court

By G. R. GILBERT, Assoc. Brit. I.R.E.

FOR years—as long as I have been reading *Wireless World* in fact—I have wondered about Earls Court. Each year I have read about the exhibits and even studied the little map provided for the more fortunate ones. On one occasion I even went so far as to take an imaginary tour around myself, but gave it up when I lost my way somewhere in a thicket of tape recorders.

And now—oh joy!—I found myself in London at the exact time the Earls Court Show was being held. My twelve thousand mile journey from New Zealand to the Old World had not been for nothing. Excitedly I bought my ticket on the Underground and blindly jumped on a train. The wrong train as it happened—I almost completed a full round of the Circle before I saw that some of the stations were too familiar. But then by taking more care—as befits a stranger—I arrived.

In company with a hundred others I streamed through the subway and arrived at some stairs. Here all progress ceased. A solid plug of citizens filled the hole. Well, I waited and waited. Fifteen minutes in fact. And began to wonder whether the manufacturers really wanted any of us to see the show after all. My enthusiasm was damped by the time I arrived at the final barrier, but it revived when I noticed the sign *Overseas Visitors*. Feeling grandly important, as any overseas visitor should, I walked through and sat in the comfortable select overseas visitors lounge. I examined my map and read about some of the sets on show. Particularly television sets. TV in New Zealand is as yet a mere infant, a premature infant some might remark. However, a 625 line infant. The idea of hundreds of television sets to examine warmed my unsophisticated heart. So I proceeded.

As I stood about eight feet away from my first operating TV receiver I at first wondered whether there might be something wrong with my eyes. It appeared that there was an eight-wire fence before the picture. I examined a few other sets—they were all the same. Anxiously I enquired.

"Oh—those are the lines," the man said nonchalantly. "We have 405 lines here, you know." "Thanks," I said.

So those were the famous lines. I didn't like them. I shied back to about twenty feet from a 23in monster before the lines faded out a bit. By this time I was wondering whether even 625 lines would be enough. And then I stumbled on a tiny bright picture without any lines at all—fascinated and relieved I watched it for a few minutes—it was very small to be sure but it was wonderfully clear and sharp. Then I walked up and examined it. It was a gimmick by G.E.C.—a little receiver with a 6in tube for demonstration purposes. But I was two feet from it before I saw lines. I stood back to four feet and admired it again.

I had my answer—either a six-inch tube or a forty-foot living room.

Having solved the TV problem I looked over the audio side. It was just as good as I had thought it would be. First-class construction and fine tone—*with* attractive design these days. I listened to a couple of speakers—they couldn't have been more than 6in ones—in little boxes hanging about four feet apart on a wall, and fed from a portable record player. Stereo it was. And it was good. All that depth of tone at such low volume and with the disadvantage of a restricted frequency response. As a man who has suffered, and caused his family to suffer, in his search for orchestral depth at high volume levels, I was converted. Stereo it would be.

The transistor sets worked very well, but their plastic boxes didn't appeal to me very much. They appeared clumsy when compared with the delicate innards. Perhaps there might be a lesson from Japan here?

And so, sitting on one of the convenient chairs thoughtfully provided in the small lounges dotted about, I ate a hot dog and comforted my feet. I had had a great time. I had spent half a day seeing something pretty good. I found that I received sensible answers to all my questions. And patiently given, too.

I still didn't like the lines. But maybe they will grow on me, and anyway I loved all those chromium-plated chassis.

Back to the Tube station I trudged, clutching my great fistfull of free handouts. Enough reading for the air trip back to New Zealand, I thought.

Transistor V.H.F./F.M. Receiver

3.—PERFORMANCE

By R. V. HARVEY*, B.Sc., A.M.I.E.E.

FOR the following tests, the loudspeaker compensation mentioned in the description of the circuit given in Parts 1 and 2 of this article was not included, so that the a.f. response was substantially uniform. It should be noted that all ratios of signal to noise or interference quoted were measured with a mean-square meter preceded by an aural sensitivity weighting network based on the C.C.I.F. (1934) curve for broadcast relay circuits. Unless otherwise stated, all signal levels refer to the open-circuit voltage from a 75-ohm source.

Sensitivity.—The sensitivity of the receiver is defined as the minimum amplitude of signal input which satisfies simultaneously the following three tests.

The measured value was 16 μV.

(*i*) *Absolute Sensitivity.*—This is the minimum input-signal amplitude, deviated ± 35 kc/s† at a frequency of 2,000 c/s, which will produce an output of 50 mW with the receiver gain control at maximum.

The measured value was 16 μV.

(*ii*) *Maximum Deviation Sensitivity for* 10% *Harmonic Distortion.*—This is the minimum input-signal amplitude, deviated ± 75 kc/s at a frequency of 400 c/s, which produces a total harmonic distortion of 10%. As this figure is less than the input required to satisfy the absolute test, the distortion occurring at the input level required by that test is given.

The distortion at 16 μV input level was 1.6%.

(*iii*) *Sensitivity for Standard Signal-to-noise Ratio.*—This is the minimum input-signal amplitude, deviated ± 35 kc/s at a frequency of 2,000 c/s, which will produce an output signal-to-noise ratio of 40 dB.

The measured value was 12.5 μV. At an input level of 16 μV the output signal-to-noise ratio was 43 dB.

Fidelity.—The following results do not, of course, include the effect of the loudspeaker.

(*i*) *Variation of Harmonic Distortion with Deviation.*—Fig. 8 shows the total harmonic distortion as a function of deviation with the receiver gain control set to give 50 mW output with a ± 30 kc/s deviation at 400 c/s. The input signal level was 10 mV.

(*ii*) *Maximum Output Power for 10% Total Harmonic Distortion.*—The measured value was 1.3 watts at a supply voltage of 13.5.

(*iii*) *Modulation-frequency Characteristic.*—This is shown by the full-line curves in Fig. 9; the broken curve of Fig. 9 shows the response after including the loudspeaker compensating circuits described earlier. Both curves are corrected for a 50-μs pre-emphasis time constant.

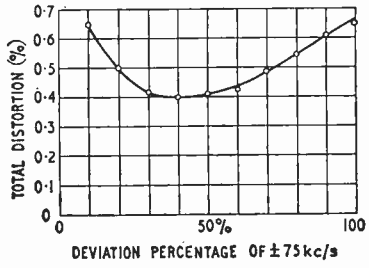


Fig. 8. Variation of harmonic distortion with deviation.

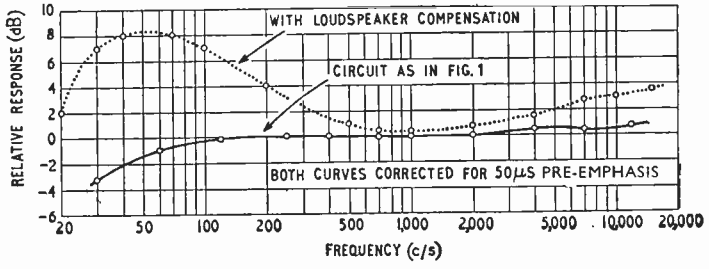


Fig. 9. Modulation-frequency characteristic.

Selectivity.—The suppression ratio for an interfering signal is measured objectively as the ratio of unwanted- to wanted-signal amplitudes giving an output signal-to-interference ratio of 40 dB when the interfering signal is frequency modulated at 2,000 c/s with a deviation of ± 35 kc/s.

The results for adjacent-, second- and third-channel interference (i.e., with 200, 400 and 600 kc/s frequency separations respectively) are given in Table 1, together with the measured ratio for the image channel. The wanted-carrier level in each case was 1 mV.

The i.f. suppression ratio was not measured in the above way but the attenuation of a signal at 10.7 Mc/s relative to that at the tuned frequency was 68 dB via the input socket and 60 dB when the

* B.B.C. Research Department.

† This is equivalent to ± 30 kc/s (i.e. 40% of ± 75 kc/s) at a low audio frequency if allowance for standard pre-emphasis is made.

TABLE 1

Frequency of unwanted carrier relative to wanted carrier	−21.4 Mc/s	−600 kc/s	−400 kc/s	−200 kc/s	+200 kc/s	+400 kc/s	+600 kc/s
Ratio of unwanted- to wanted-carrier levels (dB)	+23	>+40	+40	+6	+6	>+40	+38

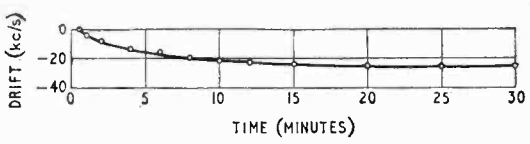


Fig. 10. Oscillator-frequency drift.

source was connected between the outer or screen connection of the socket and an external earth.

Local-oscillator Performance.—Two main factors affect the frequency of the local oscillator.

(*i*) *Local-oscillator Drift.*—The frequency variation of the local oscillator is shown in Fig. 10. As this drift is caused by a small, local temperature rise in the oscillator circuit, a further measurement was made to find the result of a change of ambient temperature. This was about −14 kc/s/°C, using an NPO type capacitor for C_{12}. The drift of the discriminator centre-frequency was small compared with this.

(*ii*) *Dependence of Local-oscillator Frequency on Supply Voltage.*—The local oscillator frequency varied at the rate of ±15 kc/s/V for a supply varying from 11 to 15 volts.

(*iii*) *Local-oscillator Radiation.*—In this test the voltage at the input terminals of the receiver due to the local oscillator was measured, the input terminals being terminated in 75 ohms.

The measured voltage was 0.5 mV.

Co-channel Suppression Ratio.—This test is performed in the same way as the selectivity test, but with the interfering signal frequency differing from the wanted signal by less than 1 kc/s.

The measured value was −7 dB.

Suppression of Amplitude Modulation.—The a.m. suppression ratio is the ratio between the output due to a carrier which is frequency modulated ±35 kc/s at 2,000 c/s and that due to a carrier which is simultaneously amplitude modulated to a depth of 40% at 2,000 c/s and frequency modulated ±30 kc/s at 100 c/s, the 100 c/s output being rejected by a high-pass filter. The results for various input signal levels are shown in Table 2.

TABLE 2

Input Signal Level	A.M. Suppression Ratio (dB)
10 μV	16
30 μV	30
100 μV	47
300 μV	44
1 mV	49
10 mV	49
100 mV	27

Dependence of Output on Signal Level.—This is shown in Fig. 11.

Impulsive Interference Performance.—Fig 12 shows the output due to impulsive interference, relative to that due to ±35 kc/s deviation at 2,000 c/s, for various input impulse amplitudes.

The measurements were made in the presence of an input carrier of 500 μV, firstly unmodulated and secondly frequency modulated with ±30 kc/s deviation at 12 kc/s.

Subjective Measurements of Selectivity and Co-channel Suppression Ratio.—For these tests the receiver was fed with two signals, a wanted signal of 1 mV and an interfering signal of controllable amplitude which was set in turn to frequencies within 1 kc/s of, and spaced by ±200 kc/s and ±400 kc/s from, the wanted signal.

Both signals were frequency modulated with programme in accordance with standard B.B.C. transmitter practice; the wanted programme was speech and the interfering programme light orchestral music which gave a consistently high level of modulation. The amplitude of the interfering signal was adjusted to give the following subjective grades of interference:—

JP Just perceptible in quiet passages.
P Perceptible, without careful listening, in quiet passages.
SD Slightly disturbing.
D Disturbing.

The results given in Table 3 are the average for four observers, the receiver having been tuned to give minimum output interference with the wanted and unwanted carrier within 1 kc/s, both unmodulated.

Discussion of Results

Both from the laboratory tests and from experience gained by using the receiver under normal home conditions, its performance is entirely satisfactory. At very low input levels (between 10 μV and 30 μV) the receiver still operates quite well though the a.m. suppression ratio falls below the value of 35 dB* recommended for the minimizing of distortion caused by multipath propagation; this would be important only when receiving unusually weak signals.

Although a r.f. amplifier was not used, the performance of the receiver is adequate in respect of image-channel suppression and sensitivity. The standard a.f. output power can be obtained at an input signal level of 16 μV with a signal-to-noise ratio of 43 dB; from this it can be deduced that the overall noise factor is about 16 dB. The incomplete suppression of a.m. at very low levels allows a.m. generated in the i.f. amplifier to appear as distortion, as given in the test results. If additional pre-limiter gain were required in order to

* I.E.E. Paper No. 3221E, see Ref. 3 given in Part 1.

TABLE 3

Frequency of interfering signal relative to wanted signal (kc/s)		−400	−200	<+1 >−1	+200	+400
Amplitude of interfering signal relative to wanted signal (dB) to give the subjective grades of interference	JP	>+40	+11	−32	+ 8	>+40
	P	>+40	+12	−28	+10	>+40
	SD	>+40	+15	−24	+12	>+40
	D	>+40	+17	−18	+14	>+40

improve the performance at input levels below 30μV, it might be better supplied by a r.f. amplifier than by the i.f. amplifier, as the gain of the latter is already as high as is convenient.

Referring again to Table 2, the a.m. suppression falls to 27 dB (somewhat less than the recommended minimum of 35 dB) at 100 mV. This is not caused by any failing of the limiter at high signal levels, but by frequency modulation of the local oscillator due to changes in the amplitude of the input signal. Although this could result in a slight increase in multipath-propagation distortion and in the level of impulsive interference, these effects are rarely important at such high input levels. The addition of a stage of r.f. gain might well aggravate the above effects but, for a.m. suppression at least, an improvement would result if the a.g.c. circuit were arranged so as to reduce the r.f. gain below unity at large input levels.

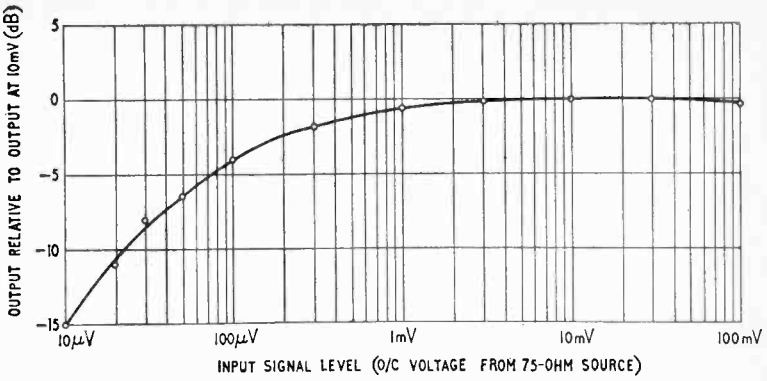


Fig. 11. Variation of a.f. output with signal level.

The local oscillator frequency is reasonably independent of supply-voltage changes and the effect of changes in ambient temperature has been reduced by using negative temperature coefficient capacitors in the oscillator circuit.

Efficient rejection of impulsive and adjacent-channel interference has been greatly assisted by using a narrow i.f. pass-band, determined mainly by two pairs of coupled circuits. These two circuits were easily incorporated in the i.f. amplifier, as four stages were required to obtain the necessary gain of 90 dB. Again, if a r.f. stage were added, it might be possible to reduce the number of i.f. stages without compromising the performance.

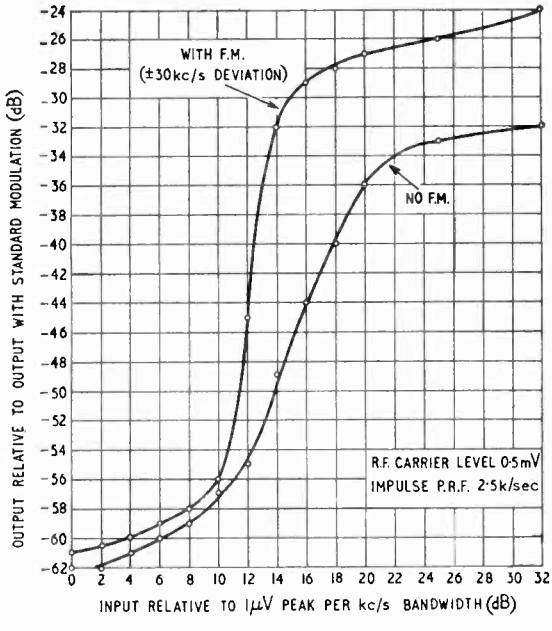


Fig. 12. Input/output characteristic for impulsive interference.

In spite of the high i.f. gain of the present receiver, the rejection of i.f. signals reaching the receiver by way of the aerial is satisfactory, as indicated in the test results. The use of a balanced mixer with inductive coupling ensures this high i.f. attenuation.

The apparent rise in distortion shown in Fig. 8 at low values of deviation is due principally to the presence of noise at a level 63 dB below that of the output at 40% deviation and not, as might be thought, to cross-over distortion in the output stage. This background noise is believed to arise principally from the residual f.m. noise of the local oscillator. The discriminator response, shown in Fig. 7, shows an inverse curvature at ±100 kc/s due to a slight unintentional over-coupling of the transformer in the model tested; this will affect the rate of rise of distortion as the receiver is detuned.

Though no tuning indicator has been fitted, the receiver is relatively easy to tune on account of the a.g.c. characteristic, and the side-responses give considerably less output than the main response. In the absence of a transistor equivalent of a "magic eye" indicator, an inexpensive meter could be connected in the discriminator circuit to give null indication of the tuning-point.

In a.f. output stages of the type used in this receiver, the loudspeaker is often connected directly between the centre-point of the output stage and the centre-point of the supply, instead of to earth via a large capacitor as shown in Fig. 1. The former method has the advantage that the load on the supply is more uniform so that less low-frequency decoupling is necessary. Although the junction of the two batteries could have been used for this purpose, the circuit was designed so as to enable the supply to be taken from any external two-terminal source, such as an accumulator, if desired.

Conclusions

The receiver described has confirmed the belief that, in all important respects, the performance obtained by the better-quality domestic v.h.f. receiver using valves can be achieved in a straightforward design using currently-available transistors of moderate cost. By using a combined limiter and discriminator circuit of a type recently developed for a valve receiver, the a.m. suppression ratio is more than adequate. It appears that the absence of a r.f. stage has not led to any serious shortcomings, although in the present design the good a.m. suppression is not maintained below 30 μV input.

Full advantage has been taken of the high efficiency of transistors, enabling the receiver, loudspeaker and battery supply to be contained in an acoustically-treated cabinet needing no ventilation, and so to provide good fidelity of reproduction. Amplification at v.h.f. has become an economic proposition since the receiver was designed; this could give a better noise factor and make it easier to improve the general performance at low signal levels but, under normal reception conditions, the performance of the present design is entirely satisfactory.

(Parts 1 and 2 of this article, dealing with design, construction and alignment of the receiver appeared in the August and September issues of *Wireless World*.)

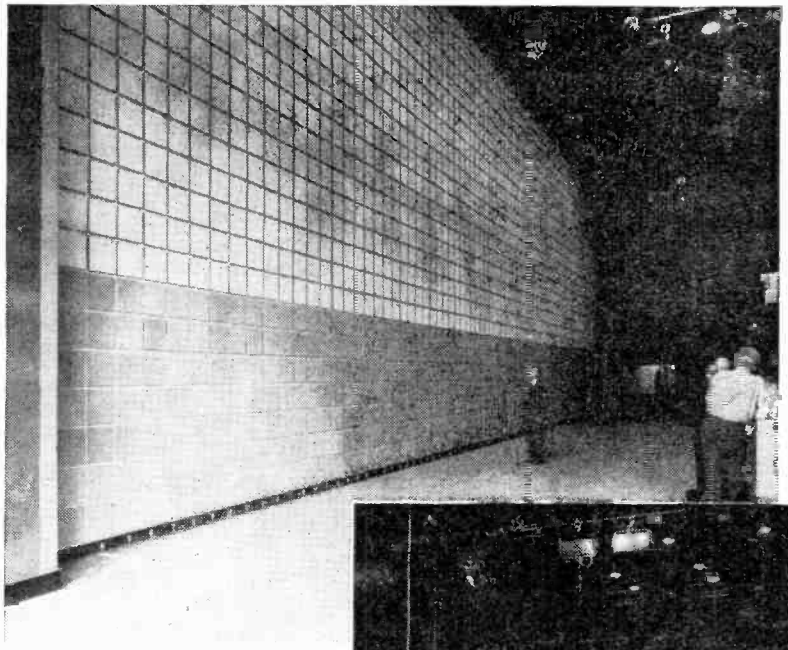
STUDIO 5

VAST AREA FOR LARGE PRODUCTIONS

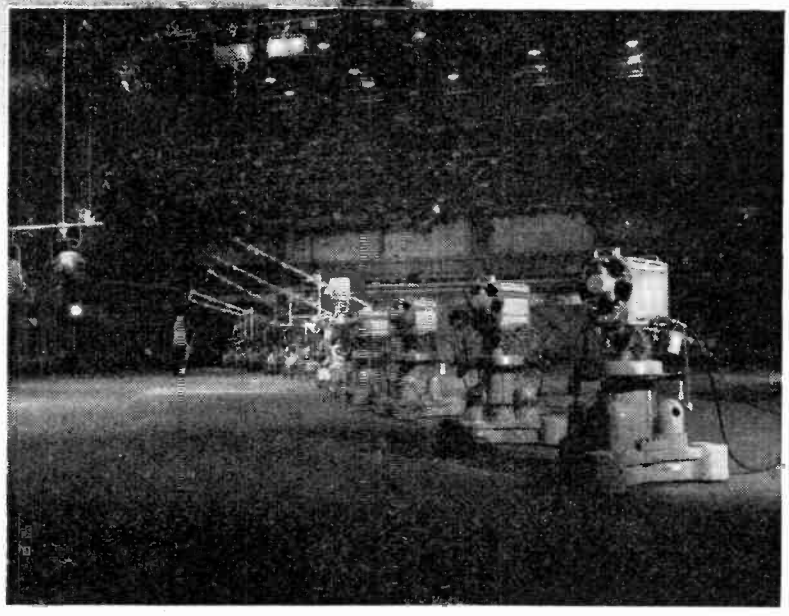
CLAIMED to be the largest studio ever built for television, Associated Rediffusion's recently opened Studio 5, at Wembley, Middlesex, has a 14,000-ft² floor area for production use. This area can be divided in two for less-than-mammoth productions by a double partition weighing 50 tons and consisting of mild-steel slabs four inches apart with a three-inch rock-wool filling. This partition provides an acoustic loss of over 60dB from 50c/s up to 4.5kc/s.

Two control rooms are provided, each with full control over the whole studio. The vision equipment, which includes ten image-orthicon cameras and 50 21-in monitors, was supplied by E.M.I. Electronics Ltd., who also carried out all the "technical" wiring and installation, using 45,000ft of vision and 104,000ft of sound cables. The vision equipment can function on 625- or 405-line systems and, with a change in mains frequency to 60c/s, 525 lines. Conversion from one standard to another is said to take only 20 minutes.

For lighting, 500-kVA supply feeds two patch-boards, each controlling 340 circuits for each half-studio. These are arranged in a manner similar to the vision control arrangements, in that the whole supply is available to each patch-board.



Above: Sound-proof dividing partition in the "lowered" position.



Right: Some of the studio-floor equipment. First four in the line up are E.M.I. mage-orthicon comeras.

Elements of Electronic Circuits

18.—ELECTRONIC MARKERS

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

WE have seen how voltages which vary linearly with time can be generated and used to deflect a c.r.t. electron beam thereby producing a trace on the screen. It is sometimes necessary to indicate visually instants of time within the period of the scan. This is done by generating separately "electronic markers" which appear as spaced pips or bright spots, the spacing and number of the pips in view being dependent on the frequency of the marker generator and that of the time base (and the nature of the time base waveform in the case of a deliberately non-linear time base). The single movable marker, the position of which can be continuously varied so that it appears at any position along the scan is another important device.

Radar Ranging

In radar the range of an object is directly proportional to the time taken by the pulse for its outward and return passage. To measure this time interval a c.r.t. and time base, which must be synchronized with the transmitted pulse, are often used. If the slant range from the set to the radar target is R yards, v=velocity of propagation of electromagnetic waves in air ($= 327.7 \times 10^6$ yd/sec) and t=the time delay in microseconds between transmission and reception of the pulse, then $R = vt/2 = 164t$ yd.

Therefore the measurement of range to a high degree of accuracy involves measurements of time intervals down to a fraction of a microsecond and often both fixed and variable markers are used. A series of uniformly spaced timing pulses locked in synchronism with the time base provides a time, and hence a distance, scale: a rough range indication is therefore given. A fine measurement of range can be obtained by aligning a movable marker, operated by a calibrated handwheel, either with the target echo or with the nearest fixed timing pulse. Range readings between the fixed markers can thus be derived with accuracy.

To separate the target echo from other echoes on the same aerial bearing a gating or strobe pulse initiated by the range marker is often generated. This target strobe can be fed, for instance, to the cathode of the c.r.t., where it brightens the trace at the instant of production. Thus this system is effectively a range gate or range-selector system in which the range marker is used to generate the strobe or gating pulse which also serves to isolate the selected target echo from all other signals.

The ranging display of a typical radar set takes the form of a coarse range display on which all echoes received from targets at ranges from, say 0-50,000 yd are displayed on a Type "A" scan (see Fig 1(a)), and a fine range display which shows a greatly expanded section of the coarse range trace, say 5,000 yd in length. The time base of the fine range display is of course much faster than that of the coarse range display, is triggered by the latter and can be adjusted by the ranging handwheel to

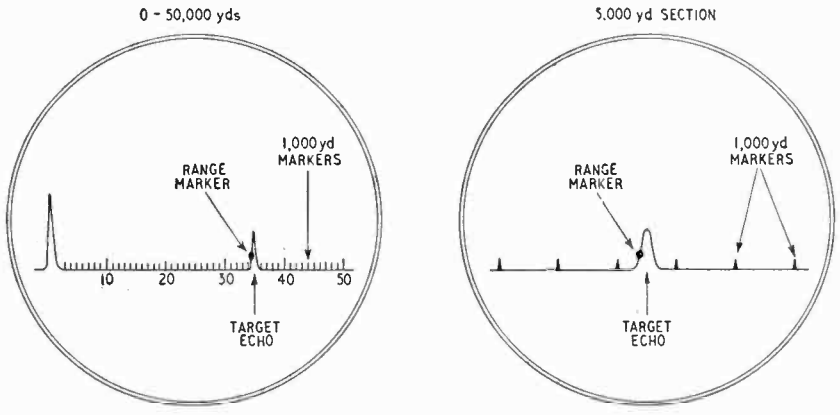


Fig. 1

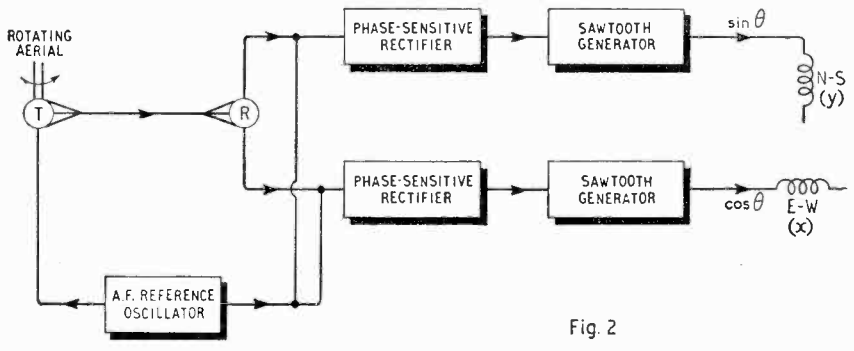


Fig. 2

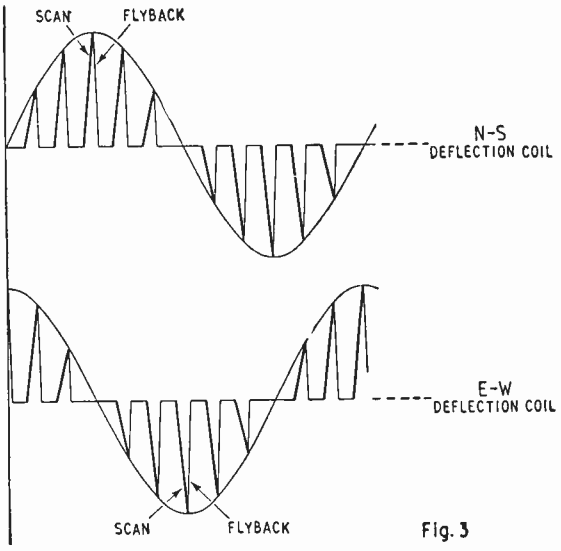


Fig. 3

produce an expanded section at any point on the coarse range scan. A train of pulses at 1,000-yd intervals (6.1μsecs apart) is produced by a very stable oscillator generating short pulses at 163.9kc/s which provides a rough range indication i.e. to the nearest 1,000-yd pip. Fine range is determined by the rotation of a calibrated phase-shifting transformer which can shift the train of pulses exactly 1,000 yd per turn of its rotating coil, so that the remaining fraction of 1,000 yd can be read off accurately from a calibrated drum fixed to the coil.

PPI Display

Radar displays of the "map" or plan-position indicator (p.p.i.) type are often required to portray symbols and markers to assist in the subsequent identification and tracking of targets.

First, we will examine how the rotating scan of a p.p.i. type of display having fixed deflection coils can be produced. Referring to Fig. 2, the transmission of aerial bearing information is carried out by a three-wire magslip system which enables, in effect, the rotation to be transferred over a circuit to a point remote from the aerial array. The aerial rotation is caused to modulate an a.f. carrier or reference voltage which is fed via the magslip receiver to two separate phase-sensitive rectifiers. These convert or "resolve" the modulated carrier signal (representing the angular position of the aerial bearing) into two signals proportional to the sine and cosine of the aerial bearing angle relative to a datum, e.g. True North. The outputs of the phase-sensitive rectifiers are therefore two voltages varying sinusoidally with aerial bearing. These signals are used to control the amplitude of a sawtooth waveform. Thus two sawtooth waveforms the amplitude of which will vary in a sinusoidal manner (as shown in Fig. 3) are produced. If these are now fed to the "North-South" and "East-West" deflection coils, the p.p.i. spot will be subjected simultaneously to:—

(a) radial deflection components due to the sawtooth currents and

(b) a rotating component caused by the deflecting currents varying in time quadrature.

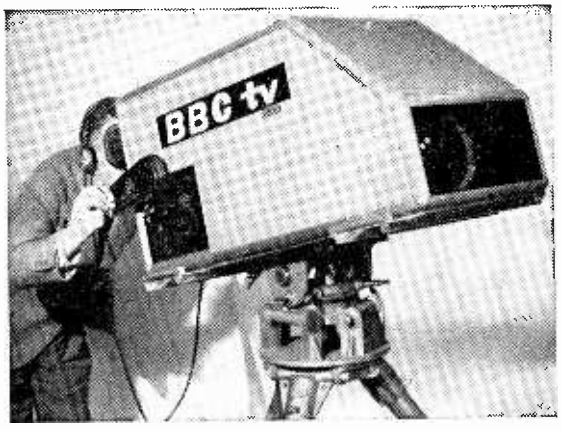
It will be appreciated that during the course of one revolution of the aerial a large number of sawteeth will occur.

By feeding amplified and detected negative-going radar-echo signals to the cathode of the c.r.t., the trace is brightened up at the appropriate distance from the origin. The combination of a rotating trace and a long persistence afterglow screen produce the well-known "map" presentation of a p.p.i.

Now, the "bright-up" type of marker dealt with above for the "A"-scan, when applied to a p.p.i. display, will result in rings being drawn on the tube face, each ring representing points of constant range from the transmitting and receiving aerial. Radial markers to indicate, for instance, the course and ground track of an aircraft on its own radar can be made to appear by brightening up a complete scan, or even several scans of the timebase. This may be done by means as simple as a contact on the aerial-rotating gear or by amplitude-selection circuits working on the sine and cosine waveforms.

If it is desired to produce a symbol at a particular range and bearing, the cartesian co-ordinates of the marker are injected during the resting period between scans of the timebase in the form of current pulses in the N-S (y) deflection coils and in the E-W (x) deflection coils. These combine to deflect the c.r.t. spot to the desired position and the spot is then brightened. By imposing small modulations on the current pulses the spot can be made to describe a square, circle or other symbol. A further refinement is possible in that the marker position could be controlled, with suitable additional circuits, by means of a joystick, or made to follow the target automatically, thus aiding target tracking.

Lissajous figures, separately generated by an h.f. sine-wave oscillator, can be used as the modulation on the current pulses to provide symbols for target identification purposes. If these symbols are suitably shaped, it is possible to produce fair approximations of numbers from 0 to 9. Other methods of number and letter generation used include direct synthesis of the desired waveform and monoscope techniques.



A built-in zoom lens is incorporated in this camera developed by B.B.C. engineers in collaboration with the Taylor, Taylor and Hobson division of Rank Precision Industries. This "Universal Zoom" camera, which has a folded optical path behind a single lens, is built around the electronic components of a Marconi Mark III image orthicon.

OCTOBER MEETINGS

LONDON

6th. I.E.E.—Presidential address by Sir Hamish MacLaren at 5.30 at Savoy Place, W.C.2.

12th. Brit. I.R.E.—"Electro-acoustics for human listeners" by Professor Colin Cherry at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

13th. Society of Instrument Technology.—"Transistor switches in monitor and control systems" by W. A. Ross at 7.0 at Manson House, 26 Portland Place, W.1.

13th. Television Society. "Automation in television presentation" by T. A. H. Marshall (Anglia Television) at 7.0 at the Cinematograph Exhibitors' Association Theatre, 164 Shaftesbury Avenue, W.C.2.

13th. Radar & Electronics Association. —"Colour television" by P. S. Carnt at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

26th. I.E.E. — "Chanelling — a sketch," by T. B. D. Terroni (chairman, Electronics and Communications Section) at 5.30 at Savoy Place, W.C.2.

26th-27th. Brit.I.R.E.—Symposium on "New components" at the School of Pharmacy, Brunswick Square, W.C.1.

27th. I.E.E.—"The principles and operation of large radio telescopes" by A. Hewish at 5.30 at Savoy Place, W.C.2.

27th. Television Society.—Discussion on "New standards and the problem of colour television" at 7.0 at 164 Shaftesbury Avenue, W.C.2.

ALDERSHOT

11th. Association of Supervising Electrical Engineers.—"Electronic control apparatus" by Dr. Fletcher at 8.0 at the Queens Hotel, High Street.

BIRMINGHAM

3rd. I.E.E.—Chairman's address by Brigadier F. Jones at 6.0 at the James Watt Memorial Institute.

26th. I.E.E.—Discussion on "The non-destructive testing of materials," opened by Dr. J. C. Wright at 6.0 at the College of Advanced Technology.

26th. Brit. I.R.E.—"Industrial applications of automatic control using electronic techniques" by R. J. F. Howard at 7.15 at the Department of Electrical Engineering, The University, Edgbaston.

26th. Television Society.—Demonstration of colour television by E.M.I. at the Alpha Studios, Aston Road North.

BRISTOL

6th-7th. Brit.I.R.E.—Convention on "Aviation electronics and its industrial applications," College of Science and Technology, Ashley Down Road.

26th. Brit.I.R.E.—"Radio aids for automatic landing developed by the Blind Landing Experimental Unit" by J. S. Shayler at 7.0 at the School of Management Studies, Unity Street.

CARDIFF

19th. Brit.I.R.E.—"The use of transistors in pulse circuitry" by A. R. Owens at 6.30 at the Welsh College of Advanced Technology.

CHELTENHAM

28th. Society of Instrument Technology.—"The atomic clock" by Dr. L. Essen at 7.30 at the Belle Vue Hotel.

EDINBURGH

5th. Brit.I.R.E.—"Technical education for the radio and television industry" by J. B. Rimmer at 7.0 at the Department of Natural Philosophy, The University, Drummond Street.

FAWLEY

7th. Society of Instrument Technology.—"The basic principles of digital instrumentation" at 5.30 at the Administration Building, Esso Refinery.

GLASGOW

6th. Brit.I.R.E.—"Technical education for the radio and television industry" by J. B. Rimmer at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

HARWELL

27th. Association of Supervising Electrical Engineers. — "Interference suppression in industrial and research establishments" by A. C. F. Leadbitter (Belling & Lee) at 5.45 at the Reactor School, Atomic Energy Research Establishment.

MALVERN

31st. I.E.E.—"Applications of microwaves" by Pro. A. L. Cullen at 7.0 at the Winter Gardens.

MANCHESTER

6th. Brit.I.R.E.—"V.H.F. f.m./a.m. transistor receivers" by L. E. Jansson at 7.0 at Reynolds Hall, College of Science and Technology, Sackville Street.

11th. I.E.E.—"Some effects of automation" by C. Ayers (chairman) at 6.15 at the Engineers' Club, Albert Square.

18th. I.E.E.—"Development of the formulæ of electro-magnetism in the m.k.s. system" by Dr. P. Vigoureux at 6.15 at the Engineers' Club, Albert Square.

NEWCASTLE-UPON-TYNE

17th. I.E.E.—Chairman's address by E. D. Taylor at 6.15 at the Rutherford College of Technology, Northumber-Road.

31st. I.E.E.—"New amplifying techniques" by Prof. C. W. Oatley at 6.15 at the Rutherford College of Technology, Northumberland Road.

RUGBY

10th. I.E.E.—Chairman's address by E. S. Hall at 6.30 at the College of Technology and Arts.

WOLVERHAMPTON

12th. Brit.I.R.E.—"Electrical synthesis of music" by Alan Douglas at 7.15 at the College of Technology, Wulfruna Street.

LATE-SEPTEMBER MEETINGS

28th. Brit.I.R.E.—Discussion on "The Land colour theory with particular reference to its applications to colour television" to be opened by M. Wilson and W. N. Sproson at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

30th. Television Society.—"A novel approach to colour television" by A. F. H. Thomson (S.E.R.L., Harlow) at 7.0 at The Cinematograph Exhibitors' Association theatre, 164 Shaftesbury Avenue, London, W.C.2.

RANDOM RADIATIONS

By "DIALLIST"

Standardization

FOR some little time the six Common Market Countries have been working towards the standardization of electrical equipment amongst their own members. And now there is a new, and still more promising, development. At a recent meeting in Zürich they agreed to collaborate to the same end with the "Seven" countries in the European Free Trade Area. This is fine news for it means that the very badly needed standardization has at last a splendid chance of coming into being. The British Electrical and Allied Manufacturers' Association has urged strongly that this country should play an active part in furthering the scheme and one earnestly hopes that we'll do so. It's far too good a chance to miss and one that's not likely to recur if we don't take it now. With thirteen European countries working together in a spirit of goodwill something really good should emerge and we'll all benefit from it in the years to come. So long as the determination to reach agreement and willingness to make reasonable compromises are there all should go well.

The Satelloon

THE satellite balloon, or satelloon, launched by the Americans early in August, and visible every cloudless night from my locality, may be of very great importance as an aid to solving the problem of long-distance v.h.f. communications. Signals are successfully bounced off it and received at distant points, provided that it is above the horizon at both transmitting and receiving ends. As you know it was suggested by A. C. Clarke in *Wireless World* as long ago as October, 1945, that if suitable orbits were calculated and satellites put into them, no more than three would be needed to provide continuous v.h.f. transmission and reception over the whole globe. At the time of writing we still don't know what the life of these balloons is likely to be. Their envelopes are so tenuous that it seems probable that a hit by the smallest meteor would be sufficient to deflate them. However, if it's found that reliable long-distance transmission with the aid of passive satellites really does work, more robust types will no doubt be developed.

Solar Flares and Radio Blackouts

AS long ago as 1916 a British astronomer, A. S. D. Maunder, suggested that the electrical disturbances which occur on earth about 21½ hours after the appearance of solar flares must be caused by particles ejected from the sun. Radiation could not be responsible, otherwise there would be no such time lag between the observation of a flare and the occurrence of its effects. Now W. R. Piggott, of the Radio Research Station of the D.S.I.R., having analysed the radio observations of the ionosphere made by physicists of many countries during the I.G.Y., has produced a neat confirmation of the belief that streams of charged particles produce such effects as the aurora and wireless blackouts. One difficulty was that great numbers of particles would be needed to give rise to such effects and that if they carried charges of the same sign, they would become very dispersed owing to their mutual repulsion. Actually, there is no such dispersal and it follows that the streams must contain about equal numbers of positively and negatively charged particles. Such a stream would be sorted out into swarms of positively and negatively charged particles by the earth's magnetic field. Piggott has shown that the effects of this sorting out can be observed in polar regions. A radio blackout is accompanied by a huge increase in the number of free electrons in the lower regions of the ionosphere. Piggott's analysis shows that positive particles cause blackouts and that negative particles are responsible for "sporadic E."

Everybody's Doing it!

LETTERS continue to pour in from readers who have been successful in receiving 819-line pictures in various parts of south-eastern England and in the Midlands. There have, in fact, been so many of them that we can now take it that such reception is possible fairly regularly in various localities and that when conditions are really favourable the pictures may be of genuine entertainment value. Some of my correspondents are puzzled by the fact that they receive two pictures side by side with a gap between them, each image being rather less than half the screen width. That's due to the fact that a 405-line time-base normally runs at approximately half the speed of that of the 819-line transmitter ($2 \times 405 = 810$). Others have sent photos showing that they get a single image just about filling the screen. That

may be because their line-hold controls enable the time-base speed to be pushed up sufficiently or because of the sync and line timebase arrangements of their receivers.

Long-Wave TV

A KIND reader sends me a cutting from *Wireless World* for June 29th, 1934 containing a letter to the Editor from H. Richardson, who was very much upset by the B.B.C.'s plan for v.h.f. television. "If," he wrote, "those responsible for [sound] broadcasting were to curtail the medium- and long-wave transmissions and erect a chain of ultra-short wave transmitters there would be an outcry. Yet this is the trend of high-definition television. Long-distance looking-in will have an even greater appeal than long-distance listening." What he wanted was *high-definition 60-line* TV in the medium- and long-wave bands. Why hadn't the B.B.C. erected a single-sideband 60-line transmitter? Weren't they going to try out the direct radiation of this high-definition TV on 1,000 metres, as suggested by G. W. Walton? No, it was to be nothing but v.h.f. transmissions . . . G. W. W. happens to be a very old friend of mine. He is a real TV enthusiast. I hope he reads this and thanks his stars that his suggestion and H. Richardson's weren't adopted by the B.B.C.!

Colour TV Goes Racing

THE installation of closed-circuit big-screen colour TV by the Redcar racecourse authorities early in August turned out to be most successful. Two cameras were in action, one was in the paddock and one covered the last three furlongs of the races. Screens some 6ft wide were erected in three 1,000-seat marquees in the different enclosures and those in the silver ring and the cheap enclosure were packed, for they enabled racegoers there to see what was done in the paddock and to have a far better view of the finishes than they'd otherwise have had. Though it was first tried out on a misty day, the colours of the riders were easy to see over the last furlong. Next year still larger screens are to be installed and one feels pretty sure that colour TV will make a welcome appearance on other racecourses. The idea might profitably be extended to other sports as well: a 5s a head marquee for those who couldn't get into the Centre Court itself might, for example, be tried at Wimbledon, although, of course, colour isn't so necessary there.

UNBIASED

By FREE GRID

Exhibitiana

I WAS interested to see that several manufacturers were exhibiting TV sets with remote control at the Radio Show. With this arrangement not only can the programme be changed, but adjustments can also be made to the emanations of the loudspeaker and of the screen as well. I expect we shall see a few more TV sets like this at next year's show, but quite frankly I don't think the idea will ever catch on while the control box is tied to the set by a cable which forms a trap for the feet of the unwary in the semi-darkness in which many people look at TV at home.

In my view, the only really worthwhile type is a wire-less control unit. As you may remember, Emerson introduced one at last year's show. This utilized two frequencies around 40kc/s to operate the station selector switch and mute the loudspeaker. This year both H.M.V. and Dynatron showed ultrasonic control units which are effective up to a distance of about 20ft from the television receiver. Both of them provide facilities for channel selection, but whereas one also controls the on/off switch the other has two push-buttons for increasing or decreasing the volume.

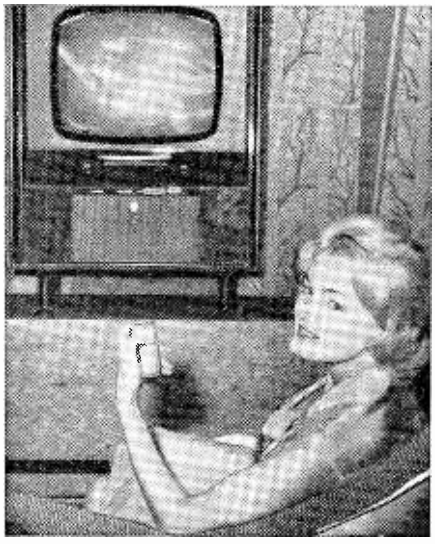
Another thing about this year's television sets is that they have become pleasingly thin in the fore-and-aft direction. But I hope the slimming diet, which the manufacturers have been giving them, does not produce the undesirable side-effects which it does in some women, whom an excessive slimming diet tends to make more irrational than they usually are. Of course, slimming couldn't make a TV set irrational but it could make it more prone to certain faults (such as overheating) and certainly more difficult to service owing to its greater compactness.

I noticed that one firm at least—perhaps there were more which I didn't notice—has had the good sense to bring out a radio-gram in which a tapedeck was provided as well as the usual turntable. It is, I think, astonishing that in these days all radio-grams do not have this feature.

I was gratified to see that on the Metropolitan Police Stand, Dr. Crippen had an honoured place. Not only was there shown Inspector Dew's Marconigram from *Montrose* announcing Crippen's arrest, but also specimens of his handiwork.

The little doctor did a very great service to radio by giving it wide publicity when it badly needed it. As Captain Kendall of the *Montrose* recently reminded us in an article in the *Sunday Times*, the number of ships fitted with wireless increased by manyfold as a direct result of the Crippen case.

I didn't spend more than a few minutes in the piano section; I just couldn't stand the cacophony created by the half a dozen or so pianists



Wire-less control of TV

(sic) who were vying with one another for a hearing.*

* "Free Grid" was unlucky. We stayed much longer than we had a right to do, held by a recital on a miniature piano which in tone and musicianship would have drawn "rave" notices from the critics had it been given in the Wigmore Hall.—Ed.

By Degrees

I HAVE received a letter from a reader (C. R. Fuller, of Hampton, Middx) which gives what I believe to be the real explanation of why the circle is divided into 360 degrees. You may recall that this matter was originally referred to by "Cathode Ray" in the May issue and I discussed it in the August number.

If my correspondent is correct—and I believe he is—the 360 degree circle has nothing to do with the $365\frac{1}{4}$ days of the year. The Babylonians based their numerology on 12 rather than on 10 as we do. The equilateral triangle with its three 60 degree angles was a favourite figure with them as its angles are a multiple of 12. Sixty degrees was to them a "unit angle". Six 60 degree angles give us the 360 degrees of a circle.

A. G. C. Cameras

THE photographic industry—or at any rate that part of it which serves the amateur market—has adopted electronic techniques for the new panautomatic cameras in which the user has only to press the button, there being no stops and suchlike to adjust beforehand.

Now, I am all for progress and I welcome the fact that these cameras are using electronic principles. They are fitted with a photocell which, by means of suitable intervening apparatus, varies the aperture of the iris diaphragm according to the prevailing light. The device could be described as an automatic gain control, since it regulates the "sensitivity" of the camera in accordance with the strength of the incoming electromagnetic waves which are, of course, common to both light and radio.

The thing that sticks in my gullet, however, is the statement of the publicity wallahs that these cameras are "new and fully automatic". To my mind this statement is, to put it mildly, quite unjustified, more especially the suggestion that there is anything new about them.

Fortunately I can prove my words about their lack of novelty quite easily, as a similar sort of camera was mentioned in *Wireless World* more than a quarter of a century ago ("Unbiased" July 20th, 1934). I suppose, however, that one could hardly expect the manufacturers to make any reference to this fact, as it would expose the claim for novelty as baseless.

The claim that these a.g.c. cameras are "fully automatic" is, strictly speaking, true, but a rather sorry subterfuge has been used to make it so. Lenses of subnormal focal length have been used so that the customary coupled or non-coupled rangefinder could be omitted. As such a device is manually operated, it would, of course, have falsified the claim that "panautomation reigns supreme in the modern miniature camera."

But surely in addition to borrowing the photocell from the radio and electronics industry, the camera makers could have borrowed radar too. What is wrong—in principle at any rate—with a radar-controlled rangefinder? It is true that a pantechnicon would be needed to carry the apparatus, but I will stick my neck out by saying that a practical automatic rangefinder will make its debut within the next decade.

A new rugged local oscillator

Mechanical tuning range 9.3 to 9.5 Gc/s.

LOW COST HIGH PERFORMANCE KLYSTRON KS9-40

Engineers now have the opportunity of designing low cost radar receivers using a high quality local oscillator. This advance is made possible by the introduction of the Mullard X-band klystron KS9-40 which incorporates many features previously only available with much more expensive valves. Brief details are given here—for full information on the KS9-40 and other microwave valves contact Mullard at the address below.

Typical operation

Frequency	9.37	Gc/s
Resonator voltage	300	V
Resonator current	35	mA
Reflector voltage	−90	V
Electronic tuning range between half power points	±20	Mc/s
Output power	40	mW

- **Rugged**
  Withstands 10g acceleration with a resultant maximum frequency modulation of 2 Mc/s.
- **Specified Noise Performance**
  Typical a.m. signal to noise ratio greater than 160 dB per cycle of i.f. bandwidth for receiver intermediate frequency in excess of 25 Mc/s.
- **External Tuned Cavity**
  This constructional feature isolates the turning cavity from the effects of variations of beam current and contributes largely to the high frequency stability.
- **Low Warm-up Frequency Drift**
  3 Mc/s max. after first 5 minutes of operation.
- **Good Altitude Performance**
  Less than 1 Mc/s change from 0 to 30,000 feet.
- **Waveguide Output**
  Incorporates a matching screw to ensure close tolerance power output.

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MVT389

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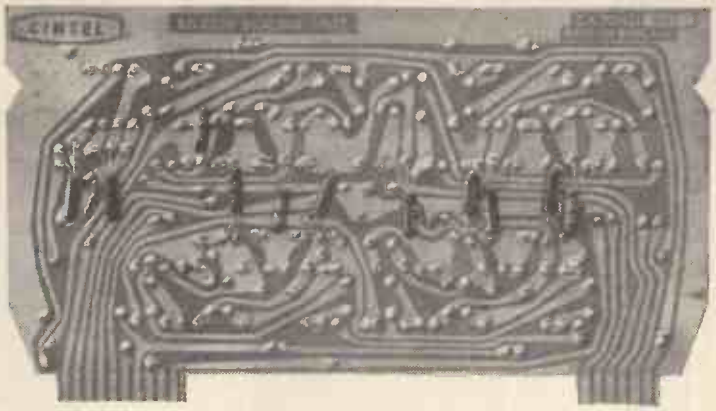

A complete range of transistorized counter panels of common size, fixing method and electrical connexion, designed to provide a flexible unit system whereby any special requirements in the counting or data processing fields can be quickly built up.

A fully illustrated brochure giving complete performance and specification figures for every panel in the range is available on request.

50kc/s Scaler
1Mc/s Scaler
Input Amplifier
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10kc/s Oscillator
1Mc/s Oscillator
Power Unit
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1Mc/s Read-out Scaler
4 Channel Output Unit
Read-out Unit
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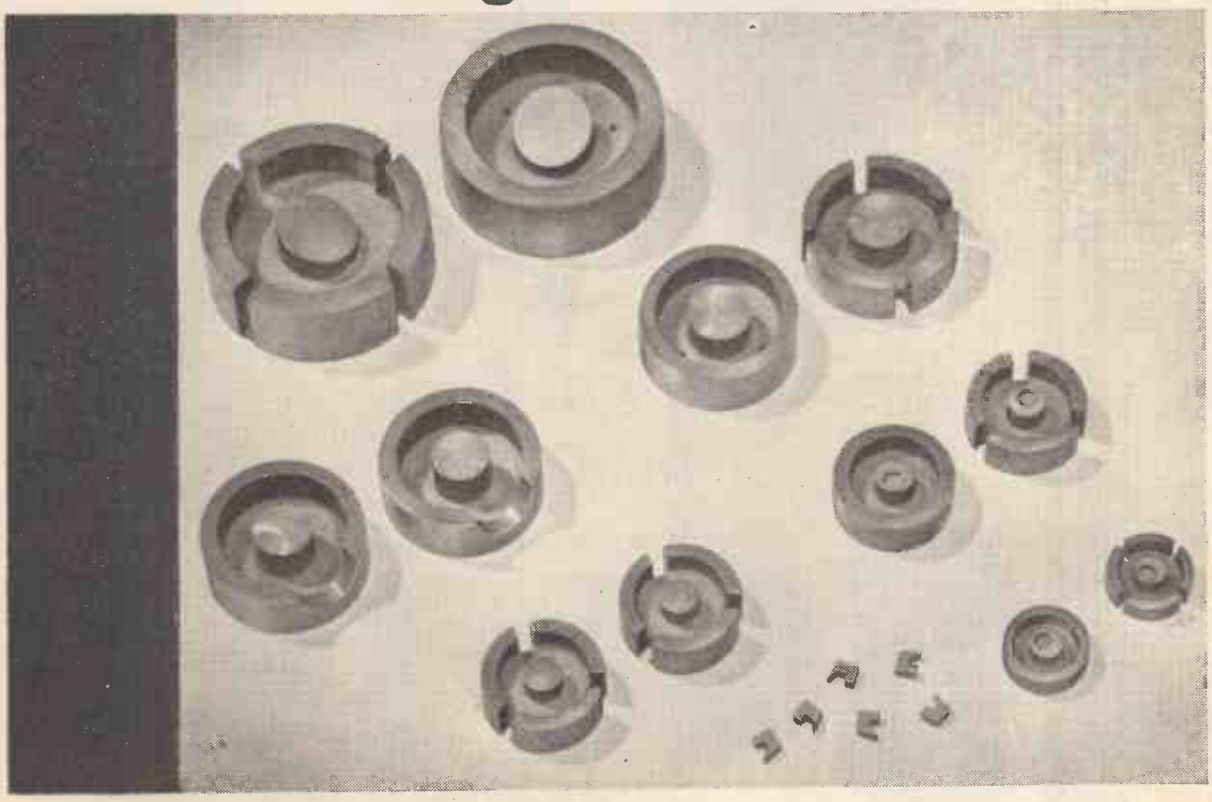
A new manganese-zinc ferrite, Stanferite 15 has been developed by STC and is now in manufacture. This material has a low temperature co-efficient of permeability with high quality performance.

Stanferite 15 has proved to be eminently suitable for carrier and audio frequency coils and its permeability is guaranteed at 1500 ± 400. Its permeability variation with temperature at the nominal permeability of 1500 at 35 deg C is ± 5% over the range 10 deg C to 60 deg C.

Send for further information.

magnetic materials



COMPONENTS GROUP

60/9MM

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

MAGNETIC MATERIALS DEPT: EDINBURGH WAY · HARLOW · ESSEX

These new STC complete packaged oscillator units represent a revolutionary step forward in crystal design. They are extremely small units for use as laboratory references or as the oscillator section of high performance equipment. The ruggedness of design together with the small size makes possible a degree of portability hitherto unknown in this type of unit. Standard frequency is 5 Mc/s.

Write for Technical Data Sheets.

1 in 10^9 per day frequency standard for laboratories at £195

One of a new, low priced range of frequency standards from STC.

- **Rugged**
- **Compact**
- **Light-weight**
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- **Low Cost**

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60/1MQ

Standard Telephones and Cables Limited

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QUARTZ CRYSTAL DIVISION: HARLOW · ESSEX

The Electronic Lung

A member of the Pye Instrument Group W. Watson & Sons Ltd. has produced an electronic lung which is capable of replacing an iron lung. The Barnet Ventilator, as the instrument is called, is transistorised and is easily portable in cases of emergency. It is shown here in its application in an operating theatre for the administration of anæsthetics.

PYE

WATSON BARNET ESTABLISHED 1837

The Pye Instruments Group Consists of:

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Pye Industrial Television Division.
Faraday Electronic Instruments Ltd.
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W. G. Pye & Co. Ltd.
Pye Telecommunications Ltd.
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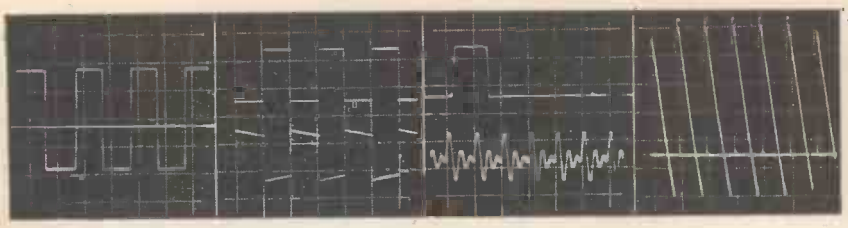


D 3 1

*D.31 double beam Serviscope**

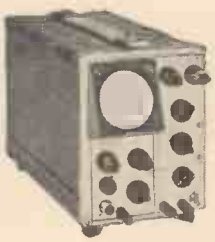
D.C. amplifiers and slow speed time base (down to 5 sec/cm if necessary) are eminently suitable for servo work and similar applications. Fast rise time (.06μ sec) and high writing speed (10cm/μsec at maximum expansion) are essential for any work dealing with fast pulses or TV waveforms. The unique triggering 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'.

Weight: 16 lbs. **Price £75.**

INTERKAMA on stand B2025/6H

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

TELEQUIPMENT

Telequipment Limited, 313 Chase Road, Southgate, London, N.14. Tel: Fox Lane 1166

2 CHECKING THE STOP ELEMENT

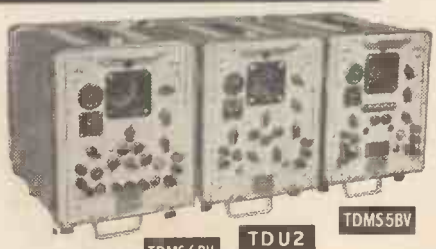
One of the unique facilities of the TDMS 6BV is examination of the stop element in cases where its mutilation is suspected. When the TDMS is operated in the spiral time base condition, the spiral is started at the beginning of each start element and the trace makes a number of revolutions, depending on the Unit Code switch setting, before returning to "rest". For example, if the switch is set for 7, the trace completes 6¾ revolutions, and while this shows any distortion at the beginning of the stop element, the duration of this element is not shown.

If the switch is set for 14, in examining a 7½ unit code signal, two complete characters appear on the trace, one at zero and the other at 50%, or displaced by a percentage indicating the amount of stop element distortion. For a 7 unit code signal the characters appear under each other at zero, separated by the stop element length; for a 7.42 unit code signal the second character appears at 42%. Each alternate stop element length is thus shown for examination and any defect in the telegraph or transmission path, affecting the stop element, made apparent. The example above shows a 50 baud 7½ unit signal, for the letter S, displayed against a 14 count. Here the stop element length is correct (1½ revs., 20 + 10 = 30 ms) but the TDMS shows a split stop element, possibly due to a faulty transmitter.

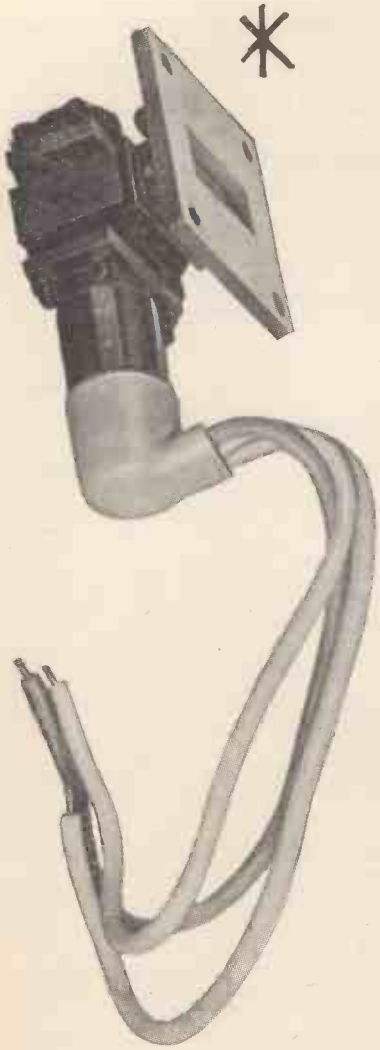
The Transmitter TDMS 5BV — *Provides telegraph test signals with or without distortion.*

The Receiver TDMS 6BV — *Enables a telegraph circuit to be monitored without interruption. The signal can be displayed against a circular or spiral time-base, each characteristic instant of modulation being shown as a bright dot on the screen.*

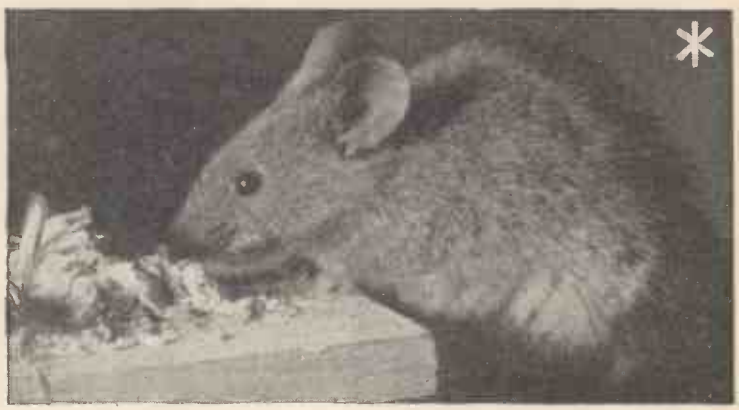
The Telegraph Signal Display Unit TDU2 - *A specialized oscilloscope, having a linear time-base of good short term stability and long term accuracy, for examination of the d.c. telegraph wave form against a continuous start/stop time-base. Valuable features of the instrument are an X shift calibrated in terms of code element transitions and an X expansion control.*



Speed Ranges. *The standard models cover the speed ranges 40-60, 60-80, 80-100, 160-180, and 180-200 bauds. Other ranges within the limits 20-200 bauds can be provided to special order.*



QUIET AS A MOUSE! OUR FORCED AIR-COOLED **K 350** A TWO RESONATOR OSCILLATOR KLYSTRON



Specially designed for low noise characteristics, the K350 is just one of the large range of Klystrons manufactured by the **English Electric Valve Co. Ltd.** It operates in the 8500 - 10000 Mc/s range and has mechanical tuning. For data and information concerning any of our wide range of thermionic tubes for industry, write to the Company

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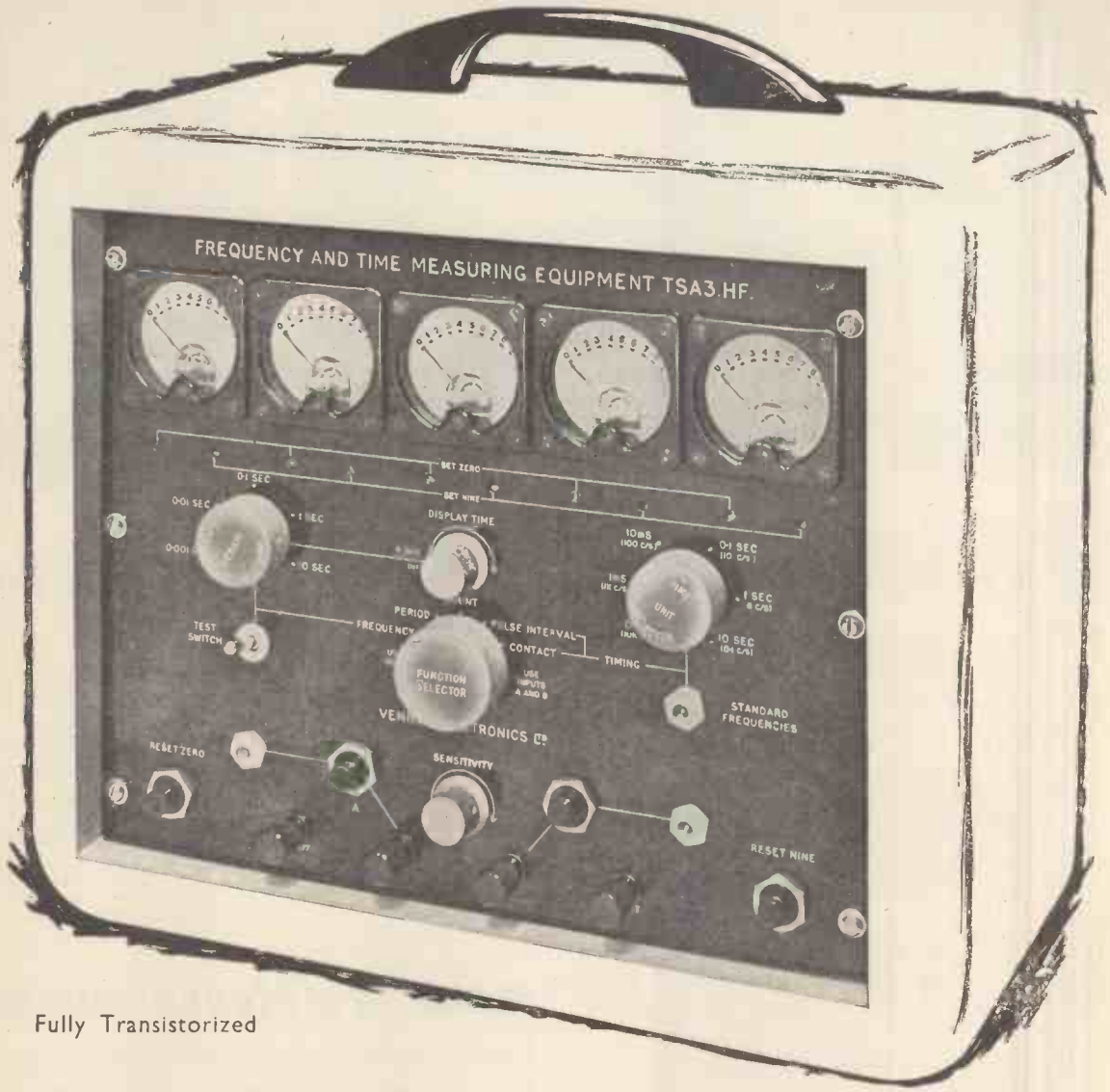

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– for less than £300

and time measurement into the bargain!

Other models available from £245

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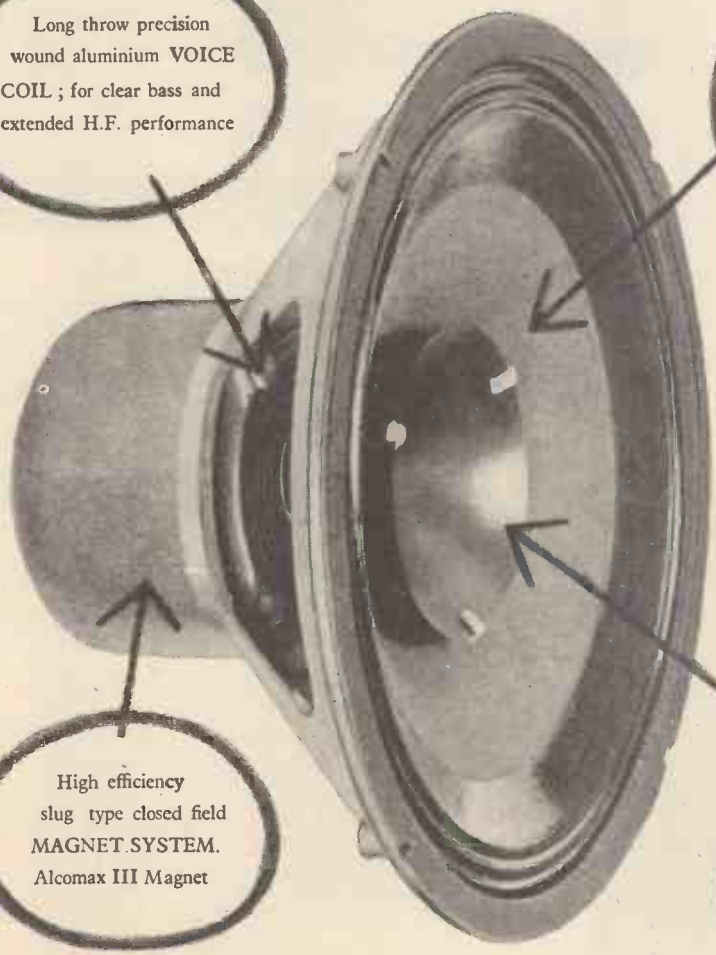

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Frequency Range : 30 *c/s.*—16,000 *c/s.*
Fundamental Resonance : 35 *c/s.* *Power Handling Capacity* : 15 *Watts.*
Flux Density : 14,000 *gauss.* *Impedance* : 15 *ohms.*

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Please send copy of High Fidelity Manual.
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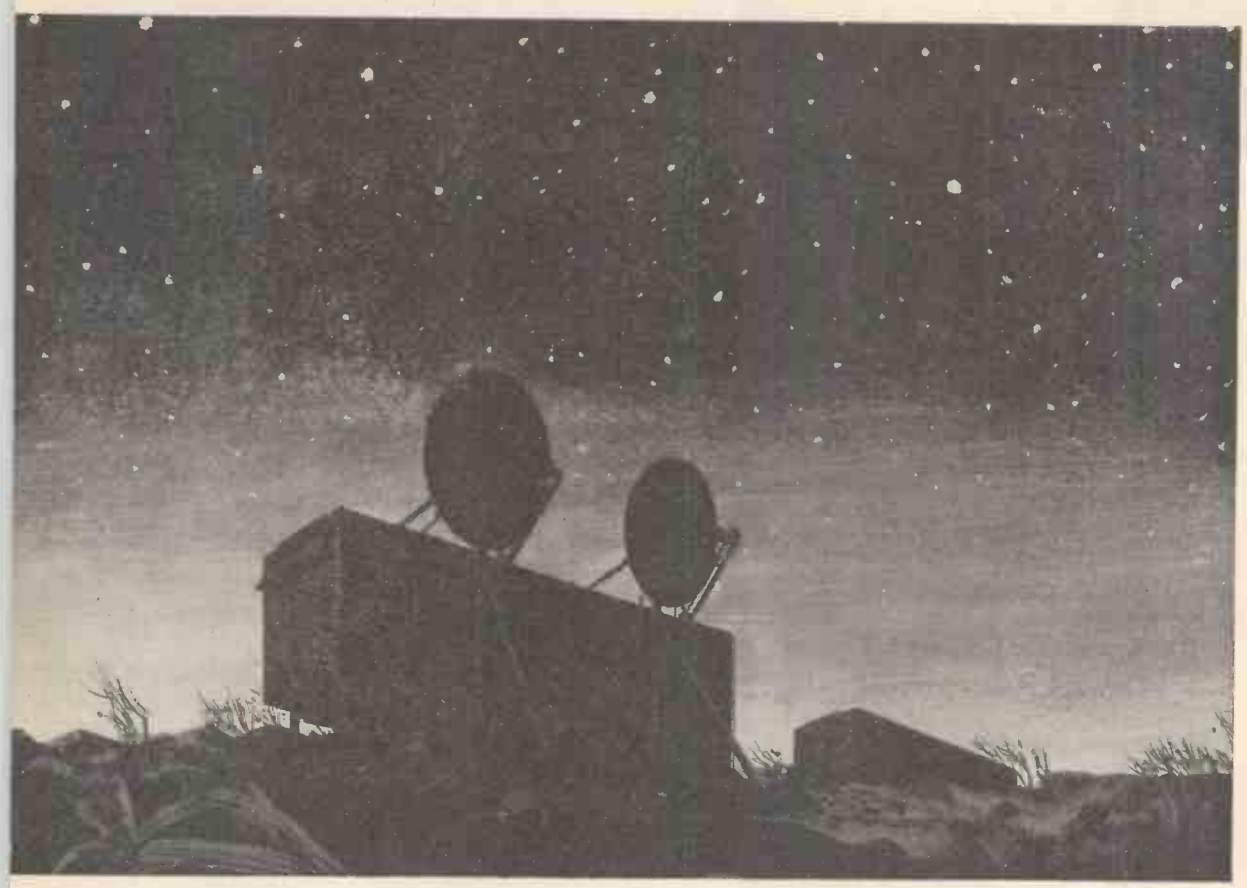

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Transportable MICROSCATTER is a super high frequency radio system for long-range communication. Developed by Canadian Westinghouse, MICROSCATTER beams signals high above the earth sending two-way voice and teletype messages up to 200 miles over land and water . . . *without* costly relay stations.

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A Westinghouse communications specialist will be pleased to explain fully the MICROSCATTER operation and relate it to your problem. Contact your nearest Westinghouse office, or write to Canadian Westinghouse Company Limited, Electronics Division, Hamilton, Canada. YOU CAN BE *SURE* . . . IF IT'S WESTINGHOUSE.

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Fixed Station — 120 telephone channels — television and sound	Wide Band — radar — data — 120 telephone channels
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FEATURES

- Frequency—4400-5000 mc
- Antennas —10 to 28 ft. diameter
- Power—2 KW
- Range—100 to 200 miles

CANADIAN
Westinghouse Microscatter

60-A-745

Chasing after the right transistor?

If the transistor you're after is a rare specimen with unusual characteristics you can go a long way before you finally pin it down. Give us an idea of the kind of specimen you are seeking and we may be able to give you the answer.

The list of Ediswan Mazda transistors is constantly growing; a request on your letterhead will bring you details of the very latest types.

This could be it!

If you are looking for a VHF pnp drift transistor, the XA131, a recent addition to our range, may be the one you want. It is suitable for use as a **Local Oscillator up to 250 Mc/s or an R.F. Amplifier up to a frequency of 100 Mc/s.**

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Associated Electrical Industries Limited
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Semiconductor Department, 155 Charing Cross Road, London W.C.2
Tel: GERrard 8660 Telegrams: Sieswan Wescent London
CRC 15/74

HF oscilloscope with differential input, type GM 5603

Vertical Amplifier

✻ ***D.C. coupled differential amplifier with a bandwidth up to 15 Mc/s and signal delay***

Deflection sensitivity: 50 mV/cm - 5 V/cm in 7 calibrated steps (1 - 2 - 5 sequence) and continuously up to at least 15 V/cm.
Accuracy of calibration: within 3%.
Bandwidth: 0 - 15 Mc/s (AC coupled 2 c/s - 15 Mc/s), rise time: 25 m μsec.
Signal delay: obtained by a 0.3 μs symmetrical delay line.
Input: selection of input I or input II single-ended, or I - II differential, all AC or DC coupled.
Input impedance: 1 MΩ in parallel with 25 μμF.
Rejection factor: 1000 for frequencies up to 100 kc/s.

Probes

✻ ***Two attenuator- and two DC coupled cathode follower probes are delivered with the instrument***

The attenuator probes increase the voltage range up to 600 V at maximum deflection.
Attenuation: 10 : 1.
Input impedance: 5 Megohm in parallel with 9 μμF.
Using the cathode follower probes full sensitivity (50 mV/cm) is maintained.
Input impedance: 0.5 Megohm in parallel with 5 μμF.

Sweep Generator

✻ ***Twenty-one calibrated sweep velocities and calibrated expansion***

Sweep range: 0.2 μs/cm - 1 s/cm in 21 calibrated steps (1 - 2 - 5 sequence) and continuously.
Accuracy of time measurements: within 3%.
Expansion: x2 or x5 (accuracy ± 5%) and continuously; fastest sweep 40 m μsec/cm.

Triggering

✻ ***Optimum triggerstability up to 2 Mc/s and HF sync up to at least 15 Mc/s***

Triggerfacilities: internal, external or mains frequency on pos. or neg. slopes.
Trigger requirements: 5 mm at internal or 1 V at external triggering for frequencies up to 2 Mc/s.

Horizontal amplifier

Bandwidth: 0 - 2 Mc/s (AC coupled 1 c/s - 2 Mc/s).
Deflection sensitivity: 1 V/cm.
Input impedance: 1 Megohm in parallel with 25 μμF.

Cathode Ray Tube

✻ ***10 kV E.H.T. applied to the spiral accelerator of the 5" C.R.T.***

Tube type DN 13-78 (medium persistance), other phosphors available.

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From all normal mains supplies between 110 V and 245 V (40 c/s - 100 c/s).

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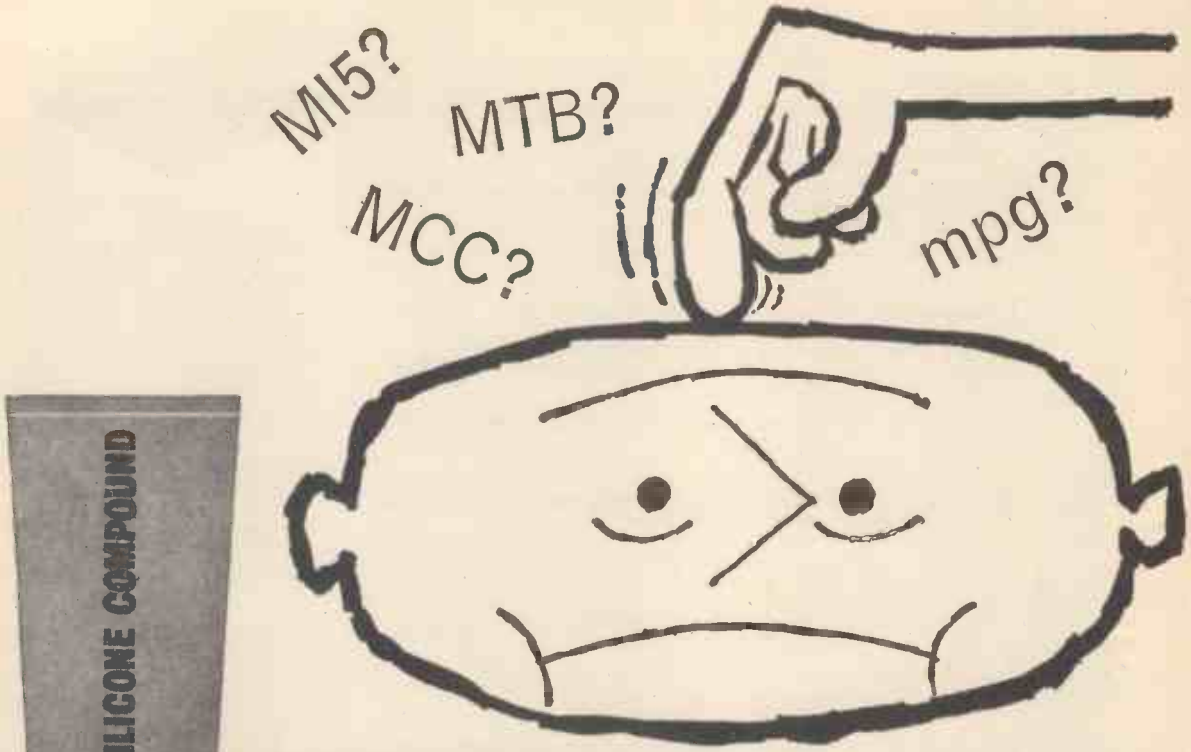
instruments: **quality *tools* for industry and research**

PHILIPS



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MSB 8

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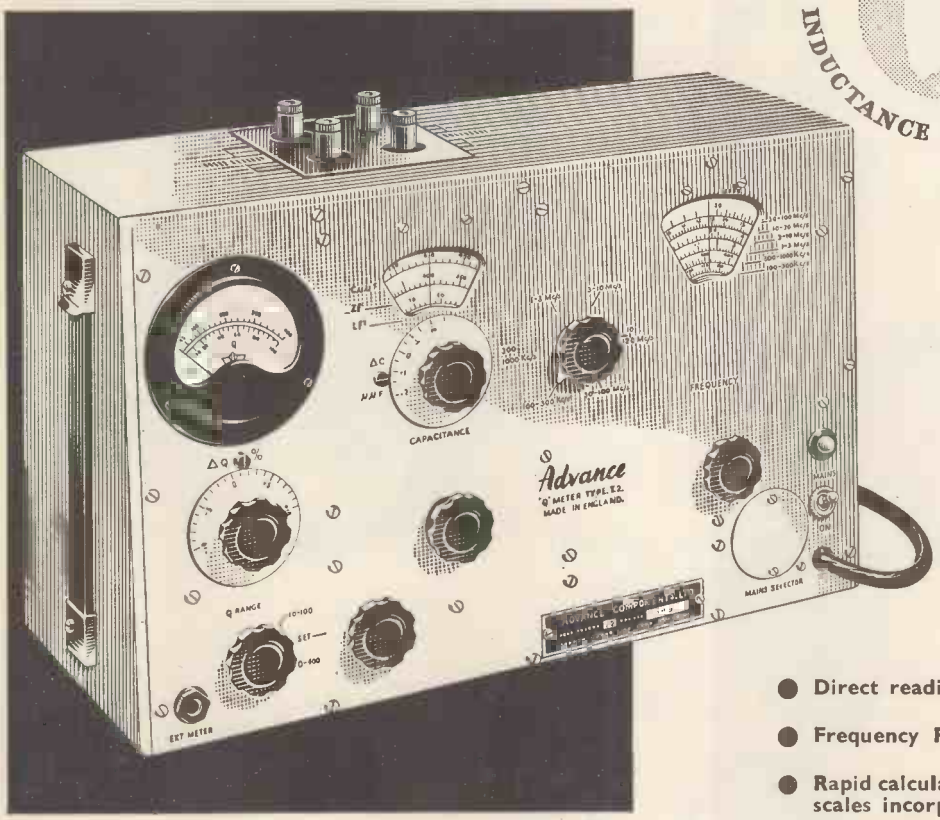

INTERKAMA

Stand No. B2025/6/D

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- Frequency Range 100kc/s-100Mc/s
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- 'Q' Comparison Range ±10%
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The 'Q' Meter Model T2 is a reliable instrument for making measurements of circuit magnification, inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. The variable-capacitor control has three calibrated scales which greatly simplify the calculations of inductance and impedance. A comparison facility is incorporated to enable batch testing by unskilled personnel.

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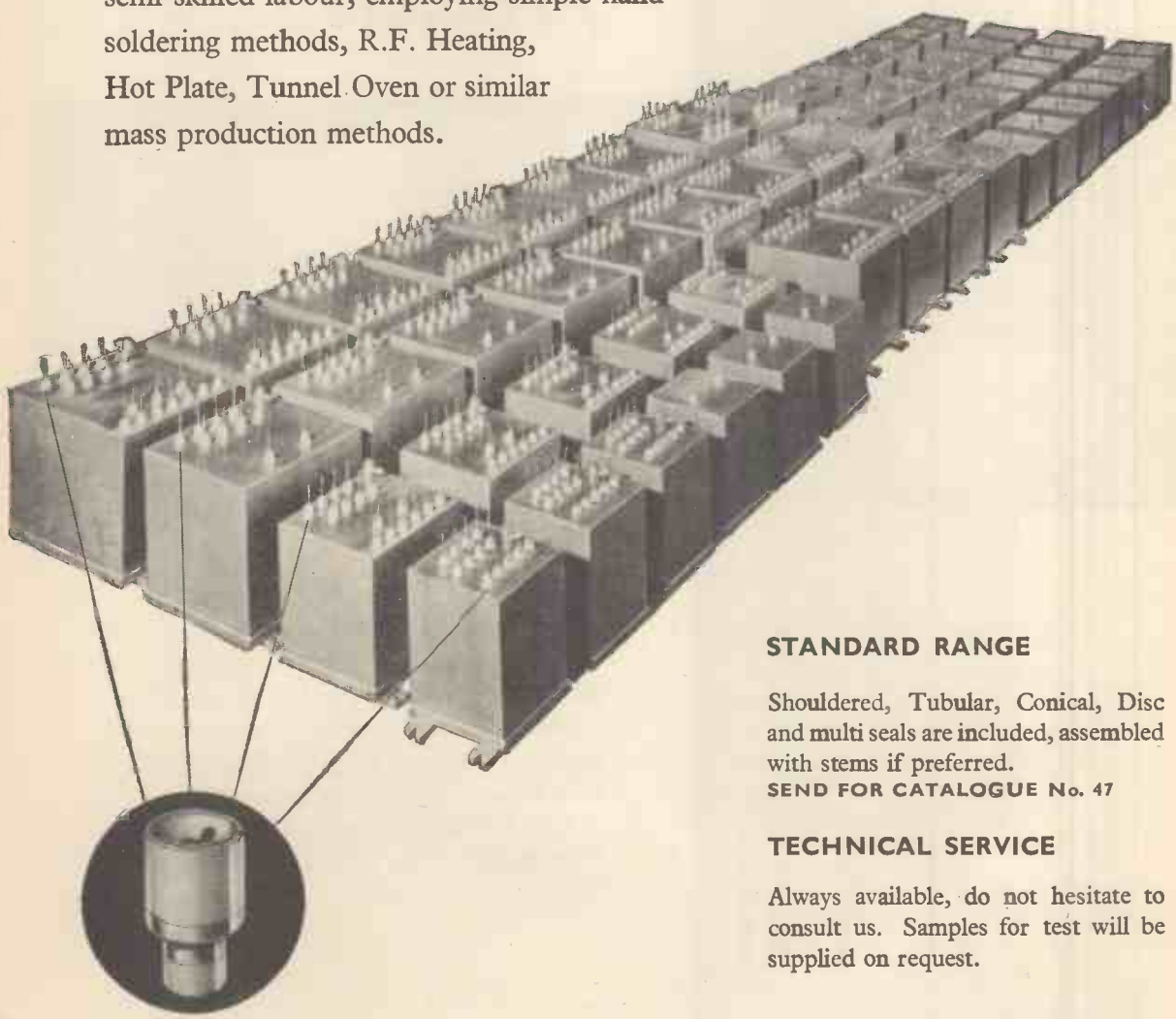

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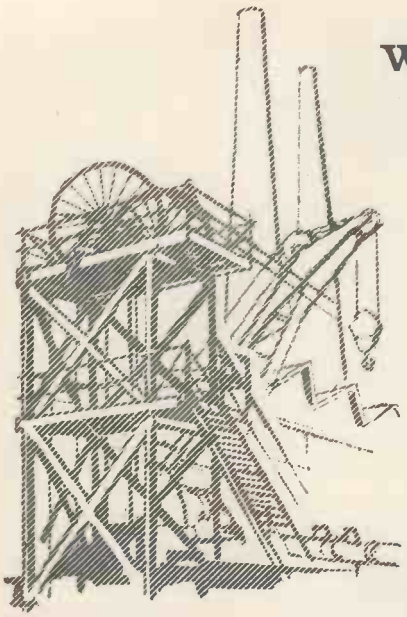

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Sanders

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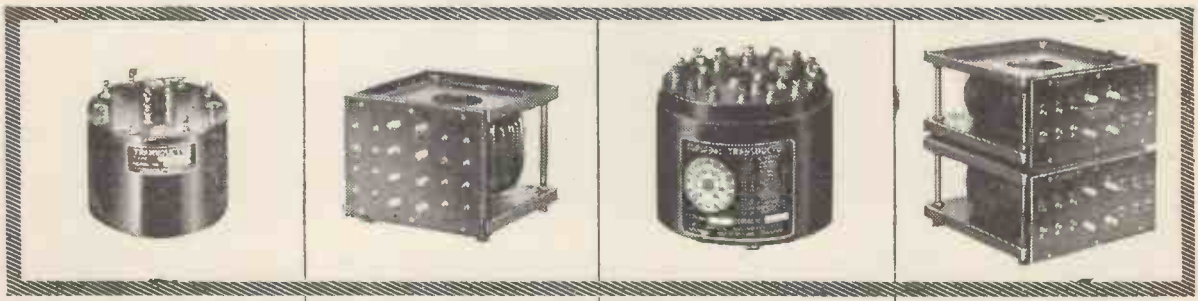

Type 1000

Encapsulated transductors meeting Climatic Classification 40/70 H1. They have passed the tests for Inter-Service Type Approval as specified in RCS (Prov) 217, and are used extensively in Service equipment.

Supply Freq.	D.C. Output
50 c/s	From 0·005W to 11W
400 c/s	From 1W to 145W

Type 2000

Open-type transductors suitable for use in industrial applications requiring Climatic Classification 40/70 H2. Many of these transductors are in use in steel works, coal mines and similar situations where robustness and reliability are of prime importance.

Supply Freq.	D.C. Output
50 c/s	From 50W to 500W
400 c/s	From 500W to 4000W

Type 3000

Transductors use toroidal cores, the whole assembly being encapsulated in an epoxy-resin to make a component satisfying the requirements of Climatic Classification 40/70 H1. This range is Admiralty Approved and is used extensively in Service equipment.

Supply Freq.	D.C. Output
50 c/s	From 50W to 250W
400 c/s	From 500W to 2000W

Type 4000

In the 4000 range the transductors are of the same high quality and finish as the 2000 range, but the construction is such that they can be supplied as either 1-, 2-, or 3-element assemblies. Climatic Classification 40/70 H2.

Supply Freq.	D.C. Output
50 c/s	From 50W to 1000W
400 c/s	From 500W to 8000W

The Sanders range of high performance transductors is ideally suitable for use in automatic control systems and applications where size, weight and quality are important. A comprehensive selection of transductors exists for operation from both 50 c/s and 400 c/s supplies. The advantage of being able to obtain a standard type of transductor with known characteristics enables them to be offered at competitive cost and with a short delivery period. In addition to this standard range, a large selection of transductors is produced using the same high quality construction, but having different windings to suit individual requirements.

This is one of a series of new instruments and components by

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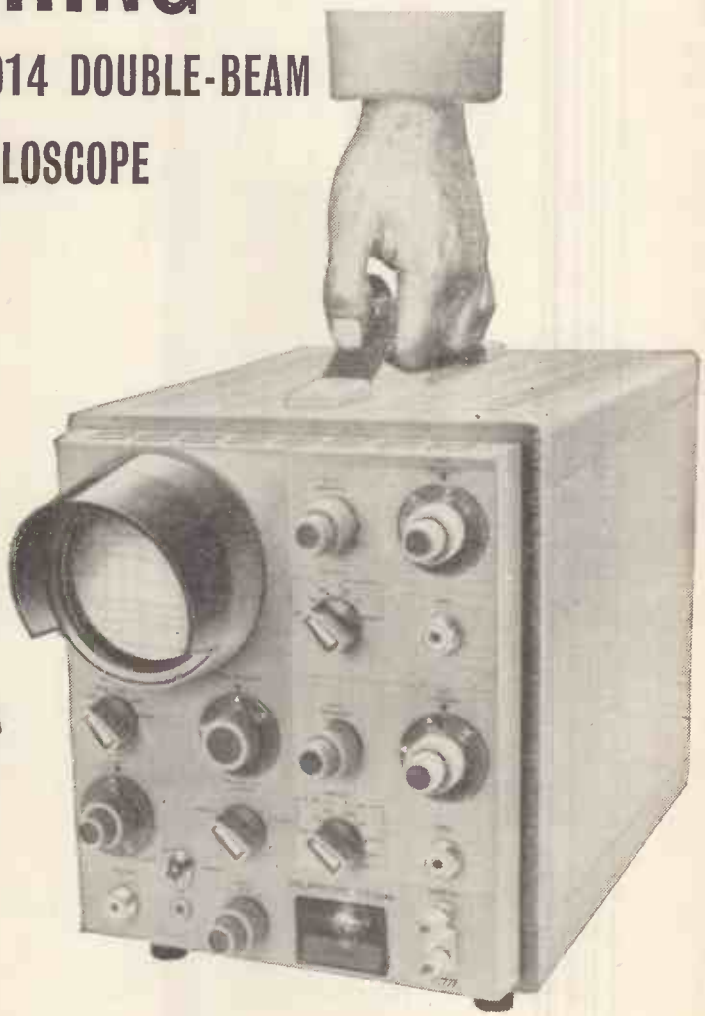
it has EVERYTHING and it's portable

SOLARTRON

CD 1014 DOUBLE-BEAM OSCILLOSCOPE



Carried around as your 'pet' instrument, this versatile double-beam 'scope makes light work of any servicing or development problems.

The CD 1014 locks to video signals with the built-in TV sync. separator; gives bright, well defined traces at fast or slow speeds; has stabilised EHT ensuring accurate calibration independent of brightness levels; incorporates high gain pre-amplifier —in fact it has all the features that make it ideal for on-the-spot servicing and general research work anywhere in the world.

'Y' SYSTEM includes two wideband amplifiers effectively covering DC–Servo–Audio–Video–and Transient applications.

Y_1 & Y_2 bandwidths DC–5 Mc/s (-3 dB) in the 100 mV/cm–100 V/cm range.

Rise time 70 mμsecs.

1 mV/cm maximum sensitivity on Y_2 a.c. Input.

Inputs can be 'floated' with respect to earth.

Input constants Main amplifiers 1 MΩ/30 pF; Y_2 preamp. 2.2 MΩ/30 pF.

Measuring accuracy to 5%.

Dual displays from a twin-gun c.r.t. 3AZP31 (P7 and P11 phosphors also available)

Calibration squarewave 0.5 V pk–pk ± 1%, at mains frequency

Only 2 valve types used, silicon rectifiers, 'C' cored main transformer

Mains input 110/220V ± 20V, 45-66 c/s

Consumption: 75 VA

'X' SYSTEM Basic time-base range 1 cm/μsec–1cm/sec, continuously variable; accurate to 5%.

Symmetrical expansion, continuously variable and calibrated at x 1, 2 and 5.

Adequate X shift centres any portion of the trace.

'Level' and 'Stability' controls for triggering and locking the signal at any selected point on the trigger waveform.

Time-base waveform from cathode follower available at a socket, 15 V pk.

Provision for direct access to X amplifier; bandwidth DC–200 Kc/s (–3 dB); sensitivity 0.2 V/cm–2 V/cm, continuously variable.

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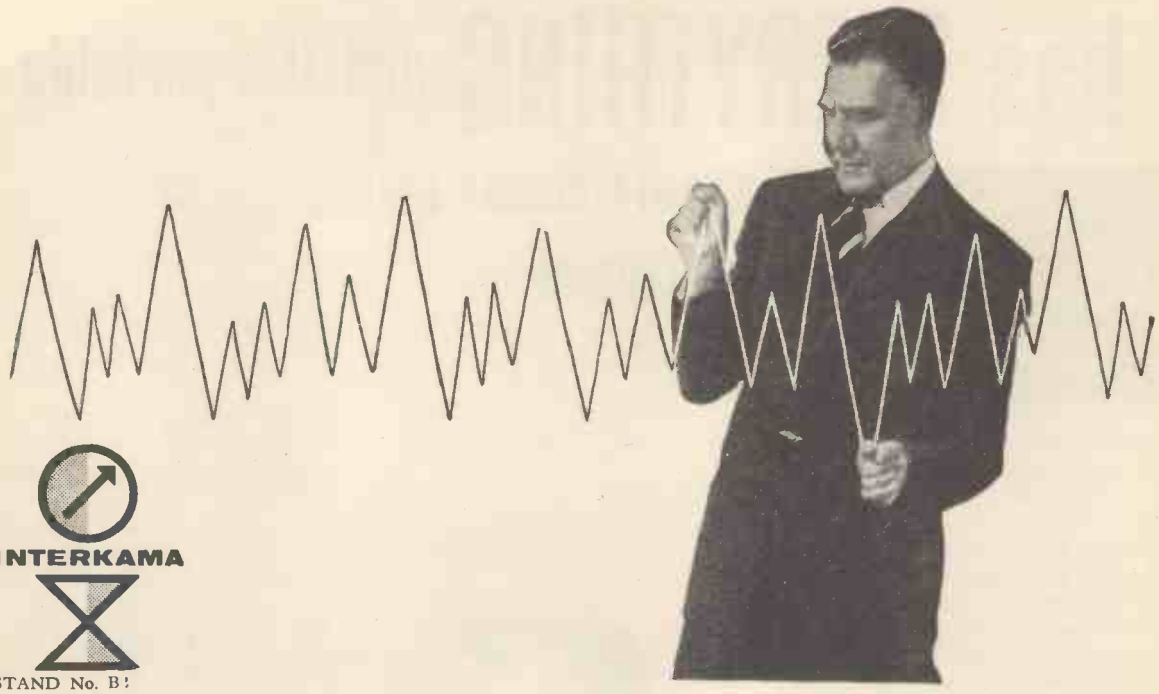

INTERKAMA

STAND No. B1

Why struggle with Mains Voltage Fluctuation?

If you have **any** *problem involving a.c. voltage regulation, the solution is to call in 'Advance'— the Constant Voltage Transformer specialists. Investigation of your problem may prove that a standard type 'Volstat' will meet the case; or maybe, a special design is called for. In either event, the wealth of experience gained by 'Advance' over many years in probing every aspect of mains stabilization provides the surest, quickest, and certainly the most economical, solution to your difficulties*

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Advance

'VOLTAGE STABILIZATION'

This 'Advance' Booklet gives authoritative information on 'Advance' Constant Voltage Transformers, and the service available to deal with your particular voltage fluctuation problems.
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MAINS STABILIZATION DIVISION

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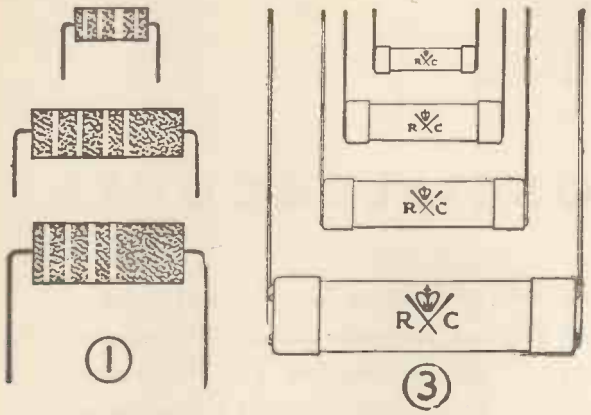

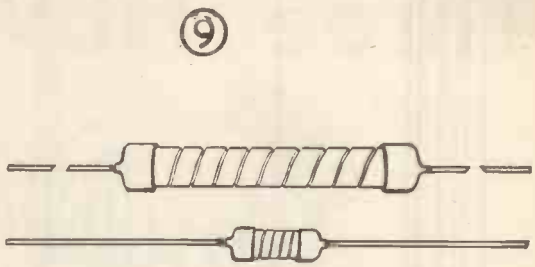

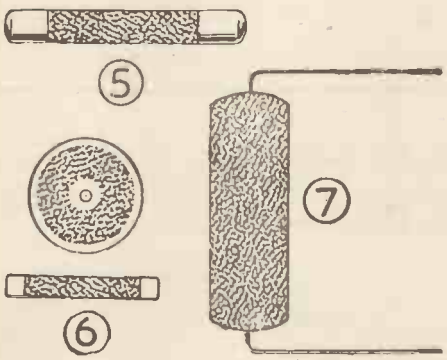

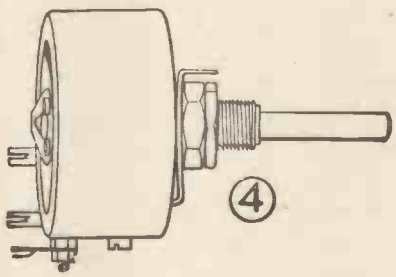

A SERVICE FOR DESIGNERS

The possibility of a component change—due to shortage of supplies, increased costs or failure to meet specific conditions—is a problem facing every designer of electronic equipment. However, one basic component can be "tailor-made" from the start, for LAB will supply the precise type of Resistor required, ex stock *and* at the right price. Write for full technical data, prototype samples and price schedules to:—

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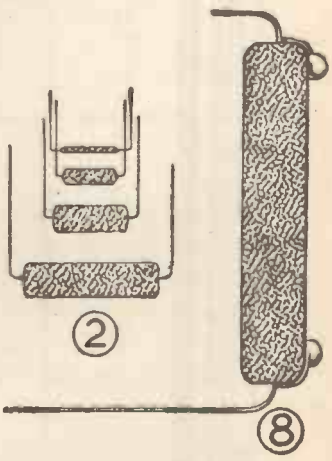
Telephone : HARrow 6347

CARBON	WATTS	OHMIC RANGE	TOLERANCES ±
1. Solid	½ 1 and 2	10—10M	5% and 10%
2. Cracked	1/30—20	1—500M	5% and 10%
3. *High Stability	1/10—3	1—50M	0.5% 1% 2% 5%
4. Variable	¼	5K—2M	—
5. V. High Resistance	¼—3	50M—10^{13}	5% and 10%
6. V.H.F. (Rods and Discs)	1/10—1	10—1K	1% and 2%
WIREWOUND			
4. Rheostats	4—500	10—18K	—
8. Vitreous	3—500	1—150K	1% 2% 5%
7. Cemented	1—15	1—25K	5% and 10%
9. Metal Oxide	¼—2	100—4.2M	1% 2% 5%

*The ubiquitous blue (1%) grey (2%) "HISTABS"



Do you KNOW

THAT Cracked Carbon Resistors (2) are more economical in the ±5% range than Solid Carbon.

THAT the sub-miniature 1/30th watt unit (2) is probably the smallest production Resistor made.

25 YEARS LAB

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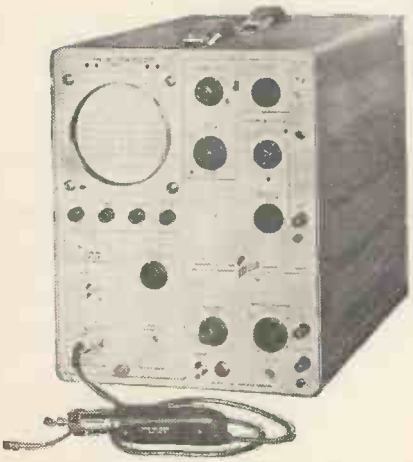
When top performance oscilloscopes are required, the range of Tektronix instruments can satisfy the most rigorous demands. Livingston Laboratories are the sole representatives in Great Britain of Tektronix Inc.



3.5 - millimicrosecond risetime.

Type 581.

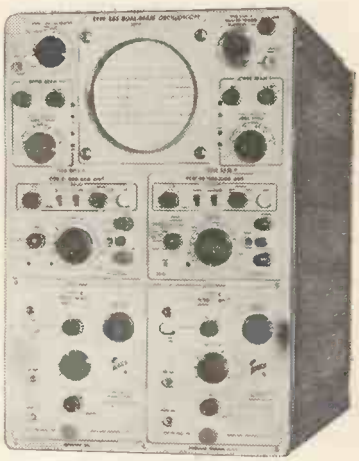
A new laboratory oscilloscope with many of the capabilities needed in the current rapid advancement of the electronic art. Its 3.5-mμ sec risetime, 0.1-v/cm sensitivity and 0.01-μsec/cm sweeptime are features for modern high-speed pulse applications. A new series of Tektronix plug-in preamplifiers promises outstanding signal-handling versatility for an oscilloscope with a vertical passband of dc to approximately 100 mc.

Type 585.

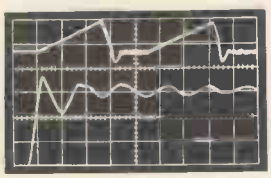
Having the identical general specifications as Type 581, the 585 has second time base generator. This acts as a sweep delay generator, providing a wide range of calibrated sweep delay, continuously variable over the range of 1μsec to 10 sec. Colour-correlated controls eliminate confusion, making this new high performance oscilloscope easy to operate.

NEW DC to 30 MC
Dual - Beam Oscilloscope

Type 555.



Two electron beams, each with its own X and Y deflection systems, help make possible a highly versatile dual-beam oscilloscope. Either of the two time-base generators in the Type 555 can deflect either beam for dual and single displays, and either can deflect both beams for a dual display on the same time base. Time-base units are the plug-in type to facilitate instrument maintenance and the sweep speed is variable between 0.02 μsec/cm and 12 sec/cm. This new oscilloscope will accept the standard range of plug-in pre-amplifiers.



Same signal displayed simultaneously on slow sweep (upper beam) and fast sweep (lower beam) shows both coarse and fine structure of waveform. Delay range—0.5 μsec. to 50 secs.

Full details from

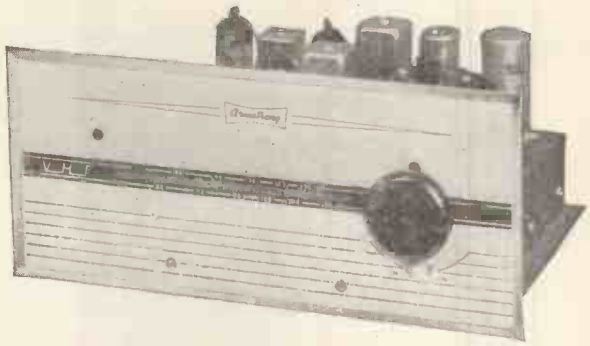
LIVINGSTON LABORATORIES LTD.
RETCAR STREET, LONDON, N.19.
Telephone : ARChway 6251

★ Armstrong Quality Tuners

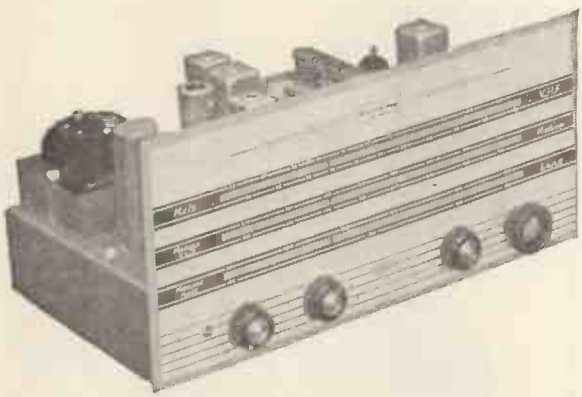
T4 FM TUNER 19gns

A high fidelity VHF tuner of attractive appearance and superb design. Incorporating features normally found only in the most expensive tuners it represents outstanding value at its price. It is completely stable with no trace of drift and A.F.C. provides broad easy tuning. A polished wood cabinet (£2/16/-) is available for those who require a separately mounted tuner.

- *Self-powered.*
- *Full VHF band (87-108 Mc/s.).*
- *Automatic frequency control.*
- *Cathode follower output.*
- *Variable output 0–500mV.*
- *Multiplex output for stereo radio adapter.*
- *Separate 75 ohm and 300 ohm aerial inputs.*



are designed to match any



ST3 Mk2 AM/FM TUNER . . 27gns

This new tuner is the successor to the well-tried and successful ST3. Improvements in design and a considerable reduction in size make the new tuner even more attractive than its predecessor. It includes all the features of the T4 tuner and the A.M. section covers the long and medium wavebands. The ferrite aerial and unique 2nd I.F. stage ensure good continental reception and there is a miniature bright-line indicator for easy tuning.

- *Self-powered.*
- *Automatic frequency control.*
- *Cathode follower stage with variable output.*
- *Multiplex output for stereo radio adapter.*
- *Ferrite rod aerial on AM and separate aerial inputs on FM.*

amplifier or tape recorder

RF125T AM TUNER . £29 . 14 . 4

A reliable high performance tuner with medium and long bands and three short wavebands. Coverage is: 13-37.5 metres, 30-90 metres, 85-250 metres, 200-550 metres, 600-2,000 metres. A tuned high gain RF stage and two I.F. stages ensure outstanding sensitivity and selectivity. The RF125T incorporates an audio pre-amplifier with separate bass, treble and gain controls for use with existing power amplifiers. It is also available as a complete receiver (RF125R, price £44/14/4) including a high fidelity power amplifier giving 10 watts push-pull output.

Although Armstrong tuners are suitable for use with any amplifier, we recommend, for the enthusiast who wants the best, the Armstrong PCU27 Stereo Pre-Amplifier (£26.10.0d.) together with A10.Mk2 Power Amplifier (£21.10.0d.) Use one A10.Mk2 for mono or two for stereo.

Post this coupon for free catalogue or call at your High Fidelity dealer or our Holloway showroom for demonstration. Open 9–5.30 weekdays, 9–5 Saturdays

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industrial power transistor OC35

Here is the OC35—a new *power* transistor which supersedes the OC16 as a standard type for general use in industry. The OC35 is inexpensive and has a maximum current rating twice that of the OC16. It is well suited for use in a wide variety of industrial low frequency amplification and electromechanical applications, and in particular those equipments which are operated from a 12 volt supply.

With this new transistor, current gain is high and is well maintained up to high current levels—even at 6 amps the minimum large signal current gain is 20. The metal envelope is of the new standard *power* construction which saves space and provides efficient heat conduction to chassis or heat sink. The resulting low thermal resistance, together with the unusually high continuous junction temperature rating of 90°C for a germanium device, allows a maximum dissipation of 10 watts at a mounting base temperature of 75°C.

The data sheet on the OC35 gives detailed information to ensure satisfactory operation of the transistor in as many industrial circuits as possible. So if you are looking for a general purpose *power* transistor for new equipment design, save yourself time by posting the coupon below.

Abridged data for Germanium Power Transistor OC35

V_{cb} max.	-60V
V_{ce} max. (cut-off)	-48V
V_{ce} max. (I_c = 6A)	-32V
I_c max.	6.0A
p_{tot} max. (at mounting base temperature 45°C)	30W
T_j max. (continuous operation)	90°C
T_j max. (intermittent operation 200 hours max.)	100°C
$\bar{\alpha}'$ (at I_c = 1A)	25 to 75
$\bar{\alpha}'$ (at I_c = 6A)	20 to 45

Mullard

data request

Mullard

industrial semiconductors

Semiconductor Division
MULLARD LIMITED
MULLARD HOUSE
TORRINGTON PLACE
LONDON · W.C.1
Tel: Langham 6633

Please send me full data for Power Transistor OC35

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MIS 19b

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MARCONI TEST EQUIPMENT

UNIVERSAL BRIDGE TF 868B

(photographed in the new Plessey laboratories at West Leigh)

Measures inductance and capacitance at 1 or 10 kc/s, resistance at d.c. Direct reading: 1μH to 100 henrys; 1$\mu\mu$F to 100μF; 0.1 ohm to 100 MΩ. Q range: 0.1 to 10 at 1 kc/s; 1 to 100 at 10 kc/s. Tan δ range: 0.001 to 0.1 at 1 kc/s; 0.01 to 1 at 10 kc/s.

Plessey, a company with a world-wide reputation for reliability, naturally make extensive use of Marconi test equipment—experience has proved its advanced design and consistent accuracy. The Universal Bridge TF 868B typifies the outstanding quality of Marconi instrumentation; this complete, direct-reading, measurement system enjoys important new advantages, including faster, easier, initial balancing, high-discrimination resistance measurement, and precision phase-balancing facilities. If you would like complete technical details of the TF 868B, or any other of our more than a hundred precision electronic measuring instruments, please get in touch with your nearest Marconi Instruments office.

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One kilowatt power in a compact ceramic package is now available to 400Mc., with the Eimac 4CX1000A radial-beam power tetrode.

The new, expanded frequency range coverage of the versatile 4CX1000A makes it ideal for AM, FM and SSB operation in the important government communication band, 225-400Mc., and for FM and VHF-TV broadcasting.

An excellent linear amplifier tube, the 4CX1000A has low voltage, high current, high gain characteristics. It achieves maximum rated power output in Class AB_1, SSB service without grid current.

Illustrated here, actual size, it is easy to see why this compact, rugged ceramic tetrode is ideal for tight space, high power situations.

A companion air-system socket to meet your specific requirement is available with the 4CX1000A.

TYPICAL OPERATION 4CX1000A (400Mc FM Amplifier)

DC Plate Voltage	3000 volts
DC Screen Voltage	250 volts
DC Plate Current	750 ma
DC Screen Current	45 ma
Driver Power Output	15 watts
Useful Output Power	1100 watts

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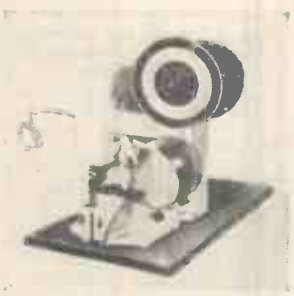
A-MP Miniature Faston Receptacles for loudspeaker and printed circuit tabs.

AMP lok the latest development in a multi-contact and economical Connector.



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AP144

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

GD412

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 3¾ ips.
Below .25% at 1⅞ ips.

FREQUENCY RANGE
15 ips: 50/16,000 c/s ± 3 db.
7½ ips: 60/12,000 c/s ± 3 db.
3¾ ips: 60/7,000 c/s ± 3 db.
1⅞ ips: 60/4,000 c/s ± 3 db.

SELECTIVE FREQUENCY CORRECTION At 15, 7½ and 3¾ ips.

SENSITIVITY
Microphone: 2.5 mVs into 2 megohms.
Radio or pick-up: 10 mVs into 150 mVs

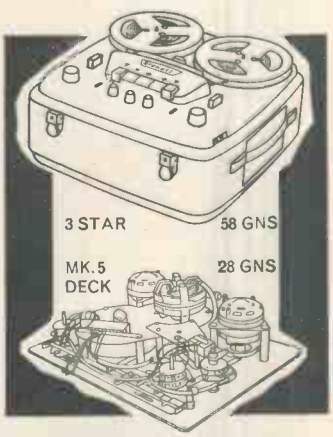
OUTPUT
4 watts into 15 ohms.

INTERNAL SPEAKER
9in. × 5in. elliptical hi-fidelity model.

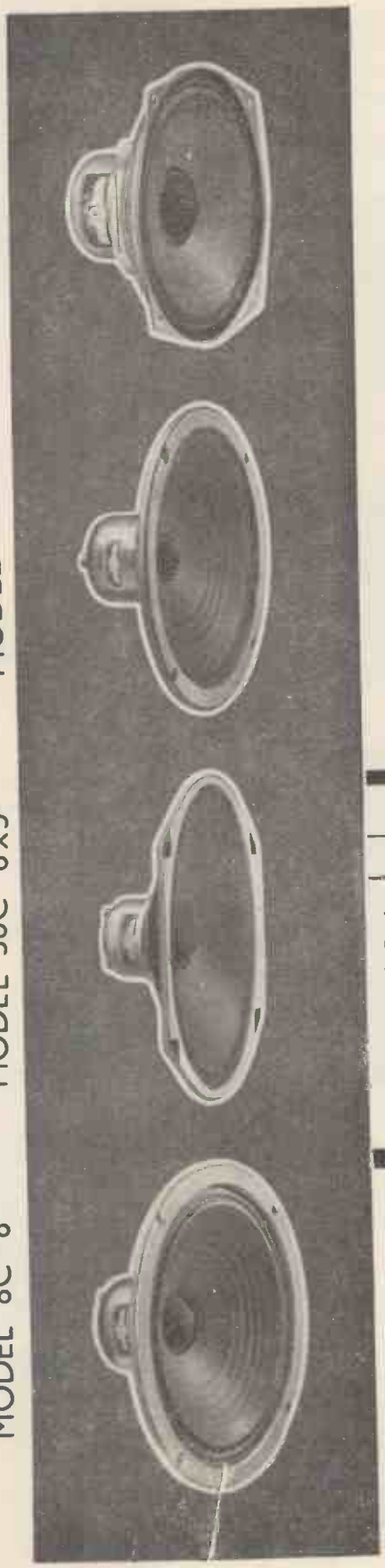
SOCKETS
1. (input) for high impedance microphone.
2. (input) for pick-up, radio or F.M. tuner.
3. (output) for headphone monitoring or to feed signal to ext. amplifier.
4 & 5. Two co-axial sockets on chassis for permanent Radio/Gram input connection, and monitoring through extra amplifying system.
6. (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



Brenell



POPULAR REPLACEMENT SPEAKERS

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.

ELAC

ELECTRO ACOUSTIC INDUSTRIES LIMITED

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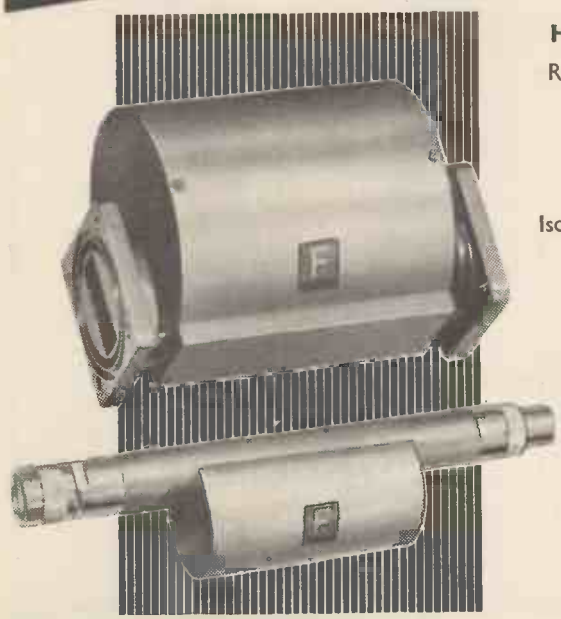
MEDIUM POWER FERRITE ISOLATORS SERIES 2M

Range of centre frequencies	8500-10, 500 Mc/s
Bandwidth about the centre frequency	±5%
Peak Power	50 KW
Isolation at centre frequency	35db
Isolation over the band	>15db
Weight	2½lb approx

2½ MW S-BAND FERRITE ISOLATORS SERIES 2C

Range of centre frequencies	2800-4000 Mc/s
Bandwidth about the centre frequency	±10%
Peak Power	2·5 MW
Mean Power	3·5 KW
Isolation at centre frequency	Not less than 12db
Isolation over the band	Not less than 9db
Weight	30lb

Ferranti Ferrite Isolators



HIGH POWER FERRITE ISOLATORS SERIES 2H

Range of centre frequencies	8500-10,500 Mc/s
Bandwidth	±5% about centre frequency
Peak Power	200 KW (pressurised)
Mean Power	250 W (pressurised)
Isolation at centre frequency	>40db
Isolation over-the band	>20db
Weight	5lb approx

COAXIAL FERRITE ISOLATORS SERIES 12M

Range of centre frequencies	2500-4500 Mc/s
Bandwidth	±500 Mc/s
Power up to	50 Watts C.W.
Isolation at centre frequency	40db
Isolation over the band	>15db
Weight	1½lb approx.

Ferranti

Write for further details to:-

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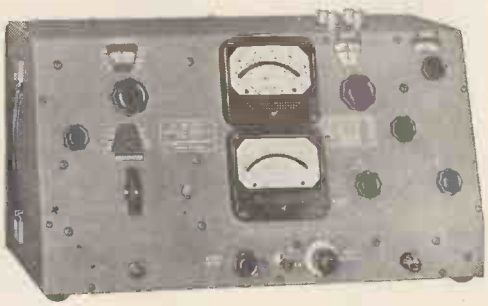

Type 260A Q-Meter

Precision Q-Measurements
from 10 to 625
Frequency Range 50 kc to 50 Mc
Capacitor Range 30 to 460 $\mu\mu$F
Inductance Range 0.09 μH to 130 mH

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AC/DC input for both axes
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OCTOBER 1960

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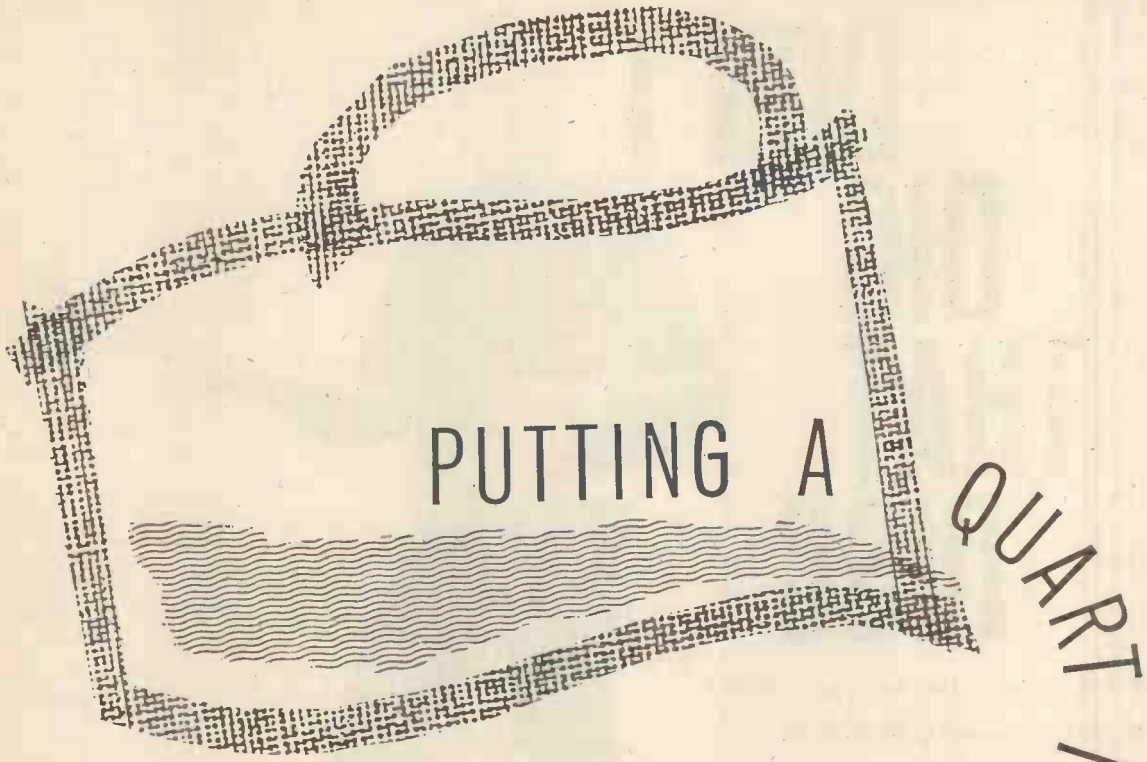

AD722 SUB-MINIATURE RADIO COMPASS combines exceptionally high performance and reliability with small size and weight. Designed for use in small, high performance aircraft, this unique ADF has since proved itself ideal for executive, sports and feeder line aircraft and helicopters, as well as a wide variety of military types. The small, compact units can be easily fitted into the smallest aeroplanes and the design of the fixed loop aerial produces negligible drag and requires no maintenance. Operating entirely from the aircraft 28v D.C. supply, 28 volts is the highest voltage present in the set. There are no invertors or vibrators and all components are run well below their rating.

In over 5 years of service, and in 40 different types of aircraft, the reliability of the AD722 has proved outstanding.

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AIRPORT AND AIRCRAFT RADIO SYSTEMS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED · CHELMSFORD · ESSEX · ENGLAND

A4A

"BELLING-LEE" NOTES

No. 21 of a series.

Fusing, part 5

The Rating of a fuse is the value of the current which it will carry continuously without deterioration*, although in the case of the cheapest types of fuselinks the term "continuously" may be qualified as to duration since it is accepted that they may have a limited working life. This is because the cost of the materials forms an appreciable part of the whole, and choice is therefore governed to a large extent by practical economics. Thus it may be necessary, for example, to substitute tinned copper for pure silver, which is much more expensive, for the material from which the element is made, although silver has properties which are considerably more stable in this application. A fuse element which is operated at or near its full rated current for any length of time becomes heated, and this can cause crystallisation in copper, from which silver would be immune. The resulting embrittlement of the element is accompanied by a change in the fusing performance characteristics, and a reduction in the working life and while these changes may not be sufficiently severe to present any practical drawbacks to the employment of such fuselinks (by their very nature they are intended for relatively uncritical applications), for maximum reliability of any equipment in which they are used, they should be replaced at the end of their guaranteed working period. It is in fact standard practice in situations where human lives may be involved, e.g. in aircraft, where vibration is an additional factor contributing to embrittlement, to replace all fuselinks in vital electronic equipment at short, regular intervals, since the cost of replacement (including the labour) is considered a small price to pay for the extra assurance of safety.

It is worth taking a quick look at a typical specification covering inexpensive fuselinks such as we have been discussing. B.S.S. 2950 is a good example, and is the specification to which the majority of better class fuselinks is made for use in radio and television receivers, and also much other electronic equipment. The whole purpose of this specification was to lay down a set of reasonable parameters, which had been found by experience to be adequate for the purposes envisaged, and which could be met inexpensively. It covers a range of cartridge fuselinks of relatively low current ratings and non-critical performance, for use in apparatus where the prospective fault currents do not exceed 10 times the fuse ratings; this meets practical safety requirements, since such apparatus is invariably used in circuits which are themselves amply protected by fuses if dangerous prospective overloads can occur. Not only did this make it possible to employ a simple form of construction, e.g. an unfilled glass cartridge in place of the much dearer ceramic body and filler which are necessary to contain the energy associated with high density arcs, but it also obviated any necessity for elaborate and expensive proving tests. Furthermore, since the cost of producing fuselinks to give even a moderately close degree of protection increases as the currents become smaller, alternative standards, "A" and "B," are provided for the lower members of the range, covering blowing at two, or three times the rated current, respectively. In this specification it is stated that the fuselink shall be capable of carrying their rated current for a minimum period of 1,000 hours.

One last point on the subject of embrittlement is noteworthy since it does not seem to be everywhere appreciated; this concerns the effect of surges. The process of embrittlement is greatly accelerated if the fuse rating is exceeded even for extremely short periods of time, e.g. half-cycle surges on a 50 c.p.s. supply. These may leave a fuselink apparently unaffected, but in fact its life may be seriously shortened on each occurrence, and premature failure will then follow without any fault having arisen in the equipment. This condition sometimes escapes recognition even by experienced circuit engineers if they are checking with instruments which have been calibrated on a sinusoidal waveform, and that of the surge departs radically from a pure sinewave, i.e. it is steep fronted, containing a high proportion of harmonics. The readiest way of detecting and measuring such surges is by means of a cathode ray oscilloscope, on which the actual shape of the waveform can be seen.

These short duration surges may in themselves be harmless to the equipment, but will necessitate an increase in the fuse rating to handle them. This reduces the degree of protection afforded to the equipment, but if this is not tolerable, a different type of fuse will be required, having suitable surge resisting properties.

★ *except in the vehicle industry, where the rating defines the fusing current.*

G.E.C. switching transistors for high speed operation!

One hundred and twenty millimicroseconds—that is the rise time which can be obtained using G.E.C. germanium p-n-p transistors. Peak collector current rating is 150 mA, and maximum junction operating temperature 85°C.

The GET 871, GET 872 and the new GET 875 are designed for use in computers, scaling units, counting circuits, shift registers, waveform generators and similar applications. These transistors are immediately available from stock.

Type	Maximum Ratings					Minimum h_{FE} $V_{ce}=-1V$, $I_c=25mA$	Minimum f_α (Mc/s) $V_{cb}=-6V$, $I_e=1mA$	Maximum V_{eb} (mV)	Maximum $V_{ce(sat)}$ (mV)	Typical Transient Response (for circuit details, see data sheet)	
	$V_{cb(pk)}$ (V)	$i_{c(pk)}$ (mA)	$T_{j(w)}$ (°C)	P_t (max) (mW) 35°C	P_t (max) (mW) 55°C			$I_c=25mA$, $I_b=0.83mA$		t_r (μs)	t_f (μs)
GET871	—15	150	85	75	45	20	3	400	250	0·18	0·07
GET872						30	7	400	250	0·14	0·04
GET875						50	15	400	250	0·12	0·04

G.E.C.

Fuller information is available on request. G E.C. also makes a range of high-speed switching diodes, described in Semiconductor Application Report No. 14

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Aspects of design

This is the twenty-seventh of a series of special features dealing with advanced problems in television and radio 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-eighth of which will appear in the November 1960 issue.

27 TRANSIENT SWITCHING PARAMETERS FOR TRANSISTORS (PART I)

In assessing transistors for switching applications, consideration is given to the way in which the collector current responds to an input waveform. This is often described in terms of current gain, and response times in a particular circuit with particular drive conditions. Information in this form can be useful in distinguishing between transistors of widely differing performance, but seldom for indicating the performance in other circuits with different drive conditions, and so is generally of limited application. The switching times, for example, of a transistor which is made to bottom and one which is not, can differ widely, and are not related.

What is wanted is a set of basic transistor switching parameters which will permit the performance in various circuits and for various drive conditions to be predicted. These parameters can be defined by regarding the transistor as a charge controlled device analogous in some respects with the thermionic valve as a voltage controlled device. (See "Measurement of Transistor Transient Switching Parameters"—Sparkes Proc I.E.E. Pt.B. Suppl. No. 15.)

Charge control implies, for example, that an increase in the collector current (ΔI_c) is due basically to an increase in the charge (ΔQ_B) in the base of the transistor, and it can be shown that over a useful range of collector currents these changes are proportional,

i.e. $\frac{\Delta Q_B}{\Delta I_c} = \tau_C$ the Collector Time Factor.

When the increase in collector current is accompanied by a change in collector voltage, an additional charge (Q_v) must be injected into the base. Then if Q_{ON} is the total charge necessary to change I_c by ΔI_c,

$$Q_{ON} = \Delta Q_B + Q_v$$
or $$Q_{ON} = \Delta I_c \tau_C + Q_v$$

Q_v can be calculated from the equation

$$Q_v = \int_{V_2+U}^{V_1+U} C_{tc} dV$$

where C_{tc} is the collector depletion layer capacity and V_1 and V_2 the initial—i.e. "off"—and final—i.e. "on"—collector voltages. (Note that the collector voltage is numerically the collector-base terminal voltage less the voltage drop in the base resistance.)

For an abrupt junction,

$$Q_v = 2\, C_{tc}\sqrt{V_M+U}\ \left(\sqrt{V_1+U}-\sqrt{V_2+U}\right)$$

where V_M is the collector voltage at which C_{tc} is quoted, U is approximately 0.3 V for Germanium and 0.7 V for Silicon transistors, and the moduli of the voltages are required.

If the emitter junction is initially reverse biased, a further charge is required from the input circuit to bring the emitter junction to the zero bias condition, the usual starting point for measurements of Q_{ON}. This can be computed using the formulæ quoted in connection with the collector depletion layer capacity, and with a knowledge of the emitter depletion layer capacity C_{te} and the associated stray capacities.

What has been said applies to operation in the active region, in which the collector junction is reverse biased and the emitter forward biased; but if the base current exceeds $\frac{I_c}{\beta_O}$ (β_O is measured with $V_{cb}=0$) when the collector current is limited by external circuitry to I_c, the collector junction is forward biased and the transistor is in the saturation region. Then an additional charge Q_{BS} accumulates in the base, Q_{BS} being proportional to I_{BS}, the base current in excess of $\frac{I_c}{\beta_O}$

i.e. $\frac{Q_{BS}}{I_{BS}} = \tau_S$, the Saturation Time Factor.

The total charge in the base which must now be removed before the transistor switches off is,

$$Q_{OFF} = \Delta I_c\, \tau_{CO} + I_{BS}\, \tau_S + Q_v$$

τ_C is somewhat dependent on collector voltage, so the "on" collector voltage at which it is measured has to be stated. In the equation for Q_{OFF}, τ_{CO} is the particular value of τ_C measured at $V_{cb} = 0$. Both τ_C and τ_S are slowly varying functions of current level and the specific values of current at which they are measured are therefore quoted.

As an example of the calculation of Q_{OFF}, consider an XA151 transistor with the following parameters in a circuit with emitter earthed, collector supply voltage 6V, collector load 600 Ω and a base current drive of 0.7 mA.

XA151 at I_c = −10 mA
τ_{CO} = 30 mμsecs.
β_O = 40
β_S = 27
τ_S = 800 mμsecs.
C_{tc} = 11.0 pF at V_{cb} = −6V
$\Delta I_c \tau_{CO} = 10\times10^{-3}\times30\times10^{-9} =$ 300 pico-coulombs
$I_{BS}\tau_S = \left(0.7-\frac{10}{30}\right)10^{-3}\times800\times10^{-9} =$ 294 pico-coulombs
$Q_v = 2\times11.0\times10^{-12}\times4.8 =$ 106 pico-coulombs
$\therefore Q_{OFF} = \Delta I_c\, \tau_{CO} + I_{BS}\, \tau_S + Q_v$
= 700 pico-coulombs

Depending on the final reverse bias on the emitter junction, the value of Q_{OFF} will be increased by the charge on the emitter depletion layer capacity.

The basic parameters β, C_{tc}, C_{te}, τ_C and τ_S are necessary and sufficient to define the transient response of a transistor, but two other dependent quantities are sometimes quoted: these are β_S and Q_{OFF}.

β_S is defined as the collector current almost immediately available on closing the collector circuit, per unit steady base current. When a transistor delivering a low or zero collector current is bottomed, the same base current I_B is sometimes insufficient to meet an immediate demand for an increased collector current of up to $\beta_O I_B$ without allowing the transistor momentarily to come out of bottoming: the collector current almost immediately available is in fact $\beta_S I_B$. A very brief transient of collector current lasting less than $\frac{1}{4\omega\alpha}$, appears before the current $\beta_S I_B$ is reached, and for this reason the definition of β_S refers to a current "almost immediately available . . ." to avoid ambiguity.

Theoretically it may be shown that $\beta_S = \frac{\tau_S}{\tau_{CO}}$ though this is not always an accurate relationship in practice.

A maximum value of Q_{OFF} is basic to the design of most switching circuits, but since Q_{OFF} is the total of several independent variables, it cannot easily be controlled to a maximum value except by direct measurement. Information in the form of Q_{OFF} however, is only useful when the application closely resembles the circuit in which the measurements are made.

The next "Aspects of Design" in this series will deal with the significance of charge storage parameters in switching circuits, and their use in predicting response times.

Associated Electrical Industries Ltd
Radio and Electronic Components Division
Technical Service Department
155 Charing Cross Road, London, W.C.2
Tel: GERrard 8660. Grams: Sieswan, Westcent, London

EDISWAN MAZDA U191

Efficiency Diode for a.c./d.c. Mains Television Receivers.

Heater Current (amps)	0.3
Heater Voltage (volts)	19

MAXIMUM DESIGN CENTRE RATINGS

Mean Anode Current (mA)	$I_{a(av)max}$	120	150
Peak Anode Current (mA)	$i_{a(pk)max}$	600	450
Peak Inverse Anode Voltage (kV)	$PIV_{(max)}$	5*†	
Heater-Cathode Voltage (h−ve, pulse) (kV)	$V_{h-k(pk)max}$	5*†	
Heater-Anode Voltage (h+ve, pulse) (kV)	$V_{h-a(pk)max}$	3*	
Heater-Cathode Voltage (h−ve, d.c. + peak a.c.) (Volts)	$V_{h-k(max)}$	900	

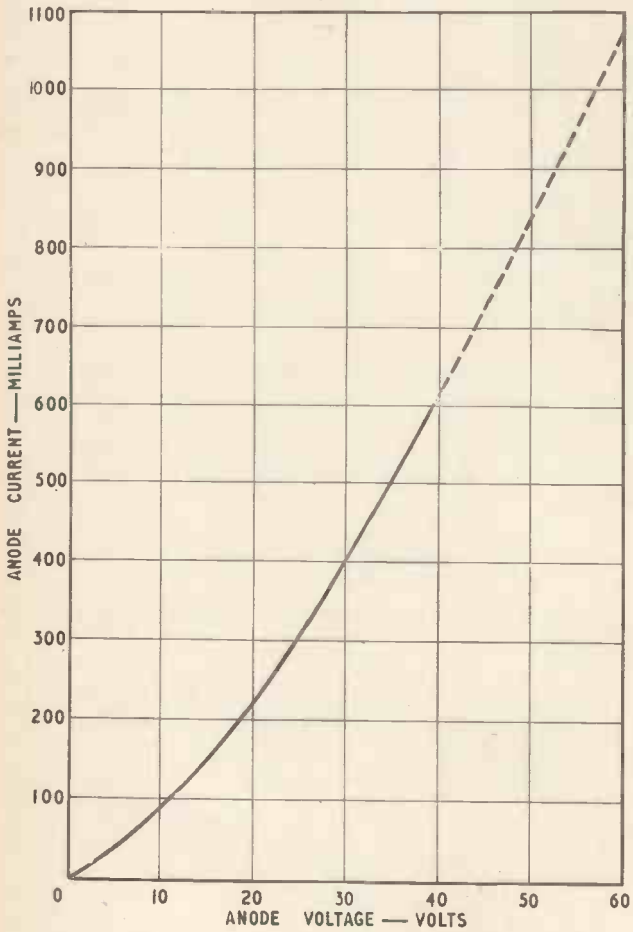
*Rated for television line scan where the duty cycle does not exceed 15% and the pulse duration does not exceed 15μs.

†An absolute rating of 5.9 kV must not be exceeded.

Inter-Electrode Capacitances (pF)

Anode to Heater and Cathode	$C_{a-h,\ k}$	7.7
Cathode to Heater and Anode	$C_{k-h,\ a}$	9.0

Characteristic Curve of Average Ediswan Mazda Valve Type U191



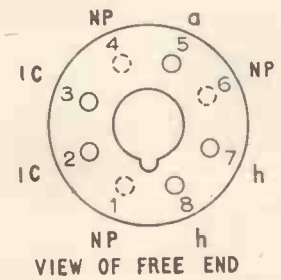
APPLICATION NOTES

The Ediswan Mazda U191 is designed specifically for use as the efficiency diode in conjunction with line scanning valves such as the 30P4 output valve in energy-recovery types of line scanning circuits in a.c./d.c. television receivers. The heater may be directly connected in the normal series chain as the insulation between heater and cathode is adequate to withstand the pulse voltages encountered in auto-transformer scanning circuits. This high voltage insulation generally results in high thermal inertia of the cathode, giving a much longer heating time than the remaining valves in a television receiver. In the U191, however, the thermal inertia has been reduced considerably so that there is only a delay of a few seconds between the warm-up of other valves in the receiver and the start of operation of the line scanning circuits. Besides reducing the waiting time for a picture to appear, this factor also alleviates problems of protection of valves where a line-gated system of automatic gain control is used.

See "Aspects of Design No. 20 'Wireless World' March, 1960—Efficiency Diodes for TV Line Output Stages" for notes on circuit considerations and limiting ratings.

Mounting Position: Unrestricted.

Base: International Octal (I05) **Top Cap:** CT1—Cathode.



Maximum Dimensions (mm)

Overall Length	90
Seated Height	77
Diameter	32

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quality equipment

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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.

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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 9½in. 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.

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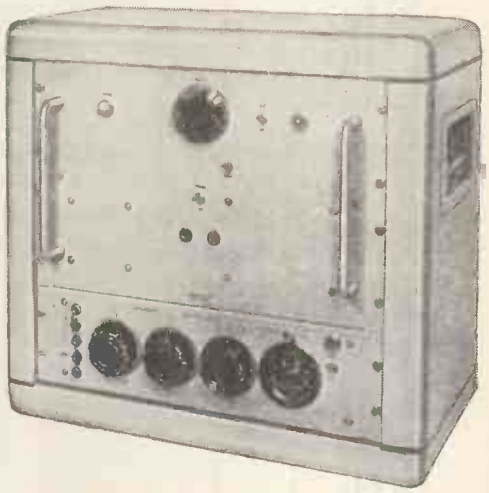

Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise lever —95 dB. A floating series parallel output is provided for 100–120 V. or 200–250 V. and this cool running amplifier occupies 12¼ inches of standard rack space by 11 inches deep. Weight 60lb.

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Price **£25**

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- TL/12 PLUS POWER AMPLIFIER
- SOUTHDOWN CABINET

TOTAL **£55:13s.**

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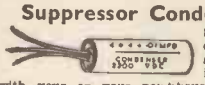

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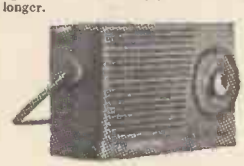
Suitable Wales, London, Midland, North, Scotland, etc. All the parts, including 2 EF80 valves, coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra.) Price only 19/6, plus 2/6 post and insurance. Data free with parts or available separately, 1/6.

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.



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Car Battery Charger—ready-made high output battery charger in stove enamelled sheet steel, louvred 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.

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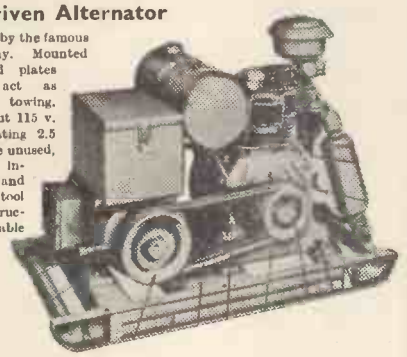
Miniature motor 2½in. long × 1½in. diameter, laminated poles and armature, separate winding for reversing. Operates off 20-30 v. D.C. or off A.C. mains through stepdown transformer. Original cost at least £3 each. Snip price for one month only 8/6. Plus 1/6 postage and insurance.

Petrol Driven Alternator



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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.

Midget 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 ¼in. spindle for transistor of Crystal set, 3/9, ditto with spindle tapped 6BA, 4/-.

Transistors tested suitable as mixers, 9/6 each. Suitable as I.F. amplifiers 8/6. Suitable for R.F. and Regen. circuits 6/6, matched pairs for Push-Pull Output 16/- a pair. High 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.

Dinghy Mast, tubular aluminium, extends from 15in. to 9ft. Price 4/6.

Magneto Generator (hand), as used in telephones. Price 7/6.

Push-Pull Transformers, input and output, midget, potted, price 5/- pair.

P.O. Type 3000 Relays. 2,000 ohm coil, 6 contacts 7/6, 4 contacts 6/6.

Versatile Wire, single strand, 18 gauge, with p.v.c. covering. New ½-mile on drum. Price 7/6 (3/6 carriage).

Wire Jointer (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.

B7G Holder, with skirt for screening can. Price 6d. or 5/6 dozen.

Metal Rectifiers, 250 v. 60-80 mA., ideal for mains set or instrument, or to replace that expensives 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).

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250-0-250 60/60 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.

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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, 50K1 100K, 250K, 1 meg., 2 meg., Gang type 3/- each—values available: 5K + 5K, 100K + 100K, ½ meg. + ½ meg., 2 meg. + 2 meg.

Heavy Duty Thyratron

Heater 5 volt 20 amp. Peak anode 16,000 volts. Peak plate current 120 amps. Unused, perfect condition. £5.

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.

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Manor Park, E.12.
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The Electronic Engineering Association and the Radio Industry Council are to award premiums of 25 guineas each for articles, which, in the judges' opinion, are likely to enhance the reputation of the Radio and Electronics Industry and to focus attention throughout the world on British leadership in these fields.

ARTICLES to be judged must EITHER
(a) concern British achievements in radio, television and electronics and have been published, between January and December of any one year, at home or abroad in registered newspapers or journals available to the public, OR
(b) be devoted to electronics and have been published in trade or technical journals serving the steel, food, atomic energy and other industries in which electronic control and production are being increasingly used, OR
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WRITERS who are salaried wholly or mainly for writing or who are earning 25% or more of their incomes from fees for articles or from royalties are NOT eligible. Joint awards may be made, but BOTH or ALL the writers concerned must be eligible.

CRITERIA will, principally, be :- The value of the article in making known British achievements in radio and electronics; technical merit; originality; presentation and clarity. Importance is also attached to arousing and sustaining interest of lay personnel, such as executives and administrators, and not simply scientists and technicians.

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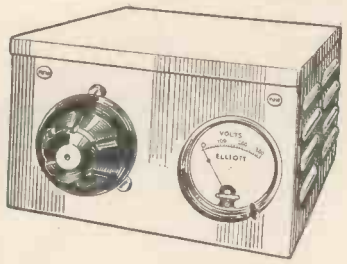


BRAND NEW VARIABLE VOLTAGE TRANSFORMER. 230 volt A.C. input. Fitted in steel hammer finish case complete with 0-300 volt M.C. A.C. Meter, fuse and neon indicator light. Output constantly variable from 0-270 volt A.C. Type 1. 2.2 amp. Price £8/10/-., carriage 10/-. Type 2. 5 amp. Price £12, carriage 10/-.

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.

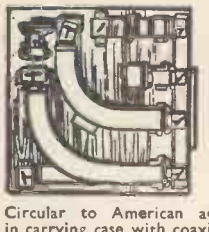
EX P.O. MAGNETIC COUNTER. 3 ohms type for 4½/6 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

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. Also 60 watts, 19/6 each. Plug P. & P. 2/-.

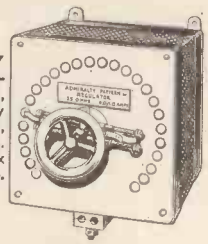
AUTO TRANSFORMER
Air cooled, very conservatively rated at 3 kVA., will handle 6 kVA. Tapped 220/230/240/250 volt, 12 amp. 105/110/115/120 volt, 28.5 amp. Brand new. Each one shrouded in a metal case and packed in original manufacturer's wooden case. Price £15. Carr. £1. Nett weight over 2 cwt.

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. Tapped 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.

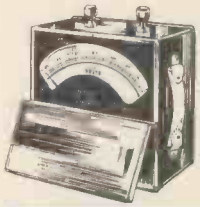


WAVE GUIDE 3 cm., mounted on a carrying board consisting of: (1) directional coupler. (2) 90 degree bend. (3) co-ax to wave guide adaptor type N. (4) British to W.916. (5) Co-ax to wave guide adaptor circular flange. (6) Circular to American adaptor. Complete in carrying case with coaxial-cable. Price 60/-. Carr. 10/-.



ROTARY SWITCH REGULATOR. 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 8in. mirror scale. Accuracy 2% £4/19/6 each. P. & P. 3/6.

BRAND NEW FREQUENCY METERS manufactured by Crompton Parkinson. Calibrated 45 cycles to 55 cycles per second. 6in. dial. Panel mounting type. In original manufacturers' boxes. PRICE £10/15/- each. 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.

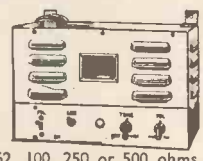
10 WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/-. P. & P. 1/6.

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.

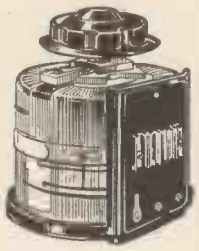
NEW MOVING COIL HEADSETS. Complete with Tannoy carbon hand microphone, with plug suitable for No.19 set. Price: 12/6 each, plus P. & P. 2/-.

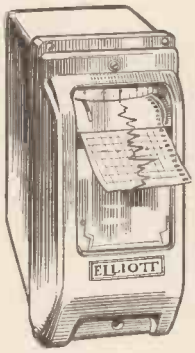


12 v. D.C. AMPLIFIER, as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7½, 15, 62, 100, 250 or 500 ohms. £9/17/6 each. Carr. 15/-.

MIDGET ROTARY TRANSFORMERS. 2½in. dia. x 4½in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 12/6 each. P. & P. 1/6.

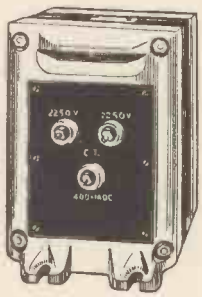
VARIABLE VOLTAGE TRANSFORMER. "BERCO." Brand new in manufacturer's boxes. For 110 volt A.C. Input. Constantly variable from 0-135 volts. 2.2 amp. type. £4. P. & P. 3/-. 5 amp. type £6/10/-. P. & P. 3/6.





ELLIOTT SWITCHBOARD MOUNTING PEN RECORDER. 2¾in. 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/-.

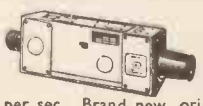


NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6 x 2 v. separate cells connected by terminal strips. 6 x 5½ x 4¼in. over terminals. Price 19/-, plus P. & P. 2/9. Wooden carrying case for same with lid and strap price 3/6.

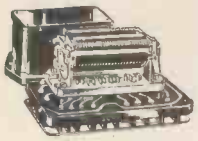
245 AMP. 2 VOLT ACCUMULATOR. Admiralty type in wooden casing. Size 15 x 7½ x 7½in. Weight 60 lb. Unfilled, uncharged. New. Price £4. Carriage 10/-.

MINIATURE P.M. MOTOR. 12/24 volt, reversible. 1¼in. 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.



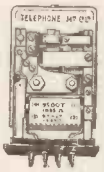
SLIDER RESISTANCES. 2 amp. 500 ohms, size 14in. x 6in., plus handle 6in., **27/6**. P. & P. 3/6.

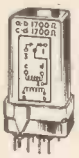


SOLENOID OPERATED MAGNETIC RELAY. Type 5CW/3945, 4 pole changeover, 10 A contacts 24 v. operation. Brand new **13/6**. P. & P. 1/6.

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 2½ 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 1¼ x ⅝ x ¾in. Price **22/6** each.

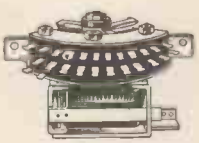
G.E.C. SEALED RELAY. Type M.1090. 180 ohms coil. 6/12 volt. 4 C/O. Brand new, **18/-**. P. & P. 1/-.

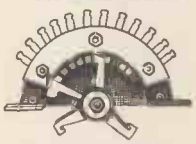
G.E.C. SEALED RELAY. Type M.1092. 680 ohms coil. 12/24 volt. 4 C/O. Ex new equipment. Unused. **10/-**. P. & P. 1/-.

G.P.O. 600 TYPE RELAY. 400 ohms coil. 24 volt. 2 C/O plus 2 M. New **7/6**. P. & P. 1/-.

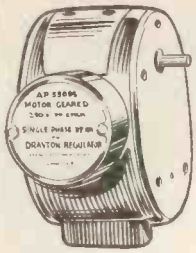
MINIATURE OPEN TYPE RELAY. 700 ohms coil. 24 volt. 2 C/O. Ex new equipment. Unused. **7/6**. P. & P. 1/-.

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.





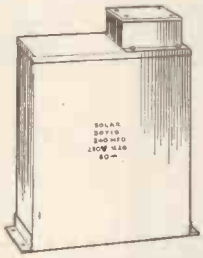
MINIATURE UNISELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohm coil for 24 volt operation. Brand new, manufacturer's packing. Price **22/6** each. P. & P. 2/6. As illustrated.



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 5½in. Weight 4½ 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 5½in. 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. 4½in. 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/-.

DESK TELEPHONE HANDSETS Brand new (perfect) complete with two-way calling system (buzzer), internal battery. All ready for simple two-wire connection. Price **£3/5/-** each, or **£6/5/-** the pair. P. & P. 3/6 each unit.

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 ½ 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/-.

CERAMIC PRECISION SWITCH. 2 pole, 6 way, 4 banks. New in manufacturer's boxes. Price **10/6** 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 2½ amp., 230 volt, 24 hour phase, ¼ 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

2½ amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2½in. fl. rnd.	11/6
7½ amp. D.C. M.I. 3½in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2½in. 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. 4½in. fl. rnd.	32/6

Voltmeters

12 v. D.C. M.C. 2½in. 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. 2½in. fl. rnd.	27/6
300 v. A.C. M.I. 2½in. fl. rnd.	22/-
400 v. A.C. M.I. 4½in. rnd.	35/-

Milliammeters

1 mA. M.C. 2½in. fl. rnd.	25/-
200 mA. M.C. 2½in. fl. rnd.	12/6
500 mA. M.C. 2½in. fl. rnd.	9/6

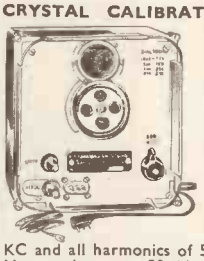
Microamp

50 microamp., scaled 0–100, M.C. 2½in. fl. rnd.	42/6
50 microA. 2½in. square, side fitting scales	35/-
500 microamp., M.C. 2½in. rnd. F.L. scaled 15/600 volt.	16/6

Postage on all meters 1/- each.

Miniature latest type moving coil 0-5 milliamp meter, 1½in. 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

OR DEPOSIT £5/7/6 and 12 monthly payments of 42/-. Cash price if settled in 3 months.

Build a high quality recorder in the £70 class for only **25½** GNS. Carr. 17/6.

Can be assembled in ½ hour.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR, THE LINEAR LT45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7×4in. LOUDSPEAKER, Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 16×13×9in., finished in two-tone rexine, and connection diagram for wiring amplifier to transcriptor.

FEATURES INCLUDE

★3 SPEEDS ★FREQUENCY RESPONSE 50-11,000 c.p.s. ★SWITCHED NEGATIVE FEEDBACK EQUALIZATION FOR EACH SPEED. ★OUTPUT 4 WATTS. ★MAGIC EYE RECORDING LEVEL INDICATOR. ★3 MOTORS. Fast rewind. ★TAPE MEASURING AND CALIBRATING DEVICE. ★TAKES FULL 7in. DIAMETER REELS OF TAPE. ★NEGLIGIBLE HUM. ★ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

Full descriptive leaflet supplied on receipt of S.A.E.

HI-FI 10 WATT AMPLIFIERS

BRAND NEW BUT IN SLIGHTLY SOILED CONDITION **6 GNS.** Carr. 7/6

A REMARKABLE OPPORTUNITY

Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed, tested and in perfect working order. 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 (specially 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.

Parmeko 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. and 200 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 5½×4½×2in. 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 8×5½×2½in. 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.

B.S.R. MONARDECKS. As fitted to most tape recorders in the £26/£30 class. With a suitable amplifier and speaker really excellent recordings can be made at 3¾in. per sec. 9 GNS. Carr. 5/-.

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, 8P61, 6F6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram, instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

EXTENSION SPEAKERS. Handsome walnut veneered cabinets. All standard 2-3 ohms. 6½in. 29/9; 8in. 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 really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

Carr. and packing 7/6.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves EZ81, ECC83, EC83, ECL84, 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	
2/6 v. ½ a. h.w. ..	1/9
6/12 v. 1 a. h.w. ..	2/9
Following F.W. (Bridge)	
6/12 v. 1 a.	3/11
6/12 v. 2 a.	6/11
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

H.T. Types H.W.	
120 v. 40 mA.	3/9
250 v. 50 m.A.	3/11
250 v. 60 mA.	4/11
250 v. 80 mA.	6/11
250 v. 250 mA.	12/9
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 2 watts. 17/9. OC71 10/-. OC72 16/9. XB102 10/-. XB104 10/-. XA101, XC101, OC44 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.

COLLARO STUDIO TAPE TRANSCRIPTORS incorporating 3 motors. Provision for extra head for stereo. Speeds 1⅞, 3¾, 7½in. per sec. 15 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.

Battery Chargers and Kits for 200-230-250 v. 50 c/s. A.C. Mains

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. 1½ a.	12/9
0-9-15 v. 2½ 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. (inclusive of ammeter)	42/9
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

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 **49/9** Carr. 3/9.

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. **69/9**

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 stove soiled and is being offered at well below usual price

LINEAR L45 MINIATURE 4/5 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 6×5×5in. 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.

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. × 4in. speaker, Long and Medium waves. Size approx. 7×4×3in. Total cost of all parts 5 GNS.

POWER PACK 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.

P.M. SPEAKERS. 2-3 ohm 2½in. Perdio 21/9. 5in. Goodmans 17/9. 7×4in. R.A. Elliptical 19/9. 6½in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 25/9. 8×6in. Elac. with high flux magnet 25/9. 10in. R.A. 28/9. 10×6in. Elliptical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms. 10 watts, 12,000 lines, 59/6.

TWEETERS. 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, ECC38, 807, 807, GZ34. Tone Control Pre-Amp stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram., etc., etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 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.** Carr. 10/-. Or Factory built with 12 months' guarantee **£13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9** and 12 monthly payments of 24/9.

Cover as illustrated **18/9** extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 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 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 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.**

FULL RANGE OF LINEAR HIGH FIDELITY AMPLIFIERS ALWAYS IN STOCK.

GL3A MINIATURE 3 WATT GRAM AMPLIFIER

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11¼×2½×2¼in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 59/6.

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.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA and L.T. of 6.3 v. 1.5 A. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-** or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

R.S.C. TRANSFORMERS

Fully Guaranteed. Interleaved & Impregnated.

WE CAN QUOTE FOR SPECIAL OR STANDARD TYPES IN ANY QUANTITY. OUR FACTORY HAS SUPPLIED LEADING EQUIPMENT MANUFACTURERS AND GOVT. DEPTS. FOR 15 YEARS.

MAINS TRANSFORMERS. Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING.

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., 2½-3-3½in...	17/11
250-0-250 v. 100 mA., 6.3 v. 4 a. 5 v. 3 a.....	25/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.....	25/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.....	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.....	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t. 5 v. 3 a.....	49/9

TOP SHROUDED DROP-THROUGH TYPE

260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a., 2½-3-2½in.	16/11
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.....	18/9
250 0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.....	23/9
300-0-300 v. 100 mA. 6.3 v. 4 a., 5 v. 3 a.....	23/9
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t. 6.3 v. 1 a., suitable for Mullard 510 Amplifier.....	29/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.....	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.....	29/9

ELIMINATOR TRANSFORMERS.

120 v. 40 mA., 5-0-5 v. 1 a.....	14/9
90 v. 15 mA., 6-0-6 v. 250 mA.....	9/11

FILAMENT TRANSFORMERS

6.3 v. 1.5 a.	5/9	12 v. 1 a.	7/9
6.3 v. 2 a.	7/6	6.3 v. 3 a.	8/11
0-4-6.3 v. 2 a.	7/9	6.3 v. 6 a.	17/6

AUTO (Step Up/Step Down) TRANSFORMERS

50-80 watts 110-120 v./230-250 v.....	11/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc...	3/9
Small Pentode 5,000Ω to 3Ω	3/9
Standard Pentode 5,000Ω to 3Ω	5/9
Standard Pentode 8,000Ω to 3Ω.....	5/9
Push-pull 8 watts 6V6 to 3 ohms.....	8/9
Push-pull 8 watts EL84s to 15 ohms.....	8/9
Push-pull 10-12 watts 6V6 to 3Ω or 15Ω.....	16/9
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω	17/9
Push-pull EL84 to 3 or 15 ohms.....	17/9
Push-pull Ultra Linear for Mullard 510.....	27/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., for 3 or 15 ohms.....	23/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω.....	47/9

MICROPHONE TRANSFORMERS

120 : 1 High quality clamped.....	6/9
120 : 1 High quality Mu metal screened	8/9

SMOOTHING CHOKES

250 mA., 5 H., 100Ω	11/9	80 mA., 10 H., 350 Ω	5/6
150 mA., 7-10 H.,250Ω	11/9	60 mA., 10 H., 400 Ω	4/11
100 mA., 10 H., 200Ω	8/9	1 amp., 0.5Ω L.T. type	6/6

PARMEKO MAINS TRANSFORMERS. Fully shrouded.

500-0-500 v. 120 mA., 6.3 v. 4 a. 5 v. 3 a.....	31/9

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 A.10 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/cs. Six negative feedback loops. Hum level 60 D.B. down, ONLY 23 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 nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra.)

ONLY **8 Gns.** Carr. 10/-

If required louvred 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.

R.S.C. PORTABLE GUITAR AMPLIFIERS

JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls, Sensitivity 15 mv. High Flux 8in. l/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (size approx. 14×14×7in.) Finished in eggshell Policrome 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 7×4in. elliptical for Treble. Cabinet finish as Junior Model. Size approx. 18×18×8in. **15 Gns.** Plus 10/- carr. **H.P. TERMS. DEPOSIT 26/9** and 12 monthly payments **26/9.** Both models for 200-250 v. A.C. mains.

STAAR GALAXY 4-SPEED MIXER AUTO-CHANGERS. Brand New, cartoned. Turnover sapphire styli. Many exclusive features. Unique design motor virtually free from rumble For 200/250 v. A.C. mains. Limited number tested and guaranteed **£5/19/6.** Carr. 4/6.

COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. Latest model for 200-250 v. A.C. mains **£6/19/6.** Carr. 4/6.

B.S.R. MONARCH AUTO-CHANGERS. Type UA8 4 speed T/O Pick-up with sapphire stylus **£6/19/6.** Carr. 4/6.

Any of above supplied with T/O stereo/monaural head for **£1** extra.

COLLARO JUNIOR. 4-speed Single Players with Hi-Fi T/O crystal pick-up head, **£3/19/6.**

LOUDSPEAKER IN VENEERED WALNUT FINISHED CABINET. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4/19/6.** Carr. 5/-. **TERMS: DEPOSIT 11/-** and 9 monthly payments of **11/-.**

12in. 20 WATT 15,000 line l/speakers 15 ohms in Cabinet finished as above. Size 18 × 18 × 8in. **£7/19/6** or Deposit **13/10** and 12 monthly payments of **13/10.**

ACOS HGP59 Hi-Fi Crystal Cartridges. (Turnover type with sapphire stylus). Standard replacement for Garrard and Collaro. Only **19/9. B.S.R. Fui-Fi 19/9.** Garrard GC2 **19/9.** Acos Stereo/Monaural **49/9.**

ACOS HIGH FIDELITY PICKUPS. GP54 with HGP59/52 Cartridge. Turnover sapphire styli, cream finish. Limited number at approx. half price. Only **29/11.**

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only **£5/17/6** Or Deposit **10/6** and 12 monthly payments of **10/6**

R.S.C. (LEEDS) LTD. MANCHESTER, LEEDS & BRADFORD

Open to callers at the following branches:—
5-7 County (Mecca) Arcade, Leeds, 1.
54-56 Morley Street (above Alhambra), Bradford.
8-10 Brown Street (Market St.), Manchester, 2.

TERMS: C.W.O. or C.O.D. No. C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage stated. Trade supplied. Post orders to: **Mail Order Dept. 29-31 Moorfield Road, Leeds, 12.**

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 O/put Trans.)..... **£10.0.0**

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

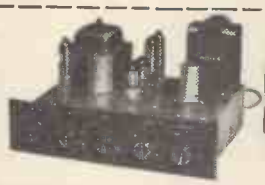
Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER, but also perfectly suitable for other makes.

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 **£6.6.0** 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.

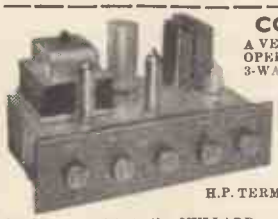
Price: COMPLETE KIT. Parmeko Transformer..... **£11.10.0**

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 Turner.

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 Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER £4 2 6
(b) The PORTABLE CARRYING CASE £3 17 6
(c) 6½in. P.M. SPEAKER.... 18 9

(Carriage and Insurance 4/- extra)

"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. £1/6/2 **£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 3¾in./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 MICROPHONE, one for CRYSTAL PICK-UPS and a Fourth for Radio or Tape.

COMPLETE KIT OF PARTS **£8.8.0**

ASSEMBLED AND TESTED **£10.0.0**

Terms Deposit £2 and 12 months at 15/-.

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.

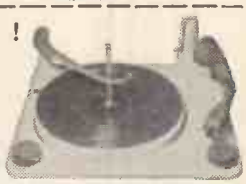
KIT OF PARTS..... **£8.10.0** or ASSEMBLED.... **£10.10.0**

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 STEREOPHONIC 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 m/v.

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/-.

! ! RECORD PLAYERS ! !



The LATEST MODELS are in Stock.
Many at REDUCED PRICES ! ! !
Send S.A.E. for ILLUSTRATED LEAFLET

B.S.R. MONARCH UA8 4-spd. Mixer Autochanger with Crystal Pick-up **£6.19.6**
The COLLARO "CONQUEST" 4-spd. Autochanger, Studio "O" Pick up **£7.10.0**
The NEW COLLARO Model RP594, 4 speed Single Record Player, Studio Cartridge **£9.18.9**
The COLLARO 4-speed Single Record Player, incorporating the Studio "O" Pick-up **£6. 9.6**
THE NEW B.S.R. Model UA12 is in stock. A 4-"SPEED" MIXER AUTOCHANGER **£8. 7.6**
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 **£10.10.0**
The latest GARRARD TRANSCRIPTION MOTOR "301" with Stroboscopically marked turntable. **£23.18.4**
The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.S. Crystal Cartridge **£18.7.6**
GARRARD Model TA/Mk. II Single Record Player fitted with high output Crystal Pick-up, detachable head **£8.10.0**

HIRE PURCHASE TERMS available on all units £8/19/6 and over
Carriage and insurance on each above 5/- extra.

! ! HOME CONSTRUCTORS ! !

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS

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 screwdriver is required.

Fully illustrated leaflets are available, including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

TO BUILD YOURSELF

ALL PARTS AVAILABLE SEPARATELY

WE ARE EXPERTS IN THIS FIELD AND CARRY THE MOST COMPREHENSIVE STOCKS IN THE COUNTRY.

	All required components at special inclusive price	P. & P.	Instruction Book and itemised price list available separately
(1) New Look " RAMBLER all dry s'het portable **NEW LOW PRICE**	£6 19 6	2/6	1/6
(2) " RAMBLER " Mains Unit (suits most portables)	£2 7 6	1/6	9d.
(3) " ECONOMY FOUR " T.R.F. Mains Receiver	£5 5 0	2/6	1/6
(4) " ECONOMY FOUR " with New Look Cabinet	£5 10 0	2/6	1/6
(5) " FAMILY FOUR " (our new T.R.F. Receiver)	£3 19 6	2/6	1/6
(6) " SUPERIOR FOUR " (four valve mains receiver)	£5 15 0	2/6	1/6
(7) Standard JASON F.M. Tuner FMT1	£6 15 0	2/6	2/-
(8) Fringe area JASON F.M. Tuner FMF	£7 15 0	2/6	2/-
(9) JASON " MERCURY 2 " Switched F.M. Tuner plus ITA/B.B.C. Sound	£10 10 0	2/6	3/6
(10) OSRAM 912 Printed circuit F.M Tuner. **NEW LOW PRICE**	£5 19 6	2/6	2/6
(11) JASON " ARGONAUT " AM/FM Chassis	£15 5 0	2/6	2/-
(12) JASON " ARGONAUT " AM/FM Tuner	£13 19 6	3/6	2/-
(13) F.M. Power Pack (suitable for most tuners)	£1 17 6	1/6	1/-
(14) R.C. 3/4 watt Amplifier (with Bass, Middle and Treble controls)	£4 5 0	2/6	1/-
(15) 2-amp. Battery Charger	£1 16 6	2/6	3d.
(16) R.C. Transistor/Crystal Receiver ('phones extra)	£1 1 0	1/3	3d.
(17) R.C. Super Transistor/Crystal Rec. (ditto)	£1 7 6	1/3	3d.
(18) R.E.P. 1-valve Battery Receiver	£2 2 0	2/-	9d.
(19) " CRY-BABY " ALARM (Baby Alarm)	£3 12 6	2/6	1/-
(20) MULLARD 510 Amplifier (printed circuit) Ultra Linear Version	£9 9 0	3/6	1/6
(21) MULLARD 510 as above plus input selector and spare power supplies	£11 10 0	3/6	2/6
(22) " DE-LUXE " Printed Circuit Superhet	£7 19 6	3/6	1/6
(23) " DE-LUXE " with New Look Cabinet	£8 4 6	3/6	1/6
(24) JASON J.T.V. 2 Tuner	£13 19 6	3/6	2/6
(25) RADIO JACK	19 6	1/6	6d.
(26) MULLARD TYPE " C " Tape pre-amp.	£12 9 6	3/6	2/6
(27) JASON WII Wobbulator	£14 19 0	3/6	3/6
(28) JASON Valve Voltmeter EM10 (23 ranges)	£18 10 0	3/6	2/6
(29) NEW JASON F.M. TUNER FMT2 with built-in power supplies and cabinet	£8 19 6	3/6	2/6
(30) NEW JASON FRINGE F.M. TUNER FMT3, as above	£10 19 6	3/6	2/6
(31) PULLIN Series 90 TEST METER	£5 19 6	2/6	1/6
(32) R.C. Super Personal Portable 1-valve (phone extra)	£1 15 0	2/6	2/-
(33) R.C. Super Personal Portable 2-valve (phone extra)	£2 1 0	2/6	2/-
(34) R.C. TRANSETTE 2-Transistor Personal Portable	£3 9 6	2/-	2/-
(35) JASON EVEREST 6-Transistor 2-wave Portable	£13 19 9	3/6	3/6
(36) JASON EVEREST 7-Transistor 2-wave Portable	£15 18 9	3/6	3/6
(37) CLYNE Cathode Ray Oscilloscope	£12 19 6	5/-	10/-
(38) Compact Multi-range Test Meter	£2 19 6	1/6	1/6
(39) CAR RADIO, Printed Circuit, 5-valve S'het. **NEW LOW PRICE**	£11 19 6	3/6	2/6
(40) JASON Audio Generator AG10	£14 5 0	3/6	2/6
(41) JASON Oscilloscope OG10	£22 10 0	5/-	3/6
(42) Super SHORT WAVE RADIO, 1 valve	£1 15 0	2/-	2/-
(43) " WAVEMASTER " 7-Transistor Luxury Portable	£10 19 6	3/6	2/6
(44) " GOLD STAR " De-luxe 1-valve Portable	£1 17 6	2/6	1/6

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

(43)

To build yourself Medium and Long Waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6¾in. x 4¼in. at base tapering to 4in. at top.

Very attractive two-tone grey Vynide 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.

TWO-TRANSISTOR PERSONAL PORTABLE. 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. 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, Deaf-aid type earpiece, wiring wire and even solder. **ONLY 69/6** plus 1/6 P. & P., or complete with single standard High Resistance earphone at ONLY 62/6. Plus 1/6 P. & P. Parts price list and Easy Lay-out Plans 2/- post free.

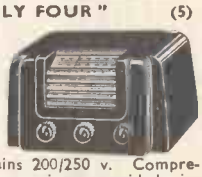
(34)

PRINTED CIRCUIT CAR RADIO (for Home Construction).

(39)

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.

" FAMILY FOUR " (5)

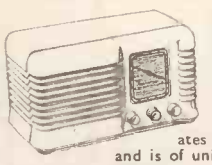


Our supersensitive T.R.F. Receiver for home construction. Covers Long and Medium Wavebands, is housed in very smart plastic table cabinet in Brown or Black. For A.C. mains 200/250 v. Comprehensive assembly instructions provided, including practical and theoretical diagrams, which are easy to follow and 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 DLR5 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).

● 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 Cheapside, London, E.C.2.

DE LUXE TAPE RECORDER CABINET

29/9

Beautifully made Tape Recording Cabinet. Size: 13" × 10½" × 7". 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.

17" T.V.s COMPLETE

19 gns. Deposit £7 and 20 weeks at 15/-. Carr. & Ins. 30/-

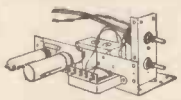
Beautifully styled polished cabinets. ITV/BBC. These are table models with option on contemporary legs fitted (2 gns. extra). 17" rectangular tube guaranteed for 12 months. Valves and chassis guaranteed for 3 months. (Chassis salvaged but reconditioned). Where possible personal collection is advised.

AMPLIFIERS

All portable. 12 months' guarantee.

MK. D.1

59/6



Brand new. Latest design, with printed circuit. Dimensions 7" × 2½" × 5". A.C. only. Mains isolated 3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs 2/6 extra. P. & P. 2/6.

MK. D.3 **89/6**

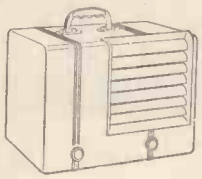
De Luxe Model. Printed circuit. Latest design. Dimensions 7" × 2½" × 5". A.C. only. Mains isolated 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume, treble and base control. Knobs 3/6 extra. P. & P. 3/6.

MK. D.5 **39/6**

Simple circuit employing ECL80 triode pentode output valve giving 2-3 watts output. A.C. only. Mains isolated. Single control for volume and on/off switch with knob. P. & P. 3/6.

THE "NEW LOOK" PORTABLE GRAM AMPLIFIER

ONLY **99/6**



STEREO MICROPHONE GUITAR RECORDS

Ideal for stereo attachment. Well styled cabinet in Brown/Ivory with carrying handle. Contains 8in. high flux speaker. For use A.C. or D.C. mains. 3 valves 10 I.F., 10P14 and U404. Maximum output 4.5 watts. Size 14" × 11" × 6½". Wonderful for HOME, HALL, AMATEUR THEATRICALS. 2 units can give a world of amusement and stereo effects. Ideal for works and offices as loud hailer, for election speaker and public address. Ready for immediate use. 12 months' guarantee. P. & P. 5/6.

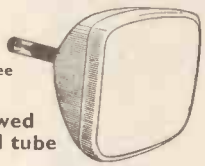
Terms: Deposit 30/- plus P. & P., and 10 weekly payments of 8/-.

MONEY BACK IF NOT DELIGHTED

EXTRAS: Mike 27/6; Record changer £6/19/6; Extra loud speaker in contemporary cabinet 19/9.

REPLACEMENT, REBUILT T.V. TUBES

12 months' guarantee



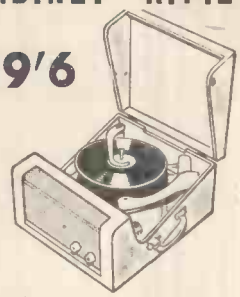
Carr. & Ins. 15/6.

21 in. TUBE £8.10.0
17 in. TUBE £7.10.0 **£2** allowed on old tube
12, 14, 15 in. TUBES £5.10.0 **£1** allowed on old tube

— TERMS AVAILABLE OVER 20 WEEKS—

RECORD PLAYER CABINET R.P.2

59/6



Made by famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size: 16" × 14½" × 8½" deep. Carr. & Ins. 4/6. Will take B.S.R. Monarch 4-speed Autochanger £6/19/6; 7" × 4" Elliptical Speaker 15/9; and our Mk. D.1 Portable Amplifier 59/6.

T.V. CHASSIS FOR SPARES 9/6

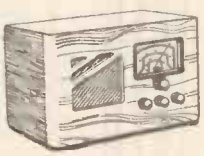
EX PLESSEY

56 resistances. 54 condensers. 13 valve holders. 4 transformers. Chokes 250 ma. Metal rectifiers 300 volts @ 250 m.a. Fuse panel. Focus magnets. Plugs. Sockets. Carr. 7/6.

SOLO SOLDERING TOOL 12/6

110v. 6 v., or 12 v. (special adaptor for 200/250 v., 10/- extra). Automatic solder feed including 20ft. reel of Ersin 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 3/6.

HOME RADIO 79/6



Terms: 10/- deposit and 10 weekly payments of 8/-. A.C.5 valve octal superhet. 3 waveband receiver. In attractive polished cabinet. Dimensions: 9¾" × 18½" × 11¾". Carr. & Ins. 4/6.

EXTENSION SPEAKERS 19/9

8" P.M. Speakers fitted into polished cabinets. Standard matching to any receiver (2.5 ohms). Complete, switch and flex included, P. & P. 3/9.

CONTEMPORARY EXTENSION SPEAKERS 19/9

Ideal for extra stereophonic speaker. Covered in smart two tone leatherette. Beautifully made. Including 8" speaker. P. & P. 3/9.

BARGAIN SPEAKER. 5/9
8" P.M. cone. Defect now repaired, not affecting reproduction quality.

8" P.M. SPEAKER. 6/9
As above, with output transformer.

8" P.M. SPEAKER. 9/9
Highest quality, fitted output transformer.

ELLIPTICAL SPEAKER. 15/9
8" × 3" and 7" × 4". Brand new.
Also 9" × 4", 19/9.
P. & P. on each 2/9.

VALVES. IDEAL FOR SPARES. SALVAGE/GUARANTEED

9d. 1D6, 3D6, 4D1, 6B7, 6B8, 7B7, 8D2, 9D2, 11D3, 12BE6, 12Y4, 15D2, 18, 75, 78, 210VPT, 1203A, 2050, 2151, 7193-2C22, AR6, ARP18, CV73, CV188, D1.EA50, EB34, EF36, EF37, EF50-638PT, GT1C, KT24-ARP18, KTZ41,LP220,NGT2,PM202, PP225, QP21-VR35, SP41, SP61, T41, TT11.VR21, VR35, VT61A.

2/9 6C4, 6F1, 6F12-Z77, 6F13, 6F14, 6F15, 6J5 6K7, 7Y4, 7D5, 10F1, DF66, DH81, EAF42, EBC41, EF42, EF91-8D3, EF92, EL32, KT33C, KT81, KTW61, P61, PEN45, PEN46, PL33, U22, UF41, UU6.

7/9 5U4, 5Y3, 6CK5-EL41, 6K8, 6SL7, 6SN7 6P28, 6V6, 6X5, 12AT7

SOUND/VISION STRIPS. 2/9
I.F.'s 10.5-14 Mc/s. 8 valve holders and I.F.'s 16-19·5 Mc/s., 8 valve holders. P. & P. 2/6.

SCANNING COILS. 7/9
Wide angle. 90°. 38 mm. Low Imp. Postage 1/3.

FOCUS MAGNETS. 5/9
Brand new. 38 mm. Incpor. picture shift control. P. & P. 1/3.

GERMANIUM CRYSTALS. 9d. each or 6/- doz.
Brand new. Long wire ends. List price 4/9. Postage on 1 4d. Postage on 1 doz. 9d.

INSULATING TAPE. 1/6
Finest quality. In metal container (75ft. × ½in.). Postage on 1 tin 9d., on 6 tins 2/-.

RECTIFIERS. 2/9
250 v. 100 ma. Full or half wave. Post & Packing 1/3.

CO-AX CABLE. 6d. yd.
Good quality, 1/6 postage on 20 yds.; 45/- per 100 yds., P. & P. 3/6.

LATE EXTRA! JUST ARRIVED!

RECORD PLAYER CABINET R.P.9

Exceptional offer. A lightweight portable player Cabinet in two-tone Rust and Cream. Famous manufacturer. Size 14½in. × 11½in. × 6in. Complete with moulded deck board of attractive design. Takes B.S.R. TU9 Single player; 2 control Amplifier; 5in. round speaker. Post, Packing and Ins., 4/6.

19/6

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LASKY'S RADIO

AMAZING NEW TAPE RECORDER BARGAIN OFFER

A complete Tape Recorder using Collaro Studio 3-speed Deck, 1⅞, 3¾, 7½ i.p.s. Twin track, with pause control, rev. counter, latest type electronic recording indicator. Superimposing switch, volume and tone controls, 7×4 loudspeaker, 4 watts output. Takes 7in. spools. In contemporary design carrying case, 9½×16×16in. Brand new, fully assembled ready for use. Limited number.

LASKY'S PRICE 29 GNS. including Acos mike and 1,200ft. Scotch Tape. Carr. & ins. 25/-.

TAPE RECORDERS

Largest stocks in London.

BRENELL, 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 Transcriptor. Uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. l.s. jack, superimposing switch. Complete with gold/black knobs. **12 Gns.** Post 3/6.

PLASTIC TAPE SPOOLS

3in.	5in.	5¾in.	7in.	8¾in.
2/9	2/9	2/9	2/9	5/6

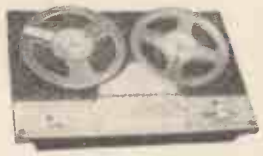
7in. Metal Spools, 1/9 each

Post extra.

"INSTANT" BULK TAPE ERASER

and Head Demagnetiser. Erases a complete reel of magnetic Tape in few seconds. 27/6. Post free.

TAPE DECK OFFERS



B.S.R. "MONARDECK" single speed, 3¾ i.p.s. uses 5in. spools. **Lasky's Price** including 850ft. Tape **£8/19/6.** Carr. free.

COLLARO STUDIO TAPE TRANSCRIPTOR. 3 motors, 3 speed, 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls. **£12/19/6** Carr. & Ins. 12/6. Tape extra.

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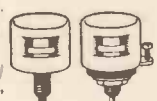
"Hi-Fi Journey with Lasky's" is the title of our superb new catalogue and it takes you all through the realm of high fidelity reproduction. Nothing like it has ever before been offered. Over 100 large pages, 11¼×8¼in. in photogravure and colour. It is a COMPARATOR-CATALOGUE to enable you to choose from all the latest and most advanced equipment. Price 3/6 part post 6d.

Fully refunded on making your first hi-fi purchase.

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. **39/6**

Lasky's Price, per pair, Post free. Worth double. Please specify upper or lower track.

SPECIAL OFFER OF TAPE

Famous make. P.V.C. base on latest type plastic spools. Brand new, boxed and guaranteed. 1,800ft. on 7in. spool, **32/6**

1,200ft. on 7in. spool	20/-
1,200ft. on 5¾in. spool	21/-
850ft. on 5¾in. 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."

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STEREOPHONIC HIGH FIDELITY EQUIPMENT AT TREMENDOUS REDUCTIONS

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 14¼in. wide, 4in. high, 8¾in. deep.

List £29/8/-. **Lasky's Price** **19 Gns.**
Carr. & Ins. 7/6.

PL6/21 20-watt Monaural Amplifier and combined Control Unit. 5 inputs.

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.

SPECIAL COMBINED OFFER

The above Unit and two DL7-35 Power Amplifiers offered at a special inclusive price of 47 Gns.
Carr. Extra.

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 14¼in. long, 9in. wide, 8¼in. high. List Price £31/10/-.

Lasky's Price **£16/19/6**
Carr. & Ins. 12/6.

LASKY'S RADIO FOR COURTEOUS SERVICE & TECHNICAL ADVICE

LASKY'S RADIO

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 milliwatts output, using two OC71 and two OC72 transistors. Fully assembled. **79/6.** Knobs 3/6 extra.

LOUDSPEAKER. 30 ohms, 7×4in. 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 17in. deep, 14in. wide, 5½in. high. **49/6.**

Batteries extra. All components available separately. Build this modern Record Player for £££s less than an equivalent ready-built player.

H.P. TERMS AVAILABLE

on certain goods.

Call or write stating your requirements.

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 type 33/1. Crystal hand or table Mike, **29/6.** Post 1/6.

RIBBON MIKE on table stand. High impedance, famous make. **£6/16/6.** Post 3/6.

BUILD THE "VANCOUVER" 3-TRANSISTOR POCKET RADIO

Employs 3 transistors plus germanium diode, on printed circuit size 3½×4×⅝in. Tunable over medium and long waves. Built-in Ferrite rod aerial. Complete Kit of Parts, with circuit diagram, **39/6.** Post 1/6. Circuit diagram only 1/6, post free.

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, 8½ × 5 × 4½in. deep. FULL DATA, instructions, circuit diagram, shopping list, 1/6.

BUILD THE COSSOR "TRAVELLER'S FRIEND" 4-Transistor POCKET SUPERHET

Uses 9 v. PP4 Battery. Covers 190-550 metres. Output 30MW. All components including 4 transistors. OC44, OC45, OC45, OC72. two OA70, diodes, two AGC systems, 2½in. M.C. speaker, Ferrite slab aerial, etc., leatherette case, size 6×3⅞×1⅝in. Printed Circuit and easy-to-follow instructions.

LASKY'S PRICE Post 2/6 **£7.19.6**

All components available separately

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 TA Mk. II, wired for STEREO, plug-in head	£8 9 0
E.M.I. 4-spd., 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...	£4 9 6

Post free.

COLLARO JUNIOR 4-speed motor and separate pick-up with cartridge styli £3 15 0

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.**

SPECIAL OFFER! PRINTED CIRCUIT GRAM AMPLIFIER

Uses two valves, ECL82 and EZ80 and separate mains transformer to minimise hum. Incorporates Elac 8×5in. loudspeaker with output transformer mounted. Concentric volume and tone controls. Size of printed circuit: 4 × 3 × 2½in.

Lasky's Price 69/6 complete,

Post 2/6. Less Speaker, **55/-.**

STEREO ADAPTOR (OR SINGLE-END AMPLIFIER)

Will convert any radiogram to give stereophonic reproduction. 2-valve Amplifier using EF80X and EL84 metal rectifier (full-wave bridge). Mains voltage 195-250, 50/60 c.p.s. Ganged volume control and ganged tone control.

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/-.

"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

3½in.	4in.	5in.	6½in.	8in.
17/6	19/6	14/6	16/-	16/6

ELLIPTICAL

7×4	9×6	10×2½	10×6	10×7
15/6	22/6	25/-	25/-	32/6

Post extra.

SHORT WAVE CONVERTER FOR CAR RADIO

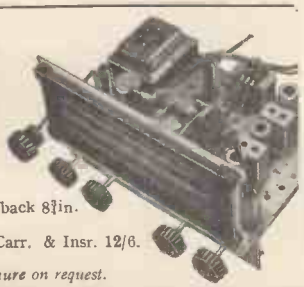
Smith's "Radiomobile" Converter offers short wave reception of your favourite stations. 6 or 12 v., positive or negative earth. Uses 6BE6 heptode freq. changer. Easily installed, may be used with any car radio. Chrome escutcheon, cream push buttons. Size 1½×7×5in. All plugs and sockets included. Supplied with 3 removable coil units of your choice. Bandspread: 16, 19, 25, 31, 41, 49, 60, 90 metres.

LASKY'S PRICE 89/6

Post 2/6.

Additional Coil Units, 6/- each

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 12in., height 7¾in., front to back 8¾in.

LASKY'S PRICE £16.19.6 Carr. & Insr. 12/6.

Available on H.P. terms. Brochure on request.

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 Brimar valves.
- ★ No Vibrator, 12 volt H.T. & L.T.
- ★ T.C.C. Printed Circuit and Condensers.
- ★ Tuned R.F. stage.
- ★ Medium and long waves.
- ★ Permeability tuning.
- ★ 7in. × 4in. elliptical speaker.

Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list 2/6 post free (returned if you order).

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

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 m/A.	75 m/A.
300 mV.	15 V.	30 m/A.	150 m/A.
1.5 V.	75 V.	150 m/A.	750 m/A.
3 V.	150 V.	300 m/A.	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.	Resistance
750 V.			0-1000 ohms
1.5 KV.			0-10 K ohms

Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price.

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; 0-100μF; 0-1MΩ each in 5 ranges. Power Factor and "Q." First-class condition, £35, carr. paid.

6-VOLT VIBRATOR PACKS. HRO type, 180 v. D.C., 65 m/amps. BRAND NEW. 29/6, post 3/6. Type PU2, 200 v. D.C. 100 m/amps., with OZ4 rectifier. BRAND NEW, 25/–. Post FREE.

ADMIRALTY HT TRANSFORMERS Pri. 230v. 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. 25 lb. 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. 4¾ x 4¼ x 5¼in. high. Wt. 12lb. Potted. Tag ends. RCA BRAND NEW. Boxed. 29/6, post 3/6.

"C" CORE TRANSFORMERS. Pri. 230 v. 50 c.p.s. 510-0-510 at 275 mA. 375-0-375 at 83 mA. 6.3 v. at 9 A. 6.3 v. at 2A. (twice), 6.3 v. at 1A. (twice), 6.3 v. at 1.5A. 6.3 v. at 0.5A, 5 v. at 3A. 6¾ x 6 x 7½in. high. Weight 25 lb. Removed from equipment but in perfect condition, 52/6. Carr. 5/6.

SANGAMO WESTON VOLTMETERS S61. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed. 27/6. Post 2/6.

V.H.F. RECEIVER

(R1392D)

Covers 95-156 Mc/s. Those we offer are in very good condition, complete with all 15 valves, 1mA tuning meter and AIR TESTED. Circuit diagram is included. Power supply required 240/250 volts at 80 mA. and 6.3v. at 4A. (Type 234A was used.) **79/6.** Carr. 10/6.

SEARCH RECEIVER

Type AN/APR4. Covers 38 to 1000 Mc/s. with 3 Plug-in R.F. Heads. TN 16 (38-95 Mc/s.), TN 17 (74-320 Mc/s.) and TN 18 (300-1000 Mc/s.). Self-contained power supply for 115v. 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. **£17/10/6.** 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 8in. 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 D.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. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1¾ x 5in. high. **BRAND NEW.** Boxed. 8/6 each, post paid.
4 mfd 1,000 v. wkg. CP 130T, 4/6 each, post paid.

MINIATURE RELAYS (ALL BRAND NEW and BOXED)
G.E.C., sealed, wire ends, 670 2M2B H/D M1095..... 8/6
G.E.C., sealed, wire ends, 670Ω, 2 H/D makes, M1099... 15/–
G.E.C. sealed, wire ends, 670Ω, 4c/overs, platinum, M1092 19/6
G.E.C. sealed, wire ends, 5,000Ω, 2 c/overs, platinum, M1052 ..... 17/6
Siemens High Speed, IK + IKΩ, 1 c/over..... 10/6

GIANT COMPONENT PARCEL

Contains 100 ¼ and 1 watt resistors, 50 Hi Stab resistors, wire wound resistors, carbon and W/W pots, 100 capacitors (mica, paper, Sprague, bias, variable, etc.), valveholders, tag strips, metal rectifiers, sleeving, etc. All components are unused. GUARANTEED VALUE. 25/- plus 2/6 post.

CHARLES BRITAIN (Radio) LTD.

11 UPPER SAINT MARTIN'S LANE
LONDON, W.C.2 *TEMple Bar 0545*

Near Leicester Sq. Station. (Opposite Thorn House)
Shop Hours: 9-6 p.m. (9-1 p.m. Thursday). Open all day Saturday

G.E.C. SELECTEST DIII

This testmeter has exactly the same ranges as the Avo "D." The scale is even larger. Those we offer are in first-class condition, completely overhauled and carefully tested prior to despatch. Complete with battery, test leads and instructions. **£7/10/-.** P. & P. 3/6.

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 TF987/1 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.

RESISTORS
Morgan "T" (½ watt) and "R" (1 watt). Latest types, all BRAND NEW. 100 assorted, **7/6.** Post 1/–.
HEAVY DUTY SLIDER RESISTORS. 1.25Ω 20 A., **12/6,** post 3/6. 1Ω 12 A., **8/6.**
ZENITH ADJUSTABLE 25Ω 4 A., **8/6.** Post 2/6.
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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This latest Caby model is a handy pocket sized tester 5¾in. × 3¾in. × 2¼in. 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 megs., D.C. current to 250 milliamps, and also Decibels. Complete with Test Leads, Batteries, and Instruction Book. ONLY £6/10/-.

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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.	
300 v.	1,500 v.	30 amp.	Resistance
750 v.			1,000 Ω
1,500 v.			10,000 Ω

ONLY £8/19/6 (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 2½in. Tube ACR 10. Front panel 19in. x 7in. for rack mounting, depth 12in., or can be used in Steel Transit Case on bench. Complete with suggested Modification data. BRAND NEW AND UNUSED. ONLY £12/10/- (carriage 15/-).

RCA 8in. P.M. SPEAKER in heavy black crackled metal case, size 11½in. × 10½in. × 6in. Designed for use with AR88 Receiver or any set with 3 ohms output. BRAND NEW IN MAKER'S CARTONS. ONLY 45/- (Post 3/6).

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BC 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/-).

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Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy Model of the well-known BC.221 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 8½in. × 8in. × 8½in. Full information on request.

R1155 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.

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RCA RECEIVERS AR88D. Thoroughly re-conditioned and in perfect working order. Cover 500 Kc/s.-31 Mc/s. ONLY £60 (carriage, etc., 25/-).

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25 microamps	D.C.	2½in. Proj.	circular	59/6
50 microamps	D.C.	2½in. Flush	circular	59/6
50 microamps	D.C.	3½in. Flush	circular	80/-
100 microamps	D.C.	2½in. Flush	circular	39/6
1 milliamp	D.C.	2in. Flush	square	22/6
1 milliamp	D.C.	2½in. Flush	circular	30/-
1 milliamp	D.C.	2½in. Flush	circular	25/-
1 milliamp	D.C.	3½in. Flush	circular	50/-
200 milliamp	D.C.	2½in. Flush	circular	12/6
20 amps	D.C.	2in. Proj.	circular	7/6
40 amps	D.C.	2in. Proj.	circular	7/6
5 amps	D.C.	2in. Flush	square	12/6
300 volts	A.C.	2½in. Flush	circular	25/-
500 volts	A.C.	2½in. Flush	circular	25/-

V.H.F. RECEIVER TYPE R.1392. A superb 15-valve superhet 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 19in. × 10in. × 10in. 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).

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Utilises 4 valves, 1 each 5Z4G, 6V6G, 6J7G, 6J5G and high quality components such as "C" Core Transformers and Block Paper Smoothing Condensers. A.C. Mains Pack for nominal 110 × 230 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 19in. × 7in. All connections to rear panel, front having "On/Off" Switch. Gain Control, Indicator Light. Fuses and Valves Inspection Panel. BRAND NEW IN MAKER'S PACKING. ONLY £4/9/6 (carriage 10/6).

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500 pF., .001 Mfd., .002 Mfd., .0025 Mfd., .003 Mfd., .005 Mfd. 6d. each., .01 Mfd. 9d.

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SUB MINIATURE ELECTROLYTIC CONDENSERS
Most with sleeves, all at 2/3 each.
.1 mfd. 50 v., .25 mfd. 15. v., .5 mfd. 50 v., 1 mfd., 10 v. 25 v., 2 mfd. 6 v. 15 v. 70 v., 4 mfd., 12 v. 5 mfd. 25 v., 6 mfd. 9 v. 6 v., 8 mfd. 3 v. 6 v. 15 v. 30 v., 10 mfd. 6 v. 25 v., 16 mfd. 3 v. 6 v. 30 v., 20 mfd. 15 v., 25 mfd. 12 v., 30 mfd. 3 v. 6 v. 12 v., 50 mfd. 6 v.

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Set of 3 I.F. Transformers 470 Kc/s plus Oscillator coil.
As specified for Mazda Circuits 23/6 complete
As specified for Mullard Circuits 23/6 complete
WTC oscillator Coils for Jackson or Plessey Gang 4/6 each. WTC 470 kc/s. I.F. Transformers 4/- each, 7/6 pair.

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Knurled knob and 6Ba fixing holes. Diam. 1in. 100Ω 5K., 10K., 25K., 50K., 100K., 200K., 250K., 500K., 1.5M., 2 M. 1/3 each, 25K. wirewound 1/6.

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Input: 12 volts.
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Impedance 7½ Ω. 6-8 watts output, weight 10lb., size: depth 7½in., diam. 10in. Easy fixing. Weatherproof spun solid steel. Hammered finish. PRICE **57/6.**

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Type 1. Dual voltage 12 or 24 v., input 265 v., 120 mA. output: 500 v., 26 mA. output.
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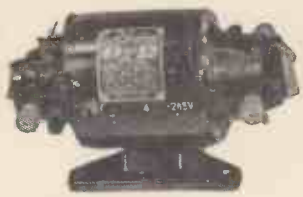

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D.C. input 27 v. Output 285 v. at 75 mA., **37/6.** D.C. input 12 v. Output 250 v. at 50 mA. **47/6.** Postage and Packing on each, 3/6.

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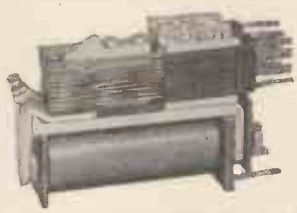

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BUILD UPS CONTACTS

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1. C/O.....	1/3	4/-	Up to	100 Ohms	3/-	5/-
2. C/O.....	2/6	9/-	,, ,,	500 ,,	4/-	6/-
3. C/O.....	3/6	12/-	,, ,,	1,000 ,,	5/-	7/-
4. C/O.....	4/6	16/-	,, ,,	5,000 ,,	6/6	8/6
6. C/O.....	6/6	24/-	,, ,,	10,000 ,,	9/-	—
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Other build ups to order; all types of relays built to your specification.			,, ,,	40,000 ,,	16/-	—
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*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*

FIELD TELEPHONE SETS

Good Condition.

50/- each. P. & P. 5/-

or £4/10/0 pair.

R.C.A. TRANSMITTER TRANSFORMERS

TYPE 900763-501
CLASS MODIFICATION
Primary 10,400 ohms.
Secondary 4,300 ohms.

NEW, BOXED, £3/10/- carriage extra.

HEAVY DUTY SLIDING RESISTORS

Supplied in two types

250 watts to carry 25 amps. Resistance 0.4 ohms, worm drive, also 125 watts, 12 amps. Resistance 1 ohm, slider. Suitable for charging board, etc. Size 9 x 4 x 6in high. Brand new. Boxed.

Price **12/6** Post 3/-.

VALVES

955 Min Acorn.....	**2/6**
2C26C I/O.	**4/6**
807 American	**8/6**

Post & Packing 1/6.

HEADPHONES. D.L.R.2 and D.L.R.5. **Brand New.** Low resistance. Balanced armatures. 7/6 pair. P. & P. 1/6. Single earpieces 3/6.

AS SUPPLIED TO GOVERNMENT DEPARTMENTS AND LEADING MANUFACTURERS

"CONTINENTAL—6" COMBINED PORTABLE/CAR RADIO

★ ★ EQUALLY SENSITIVE ON MEDIUM AND LONG WAVE BANDS ★ ★

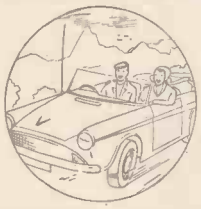
SPECIFICATION

- 425mW Push-Pull Output
- 6 "Top-Grade" Ediswan Transistors
- New Type Printed Circuit with all Components Marked
- Full Medium and Long Wave Tuning
- High "Q" Internal Ferrite Aerial
- Car Radio Adaptation Aid AVC
- Slow Motion Fingertip Tuning
- "Hi-Fi" Quality Speaker
- Size 9½ x 7½ x 3½in. Weight 4½lb

ALL COMPONENTS AVAILABLE SEPARATELY

Wherever you are

"First Class in every way"



ALL THE CONTINENTAL AND LOCAL STATIONS AT YOUR FINGERTIPS

CALL FOR DEMONSTRATION

★ STEP BY STEP FULLY ILLUSTRATED INSTRUCTIONS

★ ALL COMPONENTS GUARANTEED

Total Cost of all Components

£11.10.0 P.P. 3/6

including Cabinet, Battery Transistors, Car Radio, AVC and all necessary items.

★ SIMPLE TO CONSTRUCT

★ NO TECHNICAL KNOWLEDGE REQUIRED

★ WORTH DOUBLE WHEN BUILT

★ EXCELLENT RESULTS ANYWHERE

DESCRIPTIVE LEAFLET FREE ON REQUEST

MAJOR—3

(3-Transistor Pocket Radio)

All parts sold separately.

- ★ 5-stage Reflex Circuit.
- ★ No Aerial or Earth required.
- ★ Min. Volume Control.
- ★ 3 Ediswan Transistors.
- ★ Medium Wave Tuning.
- ★ Size 4½ x 3 x 1½in.
- ★ Personal phone included.

TOTAL **87/6** P.P. 1/6. BOOKLET FREE

★ NO AERIAL—NO EARTH ★

RESULTS GUARANTEED ANYWHERE

MAJOR—2

(2-Transistor Pocket Radio)

- ★ 4-stage reflex.
- ★ Medium wave; tunable.
- ★ Very sensitive. No aerial or earth required.
- ★ Complete illustrated layout.
- ★ Over 6 months on one battery. 4½ x 3 x 1½in.
- ★ Weight only 4 oz.
- ★ Personal phone included.

TOTAL **69/6** POST 1/6

FREE BOOKLET: All components sold separately.

★ NO AERIAL—NO EARTH ★

RECEPTION GUARANTEED ANYWHERE

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.

CRYSTAL MIC INSERTS

Acos 43-1 2¼in.	12/6,	P.P. 6d.
Acos 1½in.	7/6.	P.P. 6d.
¼in. ex units.	3/6.	P.P. 6d.
New ¾ x ½in.	7/6.	P.P. 6d.

MAGNETIC MIC INSERTS

½ x ½in. IK. Hearing aid type	15/-.
¼ x ½in. IK. ,, ,, ,,	17/6.
¾in. round IK. ,, ,, ,,	15/-.

BRAND NEW.

TELESCOPIC CHROME AERIALS

(1) 7 sections, 3ft. 6in. open, 6in. closed, with clips. **12/6.** P.P. 1/-.

(2) 9 sections, 5ft. 4in. open, 8in. closed, with clips, **17/6.** P.P. 1/-.

CATHODE RAY TUBES

(IDEAL FOR 'SCOPES)

2AP1	25/-
VCR139A	35/-
3BP1	30/-
3FP7	12/6
3AP1	30/-
Mullard DG7/5	45/-
SFP7	20/-
VCR517C	30/-
VCR97	40/-
Screens for VCR97	7/6

P.P. 2/- any type.

ALL GUARANTEED.

FREE LIST and Data on request.

PYE CONTROL UNIT

1.2 mA. movement, 6 inch dial; Bridge connected. "High-stab" controls. Only 85/-, P.P. 5/-.

Brand New Guaranteed TRANSISTORS

for F.M., S.W., Audio, Power, etc.	
XA131 250 Mc/s. 120 mw. F.M.	35/-
OC170 70 Mc/s. 70 mw. S.W.	35/-
XA102 8 Mc/s. osc./mixer R.F.	17/6
XA101 5 Mc/s. R.F./I.F.	15/-
XB103 High Gain Driver	10/-
XB102 250 mw. push-pull, pairs	15/-
XC101 325 mw. push-pull, pairs	25/-
XC121 400 mw. push-pull, pairs	34/-
XA104 6 Mc/s. osc./mixer R.F.	15/-
XA103 4 Mc/s. R.F./I.F.	12/6
OC72 Matched Pairs, pairs	30/-
XC131 750 mw. Pairs, pairs	34/-
XC141 12 watt push-pull	30/-
OC45 6 Mc/s, R.F./I.F.	18/6
OC71 General Purpose Audio	10/-
OC75 High Gain OC71	15/-
Red Spot Audio, 800 kc/s.	3/6
White Spot R.F. I.F., 5 Mc/s.	5/-
Photo Transistor General Purpose	10/-
V15/10P High Power 5 watts Audio	15/-
SB078 20 Mc/s. R.F./I.F. s.w.	7/6
SB305 25 Mc/s. Radio Control	10/-
SB231 30 Mc/s. Radio control, etc.	15/-
SB231R 50 Mc/s. Short w. osc.	22/6

COMPLETE LIST, DATA ON REQUEST.

BARGAIN BUY!

"ELECTRONIC DESIGNS"

famous VALVE VOLTMETER

D.C. ELECTRONIC VOLTMETER.
6-Ranges: 0–3–10–30–100–300 and 1,000 volts. Input resistance: 11 meg constant on all ranges. Sensitivity: 3,666,666 ohms per volt on 3 v. scale.

A.C. VOLTMETER.
5-Ranges: 0–10–30–100–300–1,000 volts. Sensitivity: 1,000 ohms per volt.

ELECTRONIC OHMMETER.
6-Ranges, from 0.1 ohms to 1,000 megohms. Movement. 200 microamps. D.C. accuracy ±2%.

COMPLETE WITH INSTRUCTION BOOK AND TEST PRODS, BRAND NEW.

Input 110-250 volts A.C.

ONLY **£12.10.0** P.P. 3/6.

QUARTZ CRYSTALS FROM 5/- EACH

From 6 Kc/s-47 Mc/s. FT243, FT241, 10XJ and B7G.
All types for all purposes.
Send for free list.

931A (27M1) PHOTO-MULTIPLIER

BRAND NEW, ORIGINAL CARTONS

80/- P.P. 1/-. BASE 2/-.

STEREO 3-D

FULL 3-D EFFECT CAN BE HEARD WITH OUR NEW HIGH-GAIN CIRCUIT

Can be used with Stereo or ordinary records.

★ Output 2 watts each speaker.
★ Valves ECC83, 2-ECL82.
★ Tone, balance and volume controls.
★ Mains operated 110/250 v. A.C.

Completely built and tested with knobs and calibrated dials, speaker sockets, etc. **£5/7/6.** P.P. 2/6 (including circuit and notes).

★ BARGAIN OFFER ★

9 x 6in. speakers for use with above 18/6 ea. Collaro Stereo 4-speed auto-changer crystal pick-up—BRAND NEW £7/10. P.P. 3/6.

TRANSMITTER/RECEIVER

Army Type 17 Mk. II

Complete with Valves, High Resistance Headphones. 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/-

44-61 Mc/s. Calibrated Wavemeter for same, 10/- extra. P.P. 2/-.

HENRY'S RADIO LTD

5 HARROW RD., PADDINGTON, W.2

(At Junction of Edgware Rd. and Harrow Rd.) PAD 1008/9

SHOP HOURS: 9 a.m. to 6 p.m. MON. to SAT., THURS. 1 p.m.

Our SPECIALITIES: Transistors, Quartz Crystals, Tubes, Valves and Miniature Components

Trade enquiries invited Compare our prices

CATALOGUES FREE ON REQUEST.

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with falling emission. Full instructions supplied.

Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries:

2 volt	12/6 each
4 volt	12/6 each
6.3 volt	12/6 each
10.8 volt	12/6 each
13.3 volt	12/6 each

OUR LATEST SUPERIOR PRODUCT. Type A2. High Quality. Low capacity, 10/15 pf. Optional boost 25%, 50%, 75%. **16/6** each

Type B. Mains input. Low capacity. Multi Output 2, 4, 6.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes 21/-.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., ½ w., 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d. 2 w. 1/-.
HIGH STABILITY. ½ w., 1%, 2/-. Preferred values 100Ω to 10 meg., Ditto 5% 9d., 100Ω to 5 meg.

5 watt 10 watt 15 watt	WIRE-WOUND RESISTORS 25 ohms—10,000 ohms.	1/3 1/6 2/-

15,000 ohms.—50,000 ohms. 5 w., 1/9; 10 w. 2/3

WIRE-WOUND POTS, 3 w. Pre-set Min. T.V. type Knurled Slotted knob. All values 25 ohms to 25K., 3/- ea., 30 K. 50 K., 4/-. Ditto ½ w. Carbon Track 30 K. to 2 Meg., 3/-.

WIRE-WOUND POTS, 4 w. Standard size Pots, long Spindle High Grade. All values 100 ohms to 50 K. 6/6: 100 K. 7/6.
W/W EXT. SPEAKER CONTROL 10 Ω, 3/-.

O/P TRANSFORMERS. Heavy duty 50 mA. 4/6. Multi-ratio push-pull 7/6. Miniature 3V4, etc. 4/6. Hygrade Push-Pull 10 watts, 15/6. Push-pull 20w. 6k. or 8k. 30/-.
L.F. CHOKES 15/10H 60/65 mA., 5/-. 10H 85 mA., 10/6. 10H 150 mA., 14/-.

MAINS TRANSFORMERS 200/250 v. A.C.

STANDARD 250-0-250, 80 mA. 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped 5 v. or 4 v. 2 a. Ditto 350-0-350	22/6
MINIATURE 220 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET, 220 v. 45 mA., 6.3 v. 2 a.	15/6
SMALL, 200-0-200 50 mA. 6.3 v. 2 a.	17/6
STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a.	17/6
HEATER TRANS., 6.3 v. 1½ a., 7/6; 3 amp.	10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A.	22/6

ALADDIN FORMERS and cores, ¼in., 8d.; ⅜in., 10d. 0.3in. FORMERS 5937 or 8 and Cans TV1 or 2, ¼in. sq. × ½in. or ⅜in. sq. × 1½in., 2/- with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
SOLON. Midget Soldering Iron, 220/40 v. 25 w., 24/-.
REMPLOY INSTRUMENT IRON. 220/40 v. 25 w., 17/6.
MAINS DROPPERS. 3 × 1½in. Adj. Sliders, .3 amp. 1,000 ohms 4/3. .2 amps. 4/3. .1 amp. 2,000 ohms, 5/-.
LINE CORD. .3 amp. 60 ohms per foot, .2 amp.. 100 ohms per foot, 2-way. 6d. per foot, 3 way 7d. per foot.

CRYSTAL MIKE INSERT by Acos 6/6

Precision engineered. Size only ¾ × 1 ⅛in.

ACOS CRYSTAL STICK MIKE 39-1. Bargain 35/-.

MIKE TRANSF. 50 : 1, 3/9 ea.; 100 : 1 Potted 10/6.
LOUDSPEAKERS PM. 3 OHM. 5in. Rola, 17/6.
6in. x 4in. Rola, 18/- 7in. x 4in. E.A., 21/-.
10in. x 6in. Rola 27/6. 8in. Plessey, 19/6.
6½in. Rola, 18/6. 8in. Rola, 21/-. 10in. E.A. 30/-.
HI-FI TWEETERS, 4in. 25/-. 12in. Plessey, 30/-.
12in. Baker 15 wt. 3 ohm. and 15 ohm models, 90/-.
12in. Baker foam suspension 15 w. 15 ohm. £8.
12in. 15 ohm Plessey 10 wt., 45/-. E.M.I. 14 × 8in. 45/-.

I.F. TRANSFORMERS 7/6 pair

465 kc/s. slug tuning miniature can 2½ × 1 × 1in. High Q and good bandwith. By Pye Radio. Data sheet supplied.

Wearite M800 I.F. Miniature 465 kc/s., 12/6 pair.
Weymouth I.F. Standard size 465 kc/s., 12/6 pair.

CRYSTAL DIODE G.E.C., 2/-. GEX34, 4/-. 40 Circuits 3/-.
H.R. HEADPHONES. 4,000 ohms, brand new, 15/- pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 pf. Miniature, 1½in. × 1½in. × 1½in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers 8/-. Midget 7/6; Single 50 pf. 2/6, 100 pf., 150 pf., 7/-. Solid dielectric 100, 300, 500 pf., 3/6.
VALVE HOLDERS. Pax. int. Oct. 4d. EF50, EA50 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 pin, 1/-.
MOULDED Mazda or Int. Oct. 6d. B7G, B8A, B8G, B9A, 9d. B7G with can. 1/6; B12A, 1/3. B9A with can, 1/9.
CERAMIC, EF50, B7G, B9A, Oct., 1/-. B7G, B9A Cans, 1/-.
SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-. 25in. × 35in., 10/-. Tygan 54in. wide, 10/- ft. 27in. wide, 5/- ft. Samples, S.A.E.
WAVECHANGE SWITCHES
2 p. 2-way, or 3 p. 2-way; short spindle 2/6
5 p. 4-way, 2 wafer, or 3 p. 11-w. 3 wafer, long spindle 6/6
2 p. 6-way, or 4 p. 2-way, or 4 p. 3-way, long spindle 3/6
3 p. 4-way or 1 p. 12-way, long spindle 3/6
Wave change "MAKITS" 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer 18/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.
TOGGLE SWITCHES, S.P., 2/-; D.P., 3/6; D.P.D.T., 4/-;
MORSE KEYS, good quality, 2/6.
SUB-MINIATURE ELECTROLYTICS (15 v.), 1, 2, 4, 5, 8, 25, 50 mfd., 100 mfd., 3/- each.

THE HI-GAIN BAND 3 PRE-AMP

Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d.
Also Band I version same prices.
(PCC84 Valve if preferred)

RCS "REGENT" 4 VALVE

"96" RANGE VALVES
KIT PRICE
£6. 6. 0
Carr. 4/-.

Leaflet S.A.E.

PRINTED CIRCUIT BATTERY PORTABLE KIT

Medium and long wave. Powerful output from 6in. high Flux Speaker. T.C.C. Printed circuit and condensers. All components of finest quality clearly identified for assembly with full instructions. Osmor Ferrite Aerial and Coils. Rexine covered attache case type cabinet. Size 12in. x 8in. x 4in. Batteries used B126 (L5512) and AD35 (L5040), 10/- extra. Details and instructions 9d. (free with kit). Mains Unit ready made for above 39/6 Same size as batteries sold separately.

1960 RADIOGRAM CHASSIS

THREE WAVEBANDS
S.W. 16 m.—50 m.
M.W. 200 m.—500 m.
L.W. 800 m.—2,000 m.
FIVE VALVES
LATEST MULLARD
ECH81, EF89, EBC81, EL84, EZ80
12-month Guarantee. A.C. 200/250 v., 4-way switch. Short-Medium-Long-Gram. A.C.C. and Negative Feedback, 4.2 watts. Chassis 13½in. × 5½in. × 2½in. Glass Dial Size 10 × 4½in. horizontal or vertical. Two Pilot Lamps. Four Knobs. Walnut or Ivory. Aligned and calibrated. Chassis isolated from mains.

BRAND NEW £9.10.0 Carr. 4/6

TERMS: Deposit £5/5/- and 5 monthly payments of £1.
MATCHED SPEAKERS 8in. 17/6; 10in. 25/-; 12in. 30/-.

RECORD PLAYER BARGAINS

4 Speed Autochangers, B.S.R., U.A.8	£6	15	0
Collaro Conquest	£7	19	6
Garrard Model 210	£10	10	0
4 speed Single Players, EMI	£6	19	6
Garrard TA Mk. II	£8	8	0
Garrard 4 HF Transcription	£17	19	6

All post free

TELETRON POCKET RADIO KIT

Transidyne Superhet Six 6" × 4" × 1¾"

T.C.C. Printed Circuit internal Ferrite aerial, Rola loudspeaker push-pull output. All parts, cabinet, 6 Ediswan transistors, GEX34 diode. Details 9d. **£9.9.0**

VOLUME CONTROLS

Midget size:
Long spindle. Guaranteed 1 year. All values.
5 K. ohms up to 2 Meg. No switch. D.P. Sw. 3/- 4/6
Linear or Log Tracks.

80 Ohm Cable Coaxial

Semi air spaced, ¼in. dia. Ideal Band III Losses cut 50% **6d.** yd. Post 1d. per yard extra.
FRINGE QUALITY AIRSPACED .... 1/- yd.

COAXIAL PLUGS.... 1/- LEAD SOCKETS.. 2/-
PANEL SOCKETS .... 1/- OUTLET BOXES 4/6
BALANCED TWIN FEEDER per yd. 6d., 80Ω or 300.
TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohm.

ALUMINIUM CHASSIS. 8 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides 7 × 4in. 4/6; 9 × 7in., 5/9; 11 × 7in., 6/9; 13 × 9in., 8/6; 14 × 11in., 10/6; 15 × 14in., 12/6 and 18 × 16 × 3in., 16/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, coloured, single or stranded 2d. yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
CORED SOLDER RADIOGRADE, 4d. yd., ½lb. 2/6.
PAXOLIN 1/16in. x 8in. x 10in., 1/6. ION TRAPS 5/-.

P.V.C. PLASTIC RECORDING TAPE

Long Play 7in. reel, 1,800ft.	32/6	ALL Spare Plastic Reels 3/- ea. Metal Reels 7in. 2/- ea.
5½in. reel, 1,200ft.	22/6	
5in. reel, 850ft.	19/6	
3in. reel, 225ft.	7/6	
Standard 7in. Reel, 1,200ft.	21/-	
5½in. reel, 850ft.	17/6	
5in. reel, 600ft.	15/-	
"Instant" Bulk Tape Eraser and Head Defluxer 200/250 v. A.C., 27/6. Leaflet, S.A.E.		

RECTIFIERS, RM1, 5/-; RM2, 6/-; RM3, 8/-; RM4, 16/-; RM5, 20/-; FC31, 27/6; 14A86, 17/6; 14A100, 21/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave 250 v. 120 mA., 15/-.
COILS. Wearite "P" type 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges.
TELETRON. L. and M. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
I.F.R.F. COILS. A/HF, 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 26/-. H.F. coil aerial coil. Oscillator coil, two I.F. transformers, 10.7 Mc/s., Detector transformer and heater chokes. Circuit and component book using four 6AM6, 2/6. Complete kit FMT1 with Jason Calibrated dial and 4 valves. £6/5/-. With new Jason Cabinet, FMT2, 30/- extra.

CONDENSERS. New Stock. .001 mfd. 7kV. T.C.C. 5/6. 20 kV., 9/6. .1 mfd. 7kV. 9/6. 100pf. to 500 pf. Micas, 6d. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/-; 0.25, 1/6; 0.5, 1/9; 0.1/350 v., 9d.; 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 v., 3/6; 0.001 mfd., 2,000 v., 1/9.
CERAMIC CONDS. 500 v. 0.3 pf. to 0.01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3.
CLOSE TOLERANCE (1± pf.) 1.5 pf. to 47 pf., 1/6. DITTO 1% 50 pf. to 815 pf., 1/9; 1,000 pf. to 2,000 pf., 2/-.
TRIMMERS. Ceramic 30, 50, 70 pf., 9d., 100 pf., 150 pf. 1/3. 250 pf., 1/6. 600 pf. 750 pf., 1/9. Philips, 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	50/350 v.	5/6	8/500 v.	3/-
2/350 v.	2/3	100/25 v.	3/-	16/500 v.	4/-
4/450 v.	2/3	250/25 v.	3/-	32/350 v.	4/-
8/450 v.	2/3	500/12 v.	3/-	100/270 v.	5/6
8/500 v.	2/9	8+8/450 v.	3/6	2,500/3 v.	4/-
16/450 v.	3/-	8+8/500 v.	5/-	5,000/6 v.	5/-
16/500 v.	4/-	8+16/450 v.	3/9	8+16/500 v.	7/-
32/450 v.	3/9	8+16/500 v.	5/6	32+32/450 v.	6/-
25/25 v.	1/9	16+16/450 v.	4/3	50+50/350 v.	7/-
50/25 v.	2/-	16+16/500	6/-	64+120/350 v.	11/6
50/50 v.	2/-	32+32/350 v.	4/6	100+200/275v.	12/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2.6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6; 6 a., 22/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6
Charger circuit free. AMPMETERS, 4 a., and 5 a., 13/6.

NEW and boxed VALVES 90 day Guarantee

1R5 ..	7/6	6L6G	10/6	EA50 ..	1/6
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3V4 ..	7/6	6SN7	6/6	EBF80	10/-
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5Z4 ..	9/6	6X5 ..	6/6	ECH42	10/6
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6BE6	7/6	12AT7	8/-	ECL82	10/6
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6BW6	9/6	12AX7	8/-	EF41 ..	9/6
6D6	6/-	12BA6	8/6	EF50 ..	5/6
6FG6	7/6	12BE6	8/6	EF80 ..	8/-
6H6GT	3/6	12K7..	6/6	EF86 ..	14/6
6J5 ..	5/6	12Q7	6/6	EF92 ..	5/6
6J6 ..	5/6	35L6	9/6	EL32 ..	5/-
6J7G	6/6	35Z4 ..	7/6	EL41 ..	9/6
6K6GT	6/6	80	9/6	EL84 ..	8/6
6K7G	5/-	807 ..	5/6	EZ40 ..	7/6
6K8G	7/6	954 ..	1/6	EZ80 ..	7/6

EY51 ..	9/6	PL36 ..	10/6
EY86 ..	10/-	PY80 ..	7/6
HABC80	12/6	PY81 ..	9/6
HVR2A	6/6	PY82 ..	7/6
MU14 ..	9/-	PY83 ..	8/6
P61	3/6	PCC84 ..	9/6
PCF80 ..	9/6	PCL82 ..	11/6
PEN25..	6/6	UBC41 ..	9/6
PL82 ..	10/6	UCH42 ..	9/6
PY80 ..	7/6	UF41 ..	9/6
PY81 ..	9/6	UL41 ..	9/6
PY82 ..	7/6	UY41 ..	8/-
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UBC41 ..	9/6	U52	7/6

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THO 1665 Buses 133 or 68

POSTAL SERVICE 1/-. OVER £2 FREE. C.O.D. 1/6. (EXPORT C.W.O. POST EXTRA). Wed. 1 p.m.

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T.C.C. "CATHODRAY" VISCONAL TYPES. 1 mfd., 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. 0.05μF., 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., 5 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.

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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 × 7 × 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 0-166. Size of unit 14½ × 9½ × 8in., £8/10/-. Carr. 10/-.

INDICATOR UNIT Type I-152-c (U.S.A.) 3in. tube 3DP1, 1 rectifier 2 × 2, and 3 × 6AG5, with controls, etc., in a neat metal box 11 × 6 × 6½in., 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. £6/10/- 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/ARC5. 2 × 1625, 12J5, VR150, Modulation transformer, 5 Relays, etc. 32/6 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 ×.6.3 volts CT., at 3 amps. and 6.3 volts at 3 amps. output, 18/3 each. (2) 230 volt input, 2×6.3 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, 3×6.3 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 × 6V6 small GT., 3 × 6X5 GT., and 2 6SN7. Seven small D.C. motors 27 v. 6 selsyn motors, 10 small micro switches. Plus gears, condensers, ball bearings and pots, etc. This unrepeatable bargain, £10 each.

DOUBLE PARALLAX AN-II-70-9. 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.

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25FT. AERIAL MASTS. Heavy galvanised steel tubes, four sections, tapered 2½ to 1 inch. No guy ropes needed, £12/10/- each. Weight 2 cwt.

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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" × 15 × 10in., £17/10/- each.

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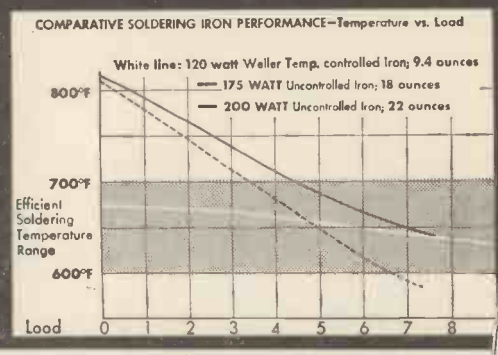
With Half the Weight

Weller SOLDERING IRONS with built-in MAGNETIC **Temperature Control**

do the work of uncontrolled irons of much higher wattage ratings!



A temperature controlled 120 watt Weller Iron does the work of a 200 watt uncontrolled iron! This is achieved by more efficient heat transfer which also keeps the handle constantly cool. Exclusive pat. pend. features automatically maintain proper soldering temperature. **Available in 40, 55, 60 and 120 watt models. Controlled Temperatures from 410°F to 720°F.**

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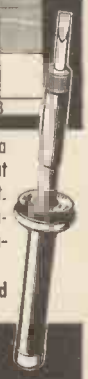

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NEW MODEL—HIGH QUALITY

6 TRANSISTOR PORTABLE RADIO

- RANGES 187-545 M AND 1095-1825 M
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- WEIGHT 3½ LBS. SIZE 10 × 8 × 3½ INS.

COMPETITIVE PRICE

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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 (30 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 Saveform available for external use; pulse/output available for checking T.V. Line O/P Transformers, etc; Provision for external X 1/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

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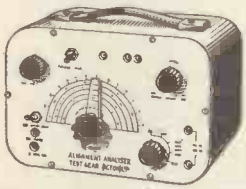

A C MAINS, 200/250 volts Provides:—"WOBBULATOR" (SWEPT FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0-60 pf. and 0—120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit L.F. 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**.

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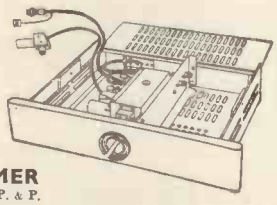


Will tune to all Band I and Band III stations. **BRAND NEW** by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series), I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied).
Complete with knobs.

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: 12½in. × 10½in. Space required above baseboard 4½in., below baseboard 2½in. Fitted with Ful-Fi turnover crystal head. **£6/19/6**. Plus 5/- P. & P.

STEREO HEAD £7/19/6 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. **29/6** Plus 4/- P. & P.

As above, but for 625 lines **£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.

0-250 180, 200 v., 60 ma., 6.3 v. 2 amps., 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., 6.3 v. 2 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.

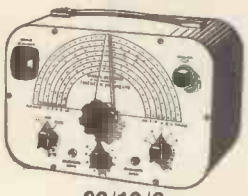
100% AUDIO TRANSISTORS

5/- each.

BATTERY RECORD PLAYER AND AMPLIFIER

Incorporating 45 r.p.m. " Starr " 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

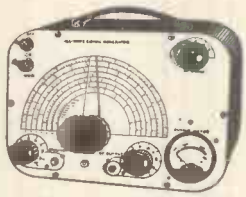


Covering 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. × 6¾in. × 5¼in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

£6/19/6

Or 25/- deposit and 6 monthly payments of 21/6. Post & Packing 5/- extra.

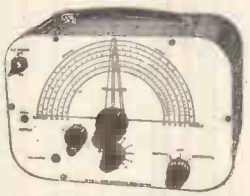
SIGNAL GENERATOR



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. × 6½in. × 4½in. Size of scale 6½in. × 3½in. 2 valves and rectifier A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated R.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 7/6 Mc/s.-210 Mc/s. in five bands, all on fundamentals, slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ± 1% A.C. mains 200-250 v.

CYLDON TURRET TELETUNER

I F 34/38 Mcs. 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.)

3-TRANSISTOR POCKET RADIO

INCORPORATING MINIATURE SPEAKER

Plus GERMANIUM DIODE and PRINTED CIRCUIT

Size 3¼" × 4" × ⅞"

Incorporating Ferrite Rod Aerial. Two Surface Barrier Transistors and one Audio. Tuneable over medium and long waves.

To build yourself **39/6** Plus 1/6 P. & P.

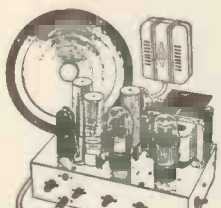
ALL PARTS SOLD SEPARATELY.

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 10½in. × 6½in. × 2½in. Incorporating 6 valves. H.F. pen. 2 triodes, 2 output pens., and rectifier. For use with all makes and types of pick-up and mike. Negative feed-back. Two inputs, mike and gram., and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 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 15 ohm speech coils. For use with Std. or L.P. 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. × 3in with tone and volume control. Valves: ECL82 and EZ80, 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.

23, ACTON HIGH STREET, LONDON, W.3

GOODS NOT DESPATCHED OUTSIDE U.K. ALL ENQUIRIES S.A.E. TERMS OF BUSINESS C.W.O.

A SELECTION OF HIGH QUALITY P.A. SPEAKERS FOR INDOOR/OUTDOOR USE

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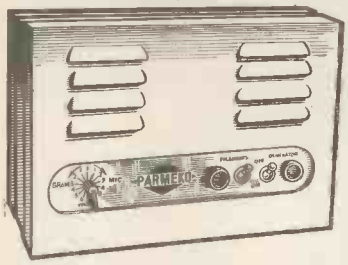
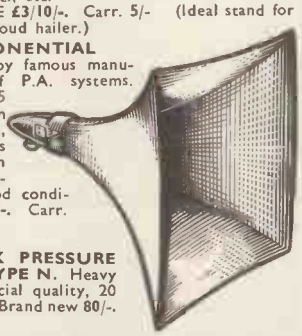


12 VOLT D.C. AMPLIFIER (Parmeko, Ardente). As new. 15 watt output with 2-EL35's in push-pull. Mike and gram. inputs, tapped output transformer. **£9/19/6.** Carr. 10/6. (Suitable microphone for above 30/- extra.)

RE-ENTRANT LOUD HAILERS (Ex-Govt.) Heavy duty 20 watts all-metal 15 ohms. Diameter 15in., length 15in. (approx.) good condition **£6/10/-** Carr. 10/-. Ditto. 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, floodlighting, 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 speech coil. (Tannoy.) Good condition, **£7/10/-.** Carr. 10/-.

VITAVOX PRESSURE UNITS TYPE N. Heavy Duty. Special quality, 20 watts P.M. Brand new **80/-.** Carr. 5/-.

FLARE HORN. 30in. x 12in. x 26in. long. Driven by heavy duty 3 ohm P.M. speaker. Ideal for music, etc. **£7/10/-.** Carr. 10/-.

NEW P.M. HEAVYDUTY SPEAKERS Complete with O.P. trans., in all steel blue-grey double grilled cabinet. **6in. 30/-. 8in. 32/6. Carr. 3/6 each** 10in. Speaker in wooden cabinet, size approx. 14x16 x8in. with padded interior and volume control, **50/-.** Carr. 3/6.

TRUVOX/TANNOY LOUD-HAILERS With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case. Brand new **25/-.** Carr. 4/6.

BAKER'S SELHURST SPEAKERS

Special new arrival!! "15in. Auditorium" 15 ohms, 35 watts, 20-12,000 c.p.s. **£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.

WESTALITE RECTIFIER UNIT. Type 925. A.C. input 200/250 v. or 440/440 v. 50/60 cycles, 3 phase. D.C. output 13-0-13 v. by 1 volt steps to 16-0-16 v., at 120 amps. Metered, switched and fused throughout. Brand new and unused. **£75** ex-stores.

WESTALITE TRANSFORMER RECTIFIER. Oil filled. Primary 380-440 v. 50 cycles. 3 phase. Supply 20 v. D.C. at 200 amps. (conservative rating). Complete with original control panel. Perfect condition, unused. **£150** ex-stores.

10-LINE TELEPHONE SWITCHBOARDS. 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.

MARCONI SIGNAL GENERATOR. TYPE TF517-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 7½ 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.

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.

RECORDING WIRE, ¼lb. spools, 3½in. dia New and unused, **12/6.** P. & P. 1/-.

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.

TRANSMITTER TYPE T.1945. As used for Air-Sea Rescue. This transmitter is a non-directional sono-buoy. The freq. band of 62.9 Mc/s. to 71.7 Mc/s. is divided into 12 channels spaced 800 kc/s apart, each buoy being set up to one of the channels. (Most channels available.) H.T. power supply is from 3-45 v. batteries, L.T. 1-5 v. Absolutely brand new and complete in tropically sealed packing (less batteries). HOME AND EXPORT ENQUIRIES INVITED.

C.M.G. 25 PHOTOCELLS (OSRAM) Brand new, **15/-.** P. & P. 1/-.

NEW AND UNUSED ACCUMULATORS

12 v. 25 A.H. (as on left) 45/-. Carr. 7/6. (Ideal for use with our Amplifier on left.)

2 v. 100 A.H. 75 actual (ex-Govt.) with carrying handle. Size 6½ x 6½ x 3½in., **15/-** each. Carr. 3/6 **12 v. 16 A.H.,** as above. 7½x 4 x 2in., 5/- each. P. & P. 2/-. 6 for **24/-.** P. & P. 10/-.

2 v. 14 A.H., as above (less handle). 7 x 2½ x 2½in., 5/- each. P. & P. 2/-. 6 for **24/-.** P. & P. 10/-.

COLLARO "STUDIO" TAPE TRANSCRIPTORS. Brand new in original cartons. 3 speeds, 1⅞, 3¾, 7½ i.p.s. 3 motors, digital counter, etc. Complete with 7in. spool, instructions and fixings. A.C. 200/250 v. operation. **SPECIAL PRICE £12/19/6** only.

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MAINS ISOLATING TRANSFORMER (Gresham). Pri. 230/250 v. Secs. 240-0-240v. 1.5 amps., 5 v. 12.5 amps. Potted. Size 7in. x 7½in. x 10½in. Weight 50 lb. Ideal for obtaining TWO ISOLATED 240 v. lines at 360 watts each. Perfect condition. **80/-.** Carr. 10/-.

3 kV/A. AUTO-TRANSFORMER. 250/110 v. 50 cycles (fully tapped primary and secondary). Capable of 25% over actual rating. Brand new and unused, **£12/10/-.** Carr. 20/-. Also **6 kV/A.** as above, **£18.** Carr. 20/-.

20 kV/A. AUTO-TRANSFORMER. 230/115 v. 50-60 cycles, by Jefferies Transformer Co., U.S.A. Perfect condition, **£20.** Carr. £1.

CONSTANT VOLTAGE TRANSFORMER. 190-260 v. primary, sec. 115 v. at 1¼ kV/A. (listed at 2 kV/A.). Brand new and unused. **£25** or **£45** per pair. Carr. 10/- each.

E.H.T. TRANSFORMER. 8,000-0-8,000 at 250 mA. Primary 230 v. 50 cycles. Oil filled. New and in original crates. **£22.** Carr. 10/-.

E.H.T. TRANSFORMER. 1,800-0-1,800 at 1 kVA. 230 v. 50 cycles primary. Fully tropicalised. New and boxed. **£6/10/-.** Carr. 10/-.

E.H.T. TRANSFORMER. 1,100-0-1,100 at 250 mA. plus 4 v. L.T. Pri. 200/250 v. at 50 cycles. **£5.** Carr. 10/-.

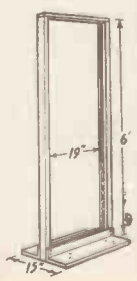
ROTARY CONVERTER. 24 v. D.C. input. 230 v. A.C. output at 250 watts. Complete with starting switch. New and unused. **£15.** Carr. 7/6.

ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 cycles, 150 watts. Brand new and unused. **£8/10/-.** Carr. 7/6. Ditto, 100 watts **£6/9/6.** Carr. 7/6.

ROTARY CONVERTER. Ex-Govt. 12 v. D.C. input, 230 v. A.C. output 50 cycles at 135 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/-.

CONDENSER, oil filled. 240 mfde 230 v. A.C. or 600 v. D.C. Made in U.S.A. Size 21in. x 5¾in. x 9in. Brand new in original cases. **£7/10/-.** Carr. 5/-.



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19in. Heavy duty, all steel Standard drilling.

5ft. 6in. angle uprights. **£3/10/-.** Carr. 15/-.

6ft. channel uprights (as illustrated). **£5.** Carr. 15/-.

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ADJOINING LEICESTER SQ. TUBE STATION—Open 9-6 Weekdays. 9-1 Sat.

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METERS GUARANTEED

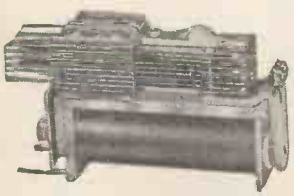
F.S.D.	Size	Type	Price
100 Microamp	3½in.	MC/FR	80/-
50 Microamp	2½in.	MC/FR	70/-
250 Microamp	2½in.	MC/PR	40/-
500 Microamp	2½in.	MC/FR	37/6
1 Milliamp	2½in.	MC/FR	35/-
2 Milliamp	2½in.	MC/FR	25/-
30 Milliamp	2½in.	MC/FR	15/-
100 Milliamp	2½in.	MC/FR	15/-
200 Milliamp	2½in.	MC/FR	15/-
1 Ampere	2½in.	MC/FR	35/-
3 Ampere	2½in.	MC/FR	35/-
5 Ampere	2½in.	MC/FR	35/-
10 Ampere	2½in.	MC/FR	35/-
20 Volts	2½in.	MC/FR	35/-
30 Volts	2½in.	MC/FR	35/-
40 Volts	2½in.	MC/FR	35/-
500 Microamp	2in.	MC/FR	25/-
1 Milliamp	2in.	MC/FR	27/6
5 Milliamp	2in.	MC/FR	27/6
10 Milliamp	2in.	MC/FR	27/6
20 Volts	2in.	MC/FR	27/6
30 Volts	2in.	MC/FR	27/6
40 Volts	2in.	MC/FR	27/6
15 Amps	2in.	MC/FR	12/6
3 Amps	2in.	MC/FS	27/6
5 Amps	2in.	MC/FS	27/6
30-0-30 Amps.	2in.	MC/FR	15/6
50-0-50 Amps	2in.	MC/FS	12/6
500 Milliamps A.C.	3½in.	MI/FR	30/-
25 Amps D.C.	2½in.	MI/FR	7/6
50 Amps A.C.	4in.	MI/F or PR	65/-
300 Volts A.C.	2½in.	MI/FR	25/-

Postage on meters 1/6

Complete list of meters available including the new Taylor pocket-size Multimeter Model 127A. 20,000 ohms per volt. 20 megohms, 20 ranges A.C. and D.C. £10, post 2/6.

METER RECTIFIERS 250μA 1 M.A., 5 M.A., F.W. bridge, 8/6, post 6d.
CROSS POINTER METERS. 2 separate 100 microamp movements, 22/6.
MICROAMMETER. 250 F.S.D. 3½in. F.R. Sangamo Mod. S37. Scaled for valve voltmeter. Circuit available free, 55/-, post 1/6.
UNI-PIVOT GALVANOMETER, by Cambridge Instruments, 50-0-50 microamps, dia. 4in. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use, £10, carriage 3/-.
PORTABLE VOLTMETER. 0-160 volts A.C./D.C. accuracy within 2%, 8in. mirror scale, knife pointer, in polished case. A precision moving iron instrument at a very low price, £4/19/6, post 3/6.
FLEXIBLE ALUMINIUM TUBING.
1½in. 3/6 per foot. ⅜in. 1/9 per foot.
1in. 2/3 „ „ ⅜in. 1/2 „ „
WHEATSTONE BRIDGE 1 to 10,000 ohms, plug type, £5, carriage 7/6.
AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condenser leakage test. Full working instructions supplied with instrument. £9/19/6, post 3/-.
SLOW MOTION VERNIER DRIVE. Scaled 0-180°. Ratio 38:1, diam. 3in. 15/6, post 1/6.
OSCILLOSCOPE. Type 43. With 3½in. C.R.T. 138A. 4—617, 3—VR54, 5Z4, VU120. Brand new with usual controls, power pack and leads. Suitable for 230 volts, £10/10/-, carriage 12/6.
FREQUENCY METERS. 45-55 cycles per second 230 volts, 6in. dia, Flush Round. Brand new in maker's box, £10/10/-, post 3/6.

RELAYS P.O. TYPE 3000



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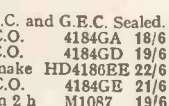
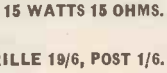
Siemens High Speed Sealed.					S.T.C. and G.E.C. Sealed.	
2.2Ω+2.2Ω	H96A	15/6	2Ω	2 C.O.	4184GA	18/6
145Ω+145Ω	H96C	19/6	700Ω	2 C.O.	4184GD	19/6
500Ω+500Ω	H96D	22/6	2500Ω	1 make	HD4186EE	22/6
1700Ω+1700Ω	H96E	25/-	2700Ω	2 C.O.	4184GE	21/6
Siemens High Speed Open			180Ω	2 m 2 b	M1087	19/6
100Ω+100Ω	H85N	15/-	670Ω	4 C.O.	M1092	21/6
850Ω+850Ω	H85W	15/-	2500Ω	1 C.O.	M1022	22/6
1000Ω+1000Ω	H95A	17/6	5000Ω	2 C.O.	M1052	25/-

ERICSSON SEALED. Highly sensitive. 7000Ω 1 C O 24 v. 25/-. Comprehensive range available from stock.
SWITCHES. 1 hole fixing, 3 amp. 250 volt. 1/6 each, 12/- doz.
RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in. in stock.



P.M. SPEAKERS. AXIOM 150 DUAL CONE 12in. 15 WATTS 15 OHMS. FULLY DUSTPROOF, £7/19/6, POST 7/6.
PYE 10in. PORTABLE 3 OHMS 50/-, CARR. 7/6.
PLESSEY SEALED TYPE WITH 3in. ROUND GRILLE 19/6, POST 1/6.
ELAC 5in. ROUND, 3 OHS, 15/6, POST 1/6.

JACK PLUGS. Cylindrical bakelite screw-on cover, 2 contact 2/6, post 6d.
SOCKETS One hole fixing for above, 3/6, post 6d.

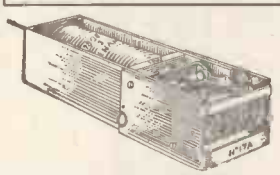


Your Own Telephone 75/-

TELEPHONE SET TYPE "A." Ringing and Speaking-both ways on a four-core cable. Carries the voice loudly and clearly over any distance. Two handsets are supplied as illustrated and the set is complete with Pushes, Buzzers, Battery, Plugs and Sockets. We can supply 4-core PVC cable at 10d. per yard or 2-core at 3d. per yard extra. Price 75/- set, post 3/6.
TELEPHONE SET "TELE-F." This is the best known portable telephone ever made, it has a built-in generator for ringing the other instrument and requires only twin wire between the sets. The set of two instruments and batteries in carrying case, £7/10/-, post 7/6. Twin flat P.V.C. wire 3d. yard.
TELEPHONE SET TYPE 'K.' The most compact telephone set available as the 4½ v. flat battery and buzzer is built-in to the hand instrument. Ringing and speaking both ways on twin wire, instrument is complete with 5ft. flex. Easily hangs on the wall. Set of two instruments, £5/10/-, post 3/6.
ROTARY CONVERTERS. Input 12 D.C. Output 230 A.C. 50 cy. 135 watts. In fitted case with variable resistance, 0/300 voltmeter. The ideal job for T.V. and tape recorders where A.C. mains are not available. £10, carr. 15/-. Special connectors, one fitted with 6ft. heavy duty flex and clips for D.C. side, 10/- set, post 1/-. **ROTARY CONVERTER,** input 12 v. or 24 v. D.C., output 230 v. A.C., 135 watts, £8/10/-, carriage 7/6.
BATTERIES. Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 16in. × 18in. × 11in. (Two will make an ideal power supply for our 12 volt Rotary Converters.) Uncharged £6/10/- each, carriage 15/-. 24 volts 85 amperes, £14 each, carriage 15/-.
GEARED CAPACITOR MOTORS. 220-240 v. 50 cy. 30 watts, 300 r.p.m. also spindle for 1425 r.p.m. A powerful and useful motor 75/-, post 3/6.
TERMINAL BLOCKS. 2-way 4/- doz., or box of 50 for 15/-, 3-way 6/- doz., 50 for 22/6, post 1/6.
TERMINAL STRIPS with ceramic supports from 2 to 24 ways @ 4d. per way.
MEGGER CIRCUIT TESTING OHM METERS. 0-1000 ohms and 100 ohms—200 K ohms INF, complete with spikes and leads. Brand New. 97/6, post 2/6.

T.C.C. CONDENSERS. 0.1 Mfd. 31 kV. 75/- each, 1 Mfd. 10 kV. 45/- each.
SOLENOIDS suitable for remote control, mechanical indicators, etc. 12 v. D.C., 400 M.A., 30Ω, 3½in. arm, ⅜in. movement, 5/- each, post 1/6.

RESISTORS EX STOCK, IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICE.



MAGNETIC COUNTERS

Counting to 9999.
2-6 v. D.C., 15/- each, post 1/6.
75-230 v. D.C. 15/- each, post 1/6.
HIGH SPEED TYPE No. 100c. 35/-, post 1/6.

VEEDER-ROOT MAGNETIC COUNTER. General purpose type with zero reset. 800 counts per minute up to 999,999. 48 volt D.C. 55/-, post 2/6.
THERMOSTAT SATCHWELL, 12in. stem 0/250 volt A.C./D.C. 15 amps. A.C. 10 to 90 degrees cent. 25/-, post 2/6.
ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Fahr., 250 v. 10 amp. A.C. Ideal for greenhouses, etc., 35/-, post 2/-.

THIS MONTH'S SPECIAL OFFER: ROTARY CONVERTER. Input 24 v. D.C. Output 220 v. A.C. 250 watts. Pedestal type with D.P. Ironclad switch. **BRAND NEW. Bargain at £17/10/-.** Cge. 15/-.

NIFE BATTERIES. Nickel Cadmium 12 volt 18 ampere hours crated and connected alkaline filled. **Brand New £4** each, carriage 10/-. Also available 2.4 volt 10 ampere hours, 20/- each, post 3/6.
TRANSFORMER. Single Phase 250-115 volts 50 cycles 5 KVA double wound, £30, carriage extra.
FANS INDUSTRIAL TYPE 230/240 volt A.C. Capacity Motor, 16-inch blades in housing, adjustable louvres, filter. Brand New, £25, carr. extra.
AIR BLOWER powered by a 230-volt A.C. motor, 15in. fan. Volume of free air at max. r.p.m. is 1,250 cu. ft. per min. At maximum efficiency 900 cu. ft. per min. Brand New £25, carriage 20/-.
EXTENSION SPEAKER in cabinet 9in. × 8in. × 4in. Permanent Magnet. 3 ohms. Ready for use, 25/-, post 2/6.
PUMP Electrically Driven by a 24v. DC motor. Works efficiently on 12v. Totally enclosed, self lubricating driven through 4 to 1 reduction gearbox delivering 60 g.p.h. /30lb./sq. in. Inlet and outlet unions ¼ BSP 37/6, post 2/6
OSCILLOSCOPE No. 11 with high-class amplifier. 230 volts. £12/10/-, cge. 15/-.

L. WILKINSON (CROYDON) LTD.
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PORTABLE TRANSISTOR RECORD PLAYER

1 Watt
4-Transistor
Amplifier

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, 17/6 extra.

SEND FOR DETAILS NOW

BARGAIN OFFER

- 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 relief. Alternative Blue/Fawn with Polka Dot relief.

★ **CABINET** incl. Motor Board and 7 x 4in. Speaker, 39/6. Carr. 2/6.

★ GARRARD BA 1 Gram Unit, 59/6. Carr. 2/6.

LIMITED BARGAIN OFFER

RECORD PLAYER BARGAINS Latest 4-speed models

NEW RELEASE by E.M.I.—4-speed Single Player Unit fitted with latest stereo and monaural Xtal cartridge and dual sapphire stylii. Auto stop and start. A fidelity unit and bargain buy at only £6/19/6, carr. & ins. 3/6.

SINGLE PLAYERS. B.S.R. (TU9) 90/-; COLLARO JUNIOR studio P.U. £4/10/-.

AUTOCHANGERS. B.S.R. (UA8), £6/19/6; COLLARO CONQUEST, £7/19/6. UA8 STEREO £7/19/6. B.S.R. (UA14.) latest model, £7/19/6.

BARGAINS GARRARD PLAYER UNITS

SINGLE PLAYERS:
Model 4SP £6/17/6. Carr. 3/6.
Model TA Mk. 2, £7/19/6. Carr. 3/6.
Model 4HF. £18. Carr. 3/6.

AUTOCHANGERS, LATEST RELEASE:
Model RC210, 10 gns. Carr. 4/6.
All current 4-speed models. Brand new and boxed.

RECORD PLAYER CABINETS

Cabinet Price
£3.3.0
Carr. and Ins. 3/6

Contemporary style. rexine covered cabinet in mottled red and white polka dot. Size 18½ x 13½ x ht. 8¼in., 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 13in. 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. £2/17/6. P. & P. 1/-. 6in. Spkr. & trans., 22/-. P. & P. 1/6.

TRANSISTORS BVA
1st Grade
New Reduced Prices

MAZDA		MULLARD		G.E.C.	
XA101	14/6	OC70	9/6	GET114	9/6
XA102	16/6	OC71	12/6	GET115	12/6
XA103	15/-	OC72	15/-	Newmarket	
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; GEX34 4/-.

NEW BOXED VALVES ALL GUARANTEED

1T4	6/-	EABC80	8/6	EZ81	7/6
1R5, 1857	7/6	ECC84	9/6	MU14	9/-
384, 3V4	7/6	ECF80	9/6	PCC84	9/6
5Z4	9/-	ECL82	10/6	PCF80	9/6
6K7	5/-	ECL80	10/6	PCL83	12/6
6K8	7/6	EF80	8/-	PL81	12/6
6Q7	7/6	EF86	12/6	PL82	9/6
6V6	6/6	EF91	5/-	PL83	10/6
DAF96	9/-	EL41	9/6	PY80	7/6
DF96	9/-	EL84	8/6	PY81	9/6
DK96	9/-	EY51	9/6	PY82	7/6
DL96	9/-	EY86	10/-	U25	12/6

SPECIAL PRICE PER SET
1R5, 1T4, 185, or 384 or 3V4, 25/-
DK96, DF96, DAF96, DL96, 35/-
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5, 32/6

JASON FM TUNER UNITS
(87-105 Mc/s)

Designer-approved kits of parts for these quality and highly popular tuners available as follows:—

STANDARD MODEL (FM1)—as previously extensively advertised. COMPLETE KIT, 5 gns., post free. Set of 4 spec. valves, 20/-, post free.

LATEST MODEL (FMT2)—attractively presented shelf mounting unit in enclosed Metal Cabinet with Built-in Power Supply. COMPLETE KIT, £7, p. & p. 3/6. Set of 5 spec. valves, 37/6.

MODEL JTV2. Self-powered Switch Tuned B1-B2-B3 AM/FM Unit. 5 pre-set stations, AFC and AGC circuits. Complete Kit incl. ready-built and valved Turret Tuner, £12/19/- post free. 4 spec. valves, 32/6 extra.

NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/6 post free. 48hr. Alignment Service, 7/6, p. & p. 3/6.

MAINS TRANS. AND QUALITY OUTPUT TRANS. Mfd. in our own workshops to top grade spec. Fully interleaved and impregnated. Enquiries welcomed for small production runs, prototypes or individual jobs.

RECORDING TAPE BARGAINS

EMI 1st grade. Brand new sealed boxes.

Standard		Long Play	
3in., 175ft.	7/-	250ft.	9/-
5in., 600ft.	19/-	850ft.	25/-
5½in., 850ft.	25/-	1,200ft.	31/6
7in., 1,200ft.	31/6	1,800ft.	45/-

SPARE REELS: Emitape, new, boxed: 3in. 3/-, 5in. 3/8, 5½in. 4/-, 7in. 4/6.

SPECIAL PURCHASE. Famous manufacturers, 1st grade tape, in sealed white boxes.

Standard		Long Play	
5in., 600ft.	15/-	850ft.	19/6
5½in., 850ft.	16/6	1,200ft.	22/6
7in., 1,200ft.	21/-	1,800ft.	32/6

Plastic Tape Reels, special offer. Manufacturers' surplus. 3in. 2/9, 5in. 3/-, 5½in. 3/3, 7in. 3/6.

2 WAVEBAND CAR RADIO KIT
12v. operation Med. & Long Waves

Recommended Buy

Modern development of the famous Brimar Hybrid vibratorless car radio circuit. Five latest type Brimar low voltage valves and power transistor. R.F. stage and permeability pre-aligned Cyldon 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 2½in., with attractive calibrated dial. Speaker and power transistor stage mounted separately approx 8 x 5 x 3in

Complete Kit Bargain Price **£12.19.6** P&P 3/6.

Instruction booklet and parts list available. 3/6 post free.

KNOBS. Modern Continental types, walnut and ivory.
1¼in. dia. with GOLD RING ..... 1/- ea
1in. dia. with GOLD CENTRE ..... 10d. ea
LARGE STOCKS—SEND YOUR ENQUIRIES.

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RESISTORS—FULL RANGE 10 ohms—10 megohms 20%, ½ w. and ¼ w. 3d., ½ w. 5d. (Midget type modern rating), 1 w. 6d., 2 w. 9d., 10% Hi-Stab. ¼ w., 5d., ½ w., 7d., 5% ¼ w., 9d., 1% HI-STAB, ½ w., 1/6 (10-100 ohms 2/-).

PRE-SET W/W POTS. T/V type. 25 ohms—50 K ohms 3/-. 50K—2 Meg. (Carbon 3/-). SPEAKER FRET—Expanded Bronze anodised metal 8 x 8in., 2/3; 12 x 8in., 3/-; 12 x 12in., 4/6; 12 x 16in., 6/-; 24 x 12in. 9/-; 36 x 12in., 13/6, etc., etc.

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Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee. Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

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THE world-famous "Globe King" kit; new and improved version; complete with all parts, chassis, coils and valve, together with "Easy-Build" charts and instructions; a highly efficient one valve short wave radio with band spread tuning; hundreds of testimonials, 79/6, postage paid.
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TRANSISTOR F.M. receiver; send s.a.e. for component price list.—Ajax Electronics, 572, Fulham Road. London, S.W.6. [9217

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1500 cycles, 2KVA, 80 volt alternators, also Inverters Input 24v D.C.; output: 1 ph., 115v. 1500 VA, 400 cycles.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham, 13. [9251

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SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0056

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GOLDRING LENCO GL 50/4 4-speed transcription turntables, variable speed, complete with pick-up arm and shell, less cartridge in sealed boxes; £12/15, postage and packing 3/-. STUDIO "O" or "P" crystal inserts, 25/- each; Collaro TX88 inserts, 35/- each. SEND for free lists of other special offers: amplifiers, tuners, tape recorders, etc. 400, Edgware Rd., Paddington, W.2. Pad. 5521. [9262

CINE-VOX disc recording mechanisms for L.P. or standard operation from 30gns.-56gns.; also complete tape-disc or direct channels from 50gns.-112gns.
DEMONSTRATIONS can be arranged in London.—For full details write to K.T.S., Ltd., "Coplow," Park Rd., Braunton, N. Devon. Callers by appointment only. [0210

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PLASTIC recording tape, brand new tape, 7in. reels 1,200ft., 27/6 each; 5½in. reels 850ft., 21/6 ea.; 5in. reels 600ft., 16/6.
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GUARANTEED satisfaction.—A. Marshall & Son, Ltd., 18, Cricklewood B'way, London, N.W.2. Gladstone 0161/2. [9253

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VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A., Boxmakers, 75a, Godwin St., Bradford 1. [0172

RECLAIMED valves, tested and perfect, huge stocks, modern and obsolete, all one price, 5/- plus 6d postage each; delivery by return.—Lewis, 46, Woodford Ave., Gants Hill, Ilford, Essex. [9247

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MISCELLANEOUS

CABLE, full or random coils, 10% to 20% under list prices; conduit, 5% to 10% under list; request new catalogue.—British Distributing, 591, Green Lanes, London, N.8. [9258

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FREEHOLD radio, TV and elec. business with living accom.; south coast; £4,500, s.a.v.—Box 1562. [9256

ESTABLISHED radio, television and general electrical business for sale; double-fronted shop on main street of busy market town in vicinity of Lake District; annual turnover over £35,000; premises includes living accommodation and room for expansion; present owner contemplating retiral.—Enquiries to Box 1251. [9232

BUSINESS OPPORTUNITIES

LONDON retail radio, television and electrical business of the highest standing requires executive director; eventual complete take-over of business envisaged on retirement of present managing director; this is an exceptional opportunity to acquire an efficiently operated business established over 30 years, which is very highly regarded; the identity of the business will only be disclosed to a bona-fide principal who can satisfy the advertiser as to his suitability and ability to provide the necessary capital.—Write in confidence, stating age and details of background and experience, Box 1625. [9270

CAPACITY AVAILABLE

ELECTRONICS engineers to the industry. Production with 100% inspection. RADIO-AIDS, Ltd., 29, Market Street, Watford (25988), Herts. [0214

RADIO components made to order.—Bel Sound Products, Marlborough Yard, N.19. [0185

SMALL London manufacturer has capacity available for experimental or production high vacuum electronic devices.—Box 8924. [9108

HIGHLY competitive quotations given for all your prototype and production requirements.—Newlyn Electronics, The Fradgan, Newlyn, Penzance. Tel. Penzance 2462. [9201

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ANYONE interested in doing up a pre-war Baird Televisor television?—Answers and s.a.e. to J. Stanley Clarke, Forest Lodge, Sharpthorne, Sx. [0112

SITUATIONS VACANT

ANTARCTICA.

VACANCIES exist for Wireless Operator Mechanics to serve with the Falkland Islands Dependencies Survey in the Antarctic for 2 years; salary is at the basic rate of £500 a year; whilst in the Antarctic everything is provided free of charge including clothing, cigarettes, etc.; generous cash payment on completion of service.
CANDIDATES, preferably between 20 and 30 years of age and must be able to transmit and receive morse at 20 w.p.m. (plain language or code) and capable of elementary maintenance of wireless transmitting and receiving equipment.
SUCCESSFUL candidates will be required to leave U.K. in October/November.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, qualifications and experience and quote M2A/50980/WF. [9234

SIGNALS Technicians.

REQUIRED by Kenya Government Police on contract for one tour, 36-45 months, with possibility of permanent and pensionable employment. Salary (including Inducement Pay) according to age and experience in scale rising to £1,341 a year. Gratuity 13½% of total salary drawn; free passages; outfit allowance £40. Liberal leave on full salary.
CANDIDATES must have wide knowledge of installation, running and maintenance of fixed and mobile high frequency and V.H.F. communications equipment.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, qualifications and experience, and quote M2A/51053/WF. [9237

ELECTRONIC Testers.

ELECTRONIC Inspectors.
MECHANICAL Inspectors.
URGENTLY required for work on long duration Government contracts; either skilled personnel holding City & Guilds or O.N.C. or ex-service with experience such as Armament Artificer (Telecoms.); alternatively, personnel with general educational standard up to G.C.E. level in Maths. and Science, preferably with some practical experience in appropriate field, will be considered as trainees; apply in writing, in first instance, giving full personal details, to the Chief Inspector, Hartley Electromotives, Ltd., Monkmoor, Shrewsbury.
EXCELLENT opportunities for further advancement exist for the right type of persons; travelling expenses paid for interview; housing assistance may be given to selected personnel after probationary period. [9266

SERVICE engineer required for industrial sound equipment. London area.—Box 0803. [9197

PART-TIME Electronic Engineer for mobile recording work with own equip. wanted in London.—Box 1579. [0134

TELEVISION service engineer, fully experienced, clean driving licence, permanent position.—A. G. Allen & Co., Ltd., 41-3, Bridge Rd., Wembley Park. Tel. Arn. 2261. [9274

SITUATIONS VACANT

LOUIS NEWMARK, Ltd.

LEADING company in the design of auto pilots for helicopters are expanding their facilities at their development laboratories at Croydon and have the following vacancies to be filled immediately.
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

RADIO Maintenance Technicians.

POLICE Department, Government of Northern Rhodesia, requires radio maintenance technicians on agreement for one tour of 3 years with prospect pensionable employment. Salary according to experience in scale rising to £1,260 a year. Pending the outcome of salaries review a special interim allowance at rate of 5% of salary is at present payable; prospects of promotion to telecommunications officer (maximum salary £1,315) and Chief Telecommunications officer (maximum salary £1,490). Married accommodation, with heavy furniture available immediately at sub-economic rent, e.g., on salary of £745 rent is £45 a year. Free passages. Liberal leave on full salary. CANDIDATES should be between 22 and 35 years, of good physique, and possessing maths. and physics at G.C.E. "O" level standard. They should have sound knowledge of installation and maintenance of modern low and medium power V.H.F. static and mobile equipment, H.F. transmitters and receivers including S.S.B. and petrol generator and diesel electric sets.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, qualifications and experience, and quote M2A/50829/WF. [9243

RADIO and television development.

A WELL-KNOWN company in the Midlands, manufacturers of radio and television equipment, has vacancies in its design and development laboratories for experienced:—
(a) DEVELOPMENT engineers.
(b) TELEVISION and radio engineers.
(c) MECHANICAL designers and draughtsmen.
(d) TECHNICAL assistants.
FOR expanding contract and commercial programmes. Opportunities exist for development work on all types of radio communications and colour television.
APPLICATIONS stating qualifications, experience and salary required should be addressed in confidence to the Personnel Manager, Box 1470. [9249

ELECTRONIC test engineers and testers.

LIGHT engineering company in the Midlands is requiring the above for the testing of electronic equipment on Government Contracts and commercial television.
APPLICANTS with a knowledge of this type of testing and wishing to obtain well paid positions should apply stating qualifications and experience to Personnel Manager Box 1471. [9250

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APPLICATIONS are invited for the post of Research Assistant at the Nuffield Radio-Astronomy Laboratories at Jodrell Bank. The post is intended for development and construction of low noise parametric amplifiers for use with a 250ft radio telescope. At least two years' electronics experience essential. Duties to commence as soon as possible. Salary according to qualifications and experience. Applications should be sent not later than October 10, 1960, to the Director, Nuffield Radio-Astronomy Laboratories, Jodrell Bank, Nr. Macclesfield, Cheshire. [9263

THE HOSPITAL FOR SICK CHILDREN, Great Ormond St., London, W.C.1.
TECHNICIAN reqd. in new medical electronics workshop, engaged in maintenance and development work of apparatus, used in various hospital depts. Salary scale £600×20 (2)×25 (4)—£740 p.a. O.N.C.+ 2 years exp. in light engineering, electrical — electronic — physics fields or equivalent.—Application forms obtainable from the House Governor. [9245

RADIO mechanics.—Permanent and pensionable vacancies exist for young men experienced in the assembly, installation and testing of HF and VHF telecommunications equipment, preferably in connection with aviation ground services.
STAFF will be based at the Engineering Division of the Company, address below, but their main duties will take place overseas for varying periods installing telecommunications equipment. Whilst overseas a generous daily allowance is paid.
EX-SERVICES personnel of fully skilled categories are particularly welcome to apply.
APPLICATIONS to the Personnel Officer, International Aeradio, Ltd., Hayes Rd., Southall, Middlesex. [0263

ELECTRONICS engineers: Men or women with at least O.N.C. or equivalent experience to do final tests and inspection on a wide range of high accuracy instruments. These are permanent staff positions with pension fund and club room facilities.—Electronic Instruments, Ltd., Richmond 6434. [0124

SITUATIONS VACANT

REQUIRED, for servicing of electrical equipment, a young technician, preferably single, having made special study of high frequency engineering, or amateur radio enthusiast with experience in mechanical engineering; living in London area; some knowledge of German useful.—Box 1607. [9244

TECHNICAL writer required for compiling radio and television service manuals; must have good theoretical and practical knowledge of radio and television receivers and the ability to write good English.—Apply to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City. [9235

SIMULATOR engineer at College of Air Training, Hamble, to maintain and overhaul electronic flight simulators; applicants should possess O.N.C. (Electrical) or equivalent and be experienced in the maintenance of electronic equipment Salary according to experience.—Write: Bursar, College of Air Training, Hamble. [9264

ENGINEERS with some five years practical experience of radio frequency design work required for interesting new project in laboratory situated in South West outskirts of London. Some experience of cables an advantage. Pension scheme.—Write giving full particulars of experience and salary required to Box 1458. [9248

LICENSED radio engineer with A licence and pulse rating required at Stansted Airport to maintain Britannias and D.C.6s; good salary offered with opportunity for progress with rapidly expanding company.—Please reply Chief Radio Engineer, Channel Airbridge, Ltd., Southend Airport; radio mechanics preferably with aircraft experience also required. [9202

A NUMBER of senior and junior new appointments available; excellent remuneration, pension scheme, full staff privileges; wide range of activities and scope in rapidly expanding company.—Write in fullest confidence to Technical Director, Clarke & Smith Mfg. Co., Ltd., Wallington, Surrey. (One min. main station.) [9241

WE are interested in individuals as well as in electronics, our steady expansion as electronic control engineers is creating more vacancies in laboratory, drawing office, mechanical and electronic production, sales and special products departments.—If you want a job now or later, write, Elcontrol, Ltd., Industrial Electronic Engineers, Hitchin, Herts. [0318

DISTRICT engineers are required to control and supervise the maintenance of television and audio relay sending and repeater stations in Scotland; a knowledge of television circuit techniques combined with considerable practical experience of servicing is an essential requirement for this post but preference will be given to those applicants who also hold suitable technical qualifications.
THESE senior positions are permanent with considerable prospects and a contributory pension fund is in operation; applicants should apply in writing stating experience, qualifications and present salary, to: Area Engineer, North British Relay, Ltd., 47a, George St., Edinburgh. [9265

AN engineer who can deal with the maintenance and development problems of electronically controlled mechanical industrial equipment is required for a rapidly expanding factory in N.W. London; H.N.C. in electronics would be an advantage; previous experience in this field essential, previous R.F. work advantageous; high salary and good prospects for the right man.—Write Box 1429. [9242

TRANSFORMER engineer required to assist with the design of a wide range of low and medium power transformers for the electronics and allied industries, O.N.C. with some experience are minimum qualifications; salary depends on age, experience and qualifications.—Write with full details to the General Manager, Reading Winding, Ltd., 169, Basingstoke Rd., Reading. [9252

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [0252

SOUND recordist required by Kodak, Ltd., to provide recordings for Company lecturers who are also using films and slides. Must be able to make magnetic tape recordings of all kinds with a fairly modest range of equipment. Must have a good knowledge of music and a sense of what is apt for use in film-making. A skilful amateur with a feeling for presentation might well be suitable for this work.—Please send an outline of career and qualifications for the post to the Personnel Manager, Kodak, Ltd., Kingsway, London, W.C.2. [9257

MINISTRY OF AVIATION requires Assistant Technical Cost Officers at Mottingham, London, to prepare estimates of prime cost of manufacture of engineering productions. Quals.: Recognised eng. apprenticeship, O.N.C., C. & G. Final Certs. or equiv. Practical exp. in ratefixing, operational planning and prime cost estimating. Radio, radar or electronic equipment exp. an advantage. Salary: £900 (age 30)-£1,065.—Application forms from Manager (P.E.2530), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4. [9239

SITUATIONS VACANT

ELECTRONIC Development Engineer required to work on VHF equipment in the field of nuclear magnetic resonance; theoretical design as well as practical ability necessary; attractive opportunity to a versatile engineer in an expanding international company; commencing salary in range £1,250 to £1,500; pension scheme.—Applications stating qualifications and experience to Managing Director, Perkin-Elmer, Ltd., Beaconsfield, Bucks. [9231

AIRCRAFT radio engineers and mechanics required with specific workshop experience of one or more of the following: VHF, HF/MF, ADF, ILS, VOR, X Band Radar. 42-hour week. Top basic wages: Engineers, £16 p.w.; mechanics, £14 p.w. Pension scheme after 12 months' satisfactory service. Overtime and bonus system in operation.—Apply in writing, stating experience, to The Managing Director, Air Transport (Charter) (C.I.), Ltd., 7, Willow Road, Poyle Trading Estate, Colnbrook, Slough, Bucks. [9236

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