

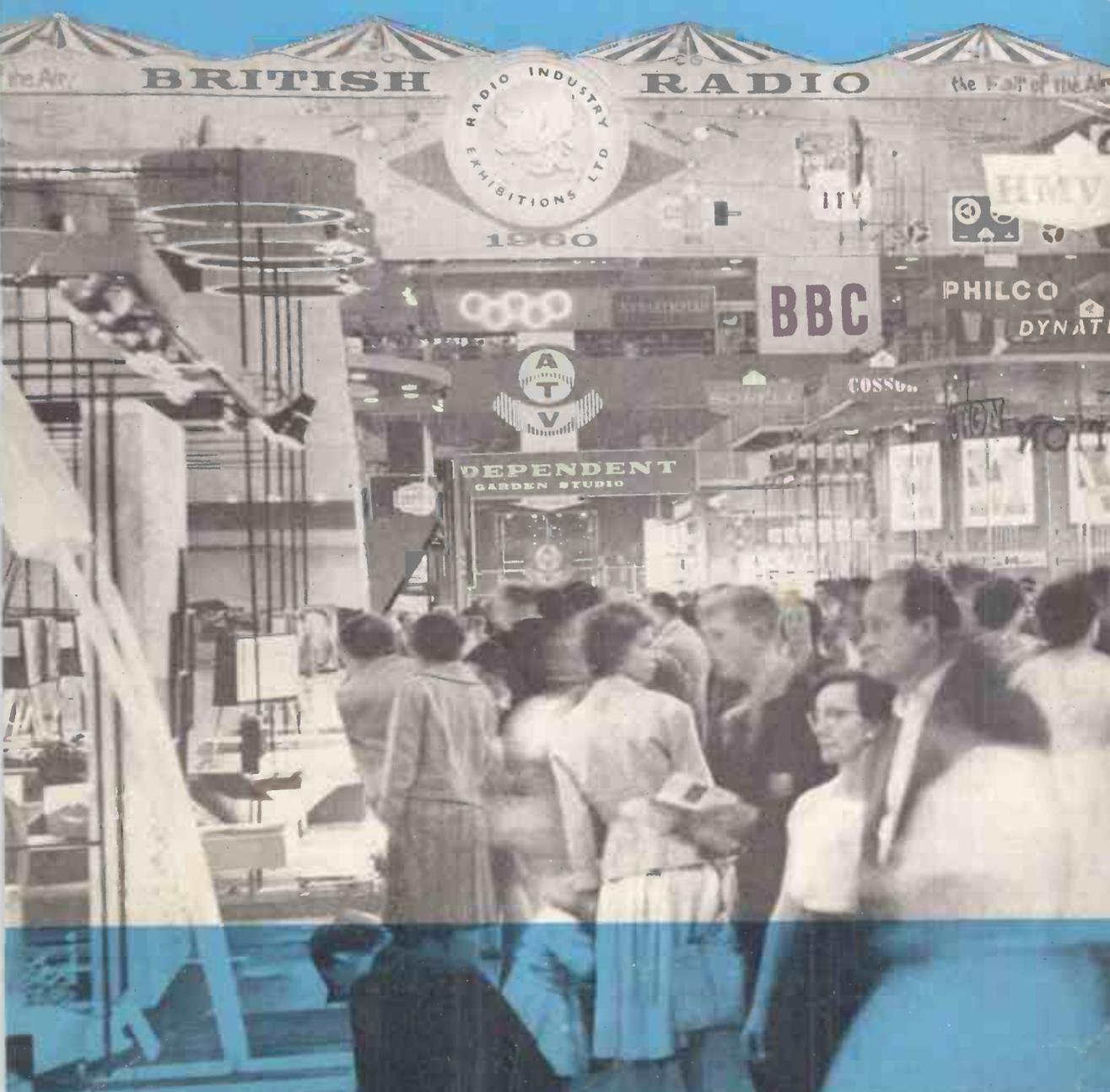
W. Smith

OCTOBER 1960 • TWO SHILLINGS

SHOW REVIEW

Wireless World

ELECTRONICS • RADIO • TELEVISION



THE SCALE IS INSIDE!



EDISWAN 6-in. Aluminised Indirectly Heated Cathode Ray Tube for Radio DF Compass and other applications. High Brightness Level. Internal Scale.

This Ediswan Radio DF Compass Tube ends parallax errors for the simple reason that the scale is printed on the inside face in actual contact with the phosphor screen. The scale pigment used is completely inert and unaffected by the electron beam. It is a dense black and does not fade after prolonged use.

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Anti-Dazzle Face All CRTs in this range have a concave face, treated on the outside with a robust process which eliminates distracting specular reflections and gives the impression of a soft matt ground glass finish.

Scale Applications The tube is available with an octantly corrected scale (31C1) or a uniformly graduated scale (31C2). Other versions can be supplied printed with selected portions of the Smith's Impedance Diagram.

Invitation We should welcome discussions with designers and manufacturers who have specific requirements involving special scales.

BRIEF SPECIFICATION

Heater voltage (volts)	V_h	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

INDUSTRIAL VALVES & CATHODE RAY TUBES
Associated Electrical Industries Limited

Radio & Electronic Components Division

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CRC 16/13

Wireless World

ELECTRONICS, RADIO, TELEVISION

OCTOBER 1960

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- 473 Editorial Comment
474 Permeability Tuners for Television *By V. H. Piddington*
480 Airshow Electronics
482 Firato 1960
484 World of Wireless
486 Personalities
487 News from Industry
489 National Radio Show Review
497 Letters to the Editor
501 Equatorial Ionospheric Effects *By T. W. Bennington*
507 Transistor Inverters & Converters—3 *By M. D. Berlock and H. Jefferson*
510 Piezoelectric Voltage Transformers *By A. E. Crawford*
515 Kirchhoff's Laws *By "Cathode Ray"*
518 A "Kiwi" at Earls Court
519 Transistor V.H.F./F.M. Receiver—3 *By R. V. Harvey*
522 Studio 5 (Associated Rediffusion)
523 Elements of Electronic Circuits—18 *By J. M. Peters*
525 October Meetings
526 Random Radiations *By "Diallist"*
528 Unbiased *By "Free Grid"*

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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_{12} , 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 capacitively coupled to the mixer grid by $C_{1,8,5}$ connected in the Band-I position of S_1 only, and $C_{1,9}$ 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.

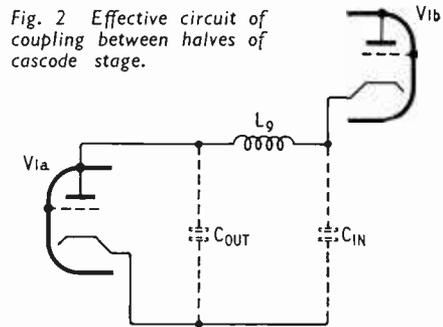
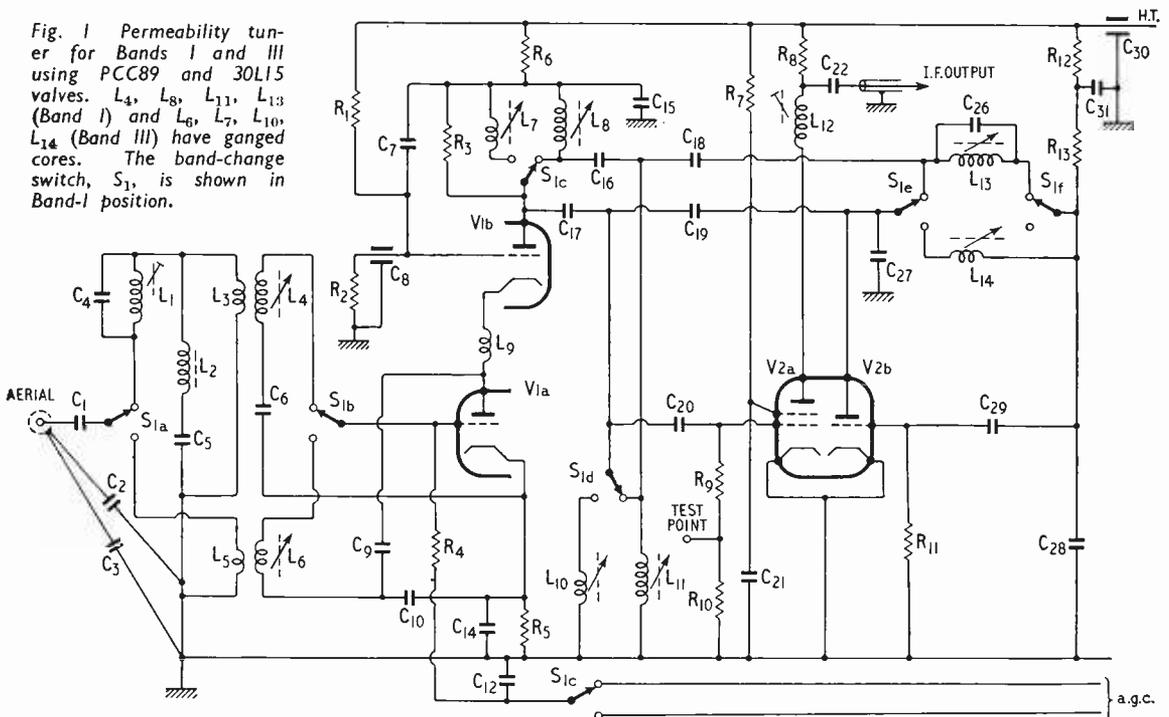


Fig. 2 Effective circuit of coupling between halves of cascode stage.

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:—

$$g_s^{\frac{1}{2}} \text{ (optimum)} = \frac{a g_t + g_c + R_{sh} (g_c + g_t)^2}{R_{sh}}$$

but for correct impedance match,

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

where: g_s = aerial conductance (referred to grid)

g_t = valve transit-time conductance

g_c = tuned-circuit conductance

g_i = 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_t and this has led to the technique of adjusting the aerial coupling transformer for minimum noise factor, and adjusting g_t for best obtainable impedance match. A convenient way of varying g_t 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

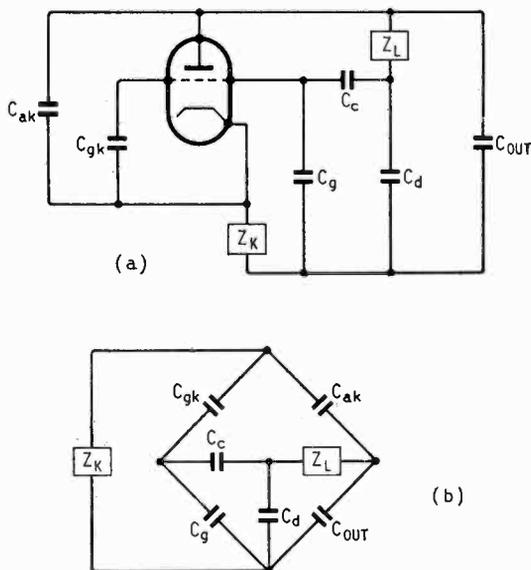


Fig. 3 (a) Effective circuit of earthed-grid stage and (b) its equivalent bridge form.

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 $C_c + C_g$; the tuning capacitance for Z_L being mainly to chassis. However, conditions for balance do exist and are:

$$\frac{C_g C_c}{C_c C_d + C_c C_u + C_g C_c + C_{gk} C_c} = \frac{C_{ak}}{C_{out} + C_{ak}}$$

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,

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

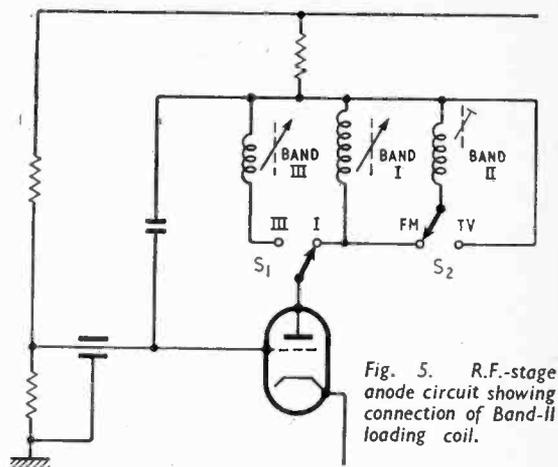
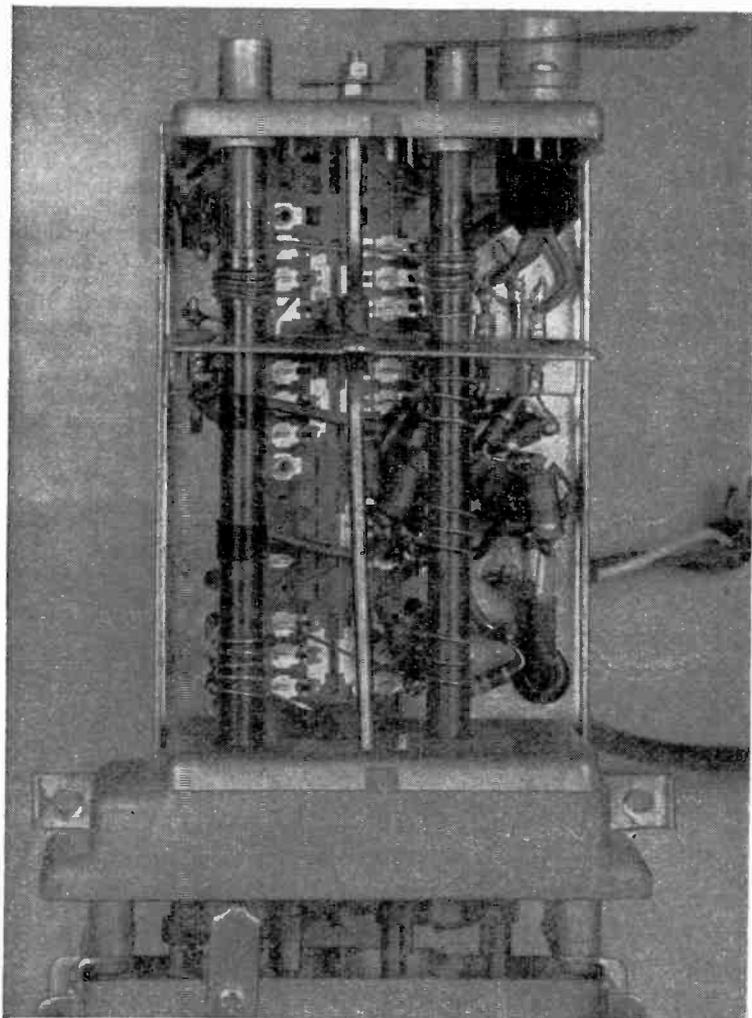
and the i.f. rejector assembly is in the top left-hand corner.

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

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.



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.

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.

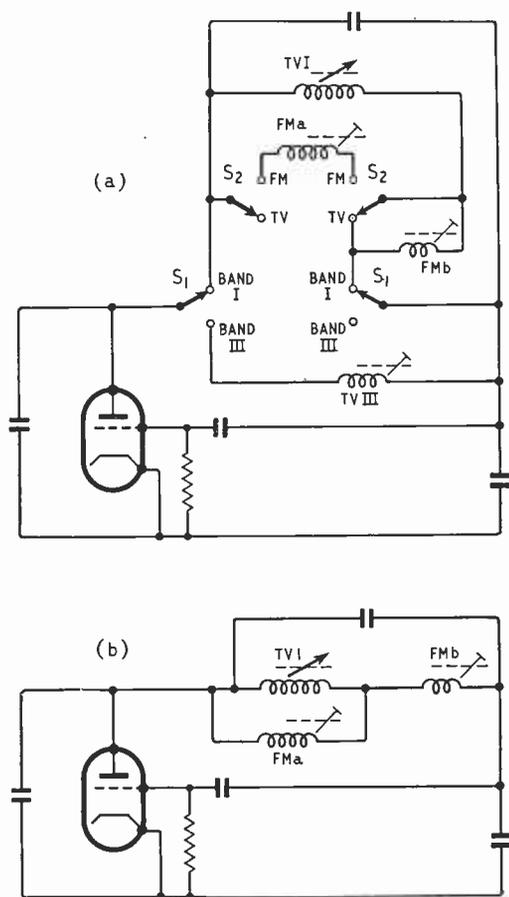
Circuit Description.—Fig. 5 shows the r.f. anode circuit to illustrate the method. The normal Band-I and -III coils, together with a section of the Band-I/III changeover switch, S_1 , is shown here. A second switch connects the Band-II loading coil across the Band-I coil, and short-circuits the Band-II 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) V.H.F./F.M.	38.1 10.75	Higher Lower	79.5 78.5	101.5 89.5	22 11	90.5 84

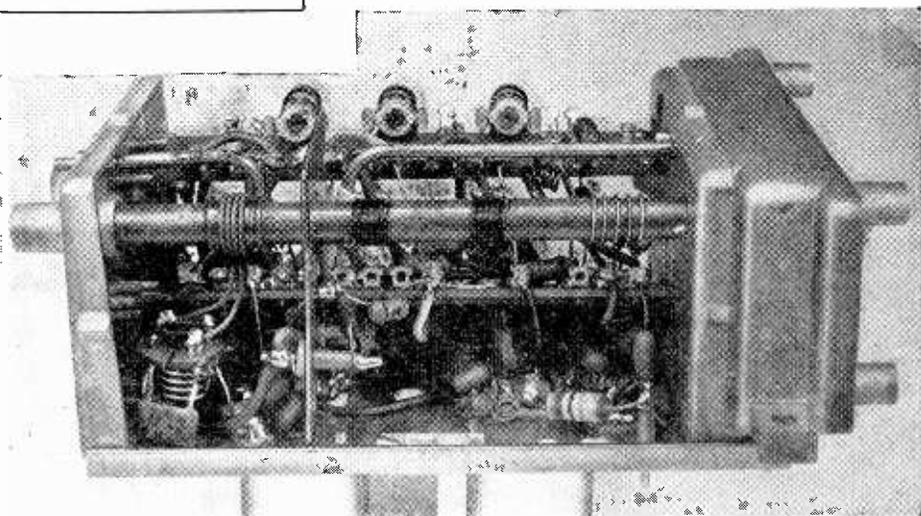


Above: Fig. 6. Simplified oscillator circuit showing (a) Band I/III/III switching and (b) components operating for Band II working.

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 shown 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.

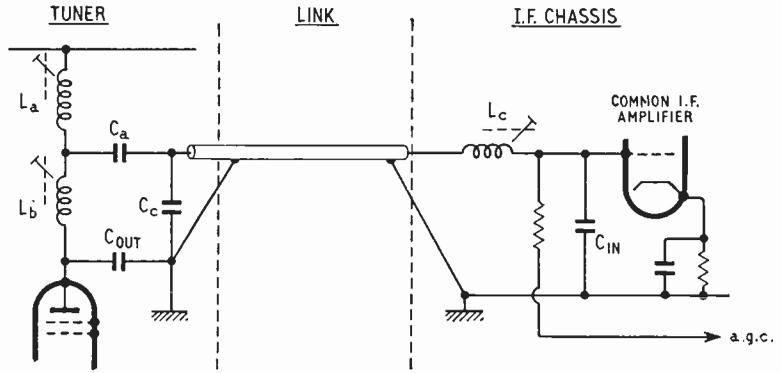
The loading-coil formers are mouldings with clip feet which enable them to be mounted on the additional changeover switch, S₂. Fig. 7 is a view of a tuner fitted with Band-II loading coils and switch. The three coils with screw core adjustment are the r.f. coils, and the coil on the right wound directly 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 S₂, 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_e, 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_e. 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 cascade 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.

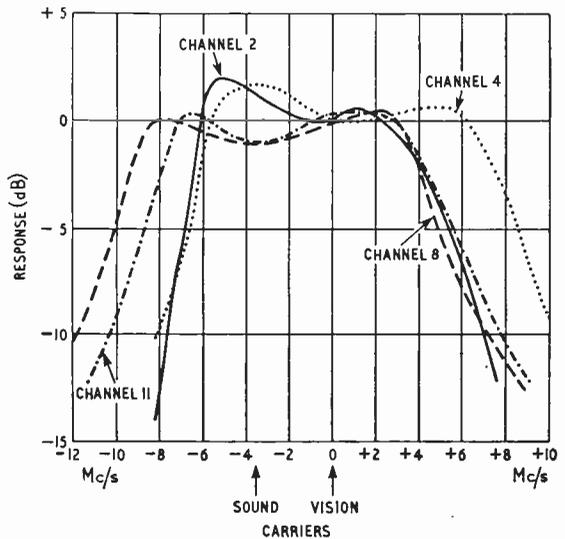


Fig. 9 R.f. response curves for tuner on Channels 2, 4, 8 and 11.

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.

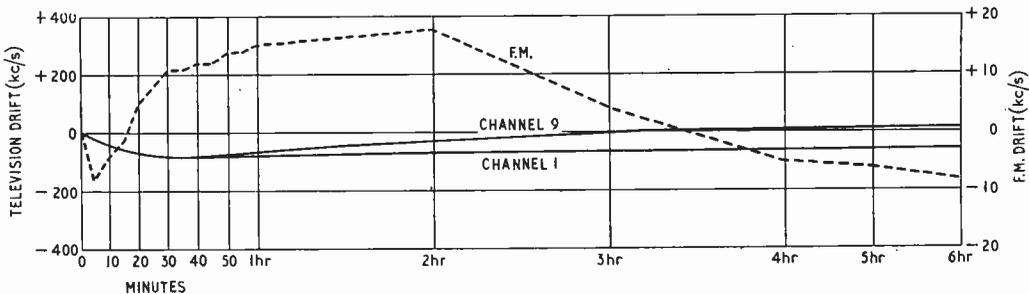


Fig. 10 Oscillator-drift characteristics for Bands I, II and III.

Airshow Electronics

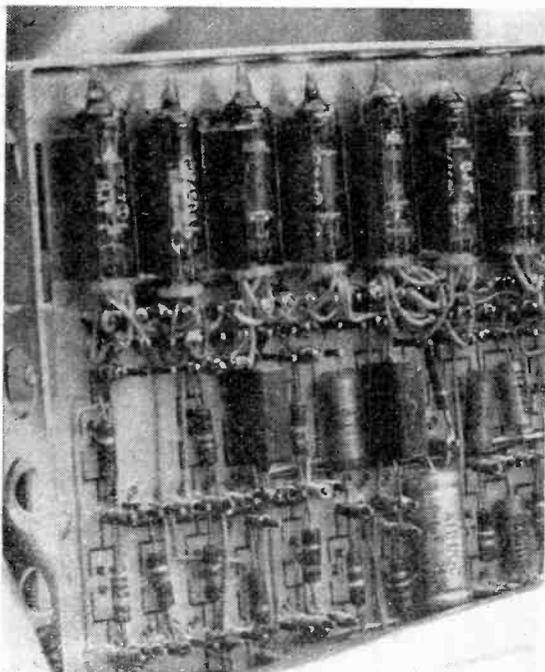
REVIEW OF TRENDS AS SEEN AT FARNBOROUGH

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 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

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



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 manoeuvres 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.t.s 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.

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 1964: later, as experience (and confidence) mount, the next steps towards completely automatic programmed take-off and landing may be taken.

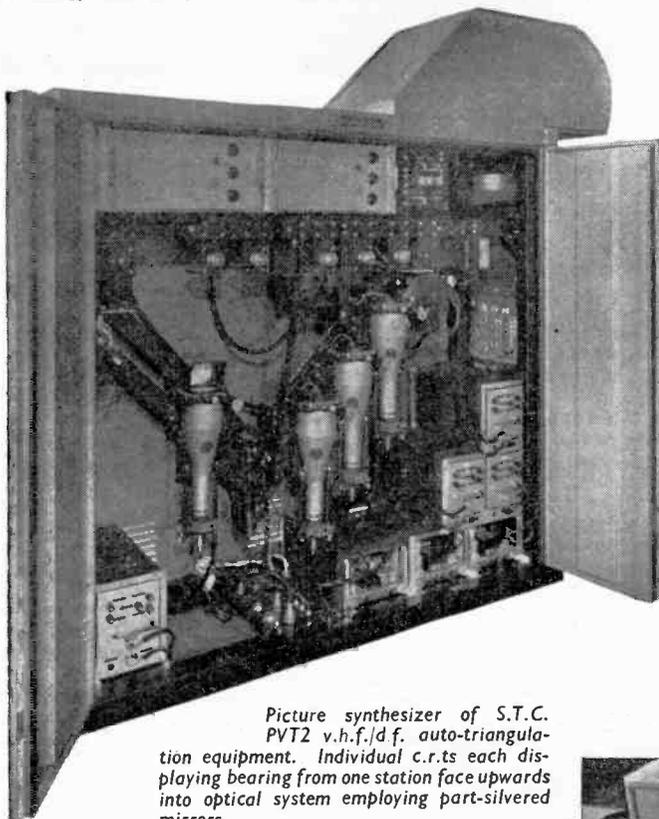
Of course, none of these exciting possibilities can come to pass without improvements in techniques to make certain the acquisition of unimpeachable data:

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.

Coscor, 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 side-

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.

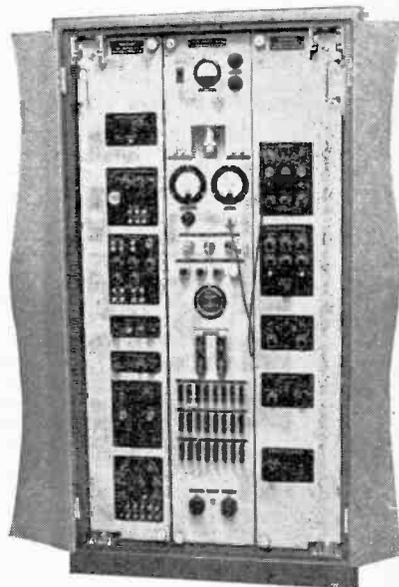


Picture synthesizer of S.T.C. PVT2 v.h.f./d.f. auto-triangulation equipment. Individual c.r.t.s each displaying bearing from one station face upwards into optical system employing part-silvered mirrors.

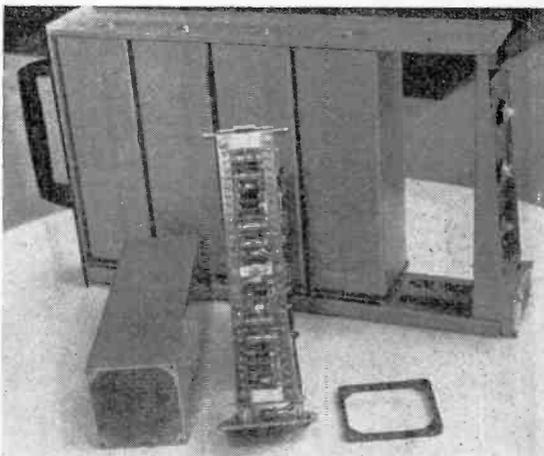
lobe. The transponder in the aircraft might ordinarily respond to sidelobes of the main array and thus give erroneous results; but with the Coscor system the transponder receives two pulses, the first from the omnidirectional array and the second from the directional aerial. Circuitry in the transponder 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.

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



Coscor 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, Epsilon, 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

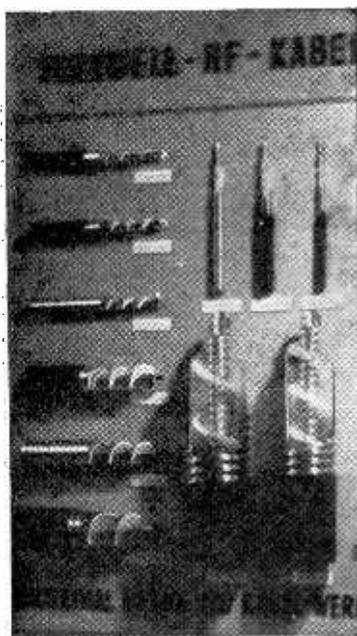
Guillaume Hewlett-Packard, Rohde & Schwarz, Saunders-Roe, Tektronix and Varian Associates and more than twenty other firms could be examined side by side.

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 (0.5 μ sec/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.

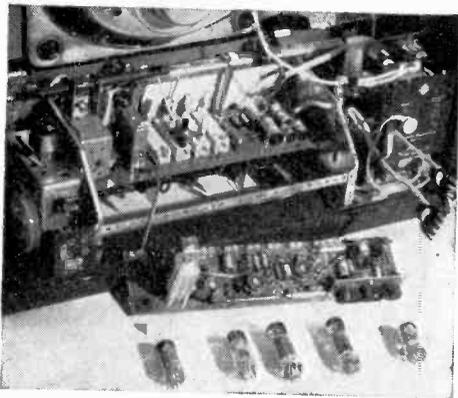
Domestic television receivers demonstrated at the show were notable for the uniform excellence of the line interlacing, which is accounted for not only by good design but also by the better synchronizing system inherent in the 625-line standard. The “new square tubes,” as the 59-cm (23-in) sizes are 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.



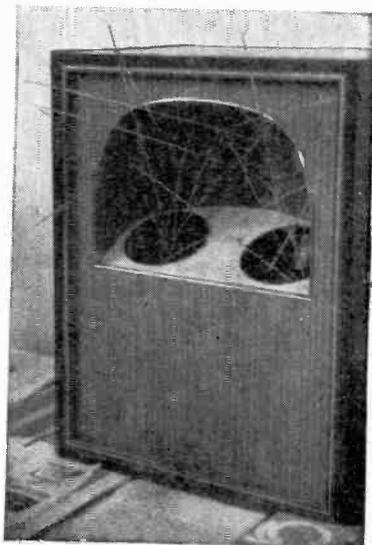
Radio Becker marine R/T transmitter and receiver Type HB-3/75-DSK. The transmitter (135W) operates on 33 channels between 17 Mc/s and 1,600 kc/s, and the receiver has a built-in auto alarm.



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 Vollautomatische 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

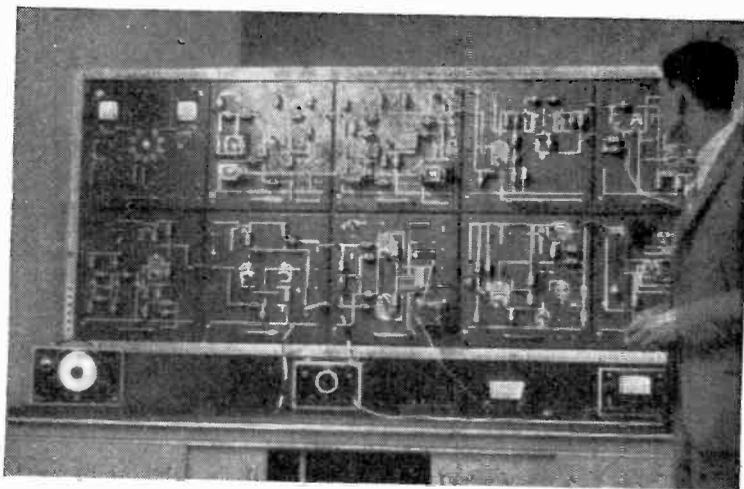
the Stereovox designed by a Dutch amateur, Mr. van Hedel, and marketed by Waller & Platte C.V. of Amsterdam. Two parallel-connected loudspeakers, tilted 55° from the vertical, project sound into a double elliptical reflector which diffuses the sound and removes the impression of a point source. The demonstration 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 Pirato 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

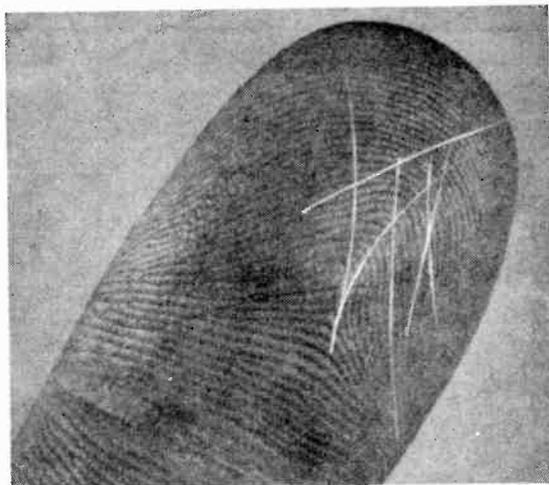
TRANSMISSIONS, both modulated and unmodulated, from the Bell Telephone Laboratories, New Jersey, and reflected from the American balloon satellite "Echo 1," were received at Malvern on August 29th. Although this was not the first occasion (the Jodrell Bank 250ft radio telescope had succeeded a week earlier) 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, teletext 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, ~~and~~ 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).

A Career in Technical Journalism?

There is a vacancy for an editorial assistant to work in the team which produces this journal. The post calls for a wide interest in and general knowledge of radio and electronics, the capacity to collect and sift information quickly and the ability to write on new developments lucidly (and, if possible, legibly!). A formal education which resulted in some qualification in physics would be an added advantage.

The successful applicant will find the work rewarding in its variety, and in the opportunities it offers of expanding his horizons.

Write in the first instance to the Editor, *Wireless World*, Dorset House, Stamford Street, London, S.E.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. Terroni

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 research 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 aeriels. 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

Phoenix.—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 Inter technique, 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.

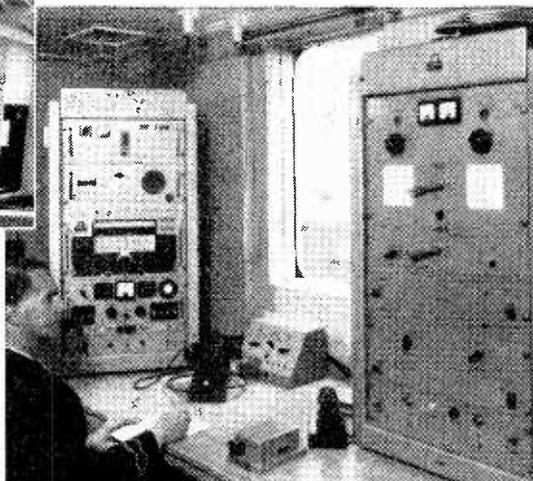
Vision and sound transmitters, as well as studio equipment, for three new television stations in New Zealand are to be supplied by Marconi's through Amalgamated Wireless (Australasia). The three stations, at Christchurch, Wellington and Dunedin, will operate in Band I using the 625-line 7-Mc/s standard.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

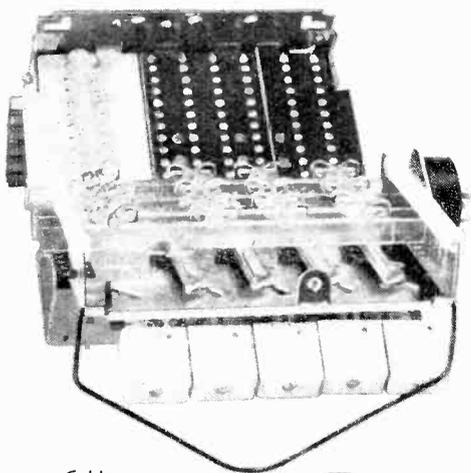
Murphy in June 1957 and was made possible by building a very stable local oscillator. This used a turret-type tuner and, last year, the principle was extended to f.m., when a.f.c. was applied with a point-contact diode. Bush introduced, two years ago, a push-button tuner using permeability tuning and 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.

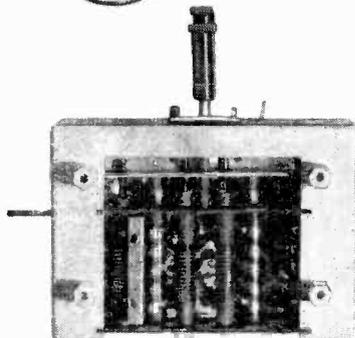
The Ferguson "Golden Glide" uses a modified disc tuner. Linear motion of the selector stud is converted to rotary motion of the spindle. Depressing the stud disengages the click, or detent, mechanism of the tuner and allows the stud to be slid to the desired channel number. The oscillator tuning for 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.

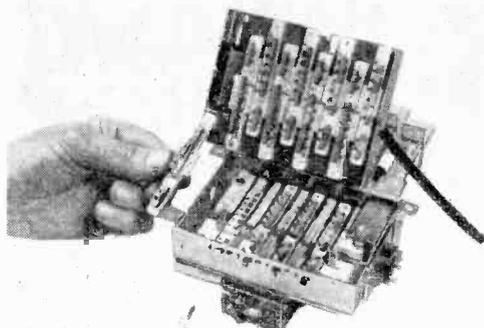
Called "Selectronic" by R.G.D., the Cyldon (made by Sidney Bird) tuner was also found to be used widely. This is of the incremental type and has printed coils on a flat board. The coil terminations are extended



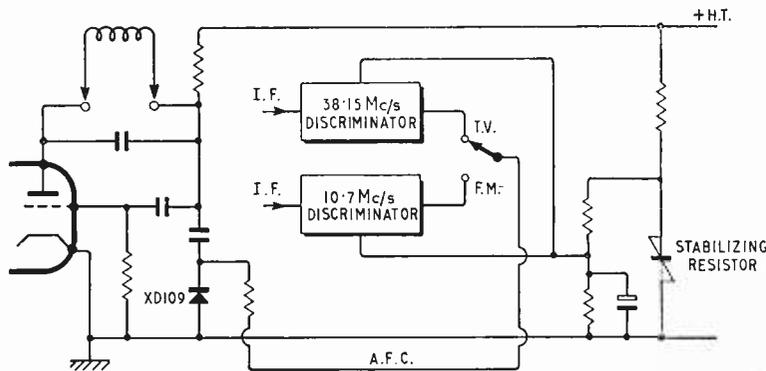
Above: Cyldon push-button tuner with coil panel folded back to show shorting contacts.



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

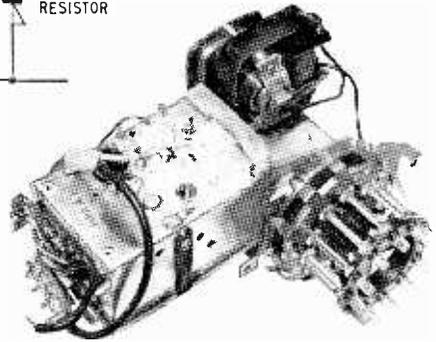


Piano-key switch tuner by A.B. Metal Products (in this case from H.M.V. receiver) has four coil biscuits inserted in the mechanism; those for other channels are housed in a cassette under the tuner.



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.

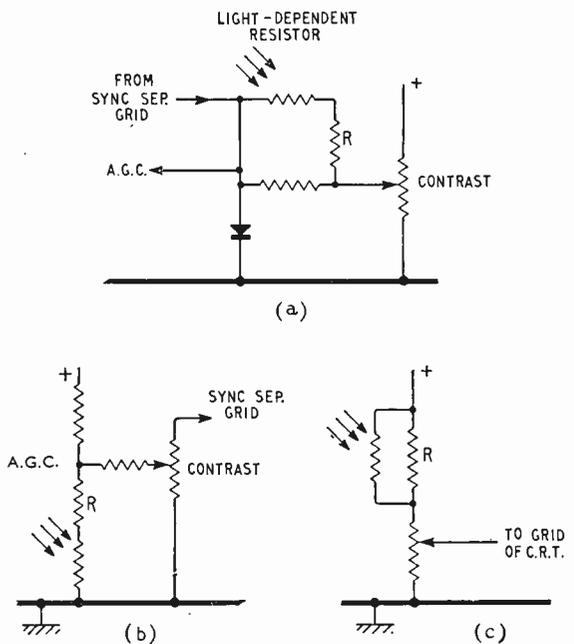
Ultra feature yet another approach—motor drive—in their "Bermuda" range of receivers. Here the tuning control looks rather like a telephone dial with twelve push buttons projecting from it. On pressing one of the buttons the dial rotates until the chosen button reaches the top of the disc, when it springs 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.

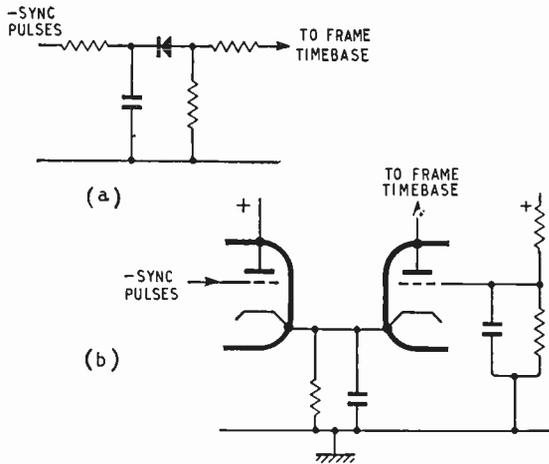
Interlace.—It has long been known that feed-through from line to frame timebase can destroy interlace; this can happen when mutual coupling exists between line and frame coils. With 110° c.r.t.s. the scan coils have to be of very high quality to give satisfactory performance. K-B, to avoid rejection 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.

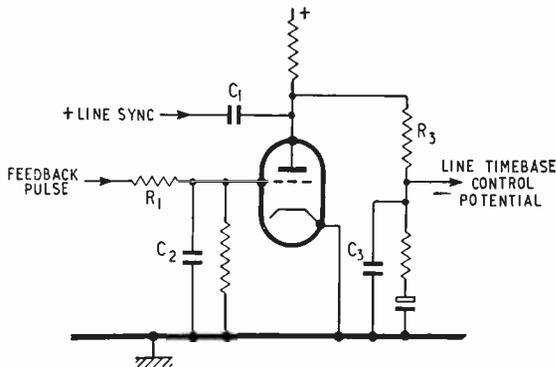
Flywheel Line-sync circuits are hardly renowned for their simplicity, but an extremely simple one has been developed by Philco (see diagram). Positive sync pulses are partially differentiated by C_1 , and a positive flyback pulse is delayed by R_1 and C_2 . Normally the valve is cut off by bias resulting 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. 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 becomes 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.

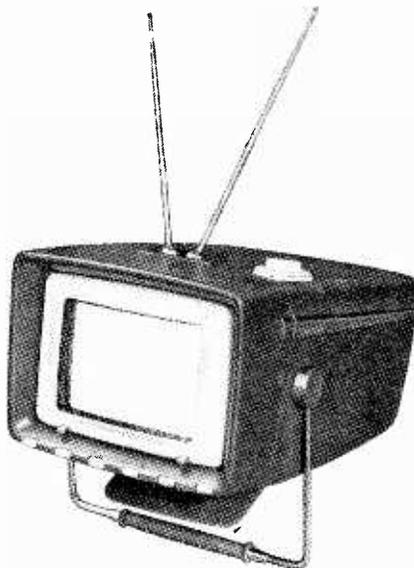
One of the major problems in using transistors is that of obtaining a sufficient amplitude of video signal to modulate the c.r.t. Pye overcame this by using a special 14-in tube, made by Cathodeon, which has a drive re-



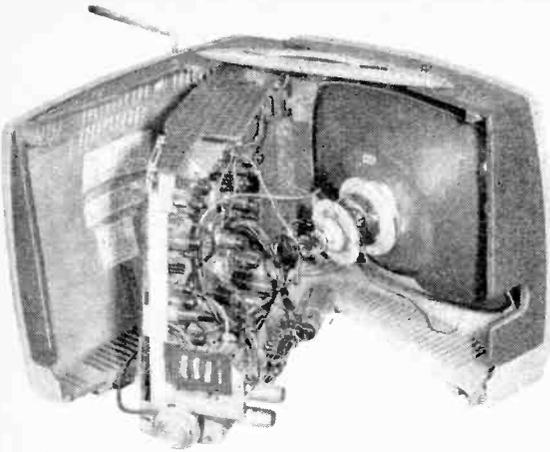
Well-ried simple (a) and relatively complicated (b) frame-pulse separator circuits found to be giving good interlace [(a) Ekco, (b) Peto Scott].



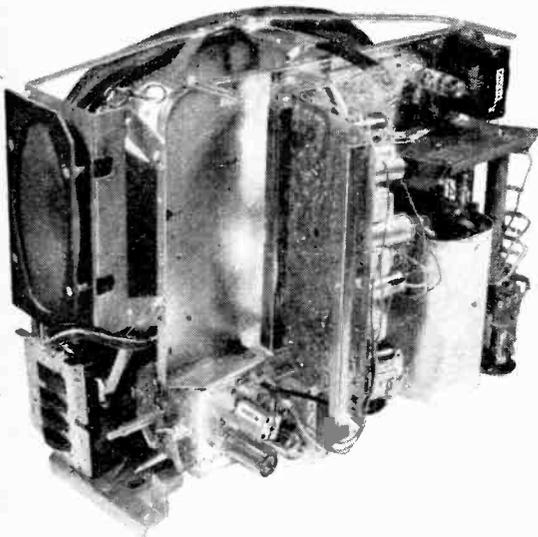
"Philcoloc" flywheel line-sync circuit.



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 $\frac{1}{4}$ -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

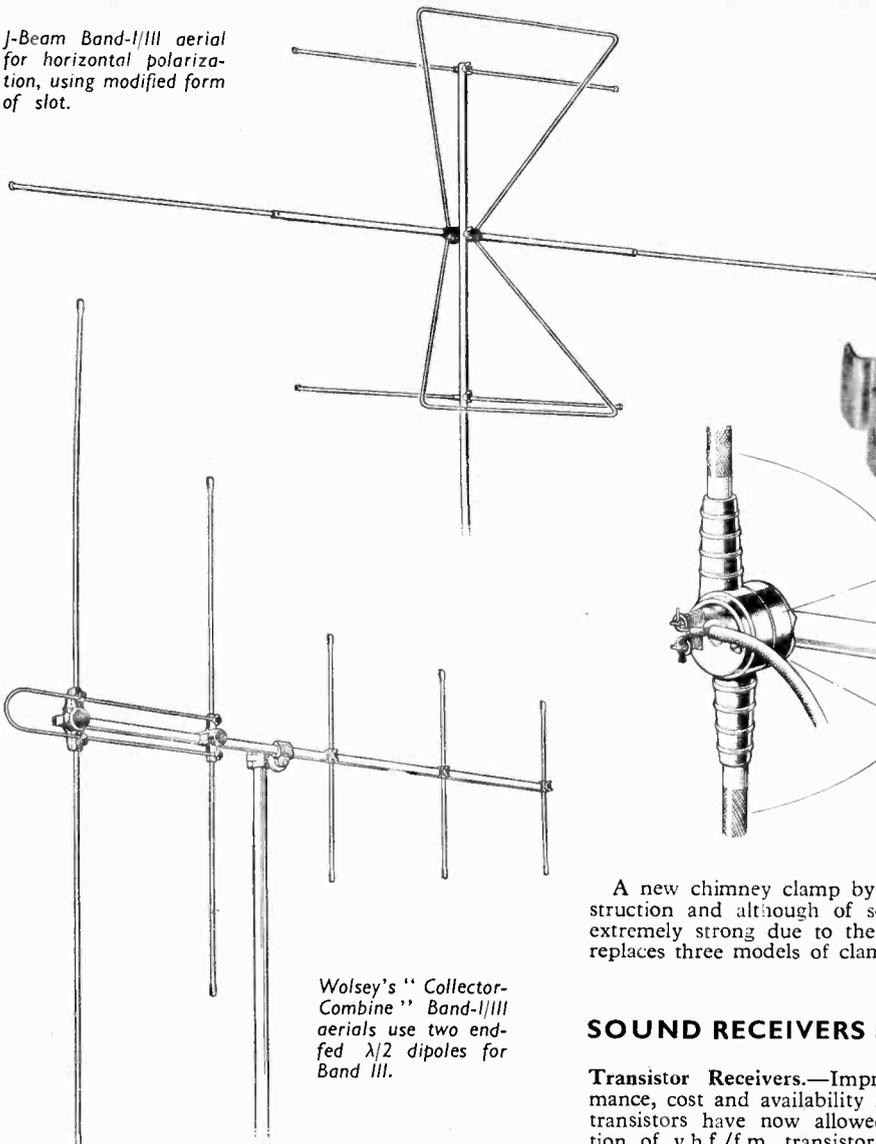
NEW developments tend to be sparse in the aerial field today; but Wolsey's "Collector-Combine" series certainly looks as if yet another method has been found for the inter-connection of Band-I and -III arrays. The aerial uses two half-wave end-fed co-linear radiators for Band III (next to Band III directors) 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.

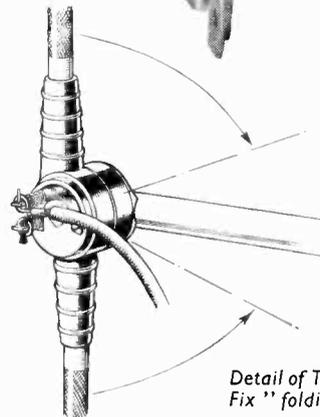
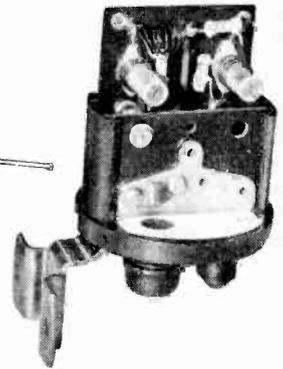
New outdoor aerials from J-Beam have been designed with a view to keeping their outline as compact as possible to reduce wind resistance and skyline "clutter." In the case of the higher-gain combined arrays this has been done by mounting the familiar J-Beam slot behind the Band-I dipole so that the directors 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.

Wolsey's "Collector-Combine" Band-I/III aerials use two ended $\lambda/2$ dipoles for Band III.

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.

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 $5\mu\text{V}$ 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

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.)

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

(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.

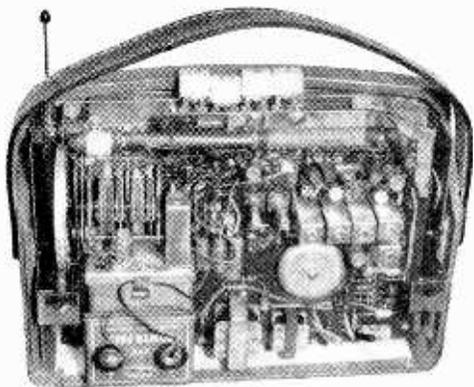
The trend towards dual-purpose portable/car-radio receivers was carried further in the Ever Ready car portable. When this set is plugged into its special container in the car, this automatically connects the car aerial, the car battery and an 8in x 5in loudspeaker in place of the internal aerial, battery 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.

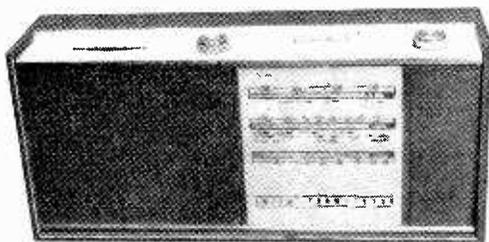
Transistor Radiogramophones.—These are no longer the comparative rarity they once were since about six companies showed new models. A compact arrangement with the receiver and record turntable on opposite sides of the cabinet was noted in the E.A.R. “Envoy”. In the Bush “Top Ten”, radio reception of 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-



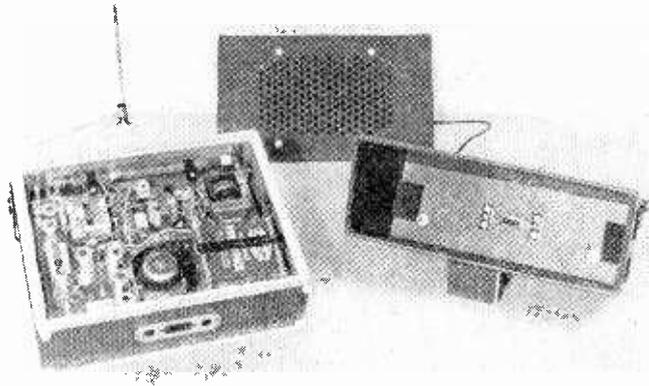
Perdio Model 95—one of the new a.m./f.m. transistor receivers.



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



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



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.

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.

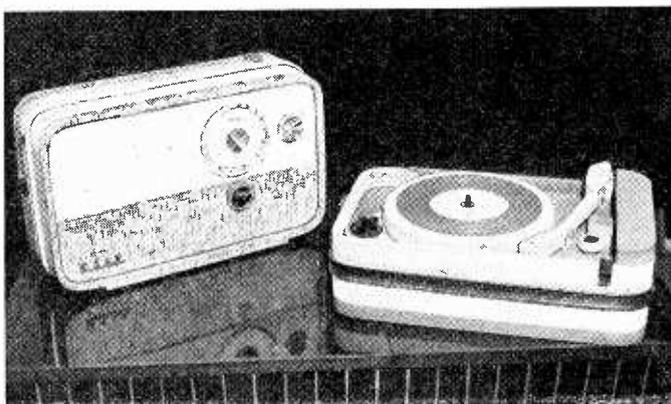
The G.E.C. demonstrated the use of a third centrally placed loudspeaker fed from both stereo channels. This was done to improve the definition of central sound sources and thus reduce the "hole-in-the-middle" effect noticeable with some recordings especially when widely-spaced loudspeakers are used. 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

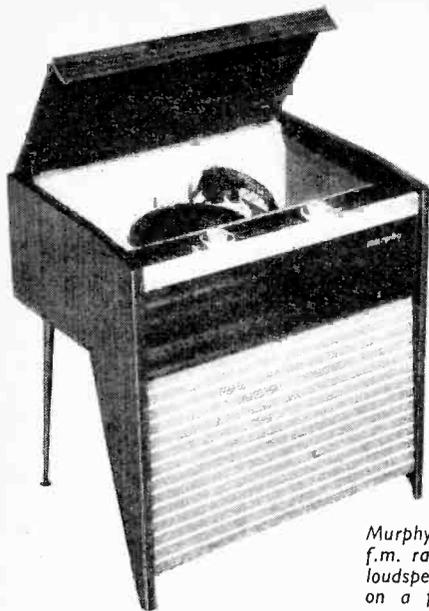
speaker being fed with about one-quarter of the power from one stereo channel. For non-central sources in which only one of these two central speakers is thus excited, the sound radiated by this speaker is increasingly reduced as the frequency is decreased below 1,000c/s owing to the coupling to the 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

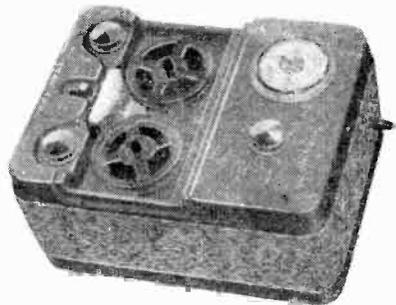
Two E.A.R. "Envoy" transistor radio-grams in which the radio and record player are on opposite sides.





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 loud-speaker 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 Repts 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.

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 $100\text{-}\Omega$ 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 value for the OC 71. His circuit defines the collector current of V_2 at about $400\mu\text{A}$, 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 $0.5M\Omega$. We have calculated that the input impedance of V_1 is about $250k\Omega$ 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 $25k\Omega$.

(3) The base current of V_2 is the emitter current of V_1 . This base current changes direction, however, when $(B+1)i_{e0} = 400\mu\text{A}$. 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_1 would be desirable and that there seems little point in including R_2 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 $250k\Omega$ with feedback and $25k\Omega$ 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_3 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_2 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_1 was set by trial to give least distortion in the output waveform. It can easily be increased by reducing the value of R_2 .

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, mere 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 OK=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.

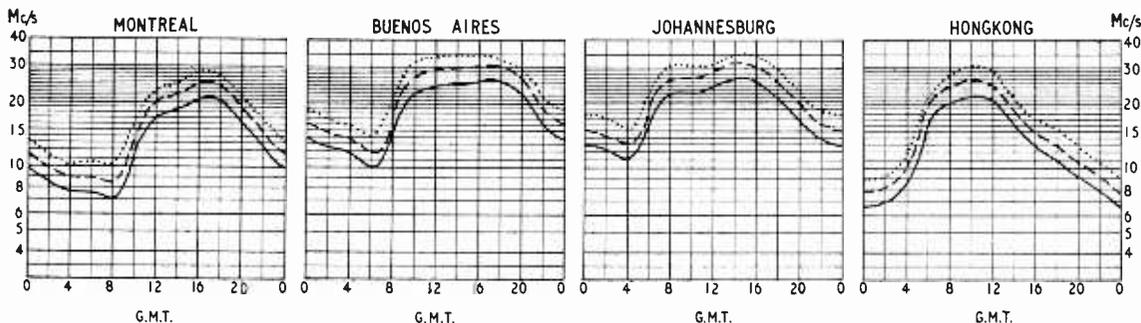
This committee is constantly studying problems concerned with standardization in the realm of technical publications, and whilst it welcomes innovations which simplify the task of the technical author or illustrator it emphasizes that in the presentation of technical information, the overriding consideration 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 Wells¹ 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

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.

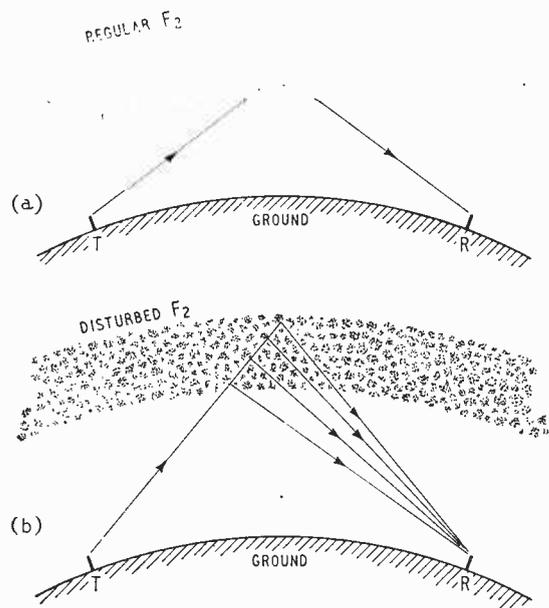


Fig. 1. Illustrating, for a single-hop transmission path, the mode of propagation of a single ray (a) via the normal F₂ layer and (b) via the cloud-like structure occurring after local sunset.

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 Osborne³ 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

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 propagation 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.

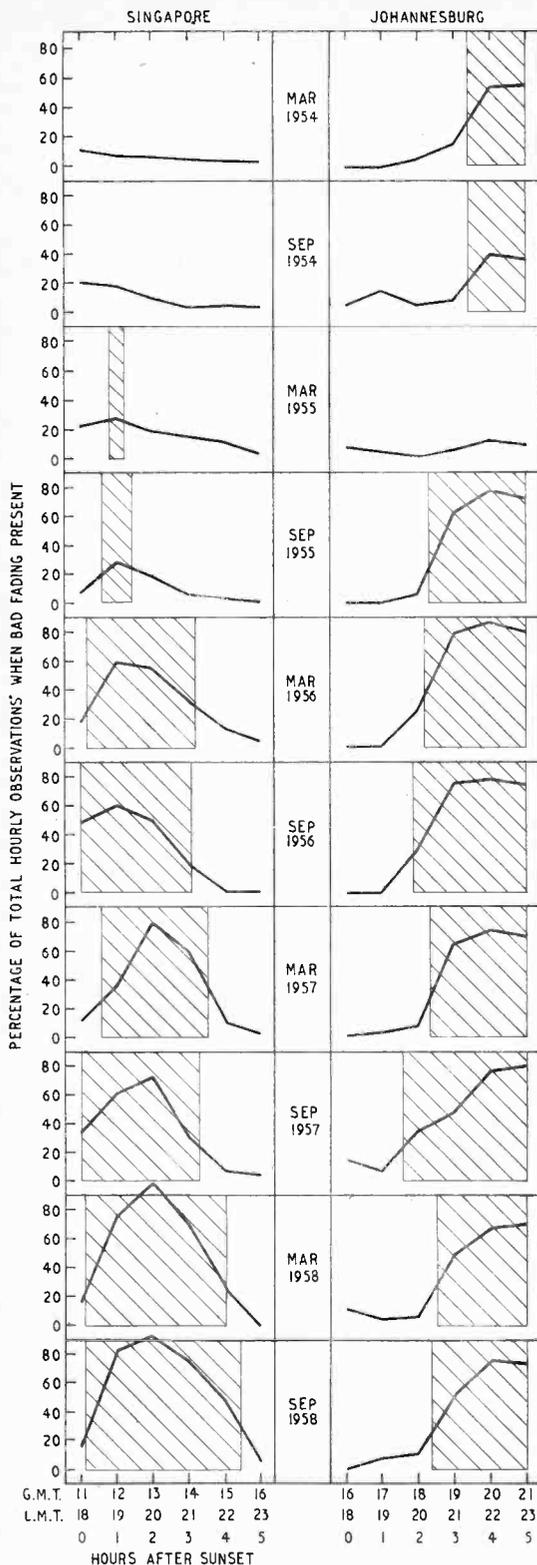


Fig. 2. Incidence of medium-rapid, or worse, fading in reception at Singapore and Johannesburg during 5 hours after sunset—equinoctial months 1954-1958.

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.

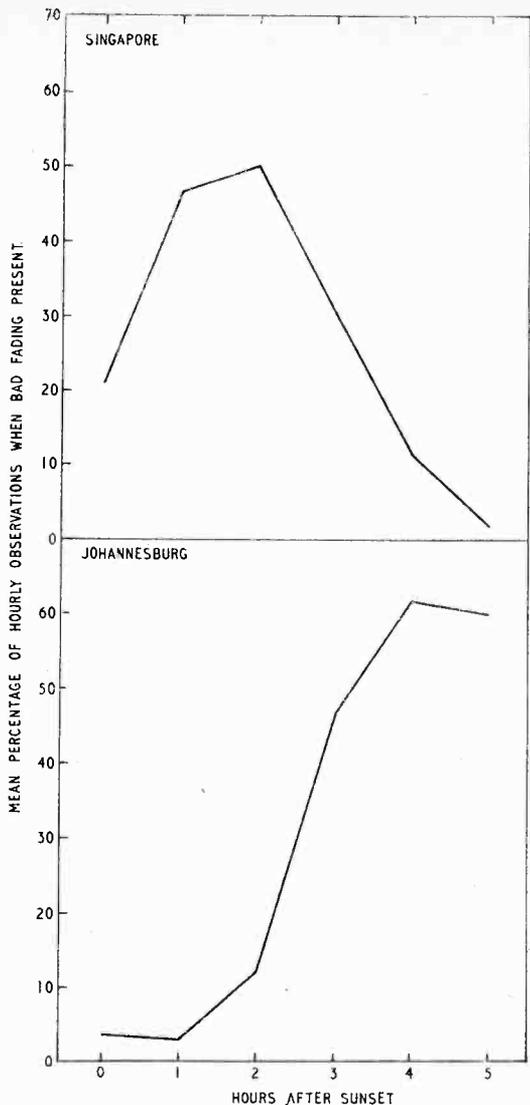
The results are given in Fig. 2, the graphs of which show the percentage of the total hourly observations during each month when medium-rapid, or worse, fading was observed at Singapore and Johannesburg respectively. The shaded areas of Fig. 2 show the times during which the fading was present for 25%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

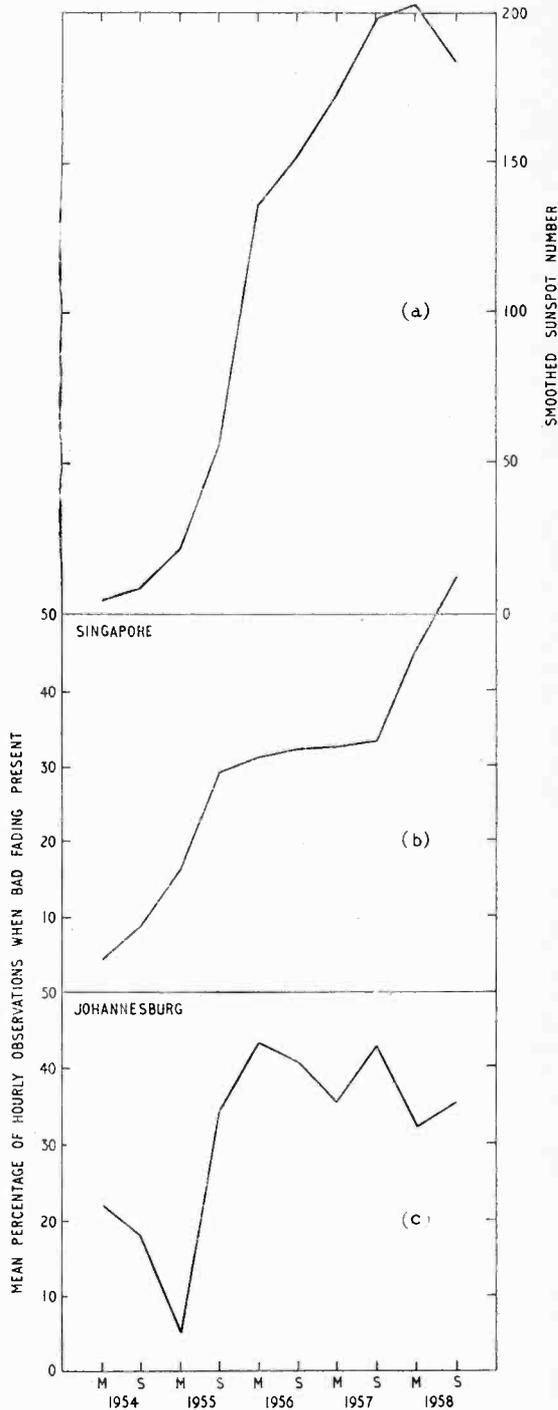
Fading Variations with Increasing Sunspot Number.

—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 Kift³ that, since h.f. radio waves would be unable to penetrate this region and so reach the F2 layer, but would be re-

flected 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.

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)

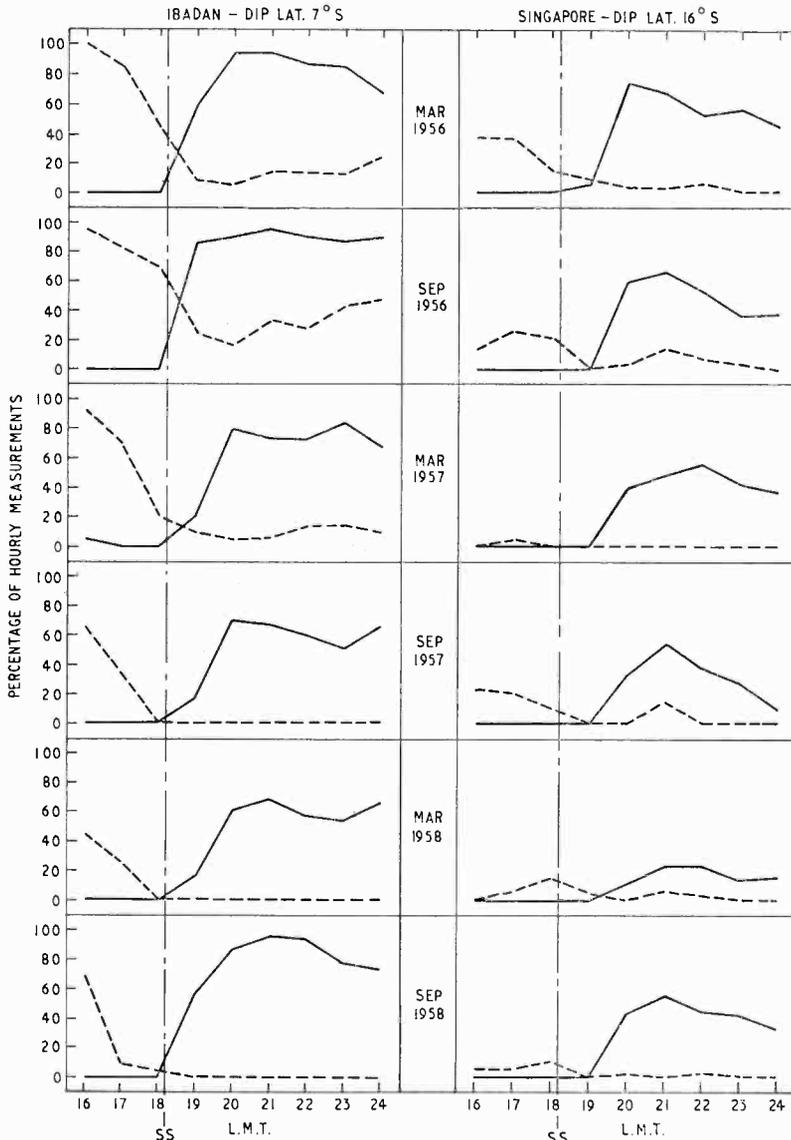


Fig. 5. Percentage of hourly measurements at Ibadan and Singapore. Full-line curves when "spread F" echoes were observed from the F2 layer and dashed-line curves when sporadic E with critical frequency ≥ 5 Mc/s was observed.

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 Wright³, 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 Wright³ 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 Wright⁵ 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.

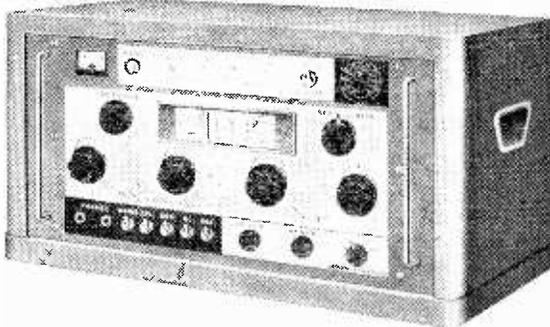
Incorporated also is a crystal-controlled marker oscillator for checking the calibration of the signal-frequency circuits, which, with the inherently high stability and accuracy of the crystal-controlled first oscillator, provides, it is claimed, a receiver setting and reading accuracy of $\pm 200c/s$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

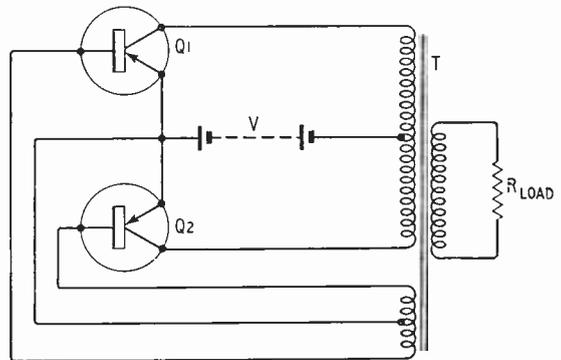


Fig. 1. Standard Uchirin-Royer circuit.

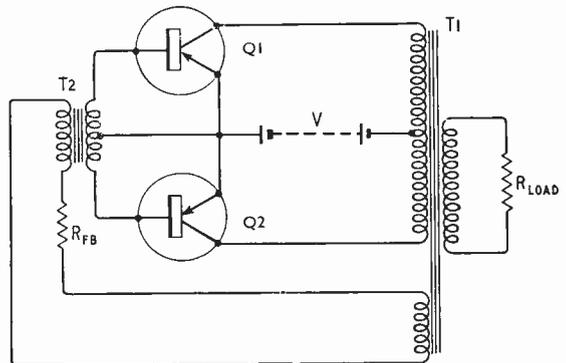


Fig. 2. Jensen introduced a small saturable transformer in the base circuits of Fig. 1.

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

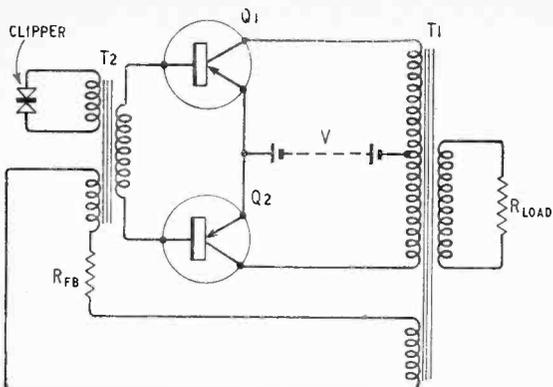


Fig. 3. The addition of a clipper diode pair to the basic Jensen circuit of Fig. 2 stabilizes the frequency.

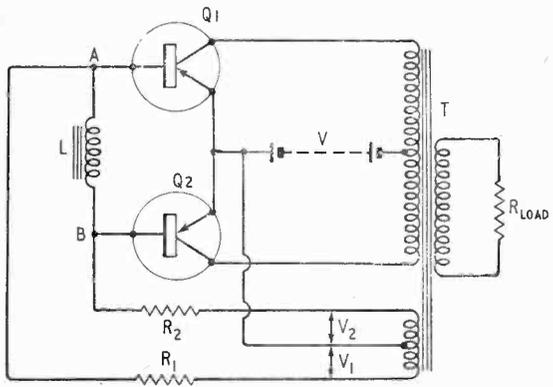


Fig. 4. In this new circuit even less square-loop core material is used and the frequency depends less on transistor properties.

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

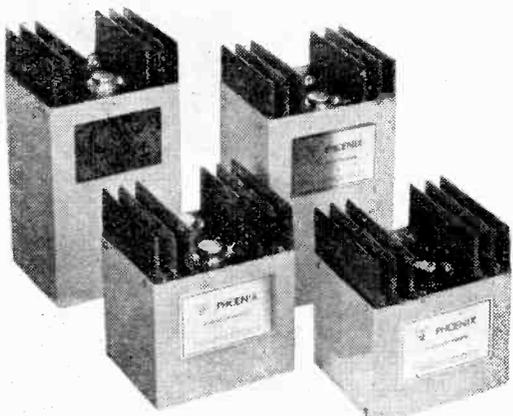
$$\frac{V_1 - V_{be}}{R_1} = \frac{I_c}{\beta(\min)}$$

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

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

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 $V_{ce}(\text{sat}) = 1$ 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 $(V_1 \text{ or } V_2) \times I_b$. 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 $V I_c = V \beta I_b \approx N V_2 \beta I_b$, since in most practical cases $V \gg V_{ce}(\text{sat})$. The loss of power in the resistors is therefore approximately $I/N\beta$ 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 September 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

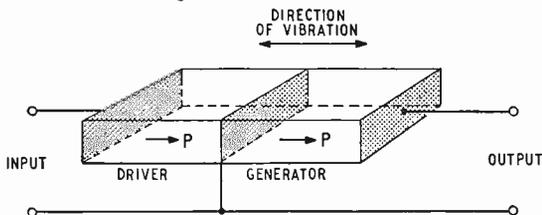


Fig. 1. Ring-type (longitudinal) piezoelectric transformer.

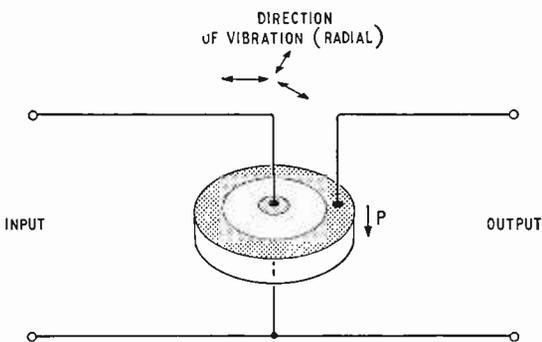


Fig. 2. Ring-type piezoelectric transformer suitable for use as an i.f. filter.

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 polycrystalline 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.

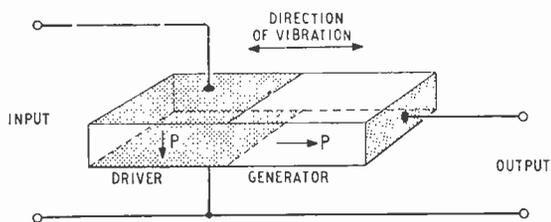


Fig. 3. Transverse-type piezoelectric transformer.

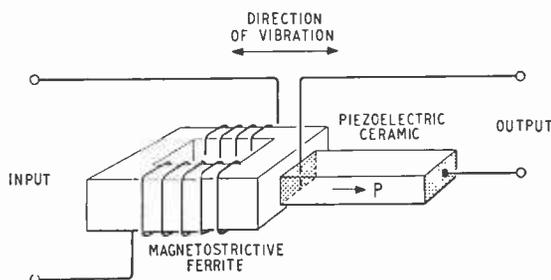


Fig. 4. Composite transformer.

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

†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.

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.

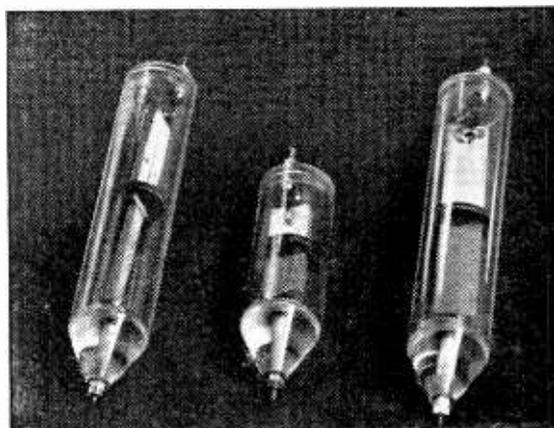
Hybrid Transformers.—The recent development of magnetostrictive ferrite materials has enabled a composite transformer to be constructed, Fig. 4. A suitably shaped and proportioned block of magnetostrictive ferrite is bonded to a length-polarized bar of piezoelectric ceramic. The necessary d.c. polarization 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.

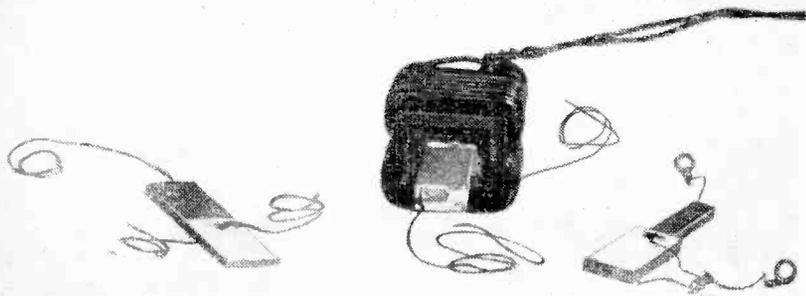
Design Considerations.—Of the three systems the transverse type appears to offer immediate promise and a number of experimental transformers have been constructed for study purposes.

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.





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.

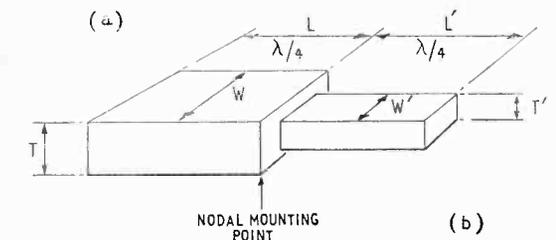
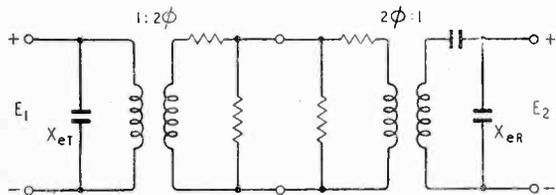


Fig. 5(a). Equivalent circuit and (b) dimensions of transverse transformer.

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

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

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

where Q_m is the mechanical Q of the system, Y^E_{33} is Young's 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.

$$\frac{X_{eR}}{R_L} \approx \frac{\pi^2}{4Q_m k^2_{33}} \dots \dots \dots (3)$$

where $X_{eR} = \frac{L}{\omega \xi^T_{33} (1 - k^2_{33})^2 T W} \dots \dots \dots (4)$

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

Combining these equations and solving for W .

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

where ϵ^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

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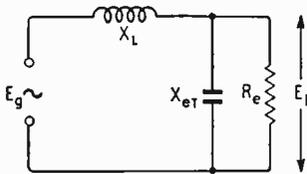


Fig. 6. Simplified circuit of transformer input with resonant inductance.

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} .

$$L' = \frac{L}{(1 - k_{33}^2)^{\frac{1}{2}}} \quad \dots \quad (7)$$

$$\text{and } W'T' = WT(1 - k_{33}^2)^{\frac{1}{2}} \quad \dots \quad (8)$$

Operating Frequency

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

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

Input Impedance Parameters

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

$$X_{eT} = \frac{1}{\omega \xi_{33}^T (1 - k_{31}^2)} \cdot \frac{T}{WL} \quad \dots \quad (10)$$

$$\text{and } R_e = \frac{\pi}{c^E Q_m Y_{33}^E d_{31}^2} \cdot \frac{T}{W} \quad \dots \quad (11)$$

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:

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

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 750 Ω at 40 kc/s and the no-load output was measured using a capacity divider input valve voltmeter. The voltmeter input capacity was 10 μ F and meter readings were corrected to give true figures, the

output section of the transformer having a capacity of 40 μ F.

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.

- $k_{31} = 0.30$ $d_{31} = -130 \times 10^{-12}$ coulomb/newton
- $k_{33} = 0.76$ $g_{33} = 28.3 \times 10^{-3}$ volt metres/newton.
- $k_3 = 1200$ $Y_{33}^E = 6.75 \times 10^{10}$; newtons/metre²
- $\tan \delta = 0.005$ $c^E = 3000$ metres/sec.
- $Q_m = 500$ $\xi_{33}^T = 1.2 \times 10^{-8}$ farad/metre
- Max. operating temp. = 250°C.

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

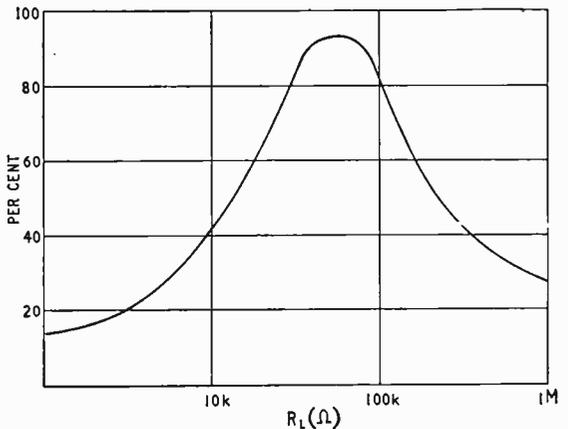


Fig. 7. Variation of efficiency with output load (40-kc/s parallel-element transformer).

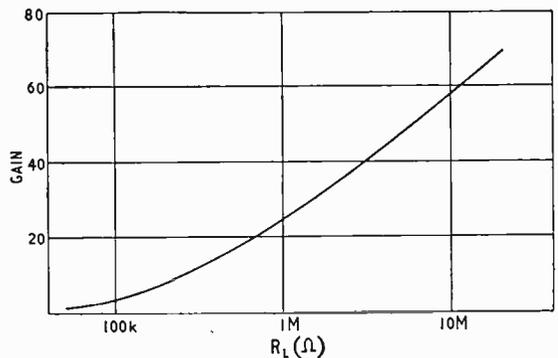


Fig. 8. Variation of gain with output load (40-kc/s parallel-element transformer).

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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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.
Invicra 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-Technico Pty. Ltd. (Australia)
Bendix-Technico (Automotive) Pty. Ltd. (Australia)

F. W. Davey & Co. Pty. Ltd. (Australia)
Technico 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 Television, 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., Phoenix 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 $47 \pm 9 \text{ mA/V}$. 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

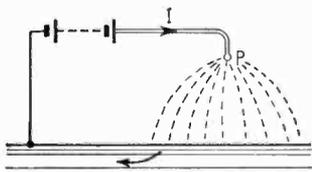


Fig. 1. Even if a "point" P is large enough to have appreciable capacitance, the very small transient current needed to charge it to any reasonable voltage has its counterpart as a displacement current in space.

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 formulæ 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 nearest, 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

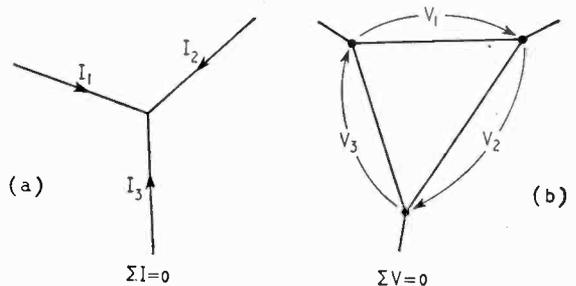


Fig. 2. Symbolic expression of Kirchhoff's two laws. They are duals of one another.

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

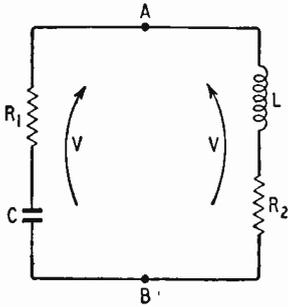


Fig. 3. The fact that the p.d. between two points is the same via any path implies the truth of Kirchhoff's second law.

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

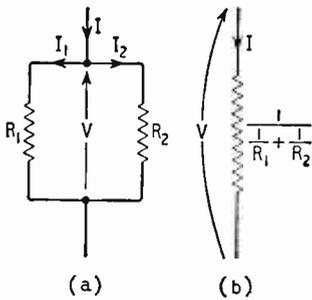
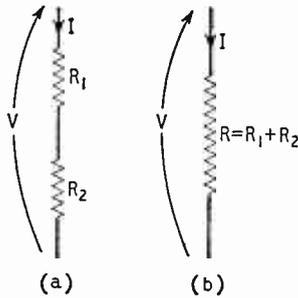


Fig. 5. And the combining of resistances in parallel follows from the second. But a dualist would work this in conductances.

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. Mathematically, 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 R₁ is added up and found to be V, the same result is found via R₂ 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 $R_1 + R_2$. 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 $I_1 - I_2$:

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

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

(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

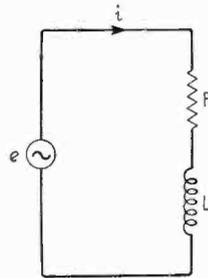


Fig. 6. Simple a.c. circuit for studying how Kirchhoff's laws apply.

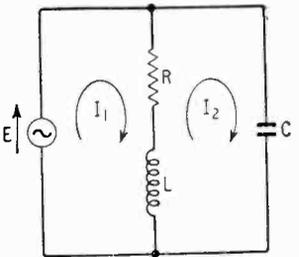


Fig. 7. Analysis of a simple a.c. network by Kirchhoff's laws.

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

$$\begin{aligned} I_1 &= E \frac{(R - j\omega L)}{R^2 + \omega^2 L^2 + j\omega C} \\ &= E \frac{R - j\omega[L - C(R^2 + \omega^2 L^2)]}{R^2 + \omega^2 L^2} \\ &= E \frac{R - j\omega[L(1 - \omega^2 LC) - CR^2]}{R^2 + \omega^2 L^2} \end{aligned}$$

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:

$$\begin{aligned} Z &= \frac{1}{\frac{1}{R + j\omega L} + j\omega C} \\ &= \frac{R + j\omega L}{1 + j\omega C(R + j\omega L)} \\ &= \frac{R + j\omega L}{1 - \omega^2 LC + j\omega CR} \\ &= \frac{(R + j\omega L)(1 - \omega^2 LC - j\omega CR)}{(1 - \omega^2 LC)^2 + \omega^2 C^2 R^2} \\ &= \frac{R + j\omega[L(1 - \omega^2 LC) - CR^2]}{(1 - \omega^2 LC)^2 + \omega^2 C^2 R^2} \end{aligned}$$

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 Kirchoff'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 μ V.

(i) **Absolute Sensitivity.**—This is the minimum input-signal amplitude, deviated ± 35 kc/s† at a frequency

which will produce an output signal-to-noise ratio of 40 dB.

The measured value was 12.5 μ V. At an input level of 16 μ V 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

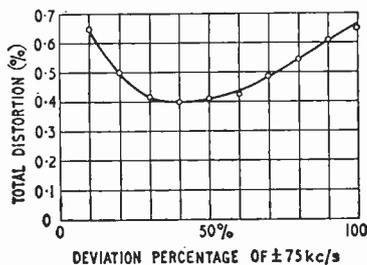


Fig. 8. Variation of harmonic distortion with deviation.

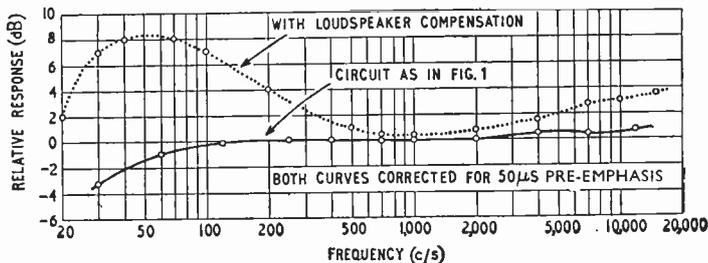


Fig. 9. Modulation-frequency characteristic.

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 μ V.

(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 μ V 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,

the loudspeaker compensating circuits described earlier. Both curves are corrected for a 50- μ s pre-emphasis time constant.

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

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

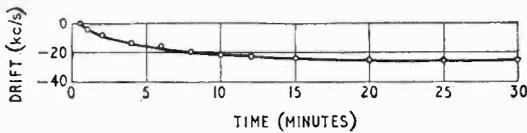


Fig. 10. Oscillator-frequency drift.

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 $-14 \text{ kc/s/}^\circ\text{C}$, 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 $\pm 15 \text{ kc/s/V}$ 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

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

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 $\pm 30 \text{ kc/s}$ 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.

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 $\pm 35 \text{ kc/s}$ 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 $\pm 30 \text{ kc/s}$ 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 $\pm 200 \text{ kc/s}$ and $\pm 400 \text{ kc/s}$ 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	> +40	+11	-32	+8	> +40
	> +40	+12	-28	+10	> +40
	> +40	+15	-24	+12	> +40
	> +40	+17	-18	+14	> +40

improve the performance at input levels below $30\mu\text{V}$, 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.

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.

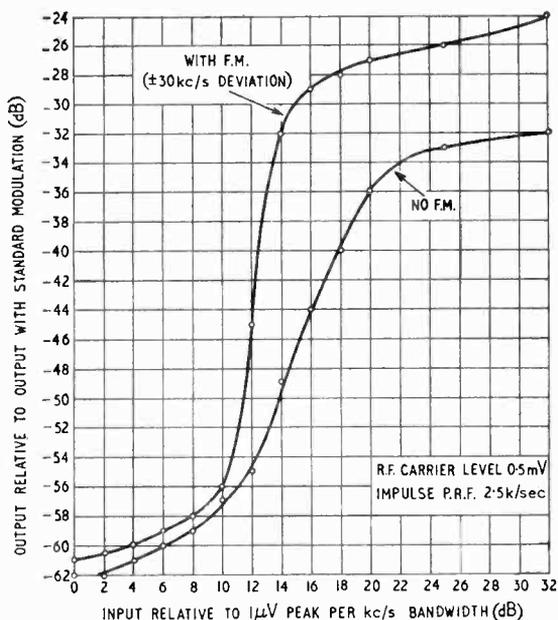


Fig. 12. Input/output characteristic for impulsive interference.

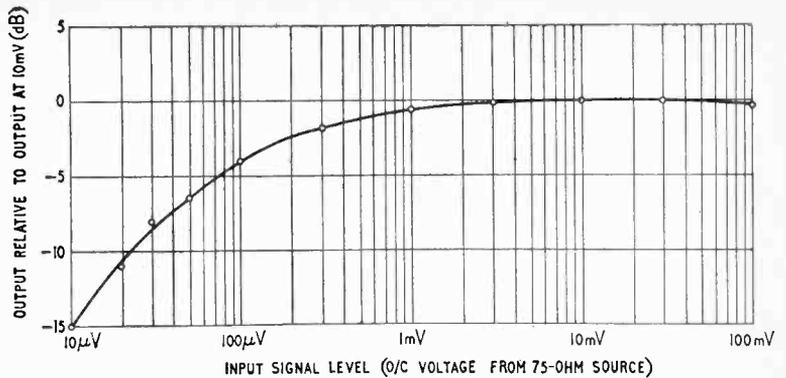


Fig. 11. Variation of a.f. output with signal level.

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 $\pm 100\text{kc/s}$ 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 $30\mu\text{V}$ 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

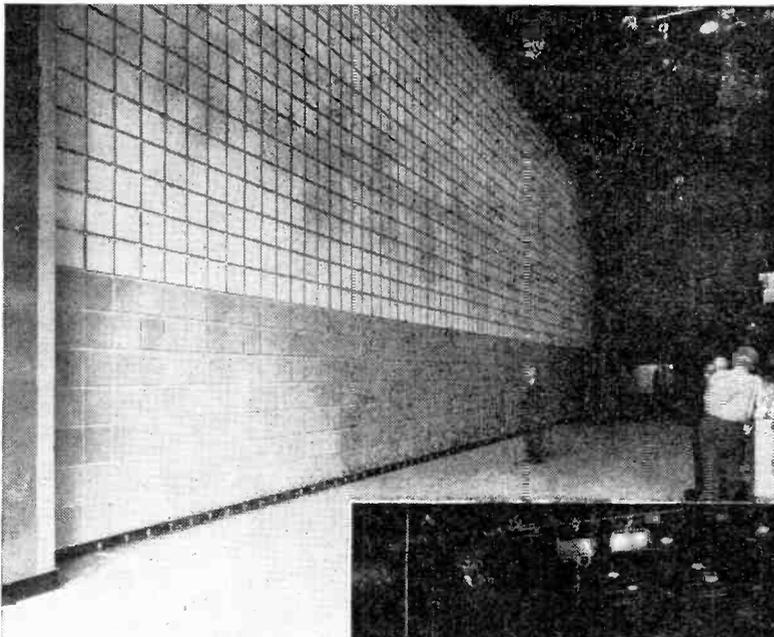
VAST AREA FOR LARGE PRODUCTIONS

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.

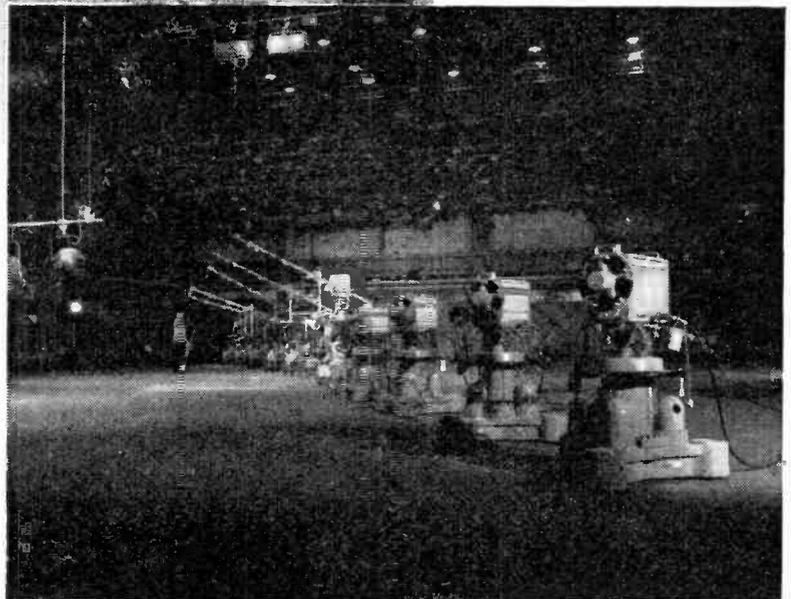
Two control rooms are provided, each with full control over the whole studio. The vision equipment, which includes ten image-orthicon cameras and 50 21-in monitors, was supplied by E.M.I. Electronics Ltd., who also carried out all the "technical" wiring and installation, using 45,000ft of vision and 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. image-orthicon cameras.



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

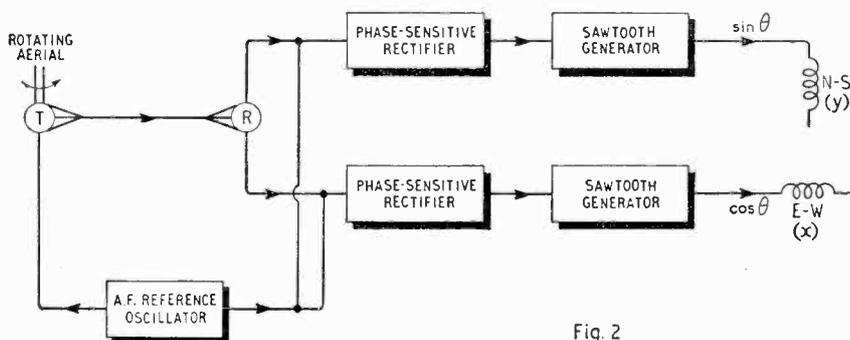
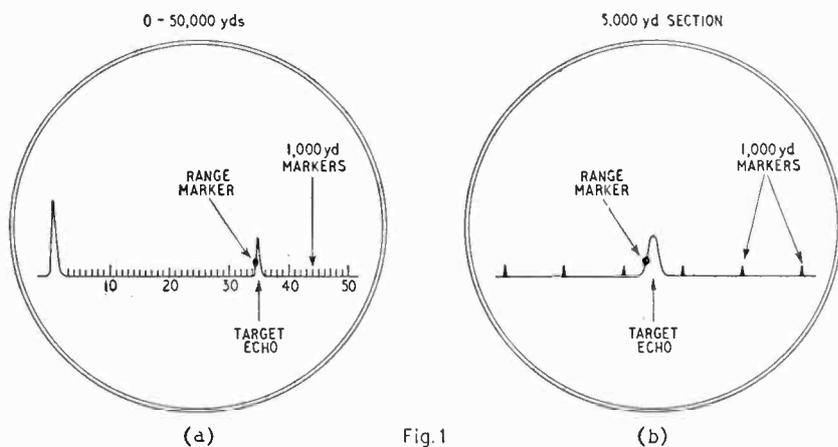
In radar the range of an object is directly proportional to the time taken by the pulse for its outward and return passage. To measure this time interval a c.r.t. and time base, which must be synchronized with the transmitted pulse, are often used. If the slant range from the set to the radar target is R yards, v = velocity of propagation of electromagnetic waves in air ($= 327.7 \times 10^8$ 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



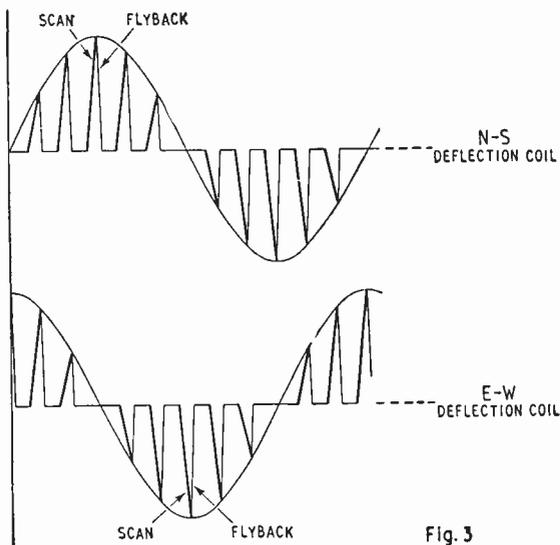


Fig. 3

produce an expanded section at any point on the coarse range scan. A train of pulses at 1,000-yd intervals (6.1 μ secs 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.—“Channelling — 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 formulae 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, Northumberland 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.

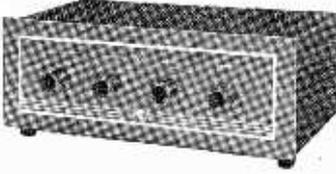


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RANDOM RADIATIONS

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 × 405 = 810). Others have sent photos showing that they get a single image just about filling the screen. That



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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 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.

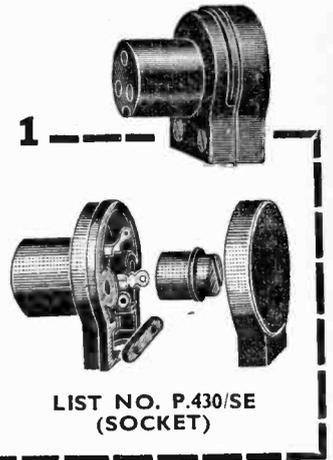
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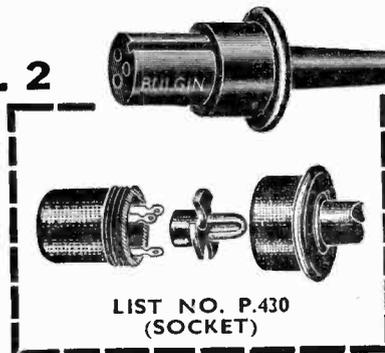
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Exhibitiana

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.

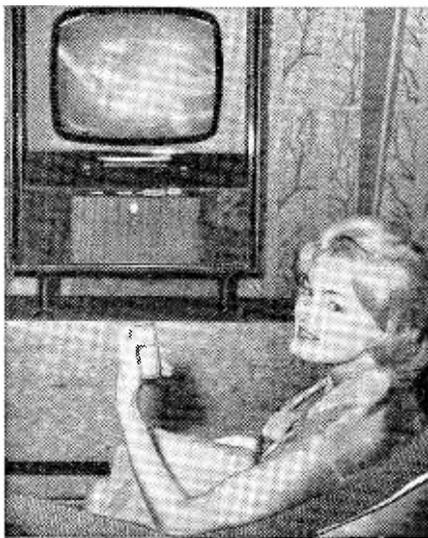
Another thing about this year's television sets is that they have become pleasingly thin in the fore-and-aft direction. But I hope the slimming diet, which the manufacturers have been giving them, does not produce the undesirable side-effects which it does in some women, whom an excessive slimming diet 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 365½ 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.

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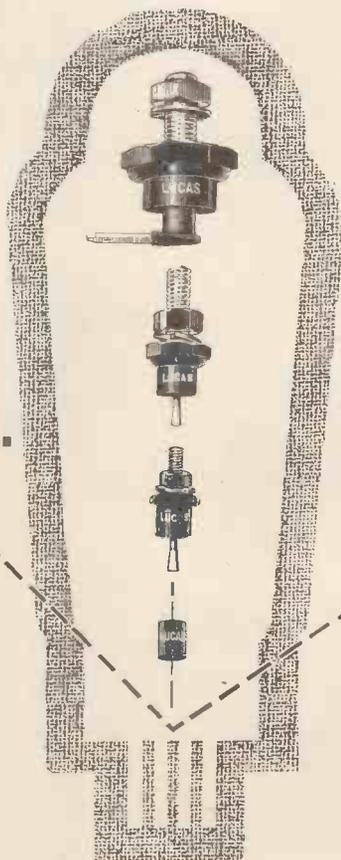
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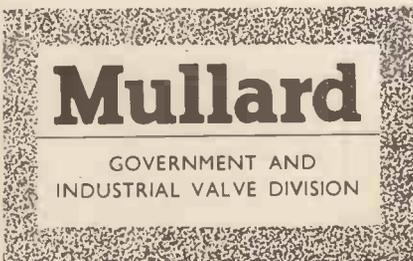
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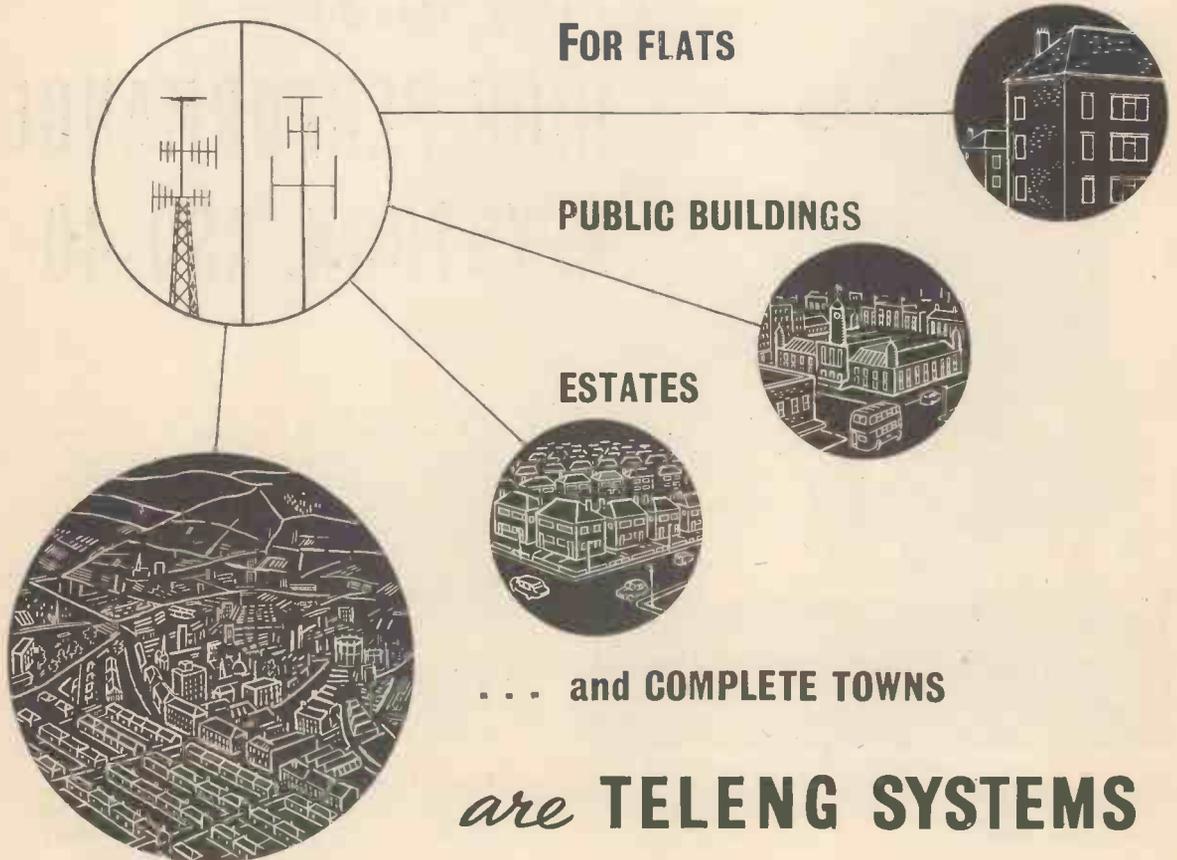
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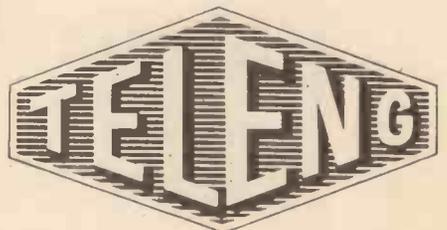


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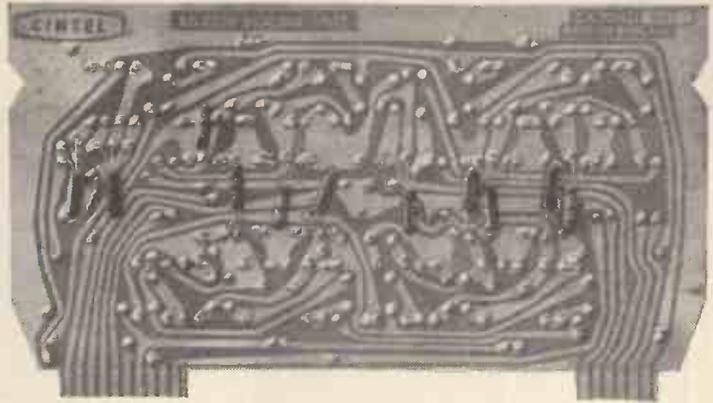
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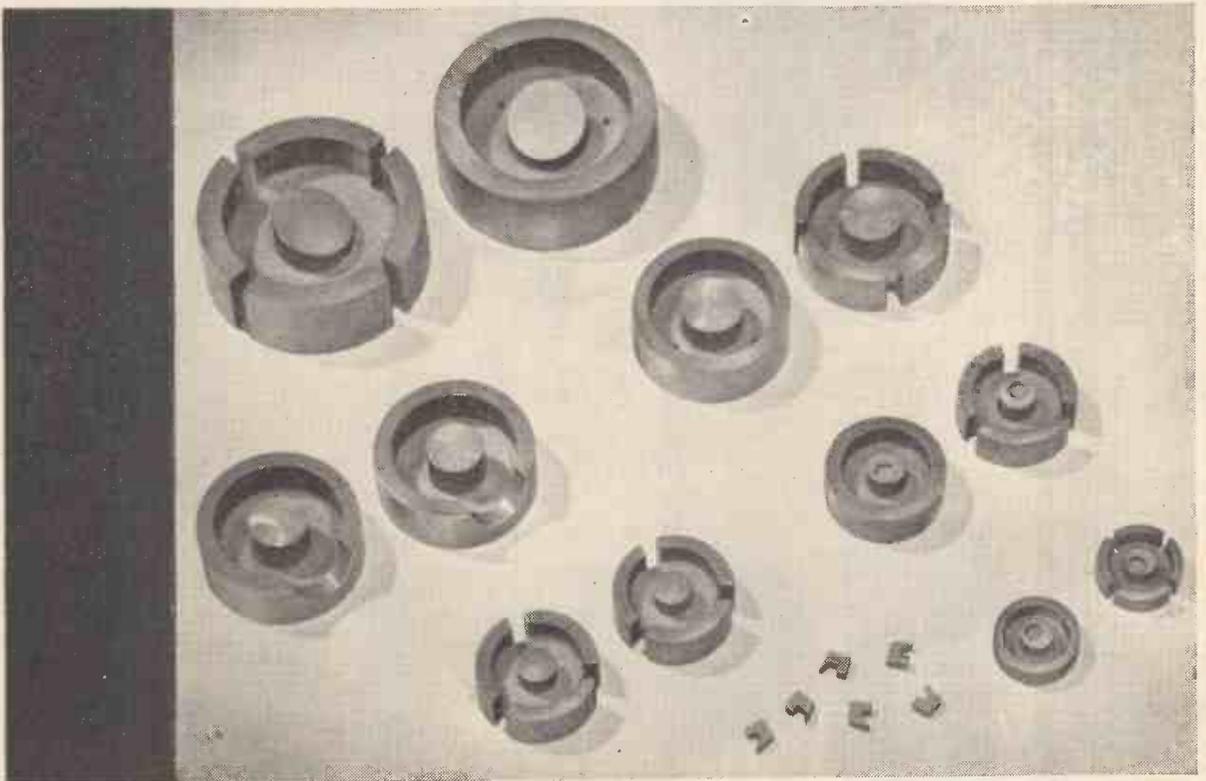
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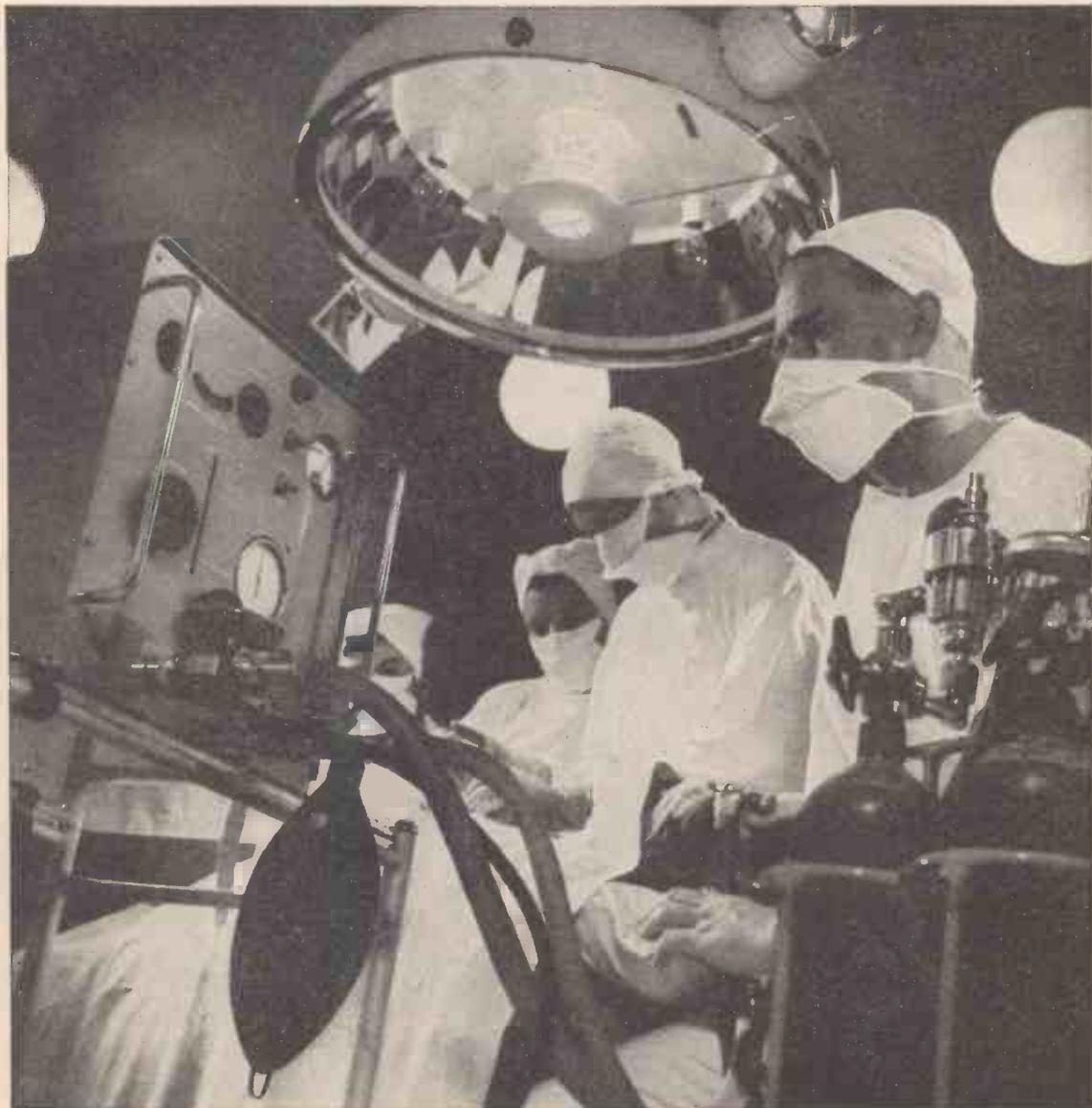


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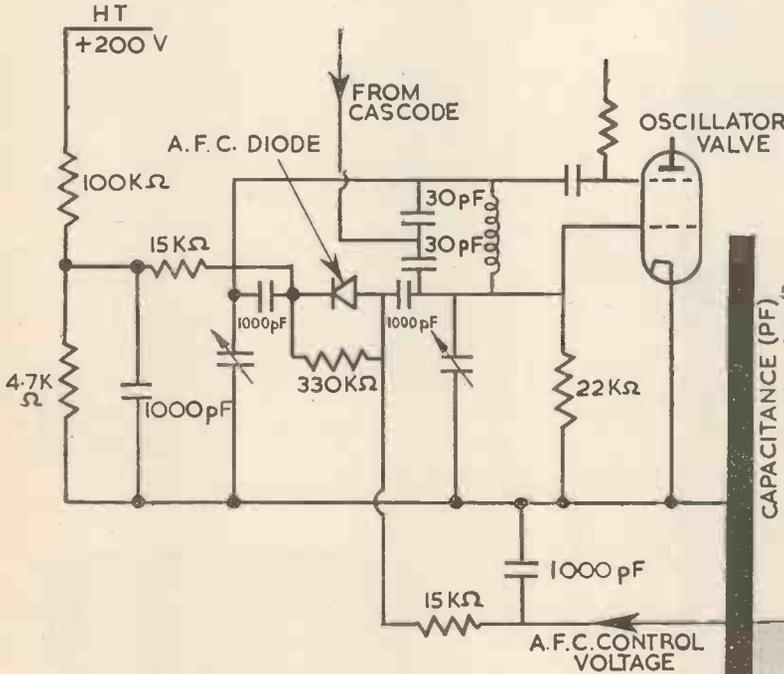
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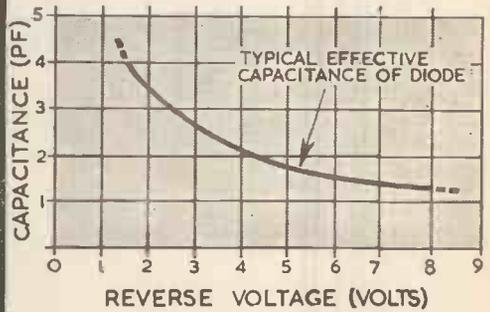
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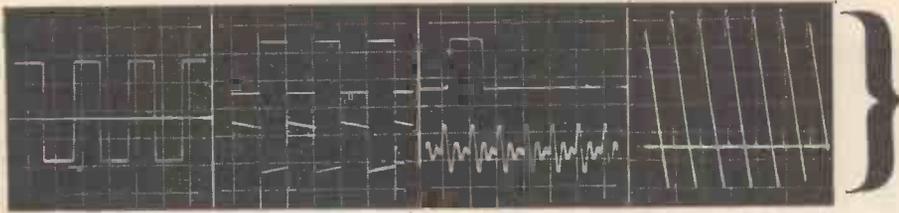
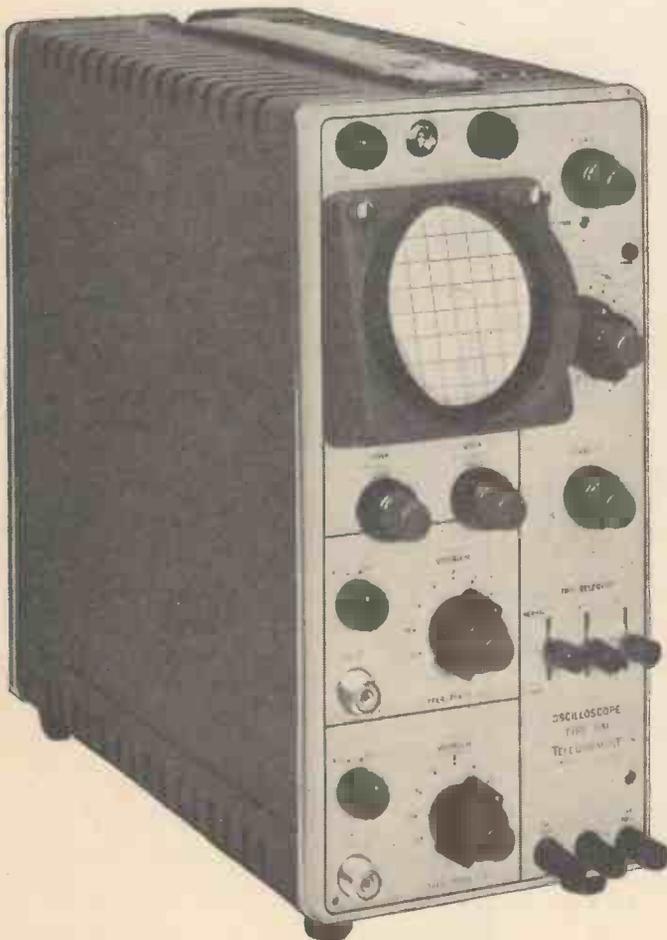


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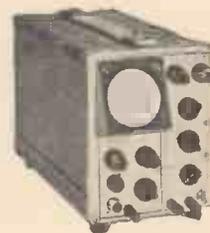
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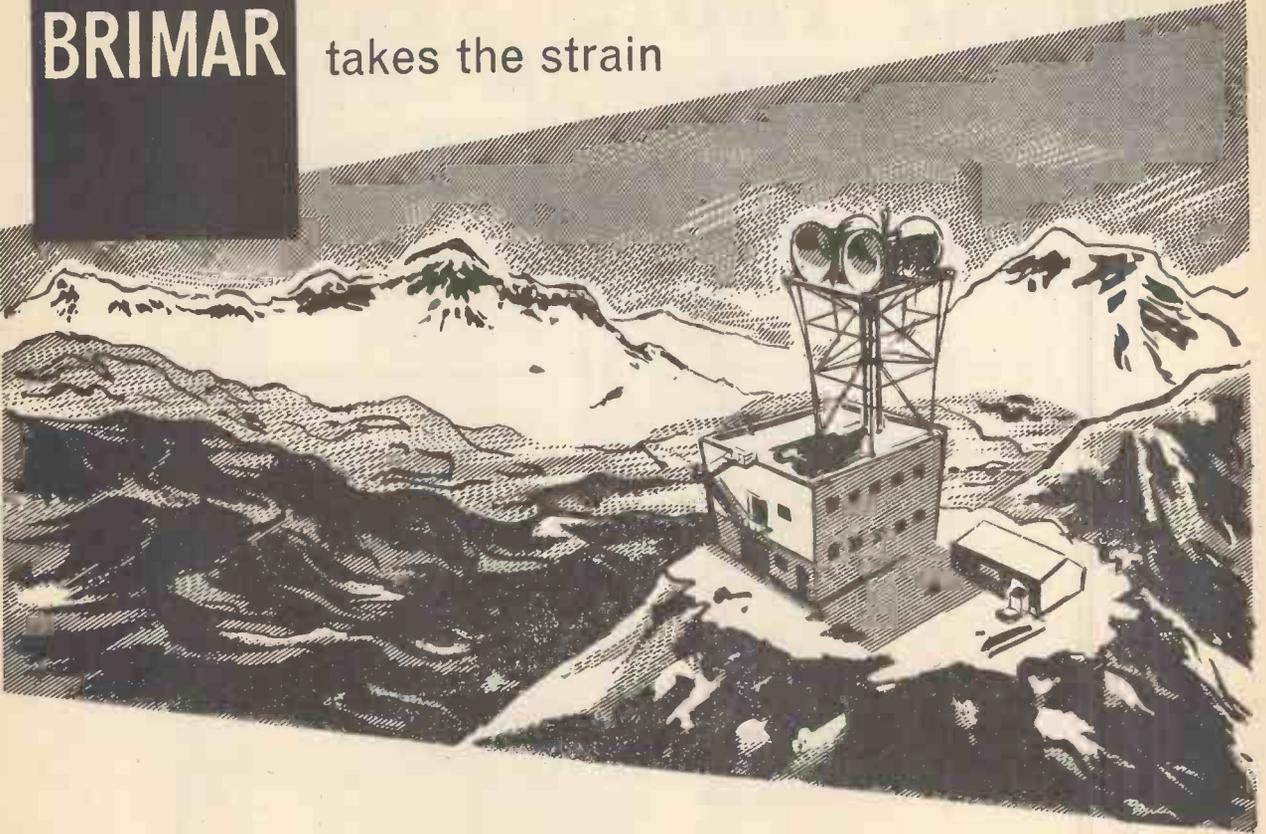
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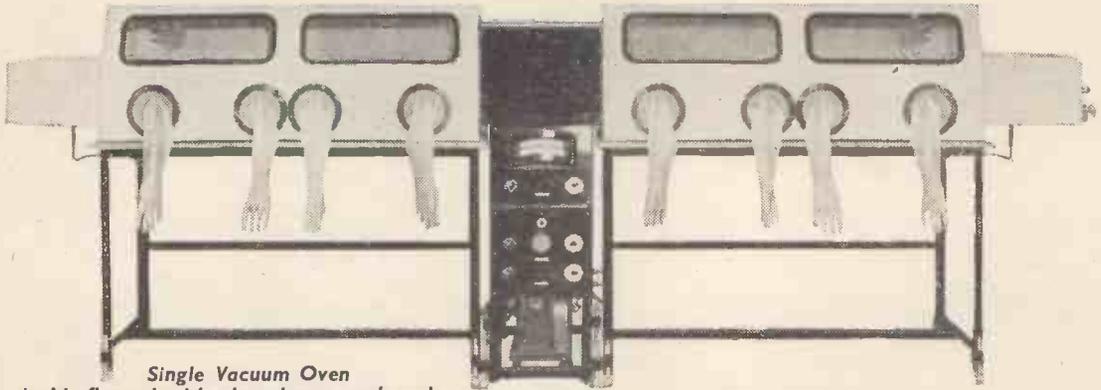
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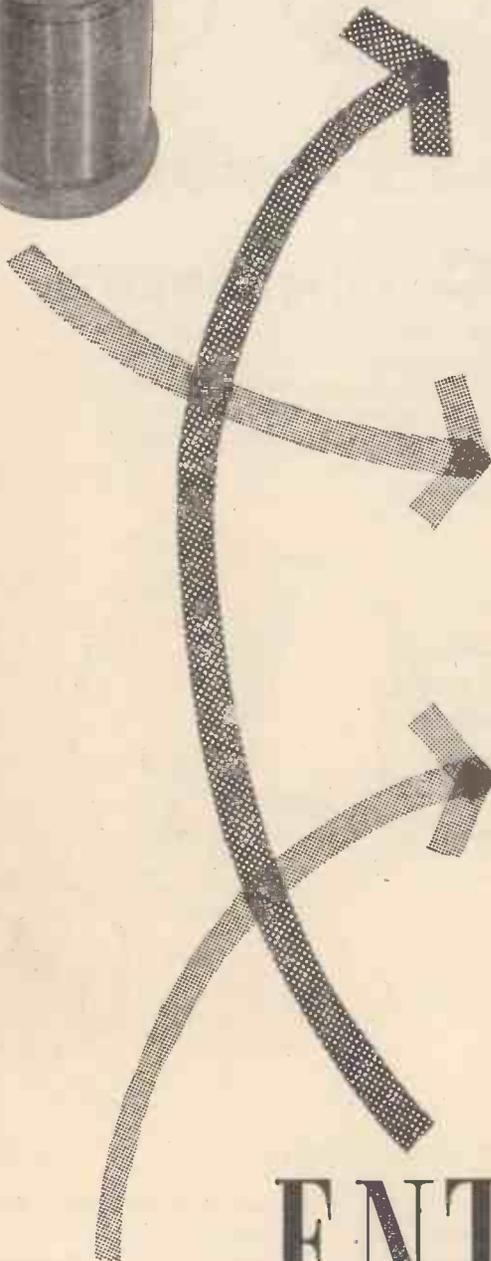
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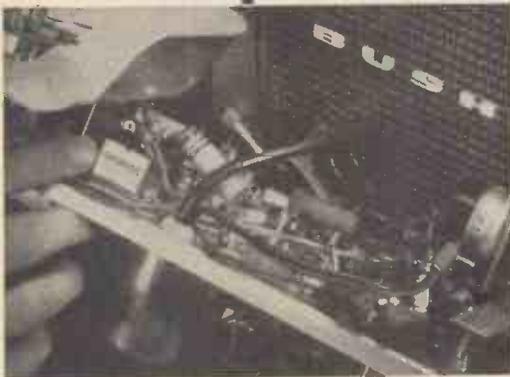
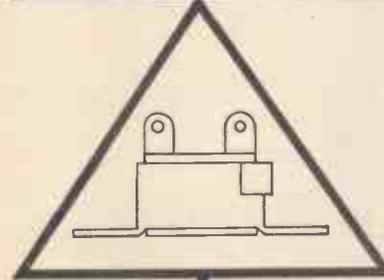
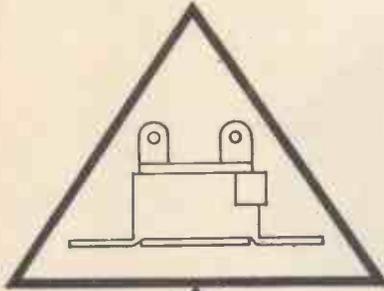
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CONTACT COOLED RECTIFIERS



SenTerCel Contact Cooled Rectifiers have been selected by Bush for H.T. supply circuits in their domestic radio receivers. These belong to a comprehensive range of rectifiers which offer important reductions in size, weight and cost over the conventional metal rectifiers. In addition greater facility in chassis layout is permitted since they can be mounted at any angle. A table of ratings is shown below

aid BUSH reliability

Half-Wave and Voltage-Doubler Connections

Qty.	Type	Circuit	Maximum Input Volts (r.m.s.)	Max. Output Current mA (mean)	Typical D.C. Output Voltage			
					16 mfd. Resrv. Cap. Half Load	16 mfd. Resrv. Cap. Full Load	32 mfd. Resrv. Cap. Half Load	32 mfd. Resrv. Cap. Full Load
1	C2H	Half-Wave	125	60	135	115	135	120
1	C3H	" "	125	120	120	85	130	120
1	C2D	" "	250	60	275	245	280	255
1	C3D	" "	250	120	275	245	290	275
1	C2D	Volt-Doubler	125	60	275	245	280	255
1	C3D	" "	125	120	260	205	285	265

Push-Pull and Bridge Connections

Qty.	Type	Circuit	Maximum Input Volts (r.m.s.)	Max. Output Current mA (mean)	Typical D.C. Output Voltage			
					16 mfd. Resrv. Cap. Half Load	16 mfd. Resrv. Cap. Full Load	32 mfd. Resrv. Cap. Half Load	32 mfd. Resrv. Cap. Full Load
1	C2V	Push-Pull	125-0-125	120	140	120	140	130
2	C2D	" "	250-0-250	120	275	250	280	255
1	C3V	" "	125-0-125	240	130	115	140	130
2	C3D	" "	250-0-250	240	280	250	280	260
1	C3B	Bridge	250	120	275	250	280	255
2	C3D	" "	250	240	280	250	280	260

Send for leaflet MF/102



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

RECTIFIER DIVISION: EDINBURGH WAY · HARLOW · ESSEX



2 CHECKING THE STOP ELEMENT

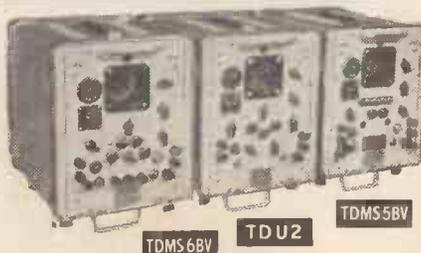
One of the unique facilities of the TDMS 6BV is examination of the stop element in cases where its mutilation is suspected. When the TDMS is operated in the spiral time base condition, the spiral is started at the beginning of each start element and the trace makes a number of revolutions, depending on the Unit Code switch setting, before returning to "rest". For example, if the switch is set for 7, the trace completes $6\frac{1}{2}$ 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 $7\frac{1}{2}$ 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 $7\frac{1}{2}$ unit signal, for the letter S, displayed against a 14 count. Here the stop element length is correct ($1\frac{1}{2}$ 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.

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VINKOR

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Assemblies
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adjustment of $\pm 7\%$

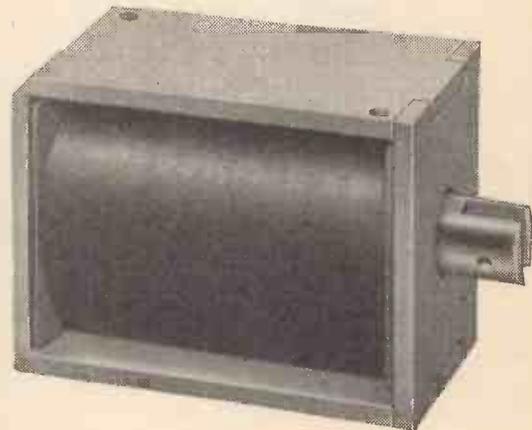
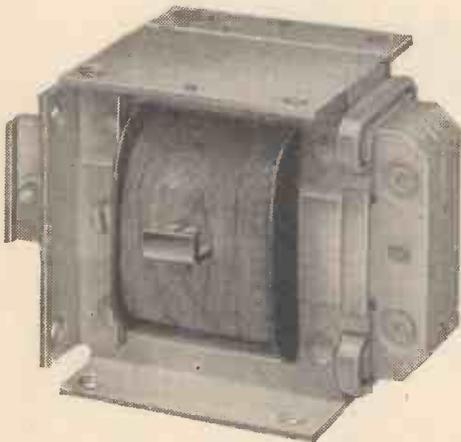
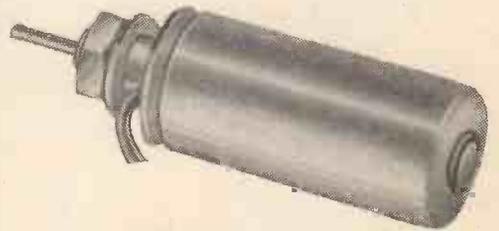
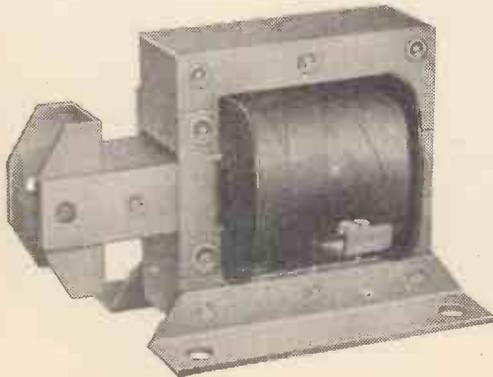
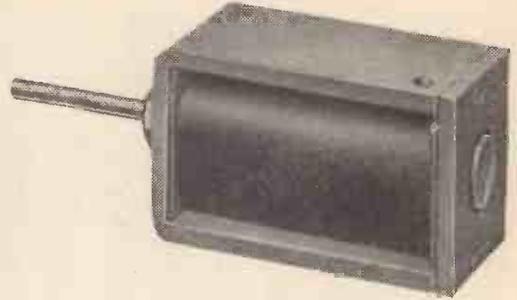
with an accuracy of better than $\pm 0.02\%$

Any assembly in the Mullard Vinkor range can be easily adjusted to an accuracy of better than $\pm 0.02\%$ by using a trimming screwdriver, whilst stability is ensured by the self-locking action of the adjuster core. The range of adjustment is approximately $\pm 7\%$ about the nominal mid-position of the adjuster core. Over and above these advantages, for each size of core there is a choice of three permeabilities which are controlled to close limits so that it is possible to calculate and wind an inductance to $\pm 3\%$ of the value required before adjustment.

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3 watts per channel, 0.3% distortion at 2.5 w/chnl., 20dB N.F.B. Inputs for Radio (or Tape) and Gram., Stereo or Monaural, ganged controls. Sensitivity 100 mV.

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Tuning range 88-108 Mc/s. For your convenience this is available in two units sold separately as follows: Tuner Unit (FMT-4U) with 10.7 Mc/s. I.F. output £3/2/- inc. P.T. 6 W Amplifier (S-33) Complete with case and valves £10/10/6. Total

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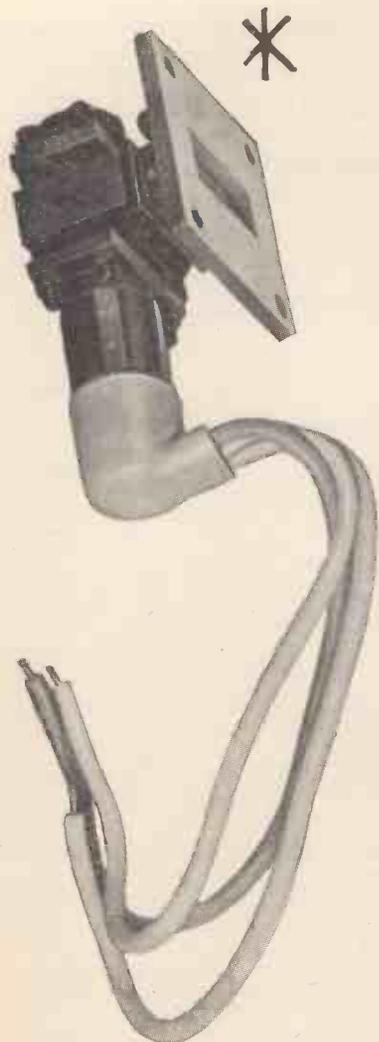
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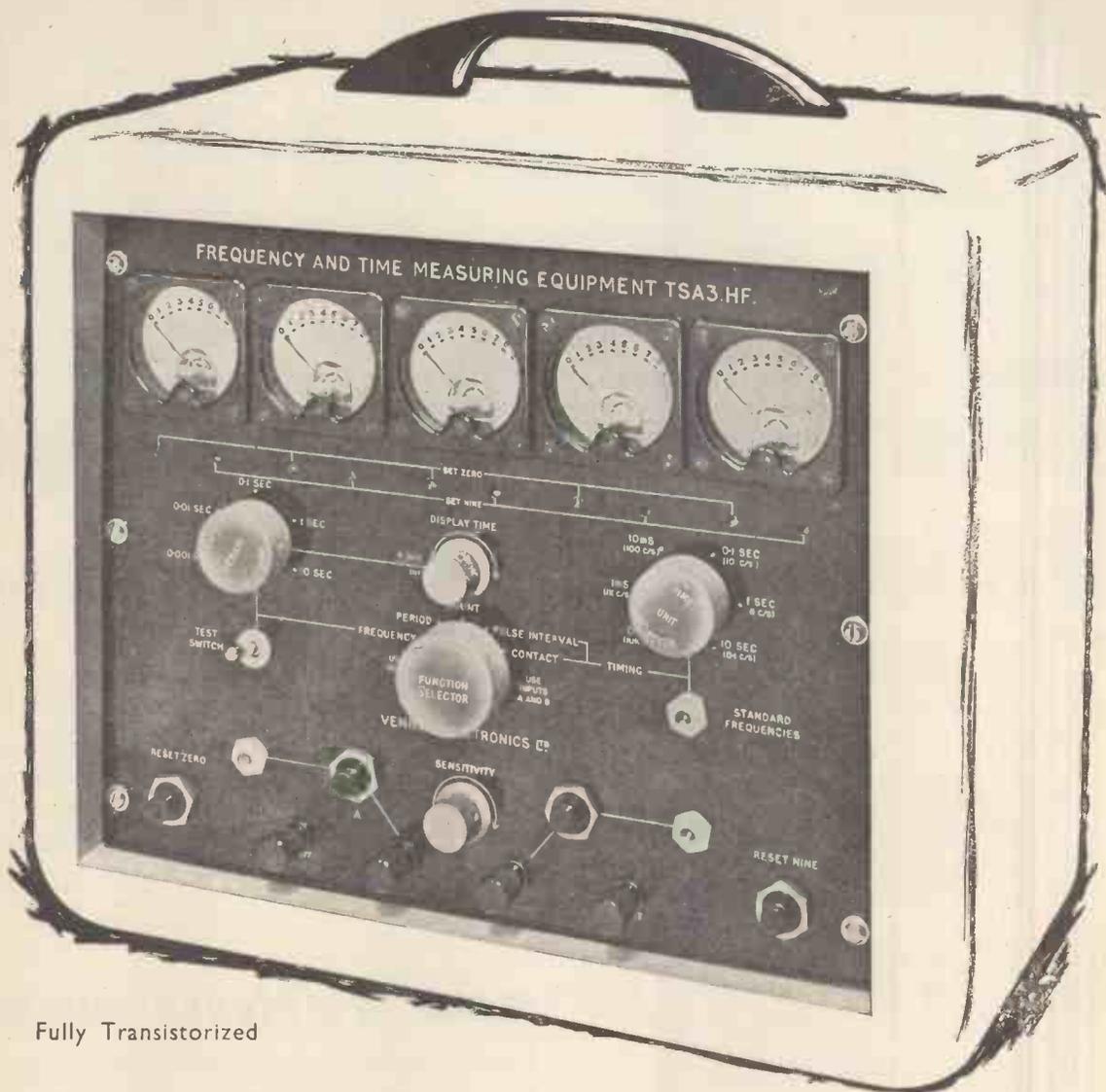
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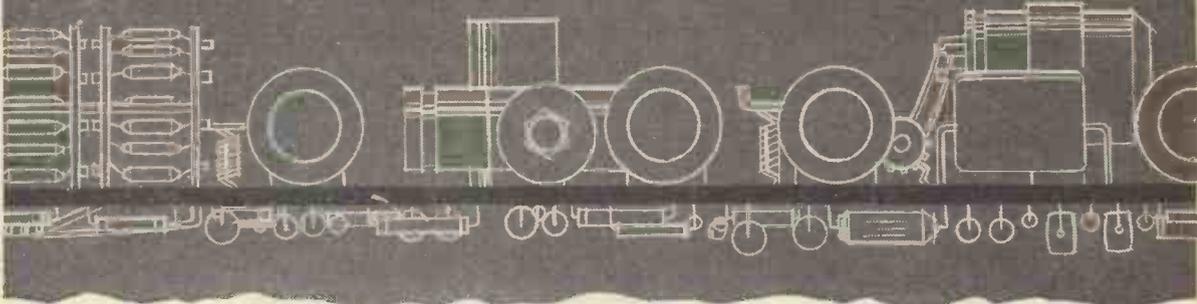
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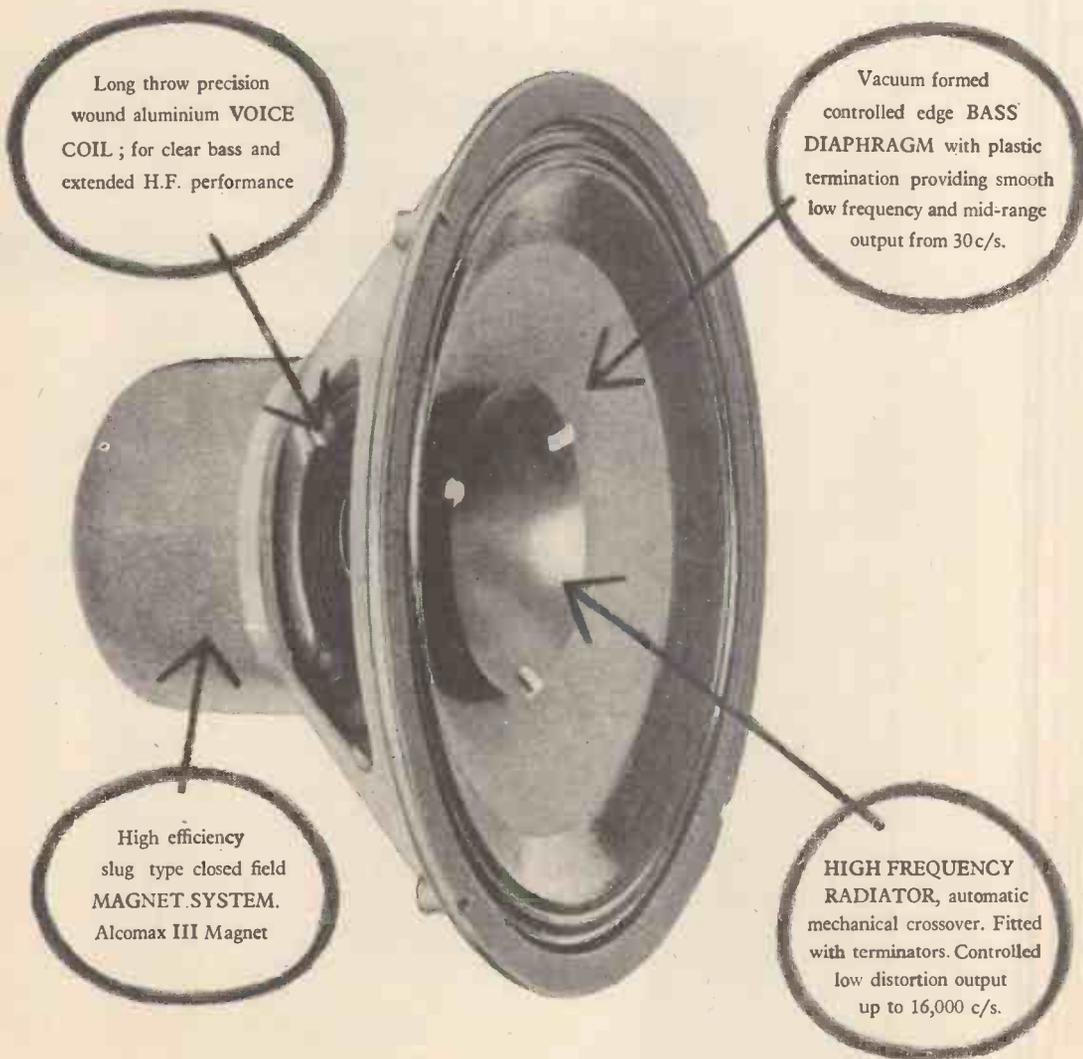
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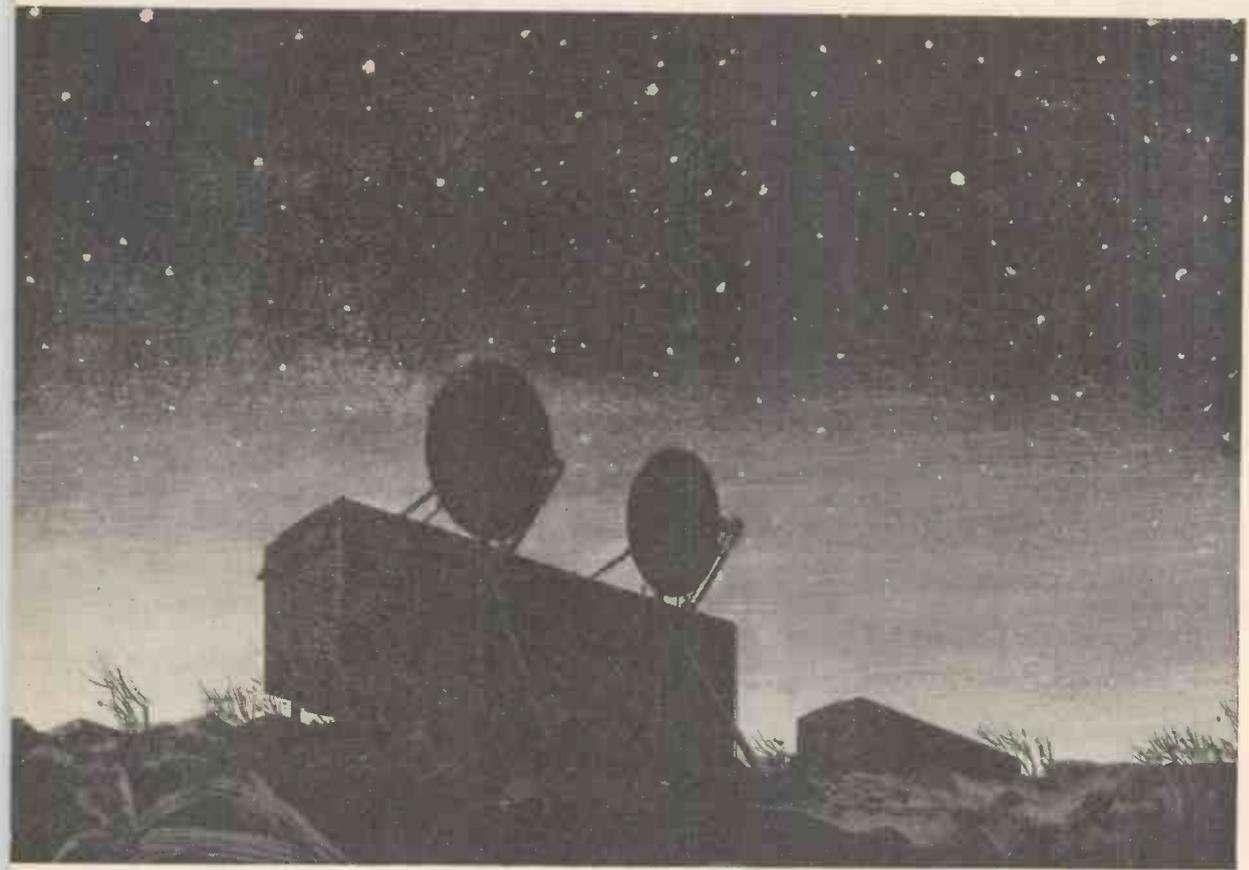
Maximum Capacitance MFD	Working Voltage	Size (Diameter)	Size (Length)
50	6	1/4"	5/8"
40	6	3/16"	5/8"
12	3	1/8"	9/16"
2	6	1/10"	13/32"

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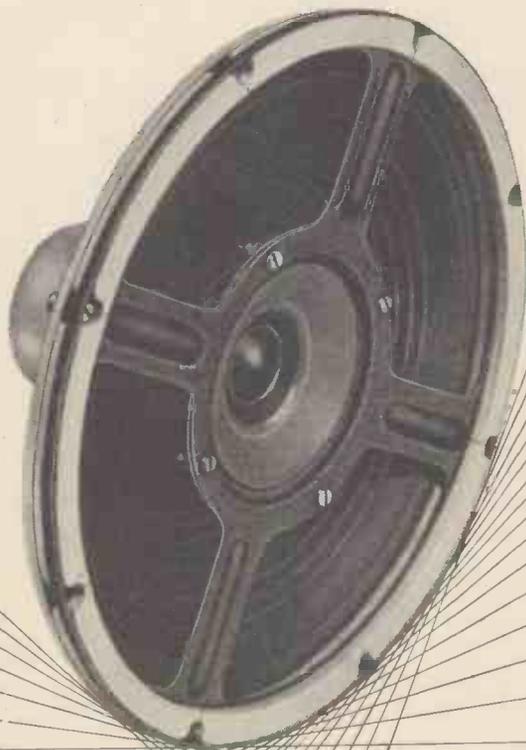
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Fixed Station — 120 telephone channels	—television and sound	Wide Band —radar	—data
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- Antennas —10 to 28 ft. diameter
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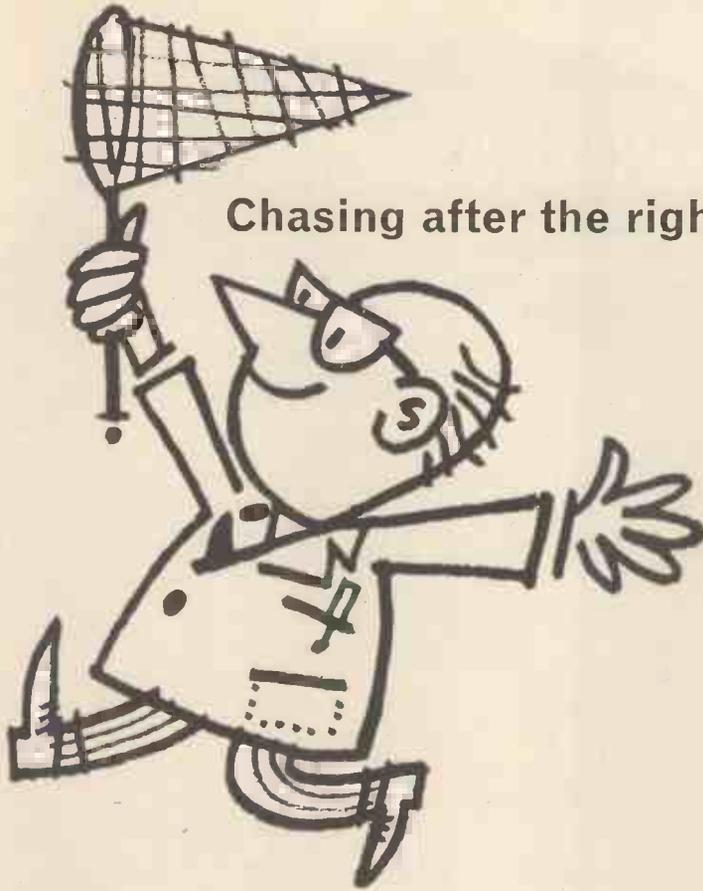
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If you are looking for a VHF pnp drift transistor, the XA131, a recent addition to our range, may be the one you want. It is suitable for use as a **Local Oscillator up to 250 Mc/s** or an **R.F. Amplifier up to a frequency of 100 Mc/s**.

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HF oscilloscope with differential input, type GM 5603

3 others from our range

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- * **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 nsec.

Signal delay: obtained by a 0.3 μ s 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 M Ω in parallel with 25 μ F.

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 μ F.

Using the cathode follower probes full sensitivity (50 mV/cm) is maintained.

Input impedance: 0.5 Megohm in parallel with 5 μ F.

Sweep Generator

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

Sweep range: 0.2 μ s/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 \pm 5%) and continuously; fastest sweep 40 nsec/cm.

Triggering

- * **Optimum trigger stability up to 2 Mc/s and HF sync up to at least 15 Mc/s**

Trigger facilities: 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 μ F.

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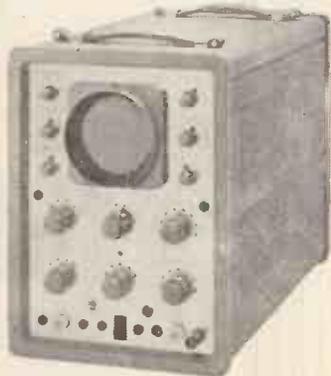
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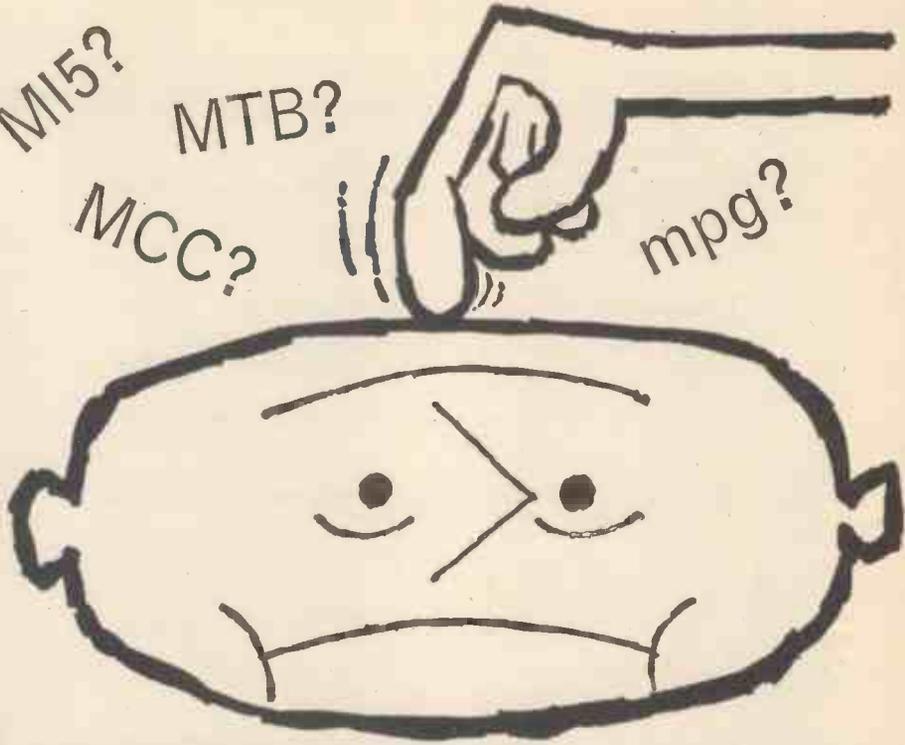


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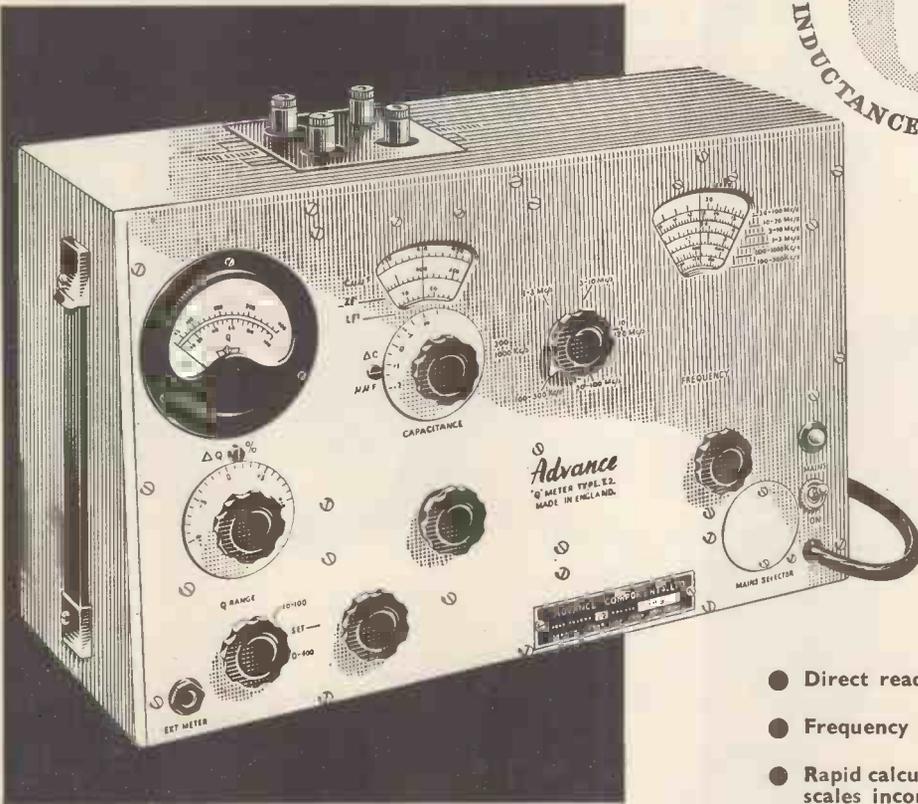
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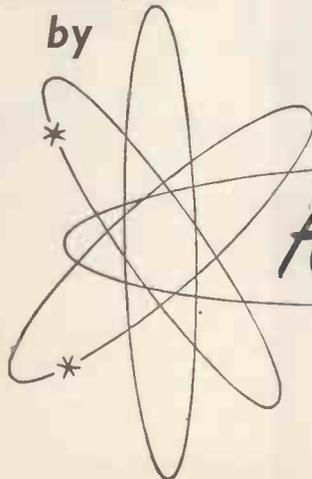


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5½"	850	1.. 31 ..	1 7 6	1200	2.. 8 ..	1 15 0	7"	2400	4.. 16 ..	4 0 0
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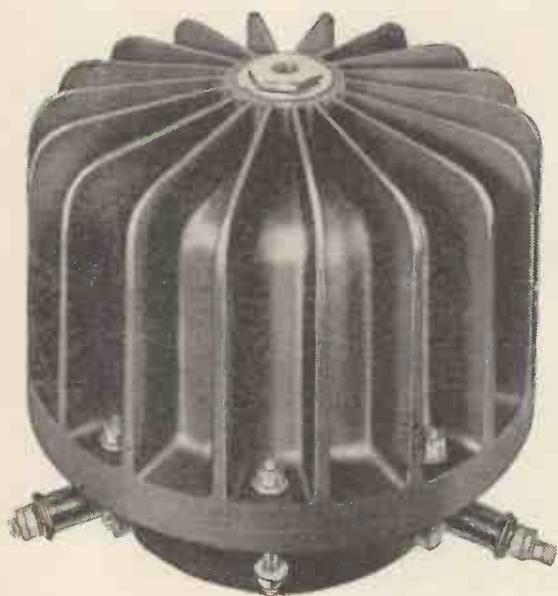
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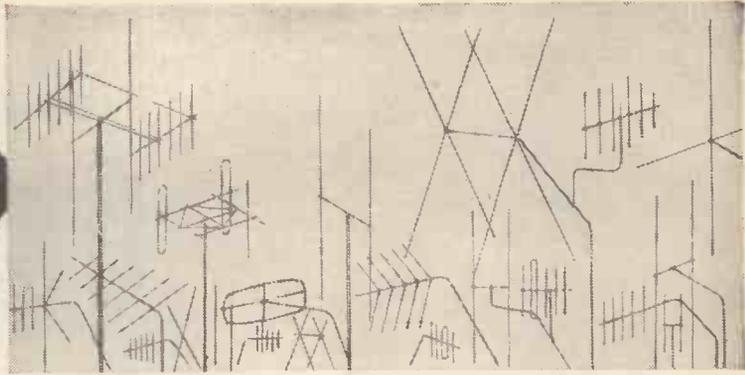
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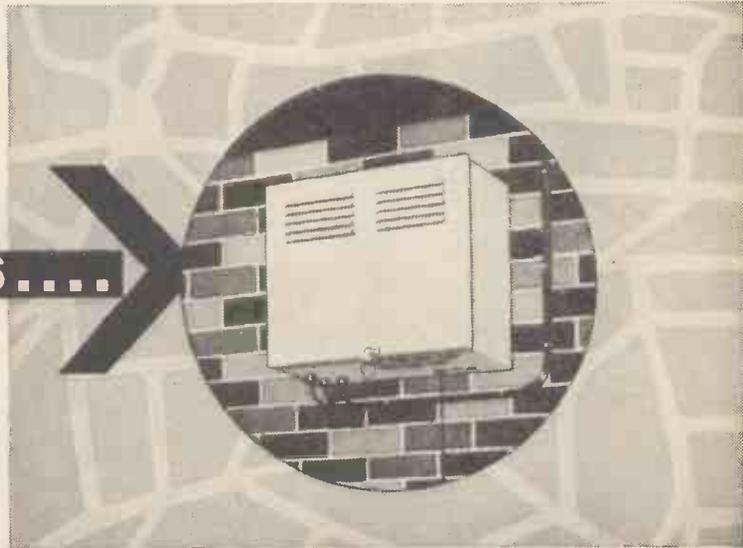
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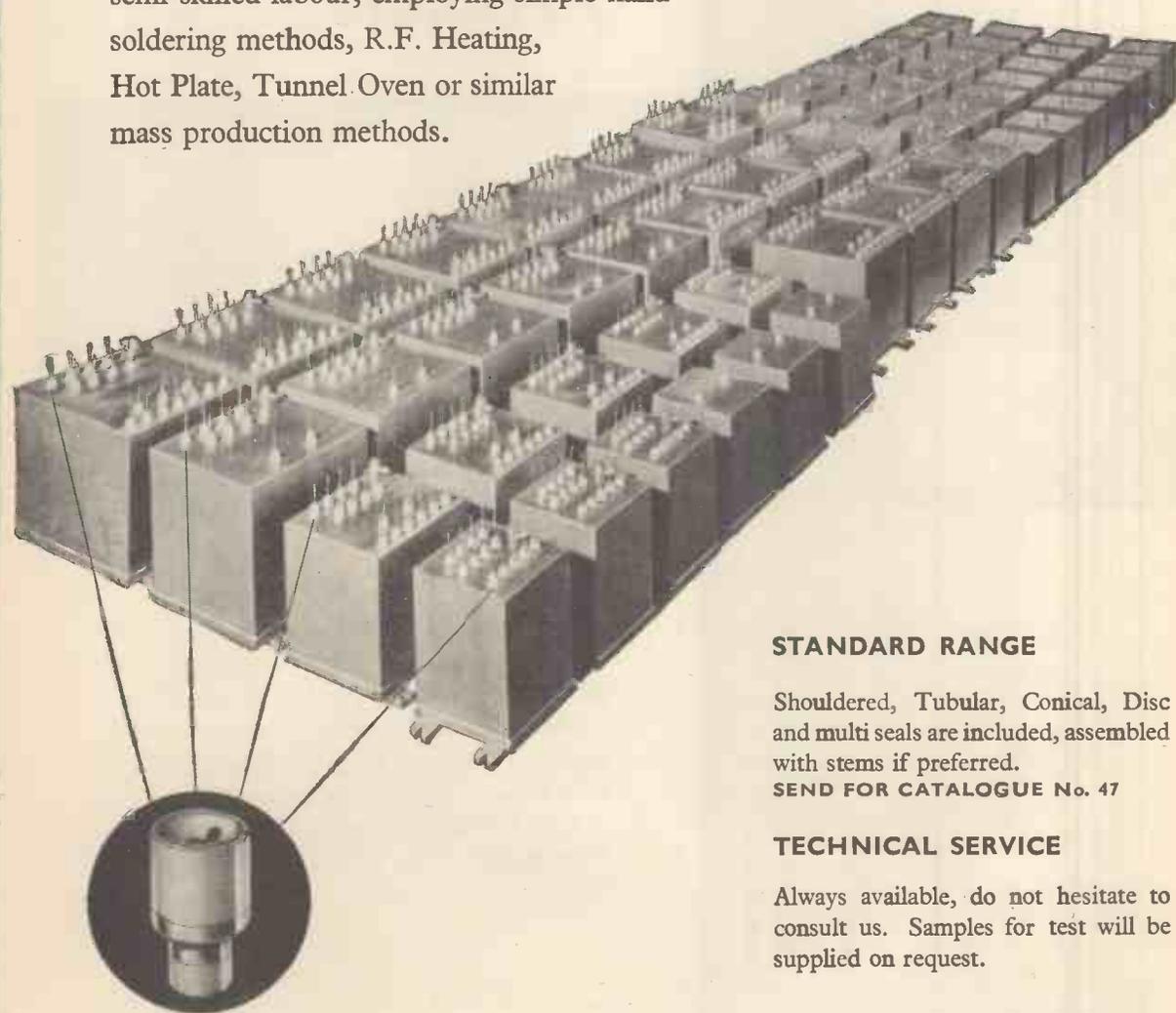
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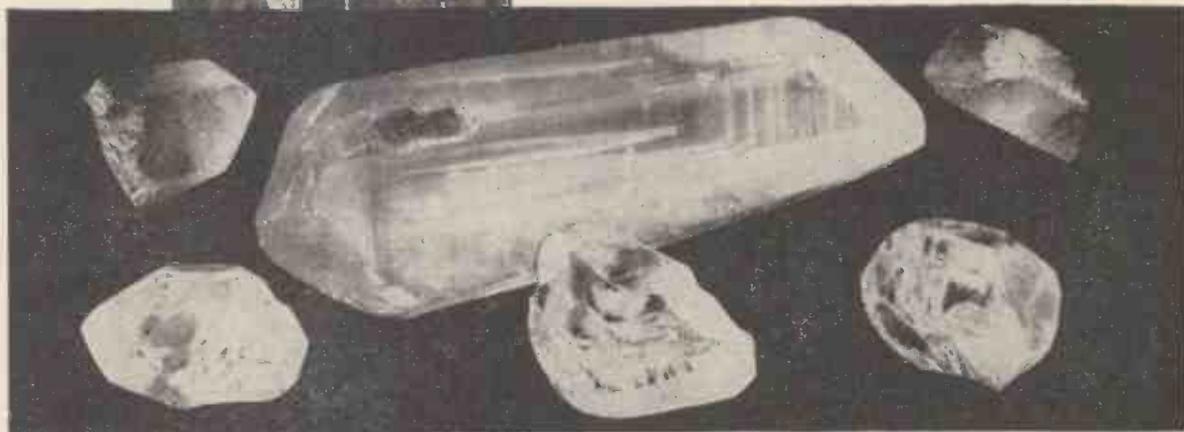
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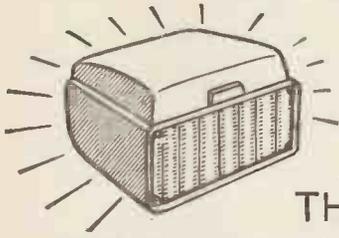
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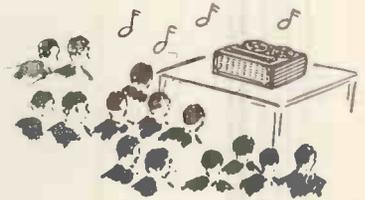
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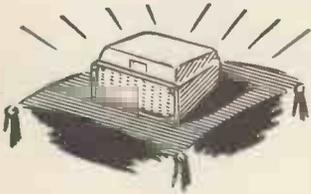
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Functional design

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Functional design

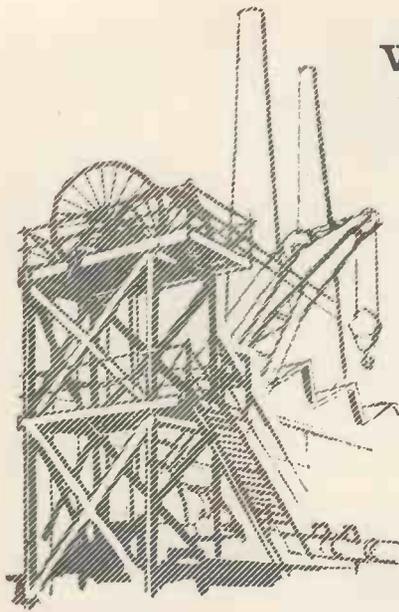
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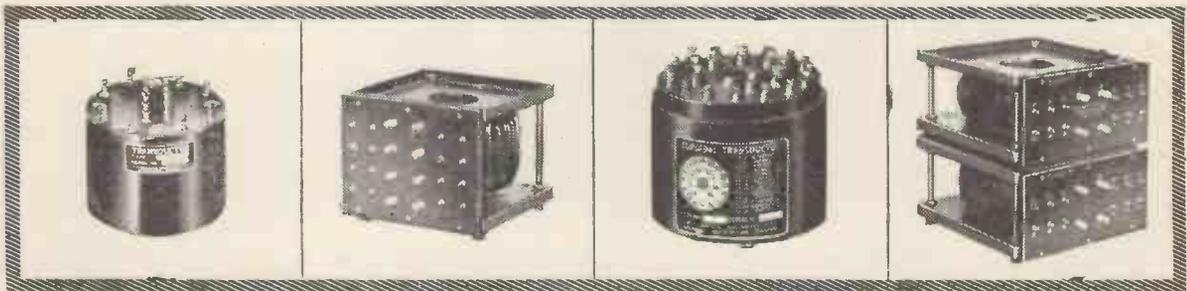
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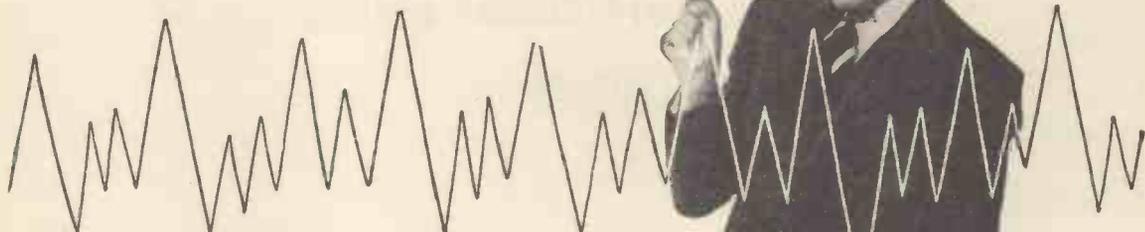
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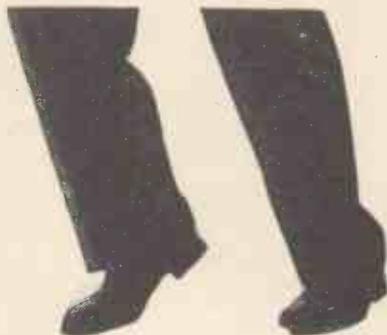
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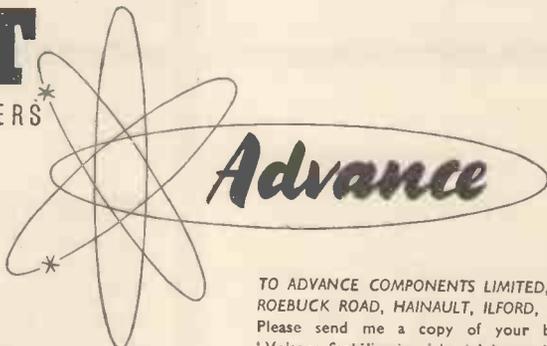
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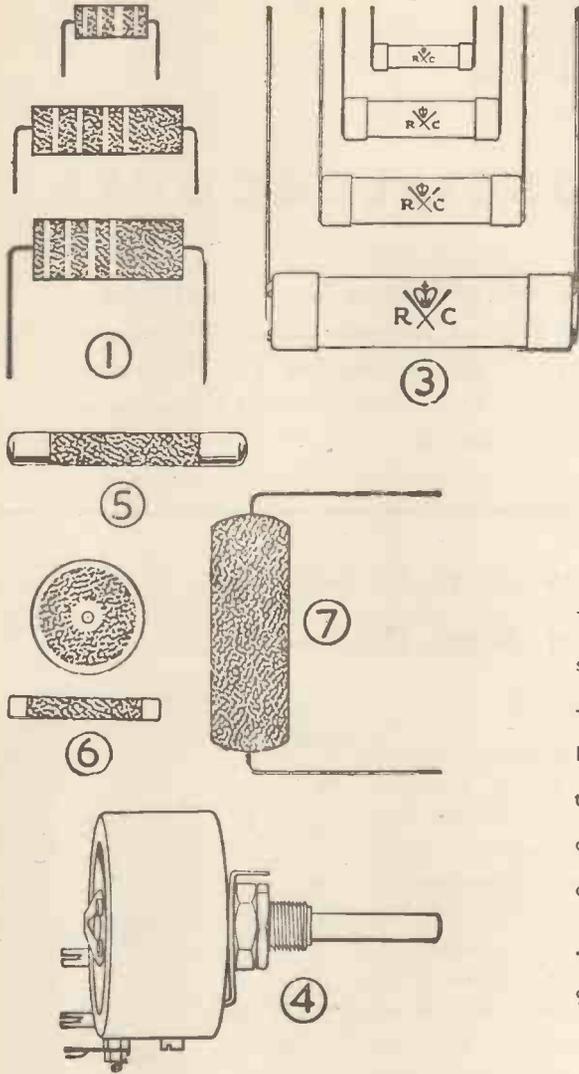
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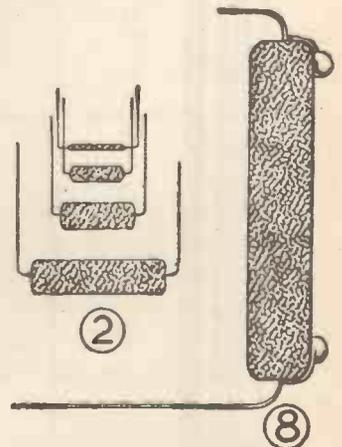
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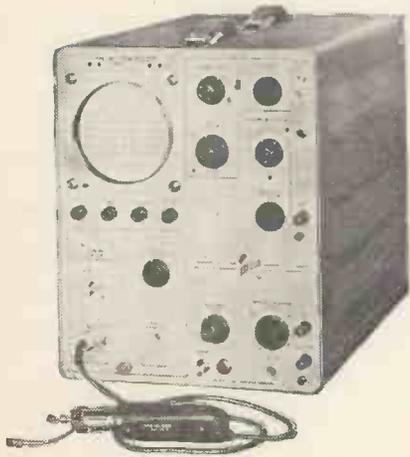


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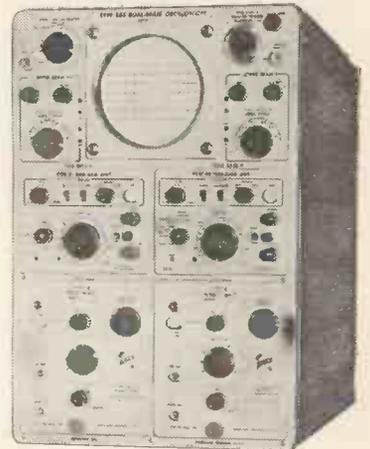
Having the identical general specifications as Type 581, the 585 has second time base generator. This acts as a sweep delay generator, providing a wide range of calibrated sweep delay, continuously variable over the range of 1 μ sec to 10 sec. Colour-correlated controls eliminate confusion, making this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

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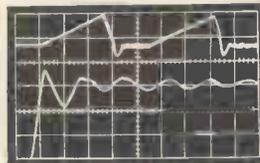
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Type 555.

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



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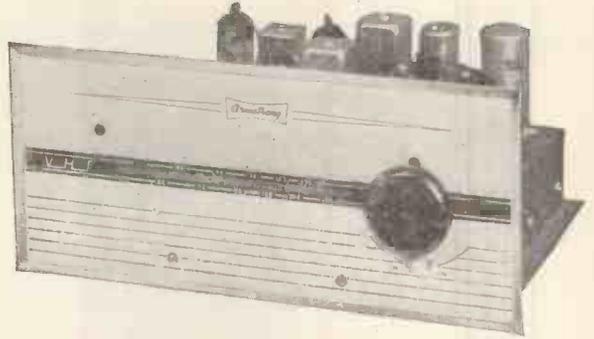
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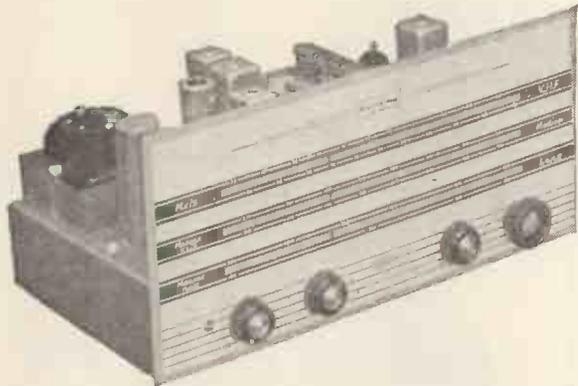
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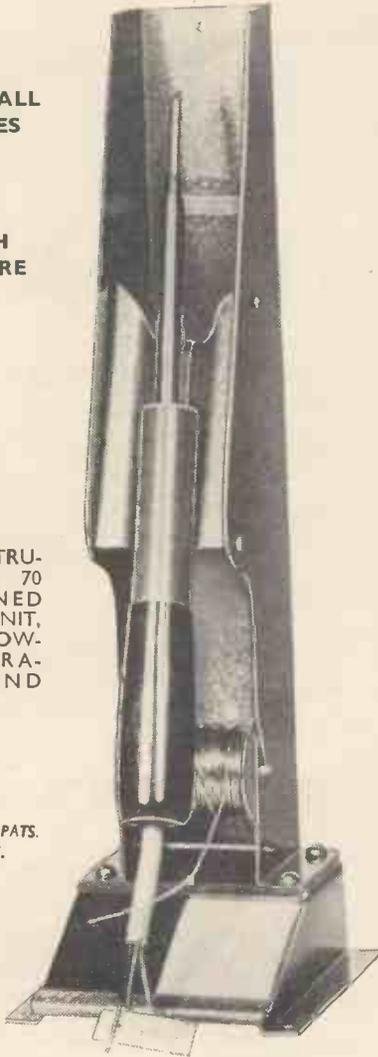
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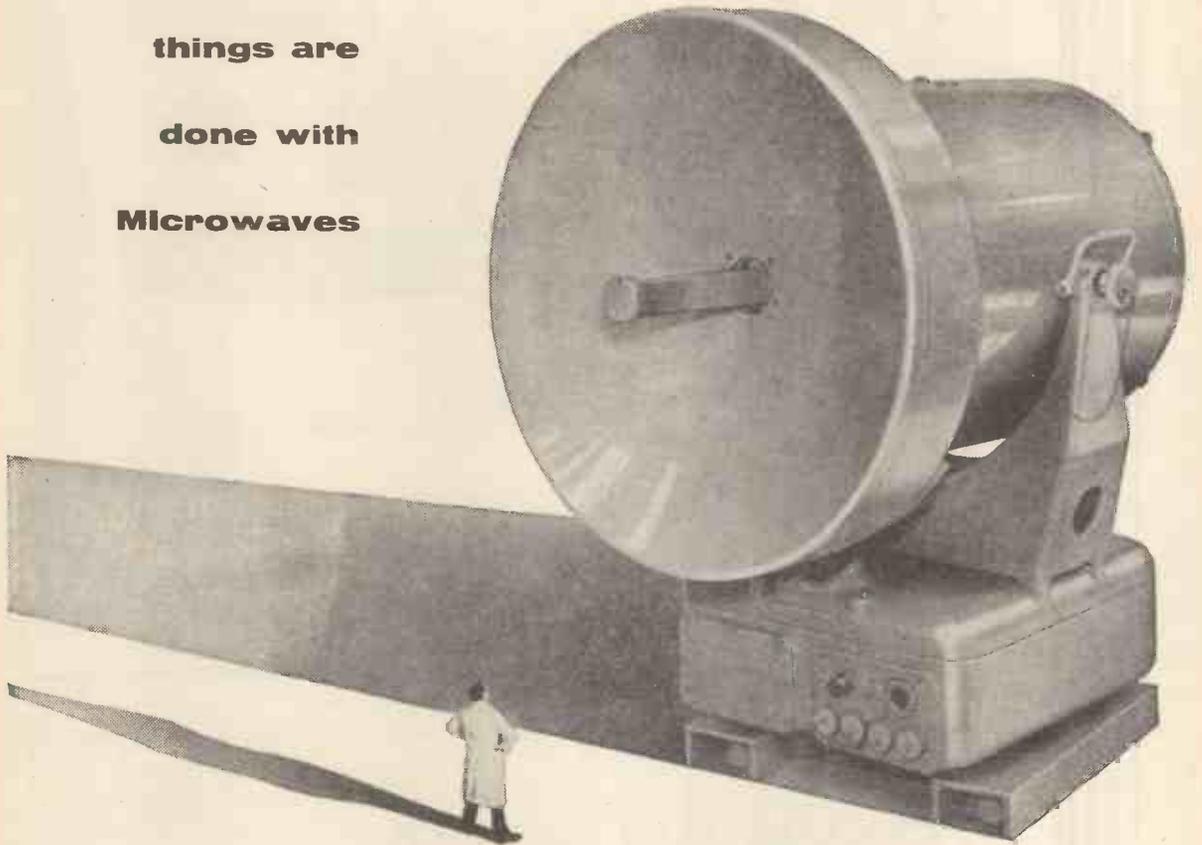
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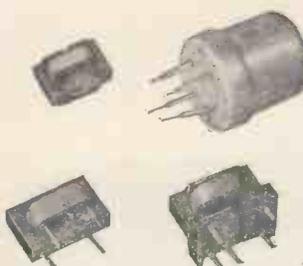
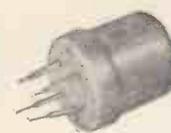
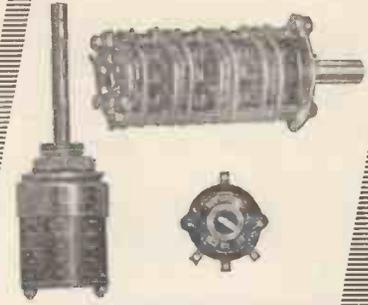
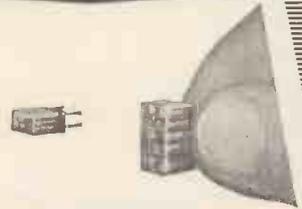
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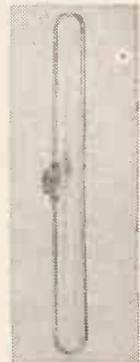


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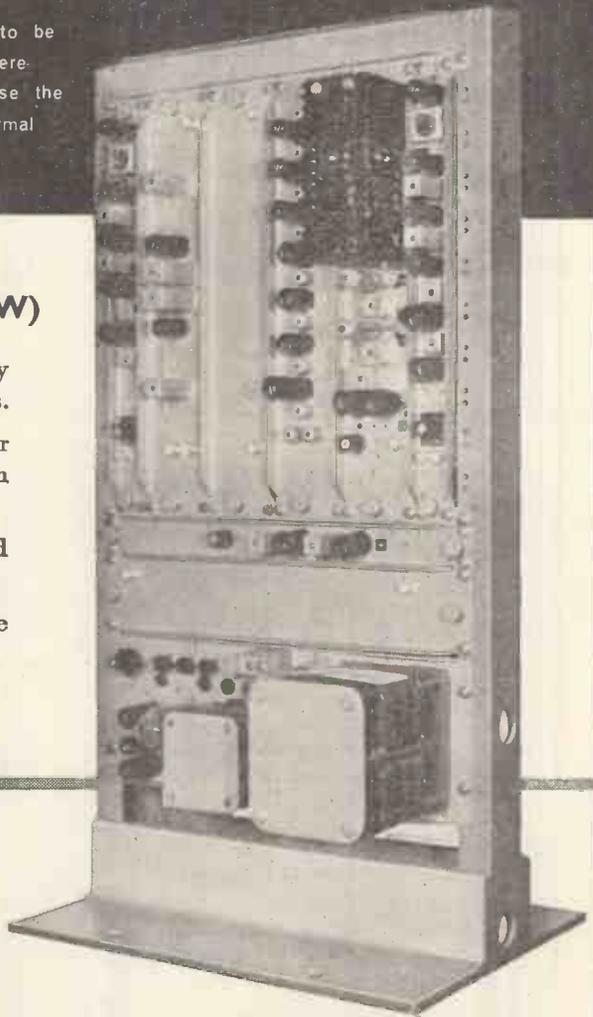
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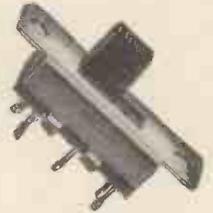
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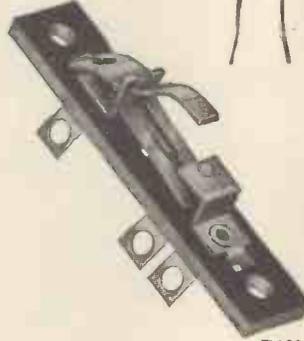
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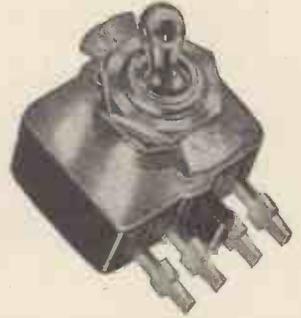
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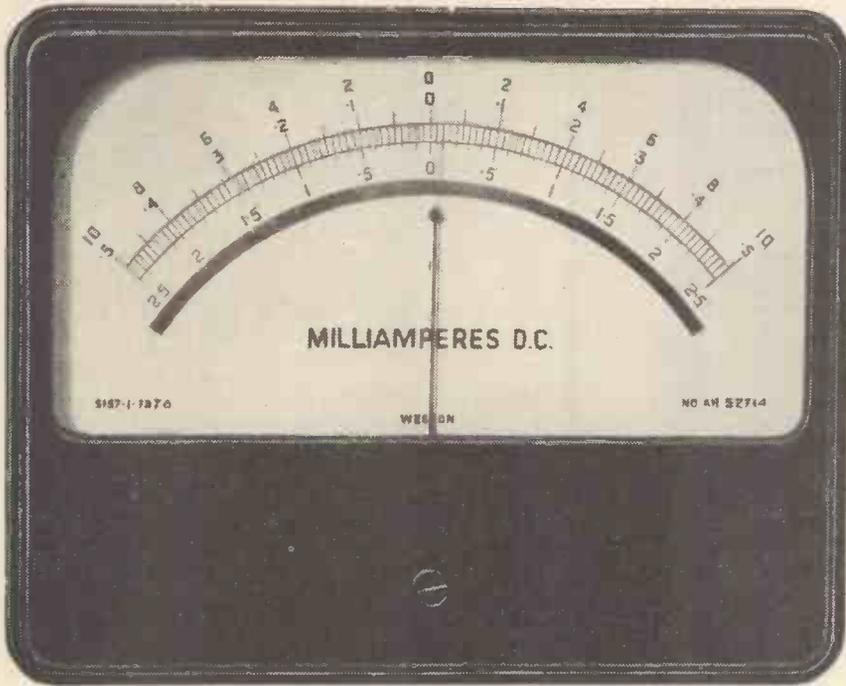
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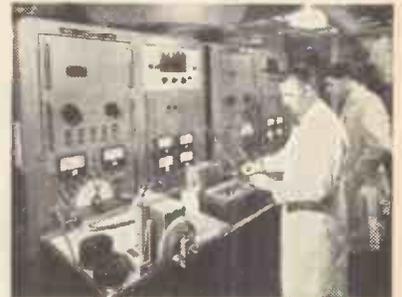


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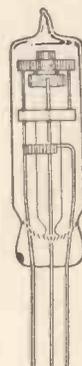
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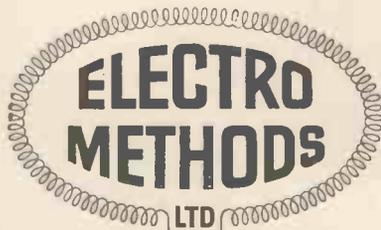
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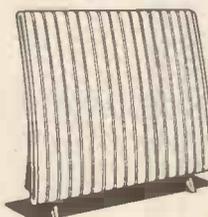
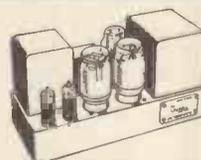
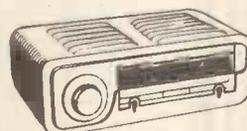
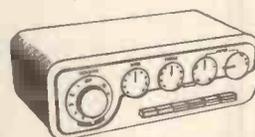
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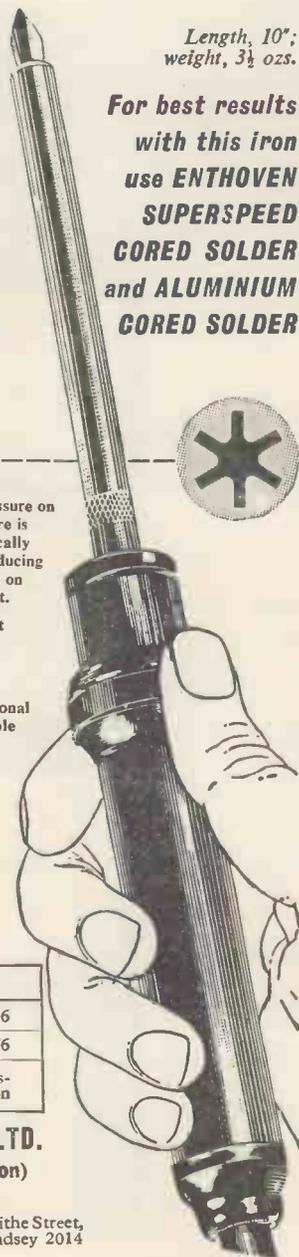


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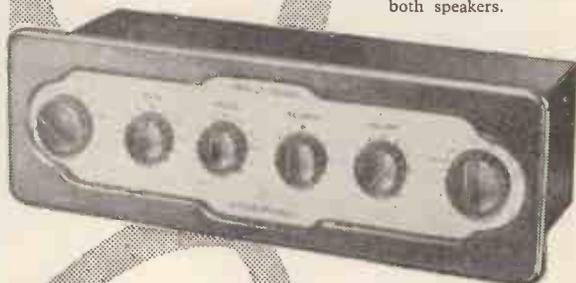
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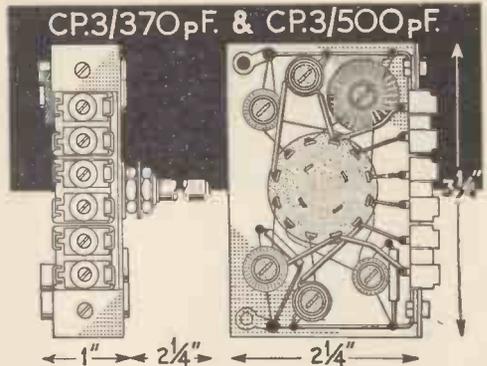
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See Technical Bulletin DTB.9 for details of all Coil Packs, 1/6.

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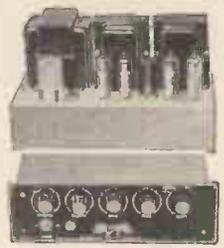
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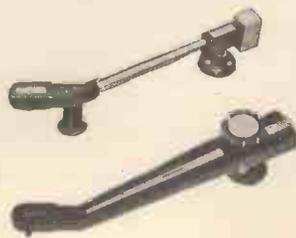
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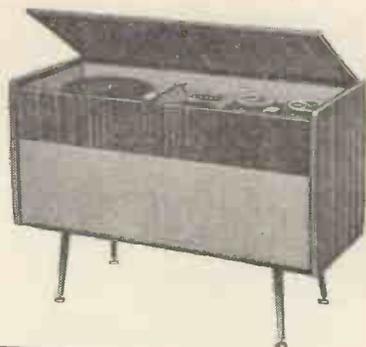
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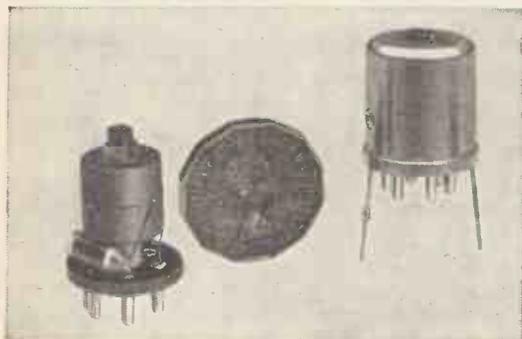
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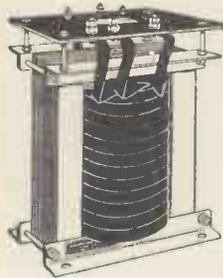
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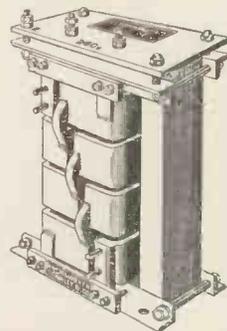
TRANSFORMERS



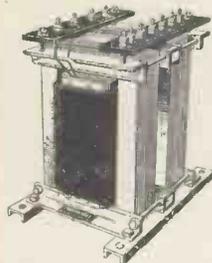
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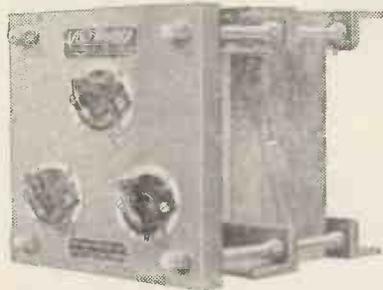
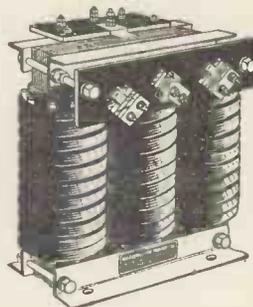
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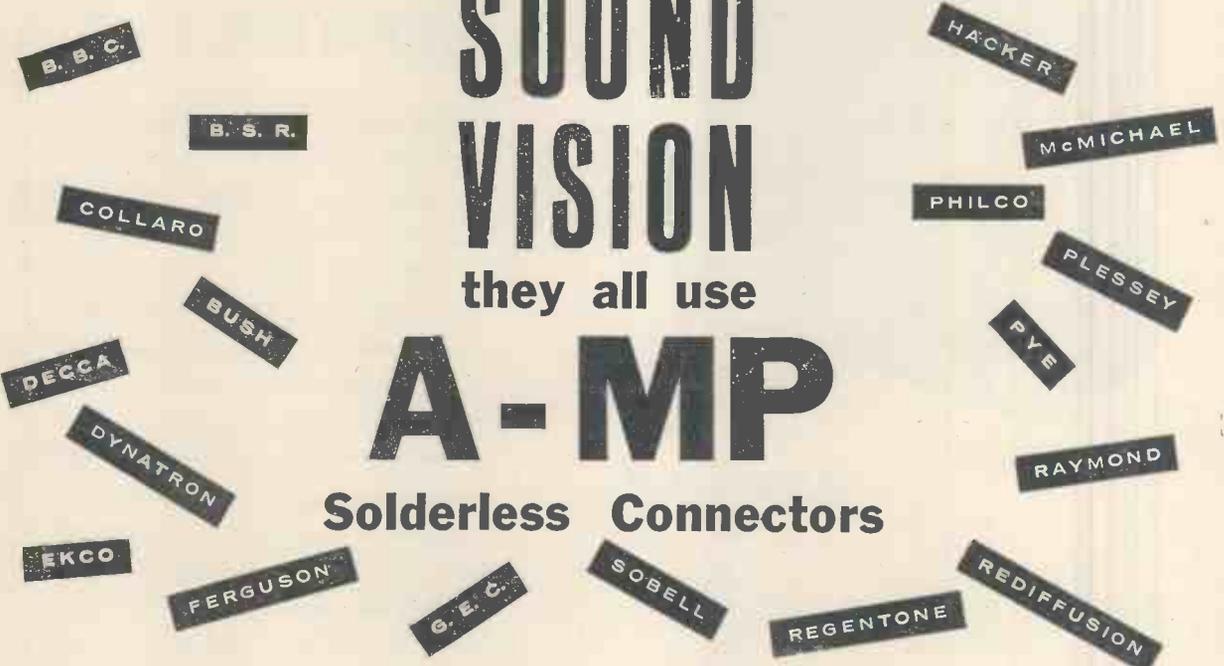
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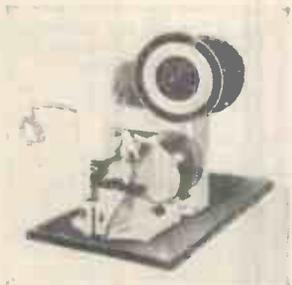
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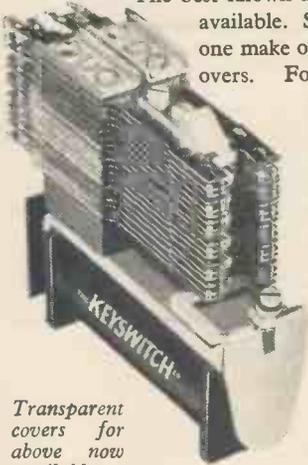
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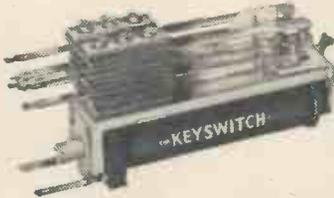
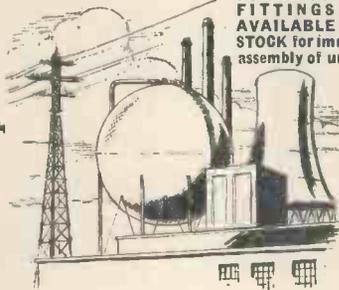
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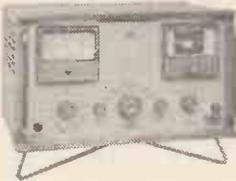
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4 RECORDING SPEEDS
FAST REWIND either direction. 1,200ft. reel rewound in 45 seconds.

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Below .1% at 7½ ips.
Below .15% at 3½ ips.
Below .25% at 1½ ips.

FREQUENCY RANGE

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3½ ips: 60/7,000 c/s ± 3 db.
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SELECTIVE FREQUENCY

CORRECTION At 15, 7½ and 3½ ips.

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Radio or pick-up: 10 mVs into 150 mVs

OUTPUT

4 watts into 15 ohms.

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9in. × 5in. elliptical hi-fidelity model.

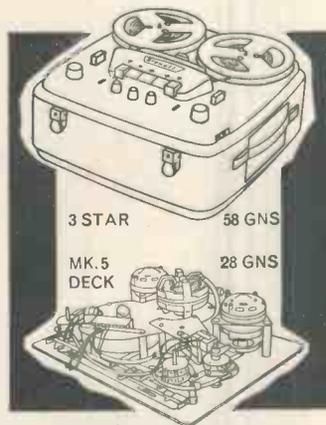
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1. (input) for high impedance microphone.
2. (input) for pick-up, radio or F.M. tuner.
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MK.5 STEREO.....	£99.12.0



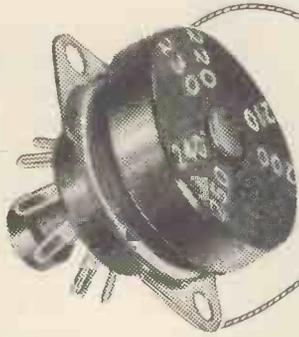
3 STAR 58 GNS

MK.5 DECK 28 GNS



6 WAY

miniature mains
voltage selector
Type **BMVS/6**



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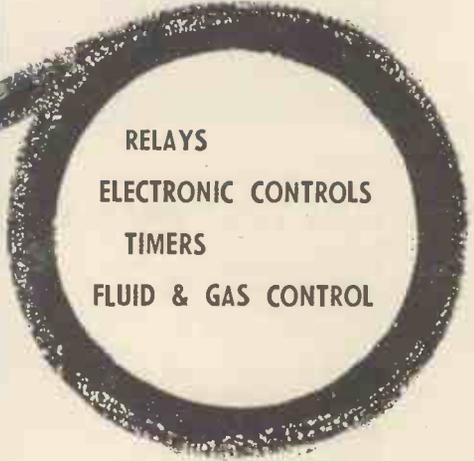
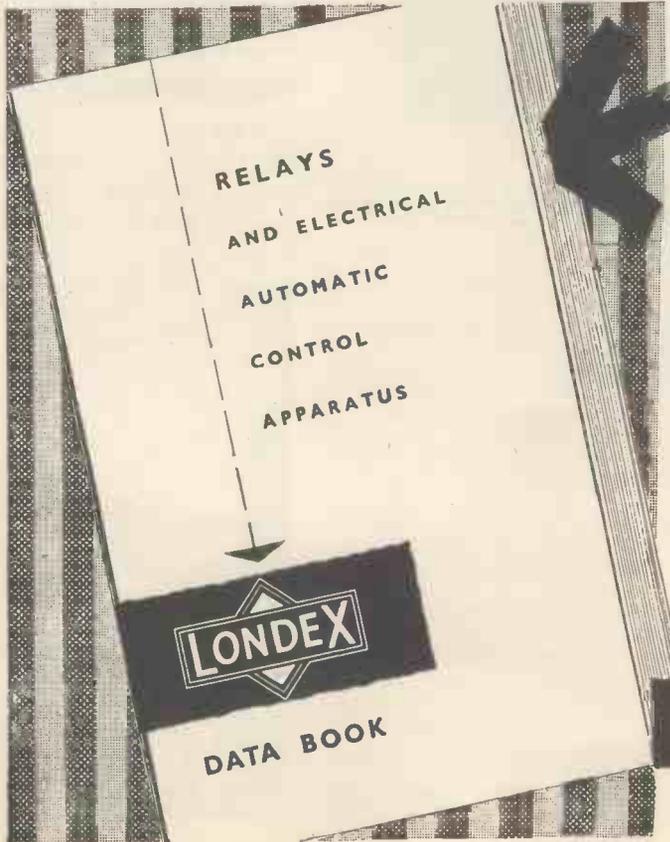
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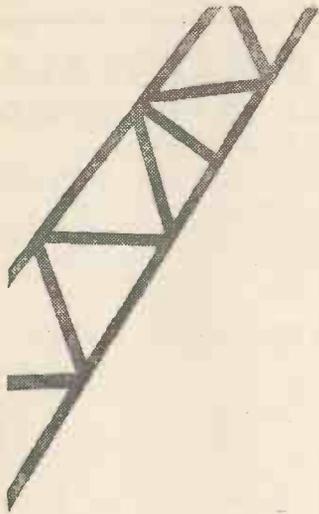
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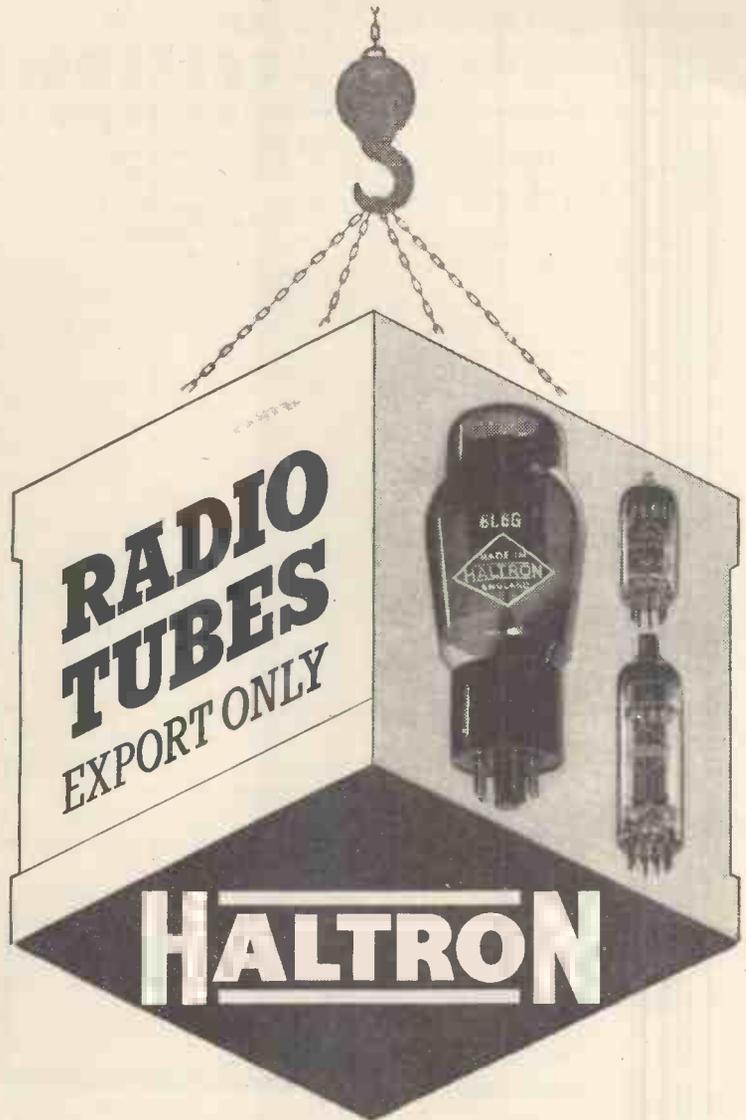
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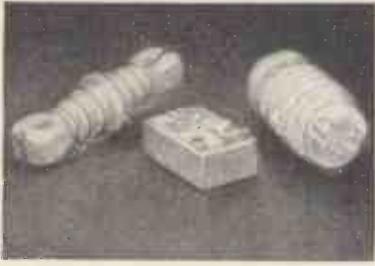
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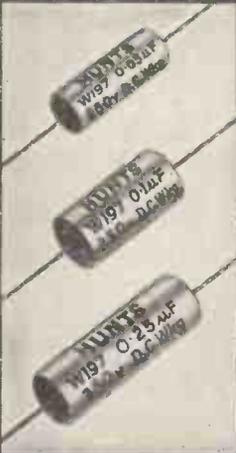
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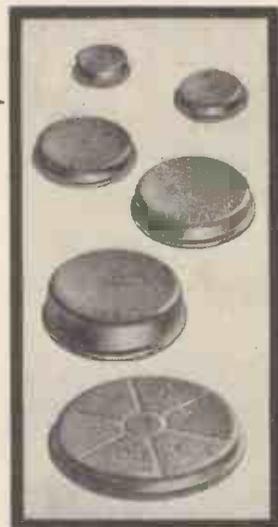
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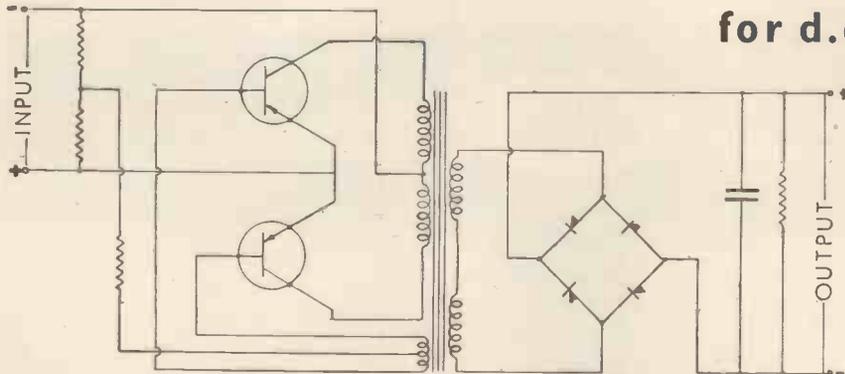


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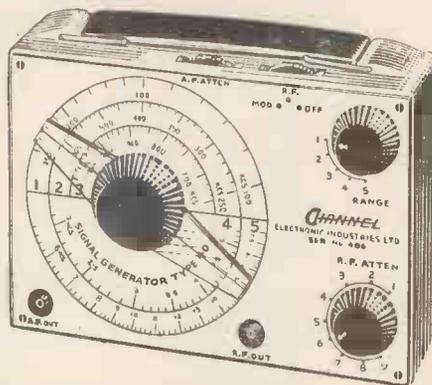
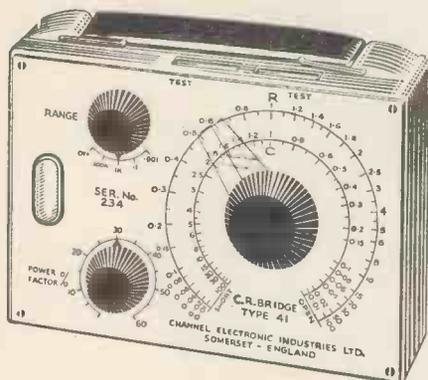
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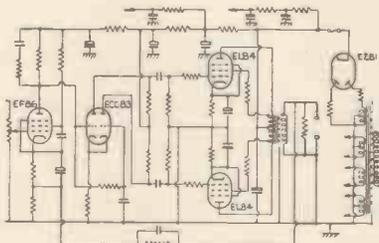
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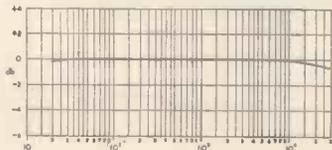
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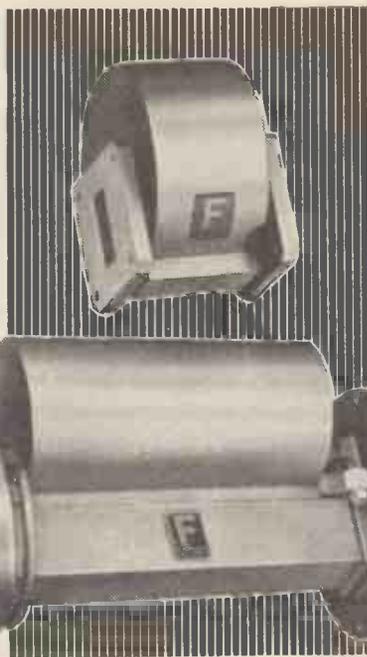
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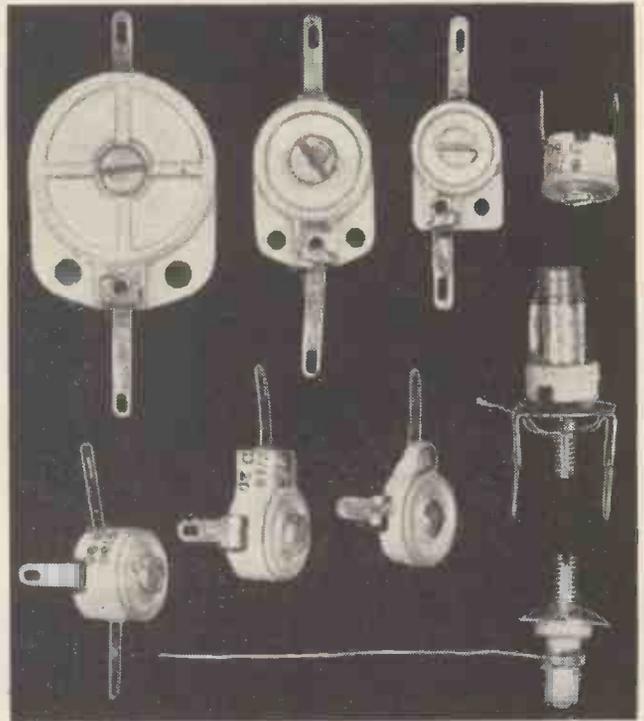
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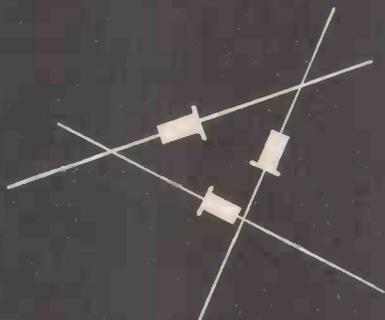
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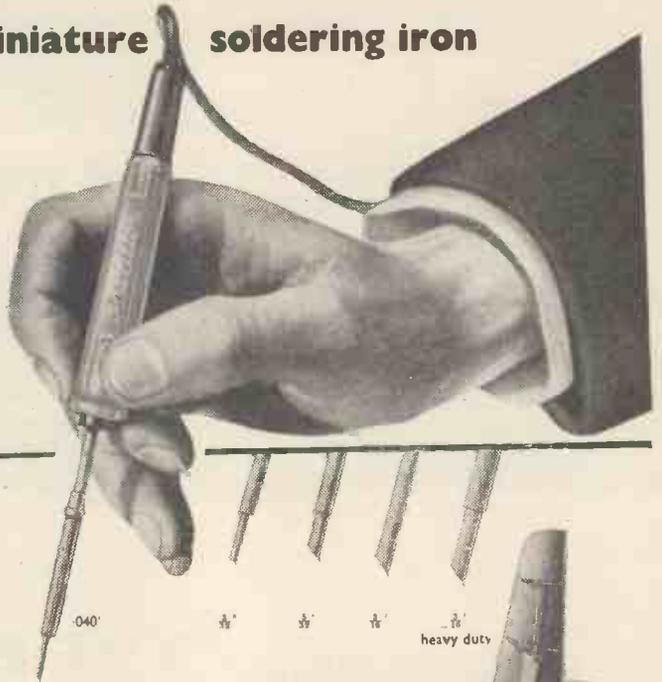
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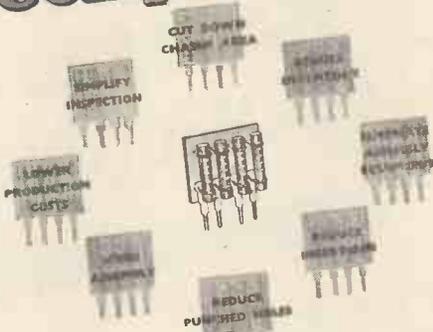
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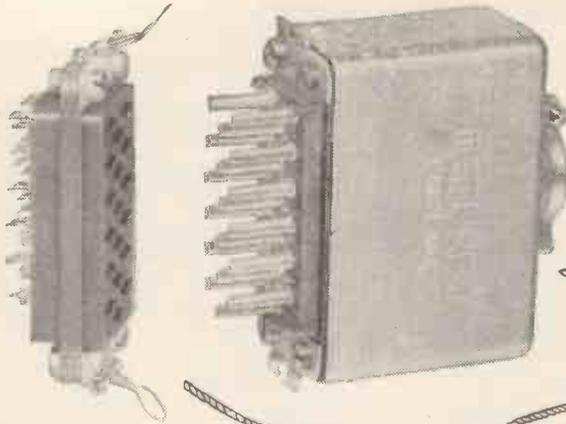
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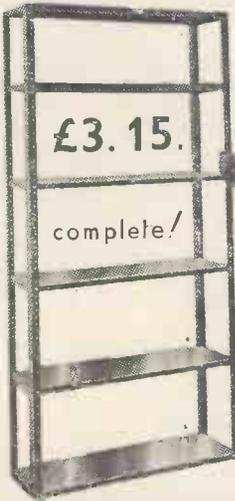
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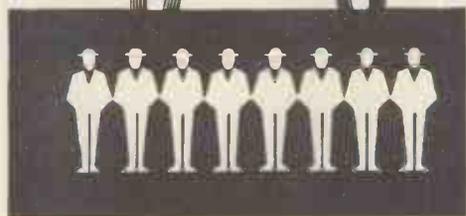
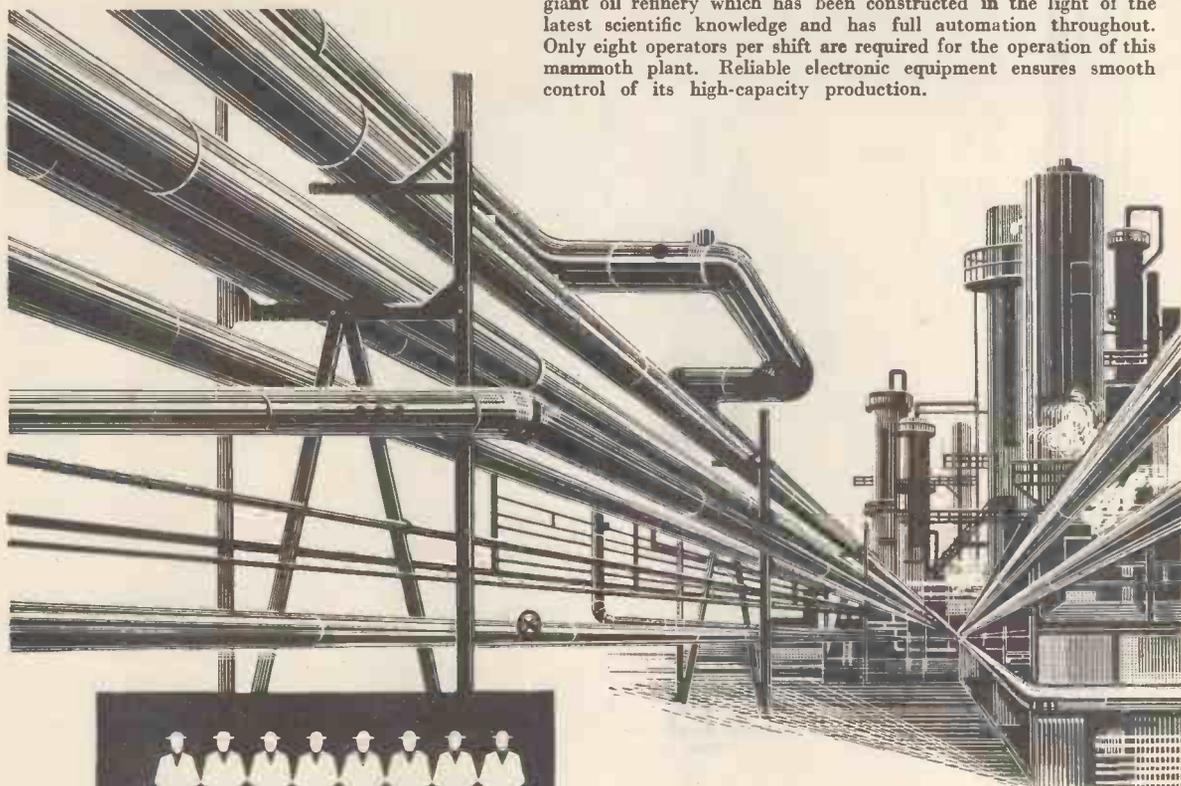
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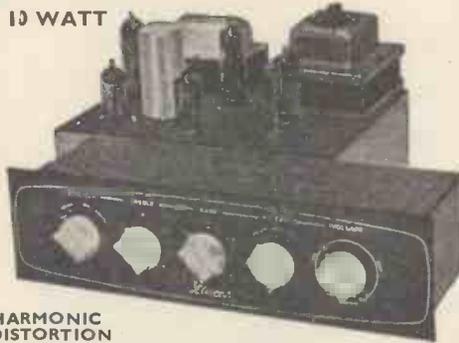
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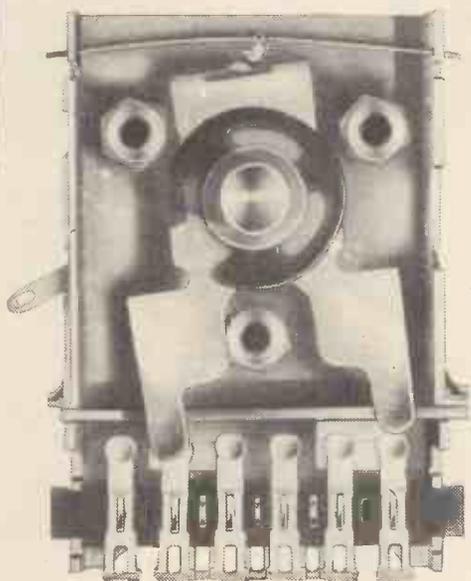
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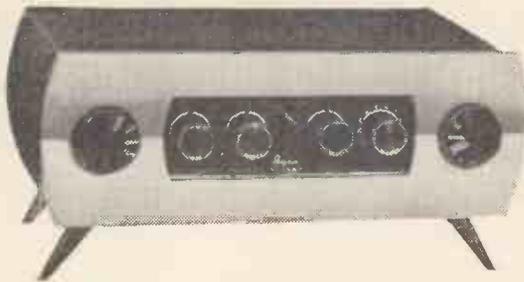


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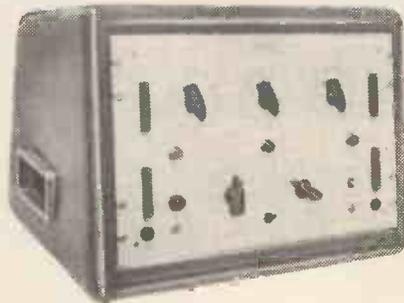
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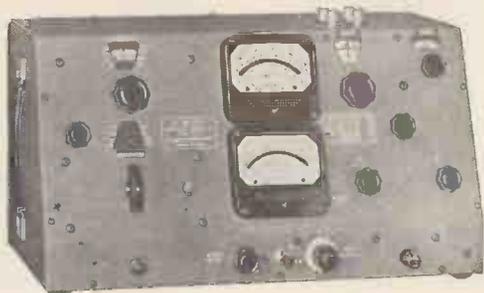
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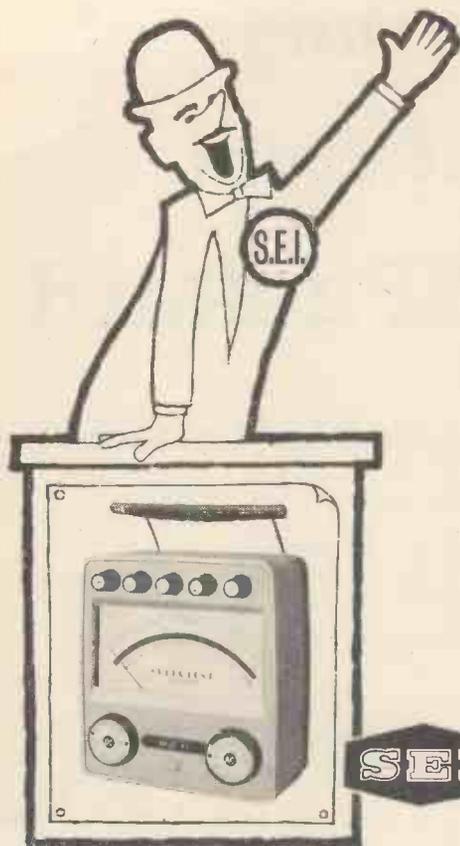
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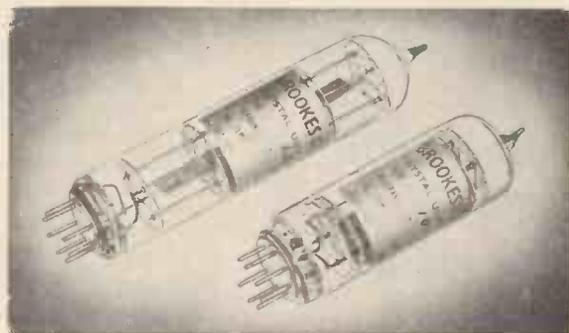
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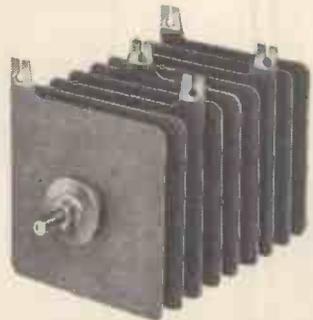
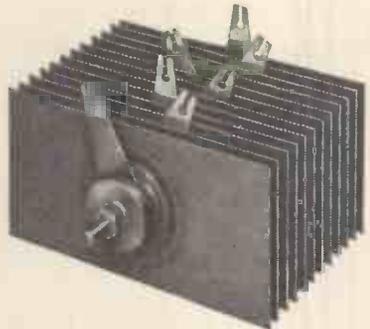
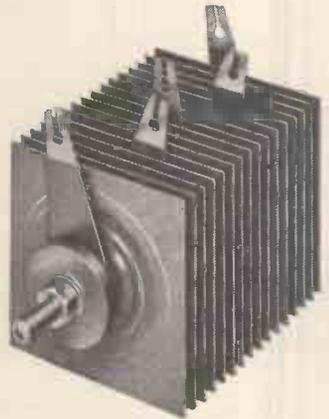
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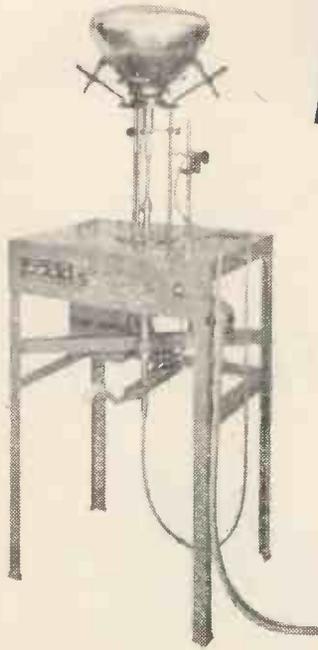
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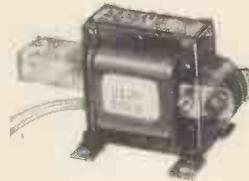
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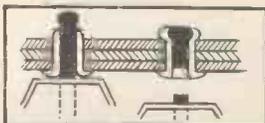
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Wireless World

ELECTRONICS, RADIO, TELEVISION

OCTOBER 1960

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FIFTIETH YEAR
OF PUBLICATION

- | | | |
|-----|-------------------------------------|-----------------------------------|
| 473 | Editorial Comment | |
| 474 | Permeability Tuners for Television | By V. H. Piddington |
| 480 | Airshow Electronics | |
| 482 | Firato 1960 | |
| 484 | World of Wireless | |
| 486 | Personalities | |
| 487 | News from Industry | |
| 489 | National Radio Show Review | |
| 497 | Letters to the Editor | |
| 501 | Equatorial Ionospheric Effects | By T. W. Bennington |
| 507 | Transistor Inverters & Converters—3 | By M. D. Berlock and H. Jefferson |
| 510 | Piezoelectric Voltage Transformers | By A. E. Crawford |
| 515 | Kirchhoff's Laws | By "Cathode Ray" |
| 518 | A "Kiwi" at Earls Court | |
| 519 | Transistor V.H.F./F.M. Receiver—3 | By R. V. Harvey |
| 522 | Studio 5 (Associated Rediffusion) | |
| 523 | Elements of Electronic Circuits—18 | By J. M. Peters |
| 525 | October Meetings | |
| 526 | Random Radiations | By "Diallist" |
| 528 | Unbiased | By "Free Grid" |

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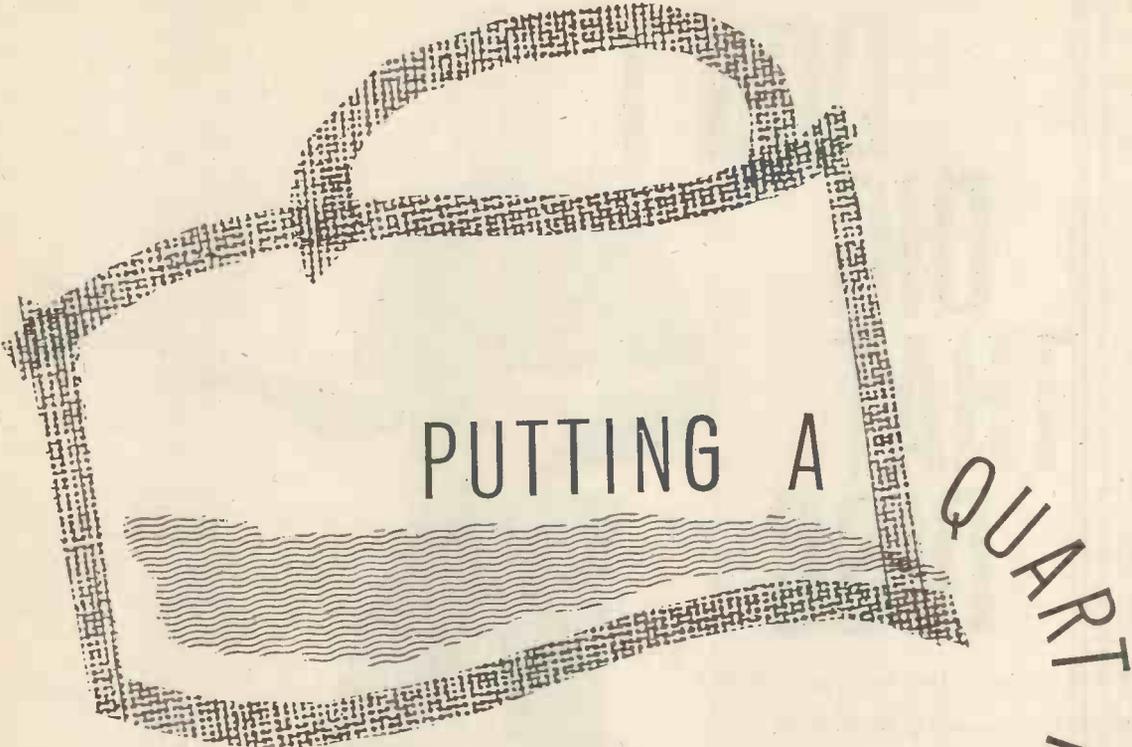
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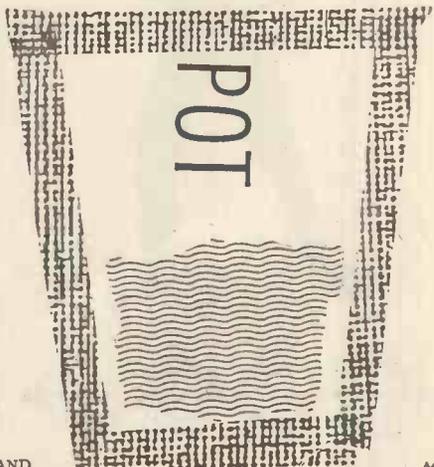
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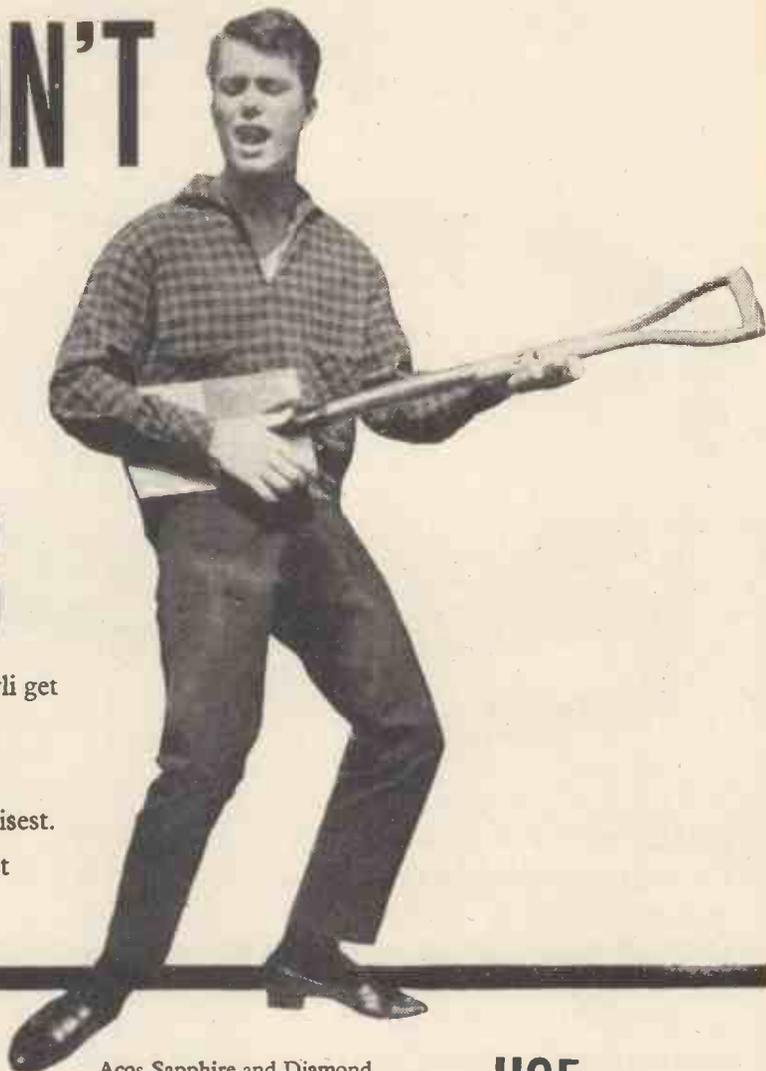
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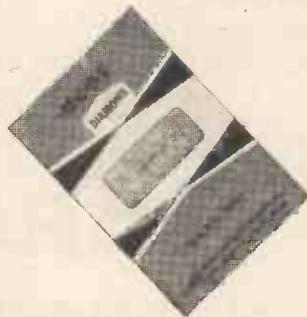
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Fusing, part 5

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,

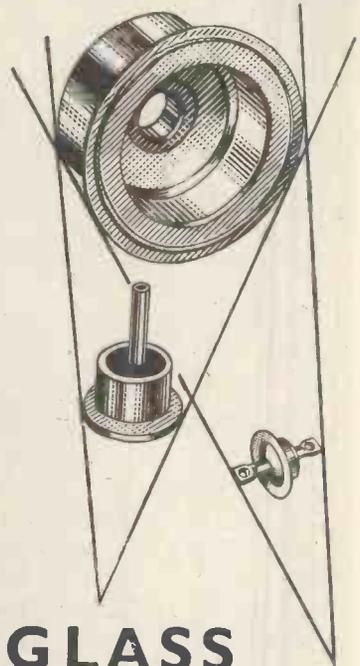
* except in the vehicle industry, where the rating defines the fusing current.

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.

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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) $I_c = 25mA$, $I_b = 0.83mA$	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)						t_r (μs)	t_f (μs)
				35°C	55°C						
GET871	-15	150	85	75	45	20	3	400	250	0.18	0.07
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Aspects of design

27 TRANSIENT SWITCHING PARAMETERS FOR TRANSISTORS (PART I)

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.

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 ,

$$Q_{ON} = \Delta Q_B + Q_v$$

$$\text{or } Q_{ON} = \Delta I_c \tau_c + Q_v$$

Q_v can be calculated from the equation

$$Q_v = \int \frac{V_1 + U}{V_2 + U} C_{tc} dV$$

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,

$$Q_v = 2 C_{tc} \sqrt{V_M + U} (\sqrt{V_1 + U} - \sqrt{V_2 + U})$$

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 formulae 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 $\frac{I_c}{\beta_0}$ (β_0 is measured

with $V_{eb}=0$) 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 $\frac{I_c}{\beta_0}$

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 m μ secs.
β_0	= 40
β_S	= 27
τ_s	= 800 m μ secs.
C_{tc}	= 11.0 pF at $V_{cb} = -6V$
$\Delta I_c \tau_{CO}$	= $10 \times 10^{-3} \times 30 \times 10^{-9} = 300$ pico-coulombs
$I_{BS} \tau_s$	= $(0.7 - \frac{10}{30}) 10^{-3} \times 800 \times 10^{-9} = 294$ pico-coulombs
Q_v	= $2 \times 11.0 \times 10^{-12} \times 4.8 = 106$ 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_{te} , C_{tc} , 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 $\beta_0 I_B$ 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.

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Efficiency Diode for a.c./d.c. Mains Television Receivers.

Heater Current (amps)	0.3
Heater Voltage (volts)	19

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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



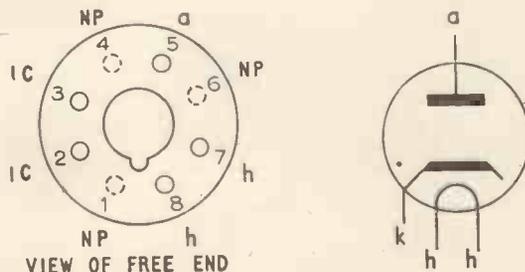
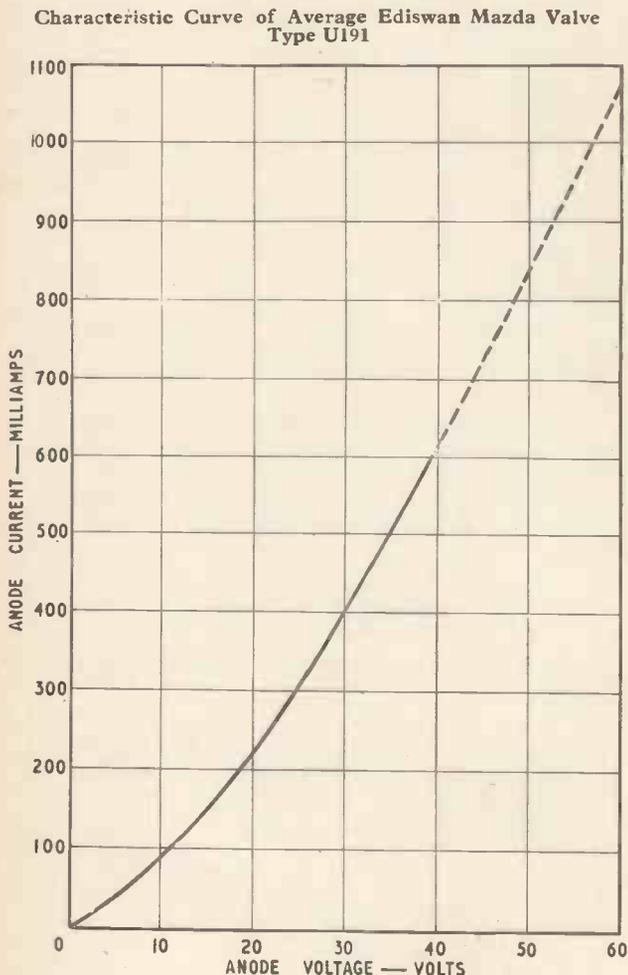
APPLICATION NOTES

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 (105) Top Cap: CT1—Cathode.

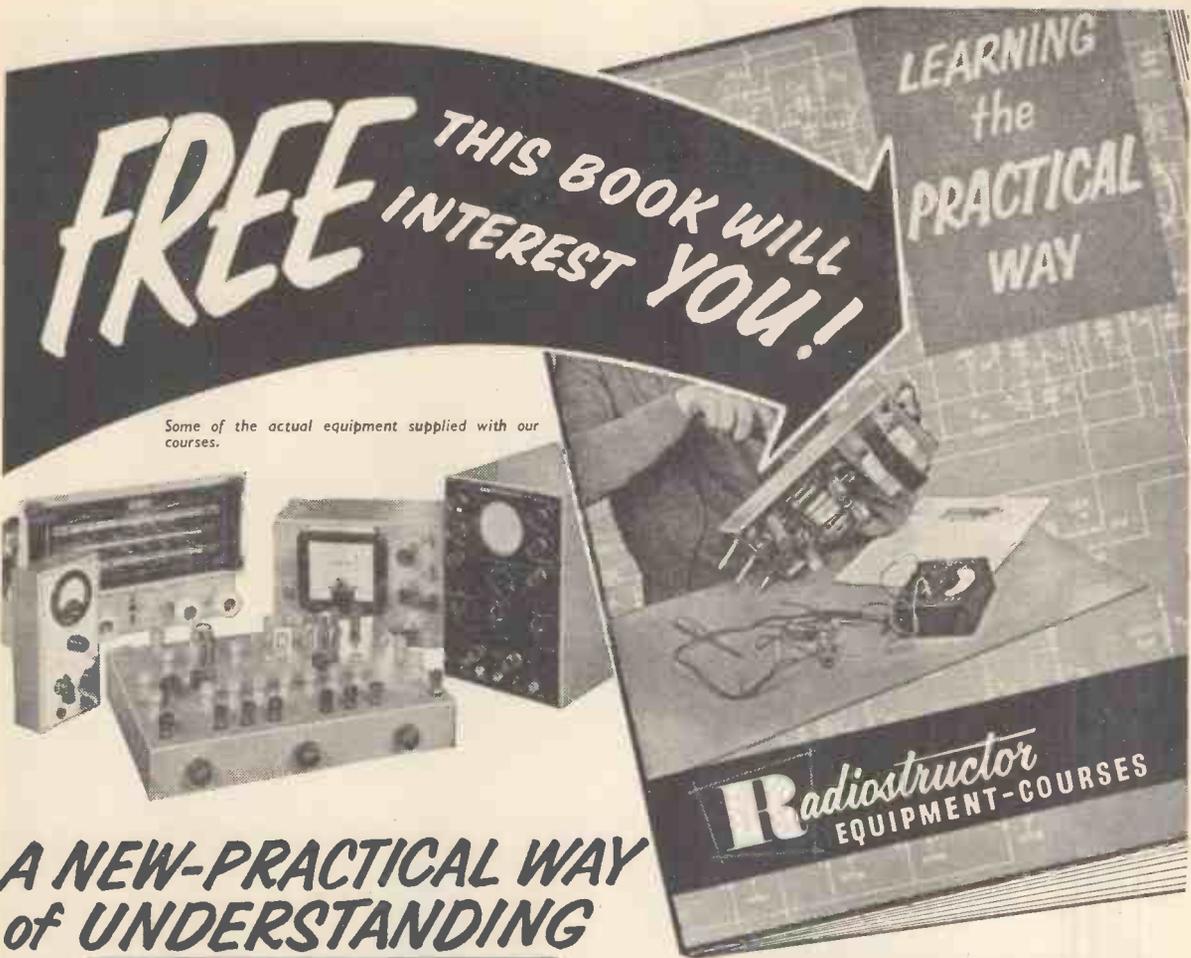


Maximum Dimensions (mm)

Overall Length	90
Seated Height	77
Diameter	32

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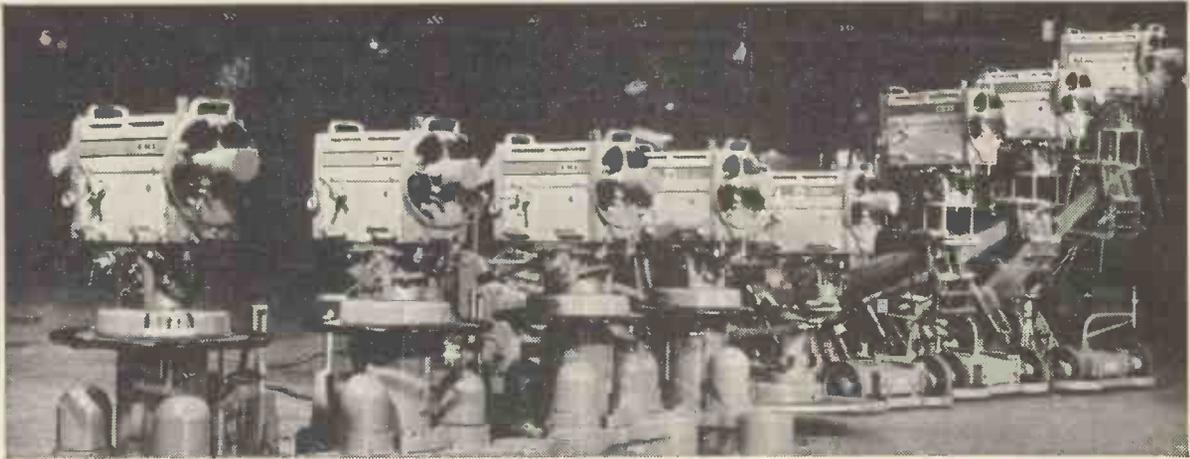
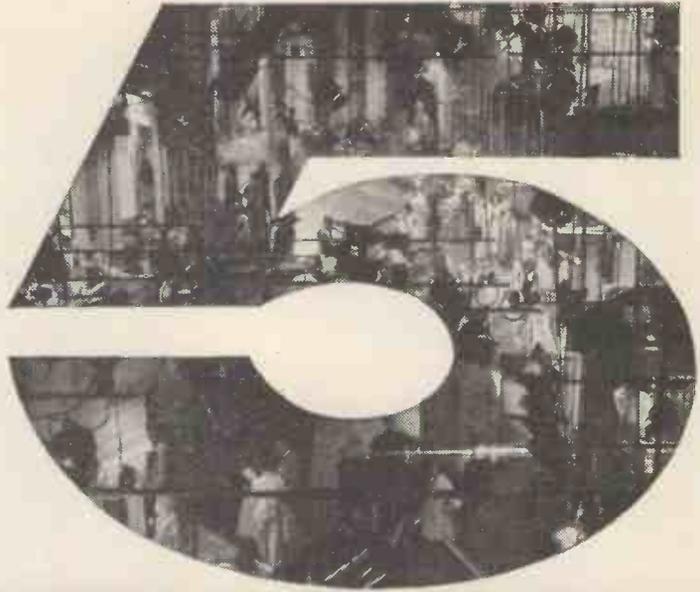
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14,000 sq. ft. of TV Studio at Associated Redifusion's new Studio 5—the largest in the world . . . using the most up-to-date equipment, by E.M.I. Ten camera channels, fifty 21" picture monitors, twin vision mixers, associated video equipment, miles of wiring, weeks of complicated installation work—constituting probably the largest order for video equipment for one TV studio ever fulfilled by a single manufacturer.

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E.M.I., pioneer of the first high definition TV systems, is still in the lead today.

Camera data: Pick up tubes: 4½" Image Orthicon normally supplied but 3" I.O. or C.P.S. Emitron can be fitted instead. 5 lens turret which can accommodate TTH Studio Varotal or Zoomar Zoom lenses without modification. Remote control of lens aperture. Optional preset filter wheel, electronic Image Orbiting and hour meter.

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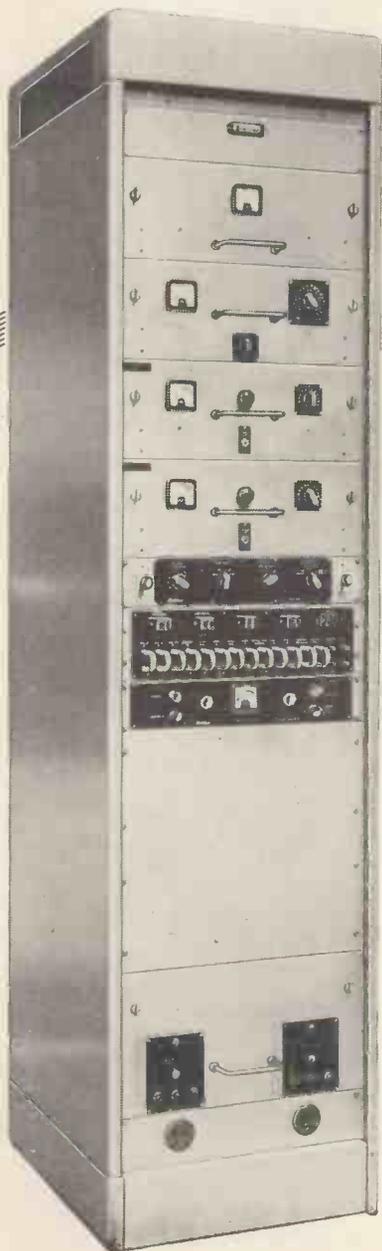


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The latest I.S.B. Drive Unit for long distance international telephone and telegraph circuits currently being supplied to the British Post Office.

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A Manufacturing Company in the Rediffusion Group.



This is the smallest 'spindle operated' moulded carbon track potentiometer in production. Although it measures only $\frac{1}{2}$ " diameter, it is rated at $\frac{1}{4}$ W and the range of values is from $1k\Omega$ to $2.5 M\Omega$.

These factors will commend the Type L to all those design engineers who strive for greater miniaturisation in electronic equipment.

Further constructional details and parameters are contained in Plessey Publication No. 313.

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type L potentiometer

by **Plessey**

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Model W.V.A.

TAPE RECORDERS

The W.V.A. tape recorder now has provision for Stereo plug in heads to enable this recorder to replay Stereo. The regular models are retained with additions and improvements. Our high standard which has made these recorders famous has been maintained, resulting in their being chosen for the foremost musical centre in this country.

30/50 WATT AMPLIFIER

Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than -85 dB referred to 30 watt.

It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.



ELECTRONIC MIXER/AMPLIFIER

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

Size 18 x 7½ x 9½in. deep.

Price of standard model £49.

Also 3-way mixers and Peak Programme Meters.

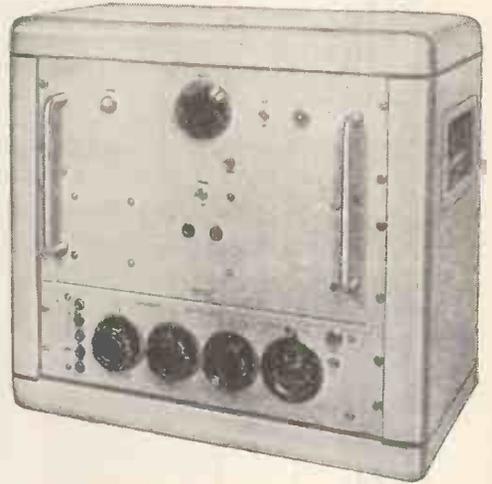
4-way mixers.

12-way mixers, and 2 x 5-way stereo mixers with outputs for echo chambers, etc. Details on request.

Vortexion

quality equipment

120/200 WATT AMPLIFIER



Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level -95 dB. A floating series parallel output is provided for 100-120 V. or 200-250 V. and this cool running amplifier occupies 12¼ inches of standard rack space by 11 inches deep. Weight 60lb.



Full details and prices of the above on request

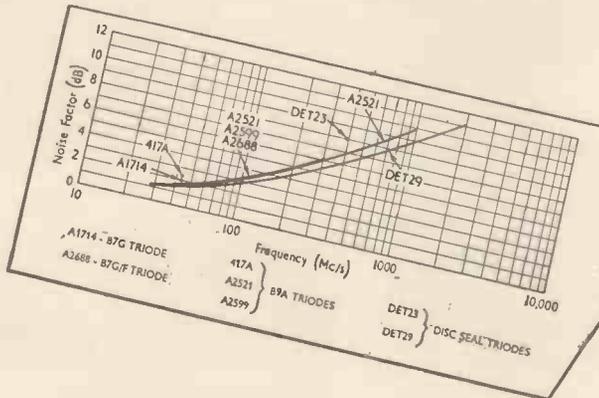
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For over twenty five years we have devoted our activities exclusively to the design and manufacture of Hi-Fi equipment. We were the first manufacturers in the world to design and market amplifiers with a distortion content as low as 0.1%.

This technical lead resulted in a demand for LEAK amplifiers from professional engineers in the B.B.C. (over 500 delivered), the South African Broadcasting Corporation (600), ITV and many other Commonwealth and Overseas broadcasting and TV systems, who use them for transmitting and/or monitoring broadcasts. Also, many gramophone records are cut via LEAK Amplifiers. This acceptance by professional engineers led to a demand from music-lovers throughout the world.

The concentrating of our resources exclusively on Hi-Fi equipment and our world-wide market enables us to offer the best equipment at the lowest prices.

The New "Varislope Stereo"

The New "Varislope Stereo" pre-amplifier incorporates facilities which make it the most comprehensive pre-amplifier presently available.

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**TL/12 PLUS ●
POWER AMPLIFIER**

**SOUTHDOWN ●
CABINET**

TOTAL

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AMPLIFIER**

● **STEREO 20
POWER
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● **SOUTHDOWN
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Piezomagnetic Ferrites

The current September issue of **ELECTRONIC TECHNOLOGY** includes an article which surveys the post-war development of piezomagnetic ferrite materials. In this details are given of the electromechanical properties of these newly developed piezomagnetic ferrites and also the acoustic design of complete ferrite transducers. Various potential applications of ferrites in electroacoustic transducer systems and in electrical and mechanical band-pass filters are included.

ARTICLES

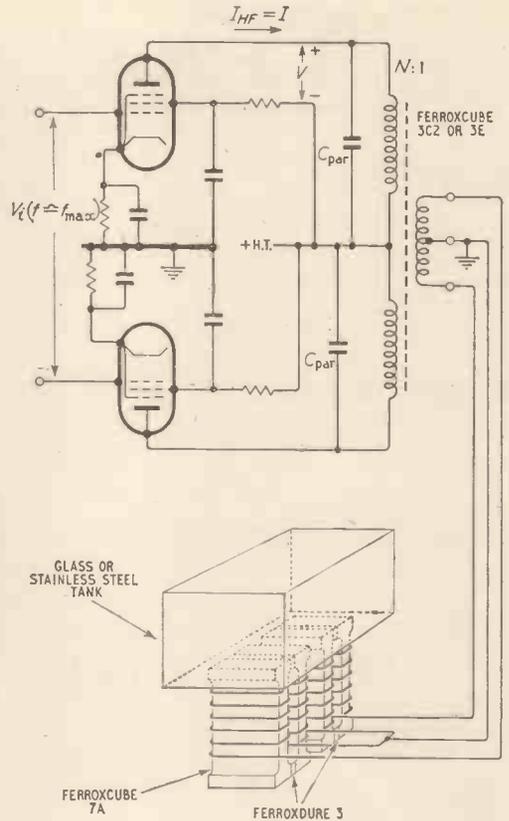
IN THE OCTOBER ISSUE INCLUDE:

SYNCHRONOUS DEMODULATOR FOR TELEVISION

This article describes the design and construction of an instrument which will enable measurements to be made on a vestigial-sideband television system and which provides high-quality monitoring facilities during the normal programme transmission.

PRECISION CRYSTAL CHRONOMETER

An instrument designed to fill the gap between conventional mechanical clocks and the caesium or ammonia maser equipment is described in this article. The author discusses design factors, particularly those affecting the stability of the master oscillator. Circuit details are given of a transistor crystal oscillator which incorporates a thermally-sensitive network for temperature compensation of the oscillator frequency.



ELECTRONIC TECHNOLOGY covers all technical interests in electronics, using this word in its widest possible sense. All the familiar features of ELECTRONIC & RADIO ENGINEER are retained, including, of course, the well-known Abstracts and References section. Regular readership will keep you in constant touch with progress in the entire field.



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Stop your drill or other appliances interfering with your or your neighbours' radio or television. Simple instructions given. 1/6 each. 12/- dozen.

Band III Converters

Suitable Wales, London, Midlands, 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.



Transistor Set Cabinet

Very modern chrome cabinet, size 8 1/2 x 3 x 1 1/2 in. with chrome handle, tuning knob and scale. Price 7/6, plus 1/6 postage and packing.

Cine Cameras

18 mm. motorised (24 V. A.C.) for 16 frames per second, contains film 1/8.5 triple anastigmatic lens and spool to carry 25ft. of film—probable cost around £150, brand new and in sealed carton £8/10/- or 20/- deposit and 13 fortnightly payments of 10/- . Post and insurance 3/6.

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OV1111 14 kV., Peak 350 mA... 7 6

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Philips AG2009 Record Player, 4 speed. Ideal for the enthusiast. Pick-up arm wire, for stereo, fine adjustment on all four speeds. Continuously variable pick-up weight (3-12 gms). Supplied with Philips Hi-Fi crystal head, type AG3019 for micro-groove and 78 r.p.m. Frequency response 30-15,000 c/s. Pick-up lifting and lowering device. Individually balanced heavy turntable. Muting switch. Can be used with any amplifier or radio set. Complete with mono-aural pick-up, £10/10/- or 2 gns. Deposit with 20 fortnightly payments of 10/- . Available also with stereo head, diamond or sapphire stylus. Prices on request. TRANSCRIPTIONISED.



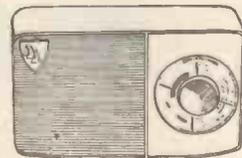
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Components Would Cost More

Car Battery Charger—ready-made high output battery charger in stove enamelled sheet steel, louvered 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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Results Guaranteed. Nothing can be more disappointing than to find that despite care in making up, your little radio just will not work. This is unlikely to happen with our kits, but if it does send it in for service, we guarantee good results.

Two Models. Pocket 3 for strong signal areas, uses two transistors and one diode, 27/6.

Pocket 4 uses three transistors and one diode and has refinements for receiving weak stations, price 42/6. Every kit complete to last nut and bolt, with proper case, tuning condenser and miniature loudspeaker. Our kits do not need external aerial also they may be built in stages to car radio output. Post and insurance 2/6.

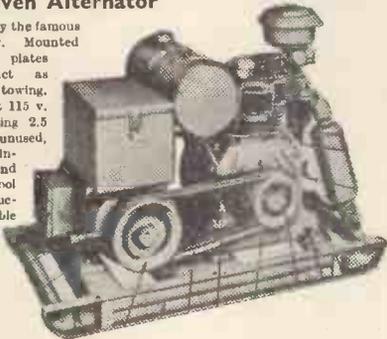
Motor Snip

Miniature motor 2 1/2 in. long x 1 1/2 in. diam. laminated poles and armature, separate winding for reversing. Operates off 20-30 v. D.C. or off A.C. mains through step-down transformer. Original cost at least £3 each. Snip price for one month only 8/6. Plus 1/6 postage and insurance.



Petrol Driven Alternator

American made by the famous ONAN Company. Mounted on heavy bed plates which also act as skids for towing. Generator output 115 v. 60 cycles. Rating 2.5 K.W. These are unused, complete with instruction book and spares, but no tool kit. £45. Instruction books available separately, price 10/-.



Component Storage Drawers

Stout board construction these drawers are ideal for small parts. Supplied complete with simple erection instructions. 1/6 each or 12 drawers each 6 x 2 1/2 x 6 1/2 in., 13/6, post 2/-.



SPECIAL THIS MONTH—

Sub-miniature electrolytics for transistor sets 1 mfd. 18 v. 2.5 mfd. 6 v. 8 mfd. 6 v. 5 mfd. 12 1/2 v. 10 mfd. 6 v. 25 mfd. 6 v. 30 mfd. 3 v. 50 mfd. 3 v. All 1/2 each. Transistor ferrite rod aerial with medium and long wave coils with circuit. Price 7/6. Oscillator Coil and set of 3 I.F. transformers for transistor set with circuit. Price 23/6. Midget 3in. P.M. Loudspeaker for transistor set. 9 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 OCT8, 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 3in. spindle for transistor of Crystal set, 3/8, ditto with spindle tapped 6BA. 4/- . Transistors tested suitable as mixers, 9/6 each. Suitable as I.F. amplifiers 8/6. Suitable for B.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 3/8, 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, 485 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. Dugby 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 1/2-mile on drum. Price 7/6 (3/6 carriage). Wire Joiner (welder for 28 gauge or thinner), in bakelite case with trigger switch, works off step-down transformer. Price 2/6. Philips Trimmer, 0-30 pF. Price 9d. or 7/6 dozen. 878 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 expensive valve. Price 3/0. Multi-speed Motor with gearbox works on A.C./D.C. mains, gives any speed from 1 r.p.m. Price 17/6 (2/6 postage). 5 amp. 12 v. full-wave Charger Rectifier. Normal price 17/6. Price 10/- . Filament Transformer, 6.3 v. 1 1/2 amps. Normally 8/6. Price 6/6 plus 1/- post. 250-0-250 60/60 mA. Mains Transformer, with 6.3 v. filament winding, half-bridged, drop through, standard replacement in many receivers, made to sell at 19/6. Price 13/6 plus 2/6 post and ins. Dittc with additional 5 v. winding for rectifier. Price 14/6 plus 2/6 post and ins. O.R.D.E.R.S over £2 post free except for heavy items where postage or carriage is mentioned specially.

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Single and 2-gang types available, standard size with good length spindles, all new and brand new. Price 17/6 (2/6 postage). 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 1 meg.+1 meg., 2 meg.+2 meg.

Heavy Duty Thyatron

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/-.

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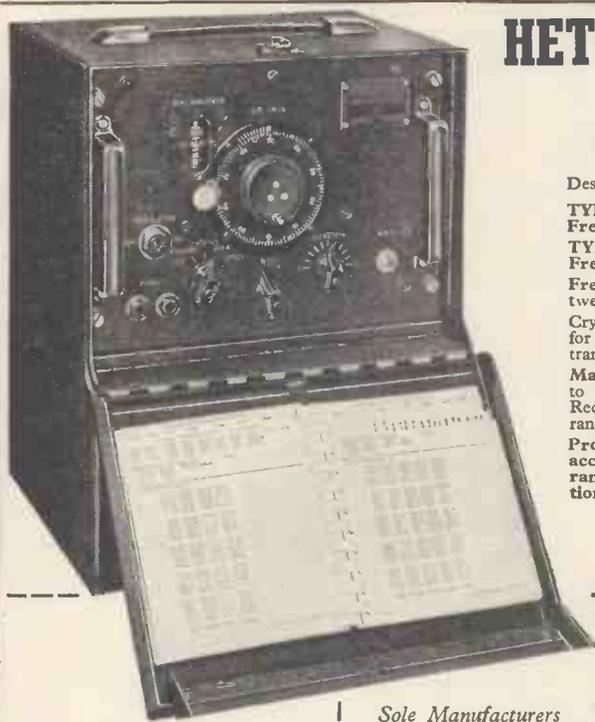
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Makers of High Voltage Test Sets and other Electronic Equipment for H.M. Government.

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BRITISH MANUFACTURED

Designed and built to rigid services specifications.

TYPE T75.

Frequency Range: 85 to 1,000 megacycles.

TYPE T74.

Frequency Range: 20 to 250 megacycles.

Frequency calibration accuracy: .002% at 25° C. (or .01% between -20° C. to +70° C.).

Crystal-controlled, portable heterodyne-type Frequency Meters used for Field testing and measurement of pulsed, modulated, or C.W.R.F. transmitters, receivers and signal-generators.

Mains Operated Power Unit available as optional extra and designed to fit into the battery compartment.

Reconditioned and calibration-checked B.C.221 Frequency Meters, range 125 Kc/s to 20 Mc/s, still available.

Provisional specifications on a new wide-range, very high accuracy Frequency Meter and also an instrument covering the range 100 Kc/s to 1,000 Mc/s (higher under favourable conditions) available on request.

Telemax

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Complete Specifications on application to:-

Sole Manufacturers

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Vortexion W.V.A.	£93 13 0	\$267
Vortexion W.V.B.	£110 3 0	\$315
Brenell Mk. V.	64 gns.	\$192
Brenell 3 Star Stereo	89 gns.	\$267
Cossor 1601 4 Tr.	37 gns.	\$75
Cossor 1602 4 Tr. 3 spd.	59 gns.	\$127
Simon Minstrelle	39 gns.	\$111
Ferrogaph 4AN	81 gns.	\$243
Ferrogaph 4AH	86 gns.	\$258
Ferrogaph 808 Stereo	105 gns.	\$315
Grundig TK60 Stereo	128 gns.	\$384
Grundig TK55 Stereo	92 gns.	\$276
Grundig TK20 with Mic.	52 gns.	\$156
Grundig TK24	62 gns.	\$186
Grundig TK30	72 gns.	\$216
Philips 4 Track	59 gns.	\$177
Philips 4 Track Stereo	92 gns.	\$276
Philips 4 Track	34 gns.	\$102
Reflectograph 'A' 4 Tr.	95 gns.	\$285
Reflectograph 'B' 4 Tr.	105 gns.	\$315
Stuzzi Magnet	69 gns.	\$207
Stuzzi Tri-corder	75 gns.	\$225

★ DECKS

Wearrite 4A	£36 10 0	\$105
Wearrite 4B	£41 10 0	\$119
Brenell Mk. V	28 gns.	\$84
Brenell Stereo Deck	£33 16 0	\$101
Brenell Pre-Amp. and Amp.	£24 0 0	\$69

Microphones by Lustraphone, Reslo, Acos, Simon Sound, Geloso, etc.

● TAPES BY ALL LEADING MAKERS

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Quad Electrostatic	£52 0 0	\$149
Wharfedale SFB/3	£39 10 0	\$113
Wharfedale Coaxial 12	£25 0 0	\$75
Wharfedale Golden 10	£8 14 11	\$18
Tannoy 12in. Monitor	£30 15 0	\$84
Tannoy 15in. Monitor	£37 10 0	\$102
WB. 1016	£7 12 3	\$16
Goodmans AL.120	£29 10 0	\$84
Goodmans AL.100	£23 10 0	\$67
Goodmans Triaxiom	£25 0 0	\$72
Goodmans 300	£11 5 9	\$32
Goodmans 400	£16 17 0	\$46
Kelly Ribbon Mk. II.	£10 10 0	\$30
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Lenco GL60 Trans. Unit	£28 19 2	\$62
Lenco GL58/R. Stereo P.U.	£29 3 10	\$62
Garrard 301	£22 7 3	\$54
Garrard 4HF/Stereo P.U.	£19 17 7	\$42
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★ AMPLIFIERS & TUNERS

Quad 22-Control Unit	£25 0 0	\$73
Quad II Amplifier	£22 10 0	\$65
Leak Stereo 20 Amp.	£30 9 0	\$87
Leak Point One Pre-Amp.	£21 0 0	\$60

Rogers Junior Stereo	£28 10 0	\$81
Rogers Master Stereo Unit	£35 0 0	\$100
Quad FM Tuner	£28 17 6	\$60
Chapman AM/FM	£29 8 0	\$60

Enquiries for all items by firms mentioned in this advertisement invited.

BINSON "ECHOREC"

is distributed exclusively by Modern Electrics Ltd. (see W.W. Feb. page 92). It is for superimposing controlled echo on to any audio signal. It achieves within the size of a compact, fully portable instrument, effects normally requiring large echo chambers and associated equipment. Three working channels, echo interval is variable, swell and other effects are obtainable.

ABRIDGED DESCRIPTION

- Three inputs and outputs.
- Push-button channel selection for 1, 2 or 3 channels.
- Controls for echo intervals, volume of echo, swell effect, volume level on input channels, etc.
- Complete with fitted carrying case, leads, plugs. A.C. mains.

Professional Discounts

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BINSON "BABY ECHOREC"

Similar to above but for single channel working 80 gns. \$240

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Cables: MODCHAREX, LONDON



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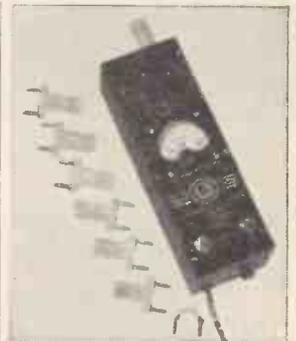
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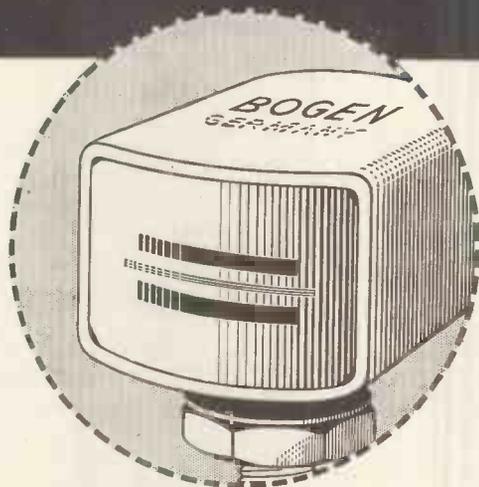
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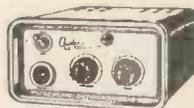
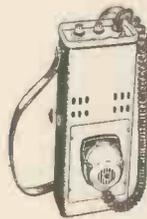
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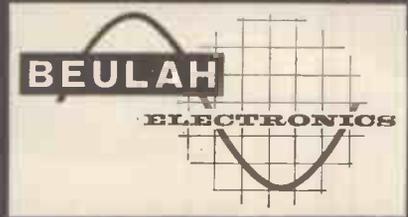
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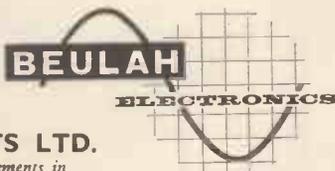
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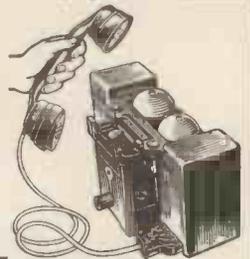
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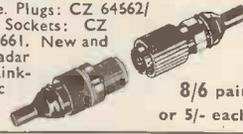
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for full details of these Awards, and how to compete, to the E.E.A. As a writer, or editor, YOU can help to create an increased awareness of Great Britain's leading part in the development of radio, television and electronics, by entering or supporting this competition.



PREMIER RADIO

23 Tottenham Court Rd., London. W.1. Tel: MUSEum 3451/2



THE EASY SIX
6-Transistor Battery Portable
MAY BE BUILT FOR **£9.15.0** plus 3/- p. p.
Ever Ready PP7 Battery Extra 3/3
★ STAR FEATURES: ★ Six 1st grade Mullard Transistors ★ Internal Ferrite Rod Aerial ★ ★ Provision for Car Radio Aerial ★ 5in. Loud-speaker ★ Printed circuit, with component positions indicated ★ Preassembled Dial Assembly ★ 300 milliwatts. Push Pull output ★ Full medium and long waveband coverage ★ Attractive two-tone Blue/Cream Vinylite covered Cabinet, dimensions 8 1/2 in. x 6 1/2 in. x 3 in. ★ Full point-to-point instructions supplied. ★ Weight 3lb with battery.

Assemble it yourself and **SAVE £ £ £'s**

COMPACT GRAM. AMPLIFIER
2-valve printed circuit type for use on A.C. or D.C. 200/250 v. mains incorporating modern miniature valves. Output 2 watts, overall dimensions 6 1/2 x 2 x 3 1/2 in.
Price 59/6, plus P. & P. 2/6.
Amplifier Cabinet, £2/19/6, plus 5/- P. & P.
7 x 4 in. Elliptical Speaker, £1/1/6, plus 1/6 P. & P.
Latest-type Collaro Conquest 4-sp. Changer, £7/19/6, plus 5/- P. & P.
If all the above items are purchased at the same time they can be supplied at £13/15/-, plus 10/- P. & P.



TAKE ADVANTAGE OF THESE... DRAMATIC PRICE REDUCTIONS

AVANTIC DL7/35 Power Amplifier. Specifications: power output 54 watts peak; L.S. impedance 4, 8 or 16 ohms, power inputs 105-250 v. Valve line-up GZ34, 2-EL34, ECC83, EF86. Dimensions 14 1/2 x 9 x 8 1/2 in. Original price 30 gns. P & P. 12/6. **OUR PRICE £16/19/6.**

AVANTIC SP21. Stereophonic Pre-amp Control Unit. Brief specifications, 6 inputs for each channel, bass, treble, volume control, on/off stereo/3D/reverse stereo switch, stereo phase switch, low pass filter. Power requirements 6.3 v. at 1.3 A., A.C. 350 v. at 5 mA. D.C. Dimensions 14 1/2 x 9 x 4 in. Original price £28/10/-. P. & P. 7/6. **OUR PRICE £16/19/6.**

AVANTIC STEP11. Stereophonic Magnetic Pick-up Amplifier Unit. Price £4/4/-.

AVANTIC SP11 Stereophonic Amplifier. Technical details: power output (each channel) 10 watts peak, L.S. impedance, 4, 8 and 16 ohms 6-position input selector, bass, treble, volume on/off controls, stereo reverse switch, phase reverse switch, stereo balance control, P.U. balance control. Dimensions 14 1/2 x 8 1/2 x 4 in. Original price 28 Gns. P. & P. 7/6. **OUR PRICE 19 Gns.**

AVANTIC PL621 20-watt monaural Amplifier, frequency response 10 cfs.-30 Kcfs. 1bB. L.S. impedance, 4, 8 or 16 ohms. Dimensions 14 in. x 8 1/2 in. x 7 1/2 in. Original price 29 Gns. P. & P. 7/6. **OUR PRICE 19 Gns.**

AVANTIC STEP21. Stereophonic Tape Pre-Amplifier Unit. Price £4/4/-.

All this equipment is Brand New and in manufacturers' original sealed cartons. Full descriptive literature available.



THE Petite PORTABLE
MAY BE BUILT FOR **£7.7.0** P. & P. 3/-

- Batteries extra.
H.T. 10/- (Type B126) or equivalent.
L/T 1/6 (Type AD 35) or equivalent.
● High Q frame aerials.
● High sensitivity on both wavebands.
● Medium and long wave superhet circuit.
● Instruction book 1/6.
● Size only 8 x 8 x 4 1/2 in.
● Weight: Including batteries 5 1/2 lb. ● 4 valves of the economy type.

WHY NOT TAKE ADVANTAGE OF THIS WONDERFUL OFFER!

Two DL7/35 POWER AMPLIFIERS. Combined Price **£14.14.6**
SP21/2 STEREO CONTROL UNIT. **47 Gns.**

A SIX TRANSISTOR POCKET RECEIVER

complete with Earpiece and Plastic case, **£14.14.6** Battery extra 2/6. Plus 2/- P. & P.
This amazing Receiver is so small that it will fit snugly into a shirt pocket or ladies' handbag, size being only 4 x 2 1/2 x 1 1/2 in. Ferrite Rod Aerial is used, full station selectivity on medium wave band.



PREMIER BATTERY ELIMINATOR
Housed in two containers which are to replace AD 35 and B126 batteries.
KIT 37/6 plus 2/- post and packing. Only suitable for use with DK 96 Series valves.

THE MODEL FMA/1 FERGUSON FM TUNER

13 gns plus 3/- p. & p.
This Tuner has been designed for use with Radio Receivers or Hi-Fi equipment. The Unit is completely self-contained being self-powered and housed in a hammered metal finished steel case, measurements 10 x 7 1/2 x 2 1/2 in. Brief technical specifications: Frequency coverage 87.6-100 Mc/s (continuously). Valve line-up: 2-6F80, EC980, 2 germanium diodes and metal rectifier, for operation on A.C. mains 200/250 v. 50-60 cycles.



WHY NOT DO IT YOURSELF!

SUPERHET may be built for **£7.7.0** Plus 3/- p. & p.
T.R.F. may be built for **£5.10.0** Plus 3/- p. & p.

These two receivers use the latest type circuitry and are fitted into attractive cabinets 12 x 6 1/2 x 5 1/2 in., in either walnut or ivory Bakelite or wood 1/- extra. Individual instruction books 1/- each, post free.



THE 'CLARION'

Transistorised miniature battery-operated **TAPE RECORDER**
★ Completely transistorised circuit.
★ Constant governed speed of 3 1/2 I.P.S.
★ Recordings interchangeable with other recorders.
★ Remarkable reproduction on both speech and music.
Price complete with Microphone **25 GNS.** plus 5/- P. & P.

FOR THE BEGINNER

A two-transistor, medium wave, receiver, ideally suited for the young enthusiast or the beginner. Incorporating two transistors and one diode and operating on two pen torch batteries.
Simple to construct, with full instructions supplied. No headphones required.
Complete set of components, including plastic case. **22/6** plus 1/6 P. & P. Batteries extra.



THE MODEL VT41 VALVE FILAMENT TESTER
Will instantly check the filaments of all Radio and T.V. Valves, Fuses and Dial Bulbs. Will also give an accurate circuit continuity test and also has built-in 7 and 9 wire straighteners. Size 5 1/2 x 3 1/2 x 1 1/2 in. with Battery, post paid. **PRICE 30/-**

CABY MODEL B20 MULTI-METER

DC/V 0-0.5 v. 0-2.5 v. (2K.ohms/V)
DC/V 10-50-250-500-1000 v. (4K.ohms/V).
AC/V 10-50-250-500-1kΩ (2kΩ/V)
DC/mA 0-100 microamps (500mV)
DC/mA 0-2.5-25-250mA (250mV)
OHMS 2K-20. meg.
COMPLETE WITH TEST LEADS—
PRICE £6/10/0 plus 2/- P. & P.

CABY MULTI-METER A-10

DC/V 10-50-250-500 1kΩ (2kΩ/V)
AC/V 10-50-250-500-1kΩ (2kΩ/V)
Ranges: DC/mA 0.5-25-250 (250mV)
OHM 0-10 kΩ-1MΩ.
Complete with test leads **£4/10/0** P. & P. 2/6.



THE VICEROY QUALITY CRYSTAL MICROPHONE
A good-quality crystal Microphone for the discerning enthusiast, finished in polished steel with Muting Switch and detachable lead. Price 42/-, P.P. 1/6.

PREMIER RADIO

309 Edgware Rd., London. W.2. Tel: PADington 6963



Visit our large and comprehensive HI-FI showrooms

The 'Carol' TR/1 TAPE RECORDER

(AT A PRICE YOU CAN AFFORD)

INCORPORATING THE NEW B.S.R. TAPE DECK. A Quality Tape Recorder at a price that YOU can afford.

The operation of this Recorder is simplicity itself and the quality in both reproduction and finish, leaves nothing to be desired, the cost being well below present-day prices. Amplifier Controls. On/Off Tone and Volume Controls. Power Output: 3 watts. Overall Size: 13 1/2 x 12 x 8 1/2 in. Weight: 20 lb.

STAR FEATURES: Deck Controls. Record/Playback Switch and rewind switch with interlocking device to prevent accidental erasure. Speed: Single 3 1/2 in. per sec. Playing Time: 5 1/2 in. Standard Tape 1 1/2 hrs. L.P. Tape 2 hrs. 8 mins.

Inputs: Sockets for Microphone, Radio, Gram, etc., with extension Speaker Socket.



PRICE, including Mic., Tape and Spare Spool **Only 19 Gns.** plus 15/- P. & P.

The 'Magnaphon'

A truly top quality and versatile Tape Recorder at a price well below the original cost. Incorporating the latest Collaro 3-speed Studio Tape Deck.

- ★ Volume and Tone Control for recordings.
- ★ Volume and separate Bass and Treble Controls for replay
- ★ Facilities for monitoring.
- ★ Output 4 watts.
- ★ Separate Output Sockets for Amplifier and Extension Speaker.
- ★ Mixing Facilities.
- ★ Housed in attractive red and beige two-tone Cabinet with detachable lid.



★ Fully guaranteed and supplied complete with the following accessories:—

Price £32.0.0

Good quality Crystal Microphone with Lead and Jack Plug fitted, 5 1/2" Reel of Standard Tape and Spare Reel, spare Lead fitted with Jack Plug and Wander Plug for recording from Radio.

Plus 21/- P. & P.

TAPE DECKS

Latest BSR Monardeck. Single speed 3 1/2 i.p.s. Will take 5 1/2 in. spools. £9/19/6. P. & P. 5/-.

Collaro Studio Tape Transcriber. 3 speeds 1 1/2, 3 1/2, 7 1/2 i.p.s. 3 motors. Push-button controls. Will take 7 in. spools. £12 19 6. P. & P. 7/6.

Collaro Mk. 4 Tape Transcriber. Twin track operation. 3 speeds, 3 1/2, 7 1/2, 15 i.p.s. Will take 7 in. spools. £17/19/6. P. & P. 7/6.

Tape Recorder Amplifier, specially designed to match the Collaro Studio Tape Deck. £12/17/6. P. & P. 4/-. Size 11 1/2 x 5 x 3 1/2 in. uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. i.s. jack, superimposing switch, with matching knobs.

RECORDING TAPE

By well-known manufacturers, brand new, boxed and fully guaranteed.

1,800ft. on 7 in. spool 32/6
1,200ft. on 5 1/2 in. spool 22/6
P. & P. 1/- per spool.

AMERICAN RECORDING TAPE

Manufactured by FerroDynamics, brand new and fully guaranteed.

1,200ft. on 7 in. spool 25/-
1,800ft. on 7 in. spool 35/-
600ft. on 5 in. spool 16/-
P. & P. 1/- per spool.

SINGLE PLAYERS

Collaro Junior 4-speed Player, complete with Pick-up £3 15 0

Garrard 4SP 4-speed Player, complete with Pick-up and automatic stop £6 9 6

Garrard TA Mk. 2, 4-speed Player, wired for stereo, with plug-in Head £8 10 0

Philips AG2009, 4-speed Player, with diecast turntable and Microlift, wired for stereo £10 10 0
P. & P. 3/6.

RECORD CHANGERS

BSR UA8, 4-speed £6 19 6

BSR UA8 4-speed with stereo cartridge £7 19 6

BSR UA12, 4-speed, wired for stereo and complete with Stereo cartridge £8 19 6

Collaro Conquest, 4-speed Changer £7 19 6

Collaro RC457, latest type 4-speed changer £8 10 0

Garrard RC111 3-speed Changer £7 19 6

Garrard RC120 Mk. 2, 4-speed £8 19 6

Garrard RC121/4D, 4-speed £9 19 6

Garrard RC121 Mk. 2 4-speed, wired for stereo and with plug-in Head £10 19 6
P. & P. 5/-.

TRANSCRIPTION UNITS

Garrard 301 £22 7 3

Garrard 301 (Strobe turntable) £23 18 4

Garrard 4HF (Stereo) £19 4 8

Garrard 4HF (GC8) £18 9 9
P. & P. 7/6.

STEREO ADAPTOR



Why not convert your Record Player or Radiogram to stereo with this easy to instal Stereo Conversion Unit, complete and ready to instal giving an output of 3 watts.

STEREOPHONIC PICK-UP CARTRIDGES AVAILABLE, 35/- post paid.

PRICE £2.19.6
Plus 2/- P. & P.

The 'Vogue'

A quality tape recorder, at a popular price including microphone, tape and spare spool.

Price 29 gns.

Plus 21/- P. & P.

- ★ Collaro 3-speed Tape Deck.
- ★ Separate Input for Microphone and Gram Recording.
- ★ Separate Volume Controls for recording.
- ★ Volume On/Off and Tone Control for replay.
- ★ 3 watts Output.
- ★ Housed in smart two-tone Blue/Beige Cabinet with detachable Lid.



MULLARD TYPE 5-10 AMPLIFIER

By Well Known Manufacturers

PRICE £13.19.6 plus 2/- P. & P.

A high quality Amplifier and Pre-Amplifier based on the Mullard modified circuit, the Hammer Amplifier is built on a sturdy chassis and both Amplifier and Pre-Amp, are bronze hammer finish. Brief technical details: Valve line-up E281, EP86, ECC83, 2 EL84, output 10 watts, output impedance 15, 7.5 and 4 ohms. Dimensions: Main chassis 10 1/2 x 7 1/2 x 6 in. Dimensions Pre-amp, 10 x 4 1/2 x 3 1/2 in. SEND FOR FULL TECHNICAL DETAILS ON THE ABOVE.

RCA VICE-PRESIDENT 8-10 WATTS PUSH-PULL AMPLIFIER

A compact versatile Amplifier complete with plug-in Power Pack, valve line-up HY90, 2-19A05 and 12AX7, separate bass and treble control, suitable for Speakers of 15 ohms impedance and two 3-ohm tapings for Tweeters. For use on A.C. mains, tapping 110-150 and 210-250 can also be supplied with Power Pack suitable for AC/DC mains. PRICE COMPLETE WITH ESCUTCHEON AND KNOBS, £6/19/6, 3/3 p. & p.

INSTANT BULK TAPE ERASURE

Erase complete Reels of Tape in a matter of seconds. PRICE 27/6 post paid.



MODEL 1629 AM/FM RADIO-GRAM CHASSIS BY FAMOUS MANUFACTURER

PRICE £15.19.6 plus 7/6 p. & p.

Due to a fortunate bulk purchase we are able to offer these exceptionally good quality Radiogram Chassis at this ridiculously low figure. Gram/on/off. Star features of this Chassis are: piano key wavechange, internal Ferrite Rod Aerial for AM and Magic Eye Tuning Indicator, waveband

coverage: Long Wave 1098-2027 metres, Medium Wave 188-547 metres, VHF/FM 87-101 Mc/s. Valve line-up: ECC85, ECH81, EP89, EM81, EABC80, EL84, suitable for use on 200/250 v. A.C. mains. Dimensions 15 1/2 wide, 12 in. high, 4 1/2 in. deep.

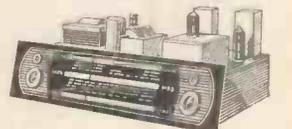
3-WAVEBAND RADIOGRAM CHASSIS

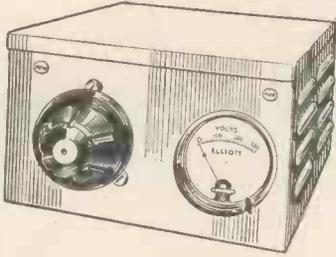
By Famous Manufacturer

£10.19.6 plus 5/- p. & p.

A special offer for a limited period only of this Continental style Radiogram chassis.

Brief details: Long, Medium and Short wavebands covering 1007-1960 metres, 185-555 metres, 16-82 metres. Valve line-up: ECH81, EP89, ECL82. Mains voltage 200/250 v. A.C. Gramophone Pick-up Input. Dimensions 17 1/2 in. long, 5 in. high, 6 in. deep.





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 4 1/2 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/-.

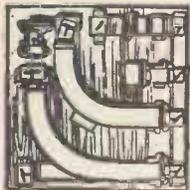
NEW GALVANOMETERS

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.

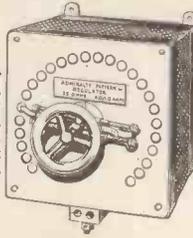


WAVE GUIDE

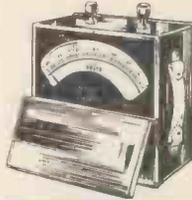
3 cm., mounted on a carrying board consisting of: (1) directional coupler. (2) 90 degree bend. (3) co-ax to waveguide adaptor type N. (4) British to W.916. (5) Co-ax to waveguide adaptor circular flange. (6) Circular to American adaptor. Complete in carrying case with coaxial-cable. Price 60/-, Carr. 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 3 1/2 x 1/2in. 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.

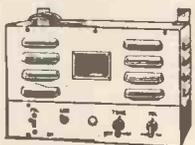
19 INCH RACK MOUNTING 20-WAY P.O. LAMP STRIPS. Price 25/-, P. & P. 2/6.

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/-.

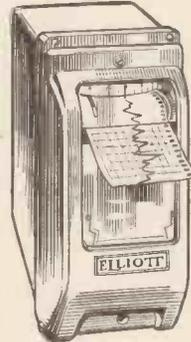
12 v. D.C. AMPLIFIER, as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7 1/2, 15, 62, 100, 250 or 500 ohms. £9/17/6 each. Carr. 15/-.



MIDGET ROTARY TRANSFORMERS. 2 1/2in. dia. x 4 1/2in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 12/6 each. P. & P. 1/6.

VARIABLE VOLTAGE TRANSFORMER

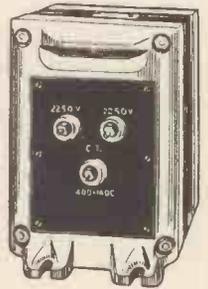
"BERCO." Brand new in manufacturer's boxes. For 110 volt A.C. Input. Constantly variable from 0-135 volts. 2.2 amp. type. £4. P. & P. 3/-, 5 amp. type £6/10/-, P. & P. 3/6.



ELLIOTT SWITCHBOARD MOUNTING PEN RECORDER. 2 1/2in. 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 6 1/2in. 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 5 1/2 x 4 1/2in. 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 7 1/2 x 7 1/2in. Weight 60 lb. Unfilled, uncharged. New. Price £4. Carriage 10/-.

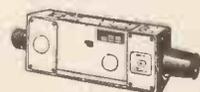


MINIATURE P.M. MOTOR.

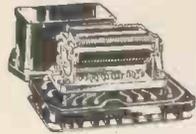
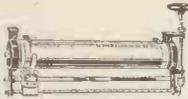
12/24 volt, reversible. 1 1/2in. dia. New. Price 10/6 each. P. & P. 1/-.

AIRCRAFT CINE CAMERA G45B Mk. III

Fully modified, fitted with 1/3.5 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 1 1/4 in. x 6 in., plus handle 6 in., 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 5A4R. Coils 1 x 3200 turns at 100 ohms and 1 x 2000 turns at 145 ohms, 22/6 each. P. & P. 1/-. Bases for same 2/6.



SIEMENS H.S. RELAY. Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C.O. contacts. Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.

Siemens sealed similar relay to above, but 2.2 ohms plus 2.2 ohms. Minus clips, 12/6 each. Plus 1/- P. & P.

SUPERIOR BRAND NEW RELAY. 7,000 ohms coil. Will pull in at 750 microamp, and out at 450 microamp. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2 1/2 oz. Price 18/6. P. & P. 1/-.

MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each. Operating current minimum 140 microamp., nominal 400 microamp., maximum 8 milliamp. One pole two way, or centre stable. Two way contact current 100 mA. at 50 V. A.C. or D.C. Size 1 1/2 x 3/8 x 3/4 in. Price 22/6 each.



G.E.C. SEALED RELAY. Type M.1090. 180 ohms coil. 6/12 volt. 4 C/O. Brand new, 18/-. P. & P. 1/-.

G.E.C. SEALED RELAY. Type M.1092. 680 ohms coil. 12/24 volt. 4 C/O. Ex new equipment. Unused. 10/-. P. & P. 1/-.

G.P.O. 600 TYPE RELAY. 400 ohms coil. 24 volt. 2 C/O plus 2 M. New 7/6. P. & P. 1/-.

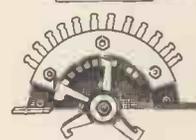
MINIATURE OPEN TYPE RELAY. 700 ohms coil. 24 volt. 2 C/O. Ex new equipment. Unused. 7/6. P. & P. 1/-.

ROTARY RELAY. 12 volt. Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price 7/6. P. & P. 1/6.



MINIATURE 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.

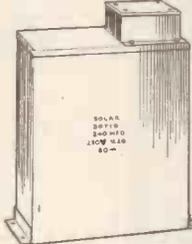


HIGHLY PRECISION MADE GEARED MOTOR BY DRAYTON REGULATOR CO., for 230 volt 50 cycles S.P. A.C.

TYPE R.Q.R., reversible. 37 r.p.m., overall size 5 in. x 4 in. x 5 1/2 in. Weight 4 1/2 lb. Ex. brand new equipment. Unused. Price £3/17/6. P. & P. 3/-.

SOLAR OIL-FILLED CONDENSER. 240 mfd. for 230 W. V.A.C.

Overall size 1 1/4 in. x 9 in. x 5 1/2 in. plus feet. Weight 46 lb. Brand new. Guaranteed perfect. Manufacturer's packing. Price £7/10/-. carriage 10/-.



DIAL THERMOMETER.

Made by Short & Mason. Calibrated 0-160 degrees Fahrenheit. 4 1/2 in. dial. 6 in. rim for flush mounting with 6 in. 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 ADMIRALTY HEAD AND BREAD SETS.

Two such sets connected up will provide perfect intercom., no batteries required. Will operate up to 1/2 mile. Original manufacturer's boxes. Price 17/6 each, plus P. & P. 2/-; or 32/6 per pair. P. & P. 3/-.



MINIATURE INSTRUMENT RECTIFIERS. Bridge Type 1 milliamp. Guaranteed perfect, 7/6 each.

S.T.C. RECTIFIER. 36 plates by 120 mm. Bridge connected. Maximum A.C. input 60 volt, D.C. output 15 amp. New, perfect. Price 60/-. P. & P. 3/6.

8-day clockwork Time Switch. Contacts 2 1/2 amp., 230 volt, 24 hour phase, 1/2 hour divisions, allow setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.



METERS GUARANTEED PERFECT

Charging Types	
2 1/2 amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2 1/2 in. fl. rnd.	11/6
7 1/2 amp. D.C. M.I. 3 1/2 in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2 1/2 in. fl. rnd.	6/6
15 amp. D.C. M.C. 2in. rnd.	10/6
30 amp. D.C. M.C. 2in. fl. sq.	12/6
100 amp. A.C. M.I. 4 1/2 in. fl. rnd.	32/6
Voltmeters	
12 v. D.C. M.C. 2 1/2 in. proj. rnd.	8/6
20 v. D.C. M.C. 2in. fl. sq.	9/6
25 v. D.C. M.C. 2in. fl. rnd.	7/6
30 v. M.I. 3in. proj. rnd.	10/6
40 v. M.C. 2in. fl. sq.	9/6
300 v. A.C. M.C. 2 1/2 in. fl. rnd.	27/6
300 v. A.C. M.I. 2 1/2 in. fl. rnd.	22/-
400 v. A.C. M.I. 4 1/2 in. rnd.	35/-
Milliammeters	
1 mA. M.C. 2 1/2 in. fl. rnd.	25/-
200 mA. M.C. 2 1/2 in. fl. rnd.	12/6
500 mA. M.C. 2 1/2 in. fl. rnd.	9/6
Microamp	
50 microamp., scaled 0-100, M.C. 2 1/2 in. fl. rnd.	42/6
50 microA. 2 1/2 in. square, side fitting scales	35/-
500 microamp., M.C. 2 1/2 in. rnd. F.L. scaled 15/600 volt.	16/6
Postage on all meters 1/- each.	

Miniature latest type moving coil 0-5 milliamp meter, 1 1/2 in. 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.



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R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only
Can be assembled in ½ hour.

25 ½ GNS. Carr. 17/6.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR, THE LINEAR L45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 x 4in. LOUDSPEAKER, Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 16x13x9in., finished in two-tone rexine, and connection diagram for wiring amplifier to transcriptor.

FEATURES INCLUDE

★ 3 SPEEDS ★ FREQUENCY RESPONSE 60-11,000 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.

OR DEPOSIT £5/7/6 and 12 monthly payments of 42/-.
Cash price if settled in 3 months.



HI-FI 10 WATT AMPLIFIERS 6 GNS.

BRAND NEW BUT IN SLIGHTLY SOILED CONDITION

Carr. 7/6

A REMARKABLE OPPORTUNITY
Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mke 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 (especially suitable for use with any of our Amplifiers). A Triode Heptode F/Changer is used. Pentode L.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. Bend S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

RE-ENTRANT LOUDSPEAKERS

For factory or outdoor use.
Tannoy 7.5 ohms 8 watts 25/9.
Parneko horn type, highly efficient. Handles up to 10 watts. 15 ohm and 200 ohm matching 59/6.
R.C.A. 20 watt rating 3 ohm, 15 ohm 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 x 4½ x 2½in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.

Type BM2. Size 8 x 5½ x 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 3½in. 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, 6SF6, 6FG 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. 6in. 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. Gauged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves E281, EC033, EC033, BCL44, 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, gauged volume, gauged treble, gauged bass, and balance. Outputs for 3 ohm speakers. Point-to-Point wiring diagrams and instructions. Carr. 7/9.

SELENIUM RECTIFIERS

We can quote special prices for quantities of 12 to 10,000 of most types. Special types made to order.

L.T. Types	H.T. Types E.W.
2/9 v. 1 a. h.w. 1/9	250 v. 50 mA. 3/9
6/12 v. 1 a. 4 w. 2/9	250 v. 50 mA. 3/11
Following F.W. (Bridge)	250 v. 60 mA. 4/11
6/12 v. 1 a. 3/11	250 v. 80 mA. 6/11
6/12 v. 2 a. 8/11	250 v. 250 mA. 12/9
6/12 v. 3 a. 9/9	
6/12 v. 4 a. 12/3	Contact Cooled
6/12 v. 5 a. 14/6	250 v. 80 mA. 6/11
6/12 v. 6 a. 15/6	250 v. 75 mA. 10/11
6/12 v. 10 a. 25/9	F.W. (Bridge)
6/12 v. 15 a. 35/9	

JUNCTION TRANSISTORS, R.F. Type 11/6. Audio type 5/9. Power type Galtop V15/40P 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. Batrd 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 1½, 3½, 7½ in. 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.

ASSEMBLED CHARGERS

6 v. 1 a.	19/9
6 v. 2 a.	29/9
6/12 v. 1 a.	29/9
6/12 v. 2 a.	38/9

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. & pkg. 3/6.

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.	
0-9-15 v. 1 a.	12/9
0-9-15 v. 2 a.	15/9
0-9-15 v. 3 a.	16/9
0-9-15 v. 5 a.	19/9
0-9-15 v. 6 a.	23/9

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.

6 v. or 12 v. 1 amp.	24/9
As above, with ammeter.	32/9
6 v. or 12 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 2 amps.	42/9
(inclusive of ammeter)	
6 v. or 12 v. 4 amps.	53/9
6 v. or 12 v. 4 amps. with variable charge rate selector and ammeter.	59/9

CHARGER AMMETERS

0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp. 8/9

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/9. **49/9**
As above, but for 3 amp. charging. Only 59/6. Carr. 3/9.

ASSEMBLED 6 v. or 12 v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 5/- Or Deposit 13/3
5 monthly payments of 13/3. As above, but for 6 amp. charging 4 GNS. Carr. 5/-. Or Deposit 18/- and 5 monthly payments of 16/-. The 6 amp. model only is slightly store soiled and is being offered at well below usual price

LINEAR L45 MINIATURE 4/5 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 2½ ohm speaker. Three miniature Mullard valves. Size only 6x5x5½in. 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. x 4in. speaker, Long and Medium waves. Size approx. 7 x 4 x 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 Window 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 x 4in. R.A. Elliptical 19/9. 6in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 25/9. 8 x 6in. Elac. with high flux magnet 25/9. 10in. R.A. 28/9. 10 x 6in. Elliptical Goodmans 28/9. 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, EOC38, 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 simple tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams. **OR Factory built with 12 months' guarantee £13/19/6. TERMS ONLY 11 Gns. ON ASSEMBLED UNITS. DEPOSIT 24/9 and 12 monthly payments of 24/9.**

Carr. 10/-
Cover as illustrated
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 12x9x8in. approx. Power consumption 350 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. 60 c.p.s. A.C. mains. Overall size only 1 1/2 x 2 1/2 in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 5/9/6.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER. Spec. exactly as A5 below with exception of output wattage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 7/6.

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 millivolt input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record 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 attractive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only 24/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.



R.S.C. TRANSFORMERS Fully Guaranteed, Interleaved & Impregnated. **WE CAN QUOTE FOR SPECIAL OR STANDARD TYPES IN ANY QUANTITY. OUR FACTORY HEAD SUPPLIED LEADING EQUIPMENT MANUFACTURERS AND GOVT. DEPTS. FOR 15 YEARS.**

MAINS TRANSFORMERS, Primaries 200-230-250 v. 50 c/s.		OUTPUT TRANSFORMERS	
FULLY SHROUDED UPRIGHT MOUNTING.		Midget Battery Pentode	
250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., 2 1/2-3-3in.	17/11	6B: 1 for 354, etc.	3/9
250-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9	Small Pentode 5,000Ω to 3Ω	3/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9	Standard Pentode 5,000Ω to 3Ω	5/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9	Standard Pentode 8,000Ω to 3Ω	5/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t. 5 v. 3 a.	49/9	Push-pull 8 watts 6V6 to 3 ohms	5/9
TOP SHROUDED DROP-THROUGH TYPE		Push-pull 10-12 watts 6V6 to 3 or 15 ohms	8/9
250-0-280 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a., 2 1/2-3-2 1/2in. 16/11		Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω	15/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9	Push-pull EL84 to 3 or 15 ohms	17/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9	Push-pull Ultra Linear for Mullard 510	27/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9	Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., for 3 or 15 ohms	23/9
300-0-300 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9	Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9	MICROPHONE TRANSFORMERS	
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9	120:1 High quality clamped	6/9
ELIMINATOR TRANSFORMERS.		120:1 High quality Mu metal screened	8/9
120 v. 40 mA., 5-0-5 v. 1 a.	14/9	SMOOTHING CHOKES	
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11	250 mA., 5 H., 100 Ω 11/9	80 mA., 10 H., 350 Ω 5/6
FILAMENT TRANSFORMERS		150 mA., 7-10 H., 250 Ω 11/9	60 mA., 10 H., 400 Ω 4/11
6.3 v. 1.5 a.	5/9	100 mA., 10 H., 200 Ω 8/9	1 amp., 0.5 Ω L.T. type 6/6
6.3 v. 2 a.	7/6	PARMEKO MAINS TRANSFORMERS. Fully shrouded.	
0-4-6.3 v. 2 a.	7/9	500-0-500 v. 120 mA., 6.3 v. 4 a. 5 v. 3 a.	31/9
0-4-6.3 v. 2 a.	7/9		
AUTO (Step Up/Step Down) TRANSFORMERS			
50-80 watts 110-120 v./230-250 v.	11/9		

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 Brunel Street (Market St.), Manchester, 2.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram, as in A10 High sensitivity. Includes 5 valves: EOC38, EOC38, 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. 30-20,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. ONLY 25 millivolt INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. **FOR STANDARD or LONG PLAYING RECORDS. FOR MUSICAL INSTRUMENTS** such as STRING BASS, GUITARS, etc. **OUTPUT SOCKET** with plug provides 300 v. 30 mA and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx.: 12.9x7in. For A.C. mains 200-250 v. 60 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last unit. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra.) **ONLY 8 Gns. 10/-** If required lourred 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. 14x14x7in.) Finished in eggshell Poliorcine and fitted carrying handle.

£8/19/6 Carr. 7/6. Or Deposit £1 and nine monthly payments £1. Send S.A.E. for leaflet.

aprox. 18x18x8in. 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 stylus. 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 8 ohms or 15 ohms. Only 24/19/6. 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 x 18 x 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.B. Ful-Fi 19/9. Garrard GC2 19/9. Acos Stereo/Monaural 49/9.	
ACOS HIGH FIDELITY PICKUPS. GP54 with HGP59/52 Cartridge. Turnover sapphire stylus, 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



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.

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With large square aluminium cooling fins. 24 v. 15 amp. F.W. (Bridge). Limited number. 29/11.

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Oak and Wearite, synchronous 7-pin, 2 v. 7/9. 6 v. 8/3. 12 v. 4-pin non-synchronous 7/9.

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All 200-250 v. 50 c/s. input.
Fr. 0-110-200-230-250 v., 275-0-275 v. 100 mA., 6.3 v. 7 a. 5 v. 3 a. 22/9
250 v. 60 mA. 6.3 v. 2 a. 10/11
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Carr. 7/6. 50 watts, 0-110/120-230/250 v. 8/11

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80 mA. 20 h. 900 ohms. 5/11
100 mA. 5 h. 100 ohms. 3/11
100 mA. 10 h. 100 ohms. 8/9
150 mA. 10 h. 100 ohms. 10/11
120 mA. 12 h. 100 ohms. 9/9
200 mA. 5-10 h. 100 ohms. 11/9
250 mA. 5 h. 50 ohms. 10/9

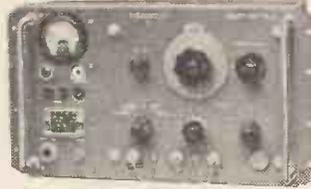
GARRARD RECORD PLAYING UNITS

Dry battery operated. Consisting of motor, turntable and pick-up. For standard 45 r.p.m. records. Only 29/19/6.

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Well ventilated, black crackle finished, undrilled cover. Size 14x10x8 1/2 in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

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8.9 to 300 megacycles. Output 1 micro-volt to 10 millivolts. Five position switched attenuator. Variable multiplier 1 to 10, calibrated 0-20 db. C.W. square wave and sine wave outputs. Vernier tuned, 5 Band Coil Turret, Potted "C" core Transformers Stabilised H.T. All voltage supplies including mains, R.F. filtered. External mod. by sine wave from 50 c.p.s. to 10 kc/s. or pulses down to 1/4 sec. Complete with all valves and charts.

SUITABLE FOR ALIGNING T.V. and V.H.F. RADIO. For 200-250 v. A.C. mains. Beautifully made to very high standards. Worth over £100. Very 17 Carr. 15/- limited number available at only 9 GNS. Or on H.P. terms.

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500 Micro-amp. Scaled in Decibels. Diameter 3 1/2 in. Flush mounting. 59/6
250-0-250 Micro-amp. Diameter 2 in. 14/9
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METER RECTIFIERS 0-5 mA. 15/6

VOLTMETERS

0-300 v. A.C., 50 c.p.s. Diameter 2 1/2 in. approx. M.I. Only 16/9

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Ferranti. Universal (A.C. and D.C.). Complete in carrying case with leads. 59/6

V.H.F./F.M. A.M. 4 WAVEBAND RADIO RECEIVERS

Complete in beautiful veneered Walnut Cabinet. Covers normal Short, Medium and Long wavebands, plus V.H.F. Brand new and covered by usual 12 month guarantee. For 200-250 v. 50 c.p.s. A.C. mains. 12 1/2 Carr. 10/- GNS.

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Operates with two 4.5 v. Dry batteries which last for months under normal conditions. Plays 45 r.p.m. records at ample output level. Ideal for picnics, etc. Attractive two-tone Rexine covered cabinet. Limited number. Brand new, guaranteed, at only 9 Carr. 5/6 half list price.

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Complete including bell. Suitable for office, warehouse, factory or outdoor communication. Operate with small dry battery lasting many months. Supplied complete in wooden carrying case. Only 59/6 Carr. 5/- each.

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THERMOSTATS A.C. 250 v. 15 AMP. 1 1/2 in. stem. Adjustable from 100-190 degrees F. Complete with sleeve, 22/6. p.p. 2/6.

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NIFE ALKALINE BATTERIES 6 VOLT 75 A.H. TYPE LRT SUITABLE FOR ENGINE STARTING
Five 1.2 v. cells crated and connected to give 6 v. Brand new and fully guaranteed. Size of crate 5 1/2 x 12 x 6 1/2 in. £7/10/-, Carr. 15/-.

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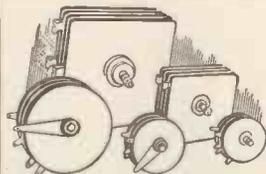
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- MT1** Standard, Primary 200/250v., Secondary 250v.-0-250v. @ 80m.a., 6.3v. @ 4a tapped 4v. and 5v. @ 2a tapped 4v.21/9 each.
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Alpha Range of Guaranteed Bridge Rectifiers suitable for Battery Chargers 6 and 12 volt output:

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Solves your Problems with Speed and Accuracy.

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Resistance ohm: 10K ohms. 1 megohm.

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Includes metal chassis, headphones, battery, valve and all other parts. An ideal set for the beginner. Can be easily modified at a later date for output and speaker. Price 45/- each. Envelope with full details 9d.

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Acos Mic 39/1. Crystal Stick Microphones for use as a hand, desk or floor stand unit for high quality recording, broadcasting and public address work. List Price £5/5/- OUR PRICE 39/6. With table stand 47/6. With floor stand adaptor 52/6. Postage 1/6.

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COLLARO STUDIO TAPE TRANSCRIBTOR

3 motors, 3-speed 1½, 3½, 7½ i.p.s., takes 7in. spool. Push button controls. PRICE £15/15/- Tape extra. Carriage and Insurance 5/6.

COLLARO MK IV TAPE TRANSCRIBTOR

Four heads. Twin track operation. Pause control. Tape measuring and calibration device. Two motors. Fast re-wind. 7in. tape spool. Three speeds: 3½in., 7½in. and 15in. per second. Finish cream polystyrene cover plate with maroon control. Delivery from stock. £17/19/6.

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All P.V.C. covered. In various colours, red, black, blue, yellow, etc. 7/18, 1/066, 1/044, 23/0076, 14/0076, etc., all 1½d. per yard. Special price for quantities.

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- Throat Microphones 3/- set
- American T30 type Throat Microphones 3/- pair

AUTOMATIC RECORD CHANGER UNITS

BSR "MONARCH" UA8. 4-speed unit with B.S.R. FULFI cartridge, £6/19/6.

B.S.R. "MONARCH" UA8. As above but fitted with B.S.R. FULFI STEREO Cartridge £7/19/6.

B.S.R. "MONARCH" UA12. 4 speed unit in green and cream. £8/19/6.

B.S.R. "MONARCH" UA14. 4 speed unit in two tone grey, £8/19/6.

COLLARO "CONQUEST" 4-speed fully mixing changer, complete with studio "O" cartridge, £7/19/6.

GARRARD RC120 MK. 2. 4-speed unit with manual control to enable records to be played singly, fitted GC2 cartridge, £8/19/6.

SINGLE PLAYERS

MODEL TA/MK11 4-speed single player. Diecast aluminium pick-up with GC2 cartridge. Automatic stop. 9½in. diameter turntable, £8/10/4 (Z).

COLLARO JUNIOR

4 speed, turntable and pick-up. Complete with crystal cartridge and sapphire styl. Finish cream with maroon turntable mat and speed control. Price 75/- or Turntable and Motor only at 52/5. Pick-up only 27/6.

CATALOGUE

OUR 1961 CATALOGUE IS NOW AVAILABLE. PLEASE SEND 1/- IN STAMPS FOR YOUR COPY. TRADE CATALOGUE ALSO AVAILABLE. PLEASE ATTACH YOUR BUSINESS LETTER-HEADING.



**103 LEEDS TERRACE,
WINTON STREET
LEEDS 7**

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 1/-; 20/- add 1/6; 40/- add 2/-; £5 add 3/- unless otherwise stated. Minimum C.O.D. fee and postage 3/-. For full terms of business see inside cover of our catalogue. Personal shoppers 9 a.m. to 5 p.m. Mon. to Friday. Saturday 10 a.m. to 1 p.m.

Each Model incorporates the highly successful HF/TR3 Amplifier (described opposite), thus ensuring truly "Hi-Fi" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1-200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them we send S.A.E. for fully descriptive leaflets.



Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

- MODEL CR2/S. Incorporates the new COLLARO "STUDIO" TWIN TRACK 3-speed Deck..... **£39.10.0**
H.P. Terms: Deposit £7/18/- and 12 months of £2/17/11.
- MODEL CR3/T. Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIBTOR" Deck which has both upper and lower tape tracks..... **£47.10.0**
H.P. Terms: Deposit £9/10/- and 12 months of £3/9/8.
- MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck..... **£49.10.0**
H.P. Terms: Deposit £9/16/- and 12 months of £3/12/7.

TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

MODEL HF/G2A-D

A complete self-contained Tape Recorder chassis incorporating Loudspeaker and comprising the Model HF/G2A Amplifier connected to the Garrard Tape Deck. Operates at 3 1/2 in./sec. speed and supplied fully tested and ready for immediate operation, designed for easy fixing into a portable case or cabinet, only four fixing screws being required.



Price **£25.0.0**
Complete working unit containing 4in. spool of Long Playing Tape.

H.P. TERMS: Deposit £5 and 12 monthly payments of £1/18/8.

Alternatively we offer—Complete Kit of Parts to build the HF/G2A Amplifier with the ASSEMBLED AND TESTED GARRARD TAPE DECK for **£22.0.0**
H.P. Deposit: £4/8/- and 12 months of £1/12/3

The Amplifier, Model HF/G2A is available separately for:

- (a) Complete kit of parts..... **£11.0.0**
- (b) Assembled..... **£12.15.0**

MODEL HF/G2P-D

THE IDEAL "LINK" TO ADD FULL TAPE RECORDING FACILITIES TO HIGH QUALITY HOME INSTALLATIONS, RADIOGRAMS, etc. Comprises the HF/G2P Tape Pre-amplifier fitted to the Garrard Tape Deck, operates at 3 1/2 in./sec. speed, connects into the tape input or pick-up sockets of existing amplifier or Radio Chassis.



Price **£23.15.0**
COMPLETE WORKING UNIT, containing 4in. spool of Long Play Tape.

Hire Purchase Terms: Deposit £4/15/- and 12 monthly payments of £1/14/10.

Alternatively we offer—Complete Kit of Parts to build the HF/G2P Pre-amplifier with the TESTED GARRARD DECK for **£20.15.0**
Deposit. £4/3/- and 12 months at £1/10/5

The Pre-amplifier Model HF/G2P is available separately for:

- (a) Complete kit of parts..... **£9.10.0**
- (b) Assembled..... **£11.5.0**

Model HF/G2R2 UNIT (described opposite). A small robust recorder with outstanding performance. Truly portable, weighs only 2 1/2 lbs. Twin Track operates on 3 1/2 in./sec. speed. Price **£29.15.0**
H.P. Terms. Deposit £6 and 12 months at £2/3/7.

MULLARD TYPE "C" TAPE-PREAMPLIFIER ERASE UNIT



The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FERROXUBE POT CORE PULL OSCILLATOR and 3-speed treble equalisation by FERROXUBE POT CORE INDUCTOR. FOR WEARITE — COLLARO — TRUVOX — BRENNELL or MOTEK TAPE DECKS. Includes separate Power Supply Unit.

Price **£14.0.0** or ASSEMBLED..... **£17.0.0**
KIT OF PARTS..... H.P. £3/8/- Deposit and 12 months at £1/4/11.

(Excluding Power Unit £11/15/- and £14/10/- respectively).

MODEL HF/TR3 TAPE AMPLIFIER



(Mullard Type "A" design) A very high quality Amplifier incorporating 3-speed treble equalisation, using the latest FERROXUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENNELL WEARITE or MOTEK Tape Decks, has GILSEN Output Transformer. Includes separate Power Supply Unit.

Price **£12.15.0** or ASSEMBLED..... **£16.10.0**
KIT OF PARTS..... H.P. £3/6/6 Deposit and 12 months at £1/4/2

FOR THE HOME CONSTRUCTOR SPECIAL "COMBINED ORDER" PRICES

- (a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit assembled and tested..... **£29.10.0**
 - (b) As above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts..... **£26.10.0**
 - (c) The COLLARO Mk. IV TAPE DECK and the MULLARD Type "C" PRE-AMPLIFIER and Power Unit assembled and tested..... **£35.0.0**
 - (d) As above but the Type "C" supplied as complete Kit of Parts..... **£32.0.0**
 - (e) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" PRE-AMPLIFIER and Power Unit..... **£40.0.0**
 - (f) As above but the Type "C" supplied as complete Kit of Parts..... **£36.10.0**
 - (g) The BRENNELL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and Power Unit..... **£46.0.0**
 - (h) As above, but the Type "C" supplied as complete Kit of Parts..... **£43.0.0**
 - (i) The WEARITE 4A DECK with Type "C" assembled and tested..... **£56.0.0**
 - (j) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK... **£25.10.0**
 - (k) As above but HF/TR3 ASSEMBLED and TESTED..... **£29.0.0**
 - (l) H.P. TERMS: Deposit £5/16/0, 12 months of £2/2/6.
 - (m) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIBTOR" DECK (£1 extra if we are required to wire up Deck Banks)..... **£30.15.0**
 - (n) As above but HF/TR3 ASSEMBLED and TESTED..... **£34.10.0**
 - (o) H.P. TERMS: Deposit £7, 12 months at £2/10/5. (£1 extra if we are required to wire up Deck Switch Banks)
 - (p) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK..... **£36.0.0**
 - (q) As above but HF/TR3 ASSEMBLED and TESTED..... **£39.10.0**
 - (r) H.P. TERMS: Deposit £7/18/-, 12 months of £2/17/11.
 - (s) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENNELL Mk. V TAPE DECK..... **£41.10.0**
 - (t) As above but HF/TR3 ASSEMBLED and TESTED..... **£45.0.0**
 - (u) H.P. TERMS: Deposit £9, 12 months of £3/6/-.
 - (v) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc..... **£55.0.0**
 - (w) H.P. TERMS: Deposit £11, 12 months of £4/0/8. (Carriage and Insurance on each above is 10/- extra)
- Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE—and 1,200ft. SPOOL E.M.I. TAPE—ALL FOR..... **£9.10.0**
(Carriage and Insurance 5/- extra)

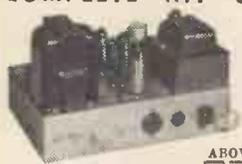
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Telephone: FLEET STREET 5812/3/4

FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E. AND STATE WHICH LEAFLET IS REQUIRED.

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification
MULLARD "5-10" MAIN AMPLIFIER



For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.
Price: COMPLETE KIT (Parmeko O/put Trans.)..... **£10.00**

Alternatively we supply ASSEMBLED AND TESTED **£11.100**

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 E.T.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 Tuner.

Price: COMPLETE 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 Retine—WE ALSO SUPPLY SEPARATELY:—

- (a) The 2-stage (plus Rectifier) AMPLIFIER **£4 2 6**
- (b) The PORTABLE CARRYING CASE **£3 17 6** (Carriage and insurance 4/- extra)
- (c) 6In. P.M. SPEAKER..... **18 9**



"Hi-Fi" LOUDSPEAKERS WE HAVE IN STOCK A COMPLETE RANGE BY GOODMANS—WHARFEDALE—W.B. ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

THE "ADD-A-DECK" incorporating the NEW B.S.R.

'MONARDECK' & MATCHED PRE-AMPLIFIER Thus providing full tape Recording facilities.

Carriage and Insurance 10/-
Deposit **£3/12/-** 12 mths. **£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 3In./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 MICROPHONES; one for CRYSTAL PICK-UPS and a Fourth to 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.

Price: COMPLETE 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 mV.

Price: COMPLETE KIT OF PARTS..... **£12.10.0** Alternatively ASSEMBLED AND TESTED **£15.0.0**

H.P. Terms on assembled unit: £3 Deposit and 12 months of £1/2/-



!! 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-sp. Mixer **£6.19.6**
- Autochanger with Crystal Pick-up
- The COLLARO "CONQUEST" 4-sp. Mixer **£7.10.0**
- Autochanger, Studio "O" Pick up
- 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 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 EC210 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 Base 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 3812/3/4

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Readers will no doubt be
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 For the benefit of constructors
 all components, key-
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 We shall be happy to
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 the attention of Mr. L. Roche.

NEW LOOK ECONOMY FOUR



(3 & 4)

Our very popular three valve
 plus rectifier mains T.R.F. receiver
 is now available with a new De-
 Luxe cabinet with polished Walnut
 finish and Cream trimming (as
 illustrated). Brief Spec: Valve
 line-up 6K7, 6I7, 6V6, and contact
 cooled rectifier. Ready drilled
 chassis, good quality 5in. loud-
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 Covers Medium and Long Wave-
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 6in. x 5in. high A.C. 200/250 v.
 Simple construction with guaran-
 teed results. Easy to follow prac-
 tical and theoretical diagrams
 supplied All necessary components,
 down to the last nut and bolt, are
 offered at a **SPECIAL INCLUSIVE
 PRICE OF £5/10/-**, plus
 5/- p. & p. Instruction book
 available separately 1/6, post free.
 Also available with plastic cabinet
 in **IVORY** or **BROWN** if preferred
 at **ONLY £5/5/-**, plus p. & p.

THE "SUPERIOR FOUR"



Our su-
 perior
 four-valve
 receiver
 A.C. mains
 200/250 v.
 M. and
 Long
 waves. As
 with our
 very suc-
 cessful
 "Econo-
 my Four" (6)
 all required components are
 supplied. Valve line-up: 2 6SG7,
 6 X5GT and 6 V6GT. Chassis
 ready drilled. Cabinet size 10in. x
 10in. wide. Maximum depth at
 base 5in. tapering to 3in. at top.
 Sloping front. Very attractively
 finished in light walnut and peach.
 Each component brand new and
 tested prior to packing. Complete
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 and theoretical diagrams is pro-
 vided. Booklet available at 1/6
 post free. Our price complete
 £5/15/-. Please add 2/6 P. & C.
 If preferred, we can supply Cabinet
 Assembly only, comprising Cabinet
 and bracket wave-change switch;
 dial pointer, drum, pulleys, drive
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 at 45/-, plus 2/6 P. & C.

THE NEW LOOK RAMBLER PORTABLE

This wonderful little Medium and Long
 wave battery superhet incorporates
 IR5, IT4, IS5, 3V4 miniature valves,
 5in. speaker and frame aerial. Housed
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 All required components at the **NEW
 LOW PRICE OF £6/19/6**, plus 2/6 p. & p.;
 or with the latest low consumption
 "96 range" valves at the **NEW LOW
 PRICE OF £7/7/0**, plus p. & p. Uses
 all-dry batteries AD35 (1/6), B126
 (9/-). Full descriptive instruction
 book with itemised price list, diagrams,
 etc., available separately at 1/6d. post
 free.

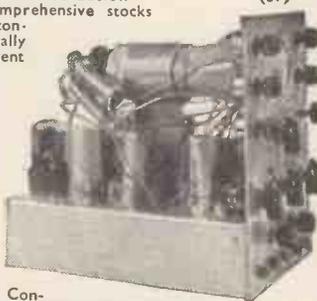
(2) **MAINS UNIT FOR ABOVE.**
 Fits into battery compartment. A.C.
 200/250 v. All required components at
ONLY 47/6 plus 1/6 p. & p. or assembled
 and tested at **£3/5/-** plus p. & p. (Also
 suitable for many other portables.)



(1)

CLYNE CATHODE RAY OSCILLOSCOPE for Home Construction

A recent addition to our comprehensive stocks
 of quality equipment for the con-
 structor. This is an exceptionally
 sound and robust instrument
 of the most versatile type,
 that will be a boon to the
 seriously minded amateur, ser-
 viceman or constructor. Specifi-
 cations: 8-Range Time Base,
 switched from 20 c/s to 160
 Kc/s. Y-Plate Amplifier
 has a sensitivity of 50 mV.
 and frequency response of
 20 c/s to 600 Kc/s with a
 gain of 150. A calibrating
 voltage of 6.3 v. 50 c/s.
 is provided. Employs ECR30
 2 1/2in. Cathode Ray Tube and 4
 valves; 2/ECF80, 1/EF91, 1/6X5. Con-
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 Frequency (Fine), Time Base Frequency (Coarse). Sync Selector. Sync.
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 available at a **SPECIAL INCLUSIVE PRICE OF ONLY £12/19/6**,
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 optional extra at only 10/6.



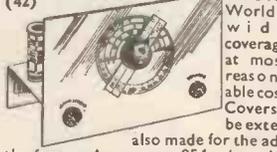
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THE R.C. 3/4 WATT AMPLIFIER

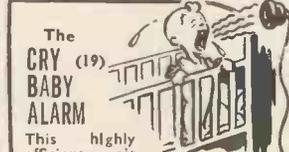


Compare the advan-
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 GT, 6SG7 metal 6X5GT. Negative
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 of the complete kit with all neces-
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 amplifier can be supplied assem-
 bled, tested, and ready for use at
£5/5/- plus p. & p.

SUPER 1 VALVE SHORT-WAVE RADIO



(42)



The
**CRY
 BABY
 ALARM**
 This highly
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 is simple to assemble, extremely
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 finished in Red and Grey (wash-
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 plastic escutcheon. Size only 7 1/2in.
 x 3 1/2in. x 6 1/2in. Supplied in
 kit form complete with mike at
ONLY 72/6 plus 2/6 P. & P. or
 assembled and tested 89/6 P. & P.
 2/6. Suitable mike flex available at
 3d. a yard. Instruction book and
 price list separately 1/- post free.
 A.C. 200-250 v.



Covers 40-100 metres with the coil supplied. Can
 be extended to cover 10-100 metres. Provision is
 also made for the addition of two extra valve stages. Employs
 the famous Acorn-type 954 valve. All necessary components can be supplied
 complete with full assembly instructions at **ONLY 35/-** plus 2/- p. & p. Send
 2/- for point-to-point wiring diagram and price list.

VISIT OUR FULLY EQUIPPED
HI-FI SHOWROOM
 AT TOTTENHAM COURT ROAD FOR
 DEMONSTRATIONS OF THE LATEST
HI-FIDELITY EQUIPMENT
 BY ALL LEADING MANUFACTURERS

We stock equipment of Quality by all leading makers:
 i.e., Leak, Quad, Armstrong, Dulci, Ferragraph, Reflectograph, Vortexion,
 Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco,
 B.T.H., Pamphonic, Simon, Brenell, Collaro, Telefunken, Fi-Cord, etc.
 A full range of high quality cabinets to suit all purposes is on show, i.e.,
 "RECORD HOUSING," "W.B." "A.D.", etc. Enquire about our
 interesting part-exchange scheme for personal callers. H.P. Available.

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		
(2) "RAMBLER" Mains Unit (suits most portables)	£6 19 6	2/6	1/6
(3) "ECONOMY FOUR" T.R.F. Mains Receiver	£2 7 6	1/6	9d.
(4) "ECONOMY FOUR" with New Look Cabinet	£5 5 0	2/6	1/6
(5) "FAMILY FOUR" (our new T.R.F. Receiver)	£5 10 0	2/6	1/6
(6) "SUPERIOR FOUR" (four valve mains receiver)	£3 19 6	2/6	1/6
(7) Standard JASON F.M. Tuner FMT1	£5 15 0	2/6	2/-
(8) Fringe area JASON F.M. Tuner FMF	£6 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		
(11) JASON "ARGONAUT" AM/FM Chassis	£5 19 6	2/6	2/6
(12) JASON "ARGONAUT" AM/FM Tuner	£15 5 0	2/6	2/-
(13) F.M. Power Pack (suitable for most tuners)	£13 19 6	3/6	2/-
(14) R.C. 3/4 watt Amplifier (with Bass, Middle and Treble controls)	£1 17 6	1/6	1/-
(15) 2-amp. Battery Charger	£4 5 0	2/6	1/-
(16) R.C. Transistor/Crystal Receiver ('phones extra)	£1 16 6	2/6	3d.
(17) R.C. Super Transistor/Crystal Rec. (ditto)	£1 1 0	1/3	3d.
(18) R.E.P. 1-valve Battery Receiver	£1 7 6	1/3	3d.
(19) "CRY-BABY" ALARM (Baby Alarm)	£2 2 0	2/-	9d.
(20) MULLARD 510 Amplifier (printed circuit) Ultra Linear Version	£3 12 6	2/6	1/-
(21) MULLARD 510 as above plus input selector and spare power supplies	£9 9 0	3/6	1/6
(22) "DE-LUXE" Printed Circuit Superhet	£11 10 0	3/6	2/6
(23) "DE-LUXE" with New Look Cabinet	£7 19 6	3/6	1/6
(24) JASON J.T.V. 2 Tuner	£8 4 6	3/6	1/6
(25) RADIO JACK	£13 19 6	3/6	2/6
(26) MULLARD TYPE "C" Tape pre-amp.	19 6 1/6	6d.	
(27) JASON WII Wobblulator	£12 9 6	3/6	2/6
(28) JASON Valve Voltmeter EM10 (23 ranges)	£14 19 0	3/6	3/6
(29) NEW JASON F.M. TUNER FMT2 with built-in power supplies and cabinet.	£18 10 0	3/6	2/6
(30) NEW JASON FRINGE F.M. TUNER FMT3, as above	£8 19 6	3/6	2/6
(31) PULLIN Series 90 TEST METER	£10 19 6	3/6	2/6
(32) R.C. Super Personal Portable 1-valve (phone extra)	£5 19 6	2/6	1/6
(33) R.C. Super Personal Portable 2-valve (phone extra)	£1 15 0	2/6	2/-
(34) R.C. TRANSETTE 2-Transistor Personal Portable	£2 1 0	2/6	2/-
(35) JASON EVEREST 6-Transistor 2-wave Portable	£3 9 6	2/-	2/-
(36) JASON EVEREST 7-Transistor 2-wave Portable	£13 19 9	3/6	3/6
(37) CLYNE Cathode Ray Oscilloscope	£15 18 9	3/6	3/6
(38) Compact Multi-range Test Meter	£12 19 6	5/-	10/-
(39) CAR RADIO, Printed Circuit, 5-valve S'het.	NEW LOW PRICE		
(40) JASON Audio Generator AG10	£2 19 6	1/6	2/6
(41) JASON Oscilloscope OG10	£14 5 0	3/6	2/6
(42) Super SHORT WAVE RADIO, 1 valve	£22 10 0	5/-	3/6
(43) "WAVEMASTER" 7-Transistor Luxury Portable	£1 15 0	2/-	2/-
(44) "GOLD STAR" De-luxe 1-valve Portable	£10 19 6	3/6	2/6
	£1 17 6	2/6	1/6

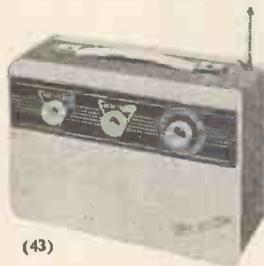
Instruction Books which contain full description, easy-to-follow practical wiring diagrams theoretical diagrams itemised price lists, etc., are free of charge with all parcels but may be purchased separately as shown above.

PLEASE NOTE:—A selection of the above items are described more fully in this advertisement!!

THE "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

400 MILLIWATTS OUTPUT

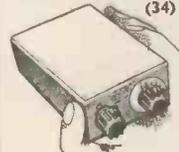
To build yourself Medium and Long Waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6 1/2in. x 4 1/4in. at base tapering to 4in. at top. Very attractive two-tone grey Vynidex covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. ★ Weight—complete with long-life 7 1/2 volt battery—4 1/2lb. ★ 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.



(43)

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



(34)

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.

PRINTED CIRCUIT CAR RADIO (for Home Construction).

We are proud to be able to offer this New type Car Radio employing up-to-the-minute circuitry, special 12 volt valves and transistorised output stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. NO VIBRATOR PACK IS REQUIRED. This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor at a Special New Low inclusive Price of Only £11/19/6 plus 3/6 P. & P. Instruction booklet with itemised price list, full description dimensions, etc., available separately at 3/6 post free.



(39)

"FAMILY FOUR" (5)

Our supersensitive T.R.F. Receiver for home construction. Covers Long and Medium Wavebands, is housed in very smart plastic table cabinet in Brown or Black. For A.C. mains 200/250 v. Comprehensive assembly instructions provided, including practical and theoretical diagrams, which are easy to follow and will enable you to complete this receiver which will be the envy of your friends. ALL NECESSARY COMPONENTS ARE BEING OFFERED FOR LIMITED PERIOD ONLY AT THE REMARKABLE PRICE OF ONLY 79/6, plus 2/6 P. & P. Instruction book available separately if you wish to study before purchase at 1/6 post free.



SUPER PERSONAL PORTABLE.

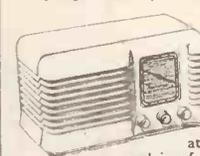
A wonderful little set that you can take anywhere. Ideal for camping, picnics, etc. Detachable aerial rod supplied. Covers Medium waveband 200-500 metres. Can be built in approx. 1 hour. All necessary components available at the following SPECIAL INCLUSIVE PRICES: 1-valve version ONLY 35/- plus 2/- P. & 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.



(32)

(33)

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.

★ MORE CLYNE RADIO BARGAINS ★

CABY UNIVERSAL TEST METERS

These pocket-size multi-range test meters are of excellent quality and cover all the most useful ranges (A.C. Volts, D.C. Volts, resistance and current). Supplied complete with test leads, instruction book and batteries. Model A.10 (2,000 ohms per volt) £4/17/6

Model B.20 (10,000 ohms per volt) £6/10/-

Plus P & P. 3/6 on each. Fully detailed and illustrated leaflet available on request.

RECORD PLAYERS

Full range at usual competitive prices. Interesting H.P. facilities B.S.R. TU9. 4-speed single-record unit with separate lightweight pick-up fitted with T.C.8H. crystal insert and sapphire styli. An ideal unit for a small portable gramophone. Brand new and fully guaranteed. SPECIAL PRICE: 75/- plus 2/6 P. & P. or motor and turntable only at 52/6 plus 2/6 P. & P. or Pick-up only at 27/6 plus 1/6 P. & P. E.M.I. 4-SPEED STEREO/MON- AURAL SINGLE RECORD UNIT. Complete with Stereo Head and Sapphire Styli. Brand New and Fully Guaranteed. ONLY £6/19/6 plus 3/6 P. & P.

JUST ARRIVED!
LATEST GARRARD MODEL 210. Four-speed manual or automatic. 10in and 12in records of same speed can be mixed in any order, wired for stereo, attractive white colour scheme. Price 104/6 gns., plus 3/6 P. & P.

LATEST B.S.R. UA14. 4-speed. Attractive appearance. Wired for stereo. Fully guaranteed. £7/19/6, plus 3/6 P. & P.
B.S.R. UA8 STEREO/MON- AURAL. Few only at £7/19/6, plus 3/6 P. & P. Brand new Guaranteed

No. 38 AFV WALKIE-TALKIE. A wonderful offer. This famous trans-receiver unit, with relay operated SEND/RECEIVE switch covering 7.4-9 Mc/s band, range approx. 5 miles. Good condition ONLY 22/6 plus 2/6 P. & P. per unit (less accessories). Quantity export inquiries welcomed.

AERIAL TUNING UNIT ZA08A1. This well made ex-W.D. unit contains a host of useful components including: 1 mA 2in flush round M/C meter, 1 mA Westinghouse full-wave meter rectifier, 5-pole 5-way heavy-duty silver plated wavechange switch. 3in. dia. silver plated rotary tuning indicator, 350 pF tuning condenser with insulated coupler and 3 1/2in. calibrated dial (0-180 deg.) etc. etc. Contained in strong metal carrying case 9in. x 9in. x 8in. with hinged lid. ONLY 27/6 plus 5/- C. & P.

A CONSTRUCTOR'S MUST
The latest "Pifco" Instrument Bit Soldering Iron
With integral Stand and built-in Spot-light for illuminating work 200/250 v. ONLY 22/6. P. & P. 1/6.
SOLDER. New boxed 1 lb reels, 16 S.W.G. 50/50, at 8/6 only, plus 1/- P. & P.

12 VOLT VIBRATOR PACK. (Mallory). Output 150 v. @ 40 mA. Complete with synchronous vibrator. Brand new. ONLY 12/6, plus 2/- P. & P.

WIRING WIRE. 5 coils 10 yds., each coil, in different colours, contained in cellophane bag, 5/- bag, plus 9d postage.

TRANSFORMER SPECIAL. Superior quality half-shrouded drop thro' type. Ex-equip, but guaranteed O.K. Input 200/250 v. Output 350-0-350 v. @ 80 mA. 6.3 v. @ 3 amps. 5 v. @ 2 amps. ONLY 9/6, plus 2/6 P. & P.

SUPER MAGNETIC RECORDING

TAPE SPECIAL !!! Trade enquiries invited. First delivery Famous American Ferrodynamic Acetate Base High Quality Recording Tape. An enthusiast's "must." Brand new (NOT SUB-STANDARD), 5in. 600ft. 16/-, 5in 900ft. 18/6, 5 1/2in. 1,200ft. 23/6, 7in. 1,200ft. 25/- 7in. 1,800ft. 35/-, Professional quality "MYLAR" Du Pont 5in. 1,200ft. 37/6, 7in. 1,800ft. 44/-, 7in. 2,400ft. 60/-, each on plastic spool. P. free.



DECCA PORTABLE AMPLIFIER. As supplied in famous DECCA-MATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3 1/2 x 8 1/2in. Only 59/6 plus 2/6 P. & P.
SPECIAL CELESTION 8 x 6in. elliptical high flux loudspeaker 30/- plus 1/- P. & P. to fit.

VERY ATTRACTIVE PORTABLE CABINET in two-tone rexine covering for accommodating the above items and ancillary equipment 75/- plus 5/- P. & P.
Note. If the above three items are purchased together they will be supplied at the special inclusive price of £7/2/6 plus 6/6 P. & P.

EXTRA SPECIAL OFFER !!

A small three-valve PORTABLE RECORD-PLAYER AMPLIFIER mounted on baffle 12 x 7in., with High Flux 6 1/2in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, £5/12/6. P. & P. 3/6.
NEW STYLE CABINET finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13 1/2 x 8 1/2in. Fitted with carrying handle, £3/9/6 plus 5/- P. & P.
NOTE. If both items purchased together they will be supplied at a special inclusive price £8/7/6 plus 6/6 P. & P.



ANOTHER PORTABLE CABINET BARGAIN! Ex leading manufacturer's battery portable attache type case. Attractive two-tone grey rexine finish. Size closed 13 1/2in. x 9 1/2in. x 3 1/2in. Complete with fittings and handle. Including Medium and Long Wave frame aerial which fits in lid. On/off switch on lid stay. Limited quantity only at bargain price of 19/6 plus 2/- P. & P. Brand new.

TAPE RECORDER CONSTRUCTORS

LATEST COLLARO STUDIO TAPE TRANSCRIPTION. 3 motors, 3 speeds, 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spools. Push-button controls. £12/19/6 plus 5/- P. & P. Usual H.P. facilities.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5 1/2in. spools—3 1/2 i.p.s. At £9/19/6 only plus 5/- P. & P.

TAPE RECORDER AMPLIFIER—MANUFACTURER'S SURPLUS: Suitable for use with either of the above Tape Decks, and most other types. For A.C. mains, 4 watts output, five valves, including EM84 recording level indicator and EZ80 rectifier. 40-12000 CPS at 7 1/2 in. x 3 db. Facilities for superimpose and use as separate straight through amplifier. Radiogram Input, mike input, tone control, volume control, Chassis measurement: 12 1/2in. x 4 1/2in. x 3in., overall height—5 1/2in. Supplied complete with circuit diagram and attractive engraved black and gold escutcheon plate. Price £10/10/- only, plus 3/6 P. & P. Limited quantity. If purchased with either of the above decks, both items post free!

ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE Suitable for above amplifier and Collaro, Studio deck. Limited quantity only at 72/6 plus 3/6 P. & P.

MIC 45-1 Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. OUR PRICE 29/6 plus 1/- P. & P.

ACOS MIC 39-1. Crystal stick microphone. List price 5 gns. Our price 39/6 plus 1/6 P. & P.

MIC 40. General purpose crystal microphone with desk stand. Our price 25/- only plus 1/6 P. & P.

M.C.24. ANOTHER HAND MIKE BARGAIN: Imported, crystal, attractive streamlined polished metal case, incorporates muting switch. List price 63/-, OUR PRICE 42/- only 1/- P. & P.

NEW! AN INEXPENSIVE TV AERIAL !!

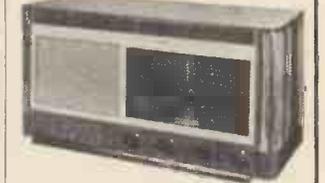
THE HANDY BURKE AERIAL. Patent applied for 17109/59. Tried and proved in most areas up to 25 miles from a transmitter "Astounding in its simplicity." "Why didn't somebody think of this before?" "Not a 'gimmick'—but scientifically right." Television signals are elusive, particularly indoors, with this aerial you have a much better chance of catching them! Descriptive leaflet available includes technical report from "Wireless World," March 1960. Featured in "Daily Express" article May 12th, 1960. Trade enquiries invited. Send for leaflet.

ONLY Plus
7/6 P. & P.
1/-

— TRANSISTORS !!! —

SURPLUS P.N.P. RED SPOT (Audio/Experimental Application) 5/- ea.
WHITE SPOT, R.F. up to 2.5 Mc/s 5/- ea.
Attractive discounts for bulk purchases. The above is a selection only. Full range in stock by all leading manufacturers. Let us have your enquiries.

(ALL POST FREE)
FRUSTRATED EXPORT. Not repeatable! L. M. and S.W. SUPER-HET RECEIVER. Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free.



Valve line-up: 6K8G, 6K7G, 6Q7C 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8in. P.M. Speaker, 4 watts output, P.U. socket Ext L.S. socket, etc. Tone control. Fitted in polished wood cabinet, size 21 1/2in. x 10 1/2in. x 10 1/2in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price £5/19/6 only plus P. & P 7/6, plus 2/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

12 CHANNEL TV TURRET TUNER (By famous manufacturer). Brand new, NOT surplus or ex-equipment, 35 Mc/s. I.F. PCC 84 and PCF 80 valves. Complete with coils: Band I Channels 1 to 5, Band III Channels 8 to 11. In manufacturers original carton. Fully guaranteed at only 39/6 plus 2/6 P. & P.



JUST ARRIVED !! PICK-UP CARTRIDGES

ACOS GP73-2A: Turnover cartridge for Stereo and Monaural Standard and L.P. Few only at 29/6 plus 9d. P. & P.

ACOS GP67-3. Latest Monaural turnover cartridge for standard and L.P., only 18/- plus 9d. P. & P.

Both of above absolutely complete, ready to fit, with two styli.

DEAF AID TYPE EARPIECES. Standard magnetic type complete with lead and plug. As new. ONLY 12/6, plus 1/- P. & P.

CLR LOW IMPEDANCE HEADPHONES. Complete with headband and leads 5/6 pr., plus 1/6 P. & P.

DLRS BALANCED ARMATURE HEADPHONES. Complete with headband and leads, 7/6 pr., plus 1/6 P. & P.

HIGH IMPEDANCE LIGHT-WEIGHT HEADPHONES. Brand new imported type finished in cream. Complete with leads, 15/- pr., plus 1/6 P. & P.

8in. LOUSPEAKER. Ex-equip. as new. Less transformer, 3 ohm speech coil. In attractive cloth covered cabinet. Ideal for extension speaker. 22/6 plus 1/6 P. & P. Speaker only, less cabinet at 13/6 plus 1/6 P. & P.

12in. BAKERS SELHURST LOUD-SPEAKER. 15 ohms, 15 watt, 30-14,000 cps. Brand new, £4/10/-, P. & P. 3/6.

12in. RICHARD ALLAN P.M. LOUSPEAKER. 3 ohm speech coil. Brand new. Only 32/6 plus 2/6 P. & P.

CLYNE RADIO LTD.
18 Tottenham Court Road, London, W.1.
162 Holloway Road, London, N.7.
99 Cheapside, London, E.C.2.

THE COMPONENT SPECIALISTS
ALSO SEE PREVIOUS PAGES

DE LUXE TAPE RECORDER CABINET

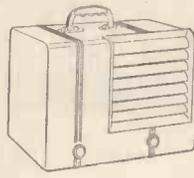


29/9

Beautifully made Tape Recorder Cabinet. Size: 13" x 10 1/2" x 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.

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" x 11" x 6 1/2". 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.

RECORD PLAYER CABINET R.P.2

59/6



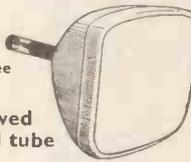
Made by famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size: 16" x 14 1/2" x 8 1/2" deep. Carr. & Ins. 4/6. Will take B.S.R. Monarch 4-speed Autochanger £6/19/6; and our Mk. D.1 Portable Amplifier 59/6.

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.

REPLACEMENT, REBUILT T.V. TUBES

12 months' guarantee



Carr. & Ins. 15/6.
21 in. TUBE £8.10.0 allowed on old tube
17 in. TUBE £7.10.0 **£2** allowed on old tube
12, 14, 15 in. TUBES **£1** allowed on old tube
£5.10.0

— TERMS AVAILABLE OVER 20 WEEKS—

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.

AMPLIFIERS

All portable. 12 months' guarantee.

MK. D.1

59/6



Brand new. Latest design, with printed circuit. Dimensions 7" x 2 1/2" x 5". A.C. only. Mains isolated 3-4 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" x 2 1/2" x 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.

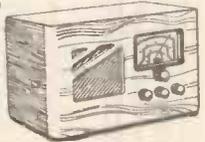
SOLO SOLDERING TOOL 12/6



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: 9 1/2" x 18 1/2" x 11 1/2". 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. 8" P.M. cone. Defect now repaired, not affecting reproduction quality. **6/9**
8" P.M. SPEAKER. As above, with output transformer. **6/9**
8" P.M. SPEAKER. Highest quality, fitted output transformer. **9/9**
ELLIPTICAL SPEAKER. 8" x 3" and 7" x 4". Brand new. **15/9**
Also 9" x 4", 19/9.
P. & P. on each 2/9.

VALVES. IDEAL FOR SPARES. SALVAGE/GUARANTEED

1D6, 3D6, 4D1, 6B7, 6B8, 7B7, 8D2, 9D2, 11D3, 12B6E, 12Y4, 15D2, 18, 75, 78, 210VPT, 1208A, 20S0, 2101, 7193-2C22, AR6, ARP18, CV73, CV188, D1, EA50, EB34, EF36, EF37, EF50-638PT, GT1C, KT21-ARP18, KT241, LP220, NGT2, PM202, PP225, Q191-VR35, 8P41, 8P41, T41, TT11, VR21, VR35, VT61A.	6C4, 6F1, 6F12-277, 6F13, 6F14, 6F15, 6J5, 6K7, 7Y4, 7D5, 10F1, DF66, DH81, EAF42, EBC41, EF42, EF91-8D3, EF92, EL32, KT33C, KT81, KTW61, P61, PEN45, PEN46, PL33, U92, UF41, U66.	5U4, 6Y3, 6CK5-EL41, 6K8, 6SL7, 6SN7 6P28, 6V6, 6X5, 12AT7
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SOUND/VISION STRIPS. 2/9
I.F.'s 10.5-14 Mc/s. 8 valve holders and I.F.'s 10-10.5 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. Incorpor. 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 doz. 4d.

INSULATING TAPE. 1/6
Finest quality. In metal container (75ft. x 1/2 in.). 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 14 1/2 in. x 11 1/2 in. x 8 in. 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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G.W. SMITH & CO

(RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE

3-34 LISLE STREET, LONDON, W.C.2

SELENIUM L.T. RECTIFIERS. Full wave, bridge connected. 12/18 v. 1.5 A. 4/3; 12/18 v. 2½ A. 6/9; 12/18 v. 4 A. 9/9; 12/18 v. 5 A. 12/6; 12/18 v. 6 A. 18/6; 24/36 v. 1 A. 12/6; 24/36 v. 4 A. 22/6; 24/36 v. 15 A. 62/6. Please add postage.

L.T. TRANSFORMERS. For charging or models. All 200/250 v. primaries. 3.5, 9 or 17 v. 1 A. 9/9; 3.5, 9 or 17 v. 2 A. 14/3; 3.5, 9 or 17 v. 4 A. 16/6; 9 or 17 v. 6 A. 26/-; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 v. 2 A. 18/6. P/P 1/3.

1 Megohm 1% **WIREWOUND RESISTORS.** 10/- per doz.

6 **VOLT AC/DC BUZZERS.** 3/6 ea. P/P 6d.

CV. 320. 1in. C.R.T. 4 v. heater, 600-1 kv. anode. Boxed, 19/6 ea. P/P 1/6.

MARCONI TF. 340 OUTPUT METERS. Reconditioned, perfect order. £9/19/6 ea. P/P 7/6.

MARCONI TF. 373 UNIVERSAL IMPEDANCE BRIDGES. Reconditioned to maker's spec. 0-100H., 0-100 mfd., 0-1 megohm, 0-100 Q. each on 5 ranges at 1,000 c/s., £35 ea.

MARCONI TF. 329 "Q" METERS. Range 0 to 500 Q. Frequency 50 kc/s to 50 mc/s. Reconditioned to maker's spec., £65 ea.

MARCONI TF. 410c VIDEO OSCILLATORS. Ranges 20 cps. to 30 kc/s., 30 kc/s to 5 mc/s. Variable attenuator. Reconditioned to maker's spec., £35 ea.

DEAF-AID EARPIECES. ER.100, 250 ohm imp. 4/6; ER.250, 1,000 ohm imp. 7/6. P/P 6d.

PAINTON MINIATURE JONES PLUGS AND SOCKETS. All new. 2 pin 2/6 pr.; 4 pin 3/6 pr.; 6 pin 4/- pr.; 8 pin 4/6 pr.; 12 pin 5/6 pr.; 18 pin 7/6 pr.; 33 pin 10/6 pr.

MINIATURE PYE COAXIAL PLUGS AND SOCKETS. Available male or female cable, per 2/6 pr.

7.5 K.V.A. AUTO TRANSFORMERS. 115/230 volts. Brand new, boxed, ex-U.S.A. £15 ea. Plus carr.

POST OFFICE TELEPHONE HANDSETS. Standard type, 12/6 ea. P/P 1/6.

A.R. 88 WAVECHANGE SWITCHES. 8 banks, 6 positions, complete with all screens. New, boxed, 17/6 ea. P/P 2/6.

AMERICAN HS-30 LIGHTWEIGHT HEADSETS. Res. 50 ohms. Extremely high quality. Brand new, 15/- pair. P/P 1/3.

AMERICAN SPRAGUE/MICAMOULD CONDENSERS. Highest quality. .1 mfd, 500 v. .01 mfd. 1,000 v. 6/- per doz. P/P 9d.

AMERICAN H.T. BATTERIES. Brand new. Tapped 90 v., 67½ v., 45 v., 22½ v., 5/- ea. P/P 1/6.

24 VOLT D.C. PUMPS



Self lubricating, capacity 60 g.p.h. at 30 lb./sq. in. Will operate O.K. on 12 v. ¼ BSP inlet/outlet union. Only 15/6 ea. P/P 2/6.

FIELD TELEPHONES TYPE F.

Ideal for all intercom. systems, house, office, building sites, etc. Generator bell ringing, 2 line connection. Supplied complete with batteries and wooden carrying case, fully tested. 59/6 ea. per telephone. 3/6 P/P.



1,000 WATT MAINS ISOLATION TRANSFORMERS

230 v. primary, 230 v. secondary. Ex-Admiralty heavy-duty type. New boxed, £5 ea. P/P 10/-.

R.1155 COMMUNICATION RECEIVERS

Standard Model B. Frequency coverage 75 kc/s to 1,500 kc/s and 3 mc/s to 18 mc/s on 5 bands. New improved geared slow-motion drive fitted. All receivers overhauled, aligned and tested. £8/19/6 ea. P/P 7/6. Combined A.C. mains power pack and audio output stage supplied 85/- extra.

BRAND NEW MEDRESCO HEARING AIDS

Supplied fully tested and complete with ear-piece, leads and battery pouch. Incorporates 3 sub-miniature valves and sensitive crystal mic. Only 32/6 each. Batteries 5/- extra. P/P 1/-.

BC.221 HETERODYNE FREQUENCY METERS

125 kc/s to 20 mc/s. As new condition. Supplied complete with valves and crystal but no calibration charts. Only £14/10/- ea. P/P 7/6.

WESTON 772 MULTI-RANGE A.C./D.C. TEST METERS

1,000 ohms per volt. Reconditioned, perfect order. See previous adverts for full spec. £7/10/- ea. P/P 3/6.

SPARES KIT FOR CR.100 RECEIVERS

Contains 15 valves: 2-U50, 2-DH63; 2-KT63; 2-X66; 7-KTW61. Condenser and resistor packs, pots, toggle switch, output transformer, etc. All brand new, 59/6. P/P 3/6.

R.C.A. LOUDSPEAKERS

High-quality 3 ohm speaker housed in black crackle metal case to match AR-88 or H.R.O. receivers. Supplied brand new and boxed, 45/- ea. P/P 3/6.

COLLARO STUDIO TAPE TRANSCRIPTORS

Latest 1960 model. 3 speeds, 1½, 3½ or 7½. Fitted with 3 separate motors, digital counter, press-button switching, provision for fitting extra stereo head. Supplied brand new and guaranteed complete with spare 7in. spool, £12/10/- ea. P/P 3/6.

DON Mk. 5 FIELD TELEPHONES

Ideal for all intercom. systems. Buzzer calling, 2 line connection. Housed in metal carrying case. Supplied complete with batteries, fully tested, 39/6 ea. P/P 3/6.

R.C.A. PLATE TRANSFORMERS

Primary 200/250 v. 50 cycles. Secondary 2,000/1,500/0/1,500/2,000 v. 500 milliamps. Supplied brand new and boxed, £6/10/- ea. P/P 10/-.

PARMEKO TABLE TOP TRANSFORMERS. Input 230 v. 50 c/s. Output 620/550/375/0/375/550/620 v. 250 mA, 5 v. 3 amp, 5 v. 3 amp. Size 6½ x 6½ x 5½in. Brand new, boxed, 45/- ea. P/P 5/-.

12/24 v. **D.C. MODEL MOTORS.** Reversible. Brand new, 8/6 ea. P/P 1/-.

200/230 v. **A.C. MAINS MOTORS.** Made for hair dryers. New, 12/6 ea. P/P 1/3.

E.M.I. 50:1 MICROPHONE TRANSFORMERS, 4/6 ea. P/P 1/-.

GERMANIUM DIODES. General purpose type, 6d. ea. High quality type equivalent to OA81, 2/- ea.

TRANSISTORS. Red spot, 4/6 ea. White spot, 4/6 ea. Yellow/green, 4/6 ea. Red/yellow 7/6 ea. P/P 3d.

SPEAKER BARGAINS

2½in.	Perdio	3 ohm	17/6
2½in.	Perdio	15 ohm	17/6
3in.	Plessey	5 ohm	15/6
3in.	Rola	3 ohm	17/6
4½in.	Plessey	3 ohm	15/6
6½in.	Plessey	3 ohm	17/6
8in.	Elac	3 ohm	19/6
10in.	R.A.	3 ohm	27/6
12in.	Plessey	3 ohm	32/6
12in.	Plessey	15 ohm	42/6
6 x 4in.	Plessey wafer	3 ohm	12/6
7 x 4in.	Plessey	3 ohm	15/6
8 x 6in.	Rola	3 ohm	17/6
10 x 7in.	Plessey	3 ohm	27/6
12 x 8in.	Plessey	3 ohm	49/6
8 x 2½in.	Goodmans	3 ohm	17/6

All brand new. Please add postage.

BRAND NEW PADDED MOVING COIL HEADPHONES. Complete with M/C hand microphone, 12/6 per set. P/P 2/-.

LEACH 12 V. DOUBLE POLE AERIAL CHANGE-OVER RELAYS. 7/6 ea. P/P 1/-.

SOUND-POWERED TELEPHONE HANDSETS. Just connect with twin flex for complete telephone system. No batteries required, 15/- ea. P/P 1/6.

INSTRUMENT TRANSFORMERS. 0/210/240 v. primary. Secondary 220 v. 85 mA and 6.3 v. 3.5 amps. New, 9/6 ea. P/P 1/3.

CONTACT-COOLED RECTIFIERS. 125 v. 85 mA 3/9; 250 v. 50 mA 5/6; 250 v. 85 mA 9/-; 250 v. 75 mA, full-wave bridge, 12/6. P/P 6d. ea.

HOOVER ROTARY TRANSFORMERS. Input 12 v. D.C.; output 310/360 v. 30 mA. New, boxed, 12/6 ea. P/P 1/3.

PORTABLE PRECISION VOLTMETERS.

Brand new moving iron instruments by famous manufacturer. Housed in polished teak case, 8in. mirror scale. 2 ranges, A.C. or D.C. 0 to 160 v. or 0 to 320 v. Accuracy within 2%, £5/19/6 ea. P/P 3/6.



LOOK! THOUSANDS OF BARGAINS AVAILABLE WHICH WE ARE UNABLE TO ADVERTISE IT IS WORTH YOUR WHILE TO PAY US A VISIT



BRAND NEW Boxed 100 MICROAMP METERS. Standard 2½ in. flush panel mounting. Scale calibrated 0-100 microamps. 42/6 each. P/P. 1/3.

MAINS PANEL NEON INDICATORS. Chrome escutcheon, flying lead connections. Available red, green or clear, 3/6 each. P/P. 6d.

ALUMINIUM CHASSIS. 18 swg. four sided, reinforced corners. All sizes 2½ in. deep. 6 x 4 in. 3/6; 7½ x 5½ in. 4/6; 10 x 7½ in. 5/3; 11½ x 7½ in. 6/-; 13½ x 9 in. 6/9. Post extra.

PARMEKO MAINS TRANSFORMER. Fine heavy duty job. Primary 0/110/230 volts. Sec. 350/0/350 volts 150 ma. 6.3v. 4 amps, 5 volts 4 amps. New, boxed, 32/6. P/P 2/-.

PRECISION WIREWOUND POTENTIOMETERS. Linear track, 3½ in. dia. Available, 500 ohm; 2.5k; 5k; 10k; 25k; 50k and 100k ohms. All 10/6 ea. P/P. 1/-.

750 WATT AUTO TRANSFORMERS. Fine heavy Admiralty type. Tapped from 110 to 230 volts to give any spot voltage. 69/6 each. P/P. 5/-.

POTTED "C" CORE CHOKES. 16 H. 120 ma.; 20 H. 80 ma.; 100 H. 30 ma. All 10/6 ea. 5 H. 500 ma. 17/6; 10H. 500 ma. not potted, 25/- ea. Post extra.

FERRANTI POTTED FILAMENT TRANSFORMERS. Primaries tapped 200/250 volts. 1. 6.3v. ct. 5.6 amp; 6.3v. ct. 4.8 amp; 6.3v. ct. 1 amp; 19/6 ea. 2. 6.3v. ct. 3.3 amp; 6.3v. ct. 1 amp; 6.3v. ct. .9 amp; 6.3v. ct. .6 amp; 15/6 ea. P/P 2/-.

GARRARD VARIABLE SPEED GRAM MOTORS. 200/250 volt A.C. Adjustable from 0 to 45 r.p.m. by arm. 22/6 ea. P/P. 2/6.

MUIRHEAD PRECISION STUD SWITCHES. 4 banks. Each bank 1 pole 24 position. Heavy contacts. Only 17/6 ea. P/P. 1/3.

ROTARY TRANSFORMERS. 12 volt DC. input. Output 250 volts 80ma. 22/6 ea. Ditto 6 volt input, 22/6. P/P 2/6.

CHOKE BARGAINS. 4H. 22.5ma. 2/6; 5H. 60ma. 3/6; 5H. 200ma. 5/6; Collins 8H. 100ma. 8/6; Rich & Bundy 50H. 120ma. 12/6. Post extra.

HEAVY "C" CORE TRANSFORMERS. 230 volt primary. 725/700/675/0/675/700/725 volt 500ma. 6.3v. 6 amp, 6.3v. 1 amp, 5v. 6 amp. New boxed, 72/6 ea. P/P. 5/-.

FERRITE CORED LOOP AERIALS. Operative up to 2 mc/s. New boxed, 22/6 ea. P/P. 2/6.

ADMIRALTY SLOW MOTION DRIVES. 180°, scaled 0 to 100. Fast and slow knob with lock and also flick mechanism for setting to fixed frequencies, new 7/6 ea. P/P. 1/3.

24 AMP. VARIAC TRANSFORMERS. Primary 230 volts. Adjustable sec. from 185 to 250 volts. 24 amps. £12/10/0 each. P/P. 10/-.

"C" CORE POTTED L.T. TRANSFORMERS. Primaries all 230 volts. 1. 6.3v. 3 amp. 6.3v. 3 amp., 6.3v. 3 amp., 6.3v. 1.5 amp. 21/- ea. P/P. 2/-.

12 VOLT ROTARY CONVERTERS. Input 12 volt D.C. Output 230 volts A.C. 50 cycles, 150 watts. Housed in wooden case and fitted with voltage control resistance and 300 volt A.C. output check meter. Supplied fully tested, £9/19/6 ea., P/P. 10/-.

MINE DETECTORS NO. 4A.

Complete equipment comprises search head, amplifier, headset, control box, telescopic rods for search head, search head test unit, test measure and haversack. Operation is from standard 67½/1½v. battery. The unit will detect ferrous or non ferrous metals to a depth of 24 ins. giving maximum signal but can be used at greater depths giving lower output. Ideal for tracing underground pipes or cables and any hidden metal objects. Fully waterproof. Complete equipment supplied brand new in original transit cases complete with operating instructions. Price 99/6 ea. Carriage 10/- extra.

BARGAINS IN RECORD CHANGERS.

B.S.R. UA8 Automatic 4-speed record changers, brand new, guaranteed, £6/12/6 ea. P/P. 3/6.

COLLARO CONQUEST automatic 4-spd. record changers, brand new, guaranteed, £6/15/0 ea. P/P. 3/6.

COLLARO JUNIOR 4 speed single record changers, 79/6 ea. P/P. 2/6.

GARRARD 45 R.P.M. BATTERY PLAYERS. Operate from 6v. battery, 59/6 ea. P/P. 2/6.

FIELD TELEPHONES TYPES L.

Ideal for all intercom systems. House, office or building site. Generator bell ringing. Two line connection. Supplied complete with batteries, fully tested. As new, 59/6 ea. P/P. 3/6.

8 RANGE SUB-STANDARD D.C. AMMETERS

Ranges 1.5, 3, 7.5, 15, 30, 60, 300 and 450 amps. 8in. mirror scale. Housed in polished teak case. Supplied complete with all shunts and leather carrying case, £15 each. P/P. 7/6.

PHOTO VOLTAGE AMPLIFIERS

These special units contain a 1 microamp. Tinsley mirror galvanometer and a double selenium photo electric cell. Brand new, £9/19/6 ea., P/P. 7/6.

HIGH FIDELITY RECORDING TAPES BARGAIN PRICES

3in. spool 225 ft.	L.P.	6/-
5in. spool 600 ft.	std.	12/-
5in. spool 900ft.	L.P.	17/-
5½in. spool 1200ft.	L.P.	19/6
7in. spool 1200ft.	std.	19/-
7in. spool 1800ft.	L.P.	29/-

SPARE PLASTIC SPOOLS, 5½in. 2/3; 7in. 3/6. New, Boxed, Guaranteed. Post extra.

COSSOR 339 DOUBLE BEAM OSCILLOSCOPES.

Operation 110 / 200 / 250 volts A.C. Time base frequency sweep 6 cps. to 250,000 cps. Amplifier bandwidth 10 cps. to 2,000,000 cps. Supplied in perfect working order fully tested, £15 ea., P/P. 10/-.

METER BARGAINS

20 microamp D.C. M/C flush rd.	2½ in.	69/6
25 microamp D.C. M/C proj. rd.	2½ in.	59/6
50 microamp D.C. M/C proj. rd.	2½ in.	49/6
100 microamp D.C. M/C flush rd.	2½ in.	42/6
100 microamp D.C. M/C flush rd.	3½ in.	62/6
200 microamp D.C. M/C proj. rd.	2½ in.	29/6
300 microamp D.C. M/C flush rd.	2½ in.	29/6
1 milliamp. D.C. M/C flush sq.	2in.	22/6
1 milliamp. D.C. M/C flush rd.	2½ in.	25/-
1 milliamp. D.C. M/C flush sq.	4in.	69/6
30/0/30 milliamp. D.C. M/C flush 2½ in.		9/6
15 amp. D.C. M/C proj. rd.	2in.	8/6
120 volts D.C. M/C flush rd.	3½ in.	32/6
300 volt A.C. M/C rectifier flush rd.	2½ in.	25/-
300 volt A.C. M/I flush rd.	2½ in.	25/-
500 volt A.C. M/I flush rd.	2½ in.	25/-
1,500 volts electrostatic. proj. rd.	2½ in.	25/-

Postage extra.

NEW BLOCK PAPER CONDENSERS.

Nitrolon, Visconol types. .25mfd. 4kv. 3/6; .25mfd. 7.5kv. 10/6; .25mfd. 10kv. 15/-; 1 mfd. 600v. 1/9; 1 mfd. 1kv. 3/6; 1 mfd. 2.5kv. 6/6; 1 mfd. 5kv. 15/-; 2 mfd. 400v. 2/6; 2 mfd. 600v. 4/6; 4 mfd. 400v. 3/6; 4 mfd. 600v. 4/6; 4 mfd. 1,000v. 6/6; 4 mfd. 1.5k. 8/6; 8 mfd. 400v. 6/6; 8 mfd. 800v. 8/6; 8 mfd. 1.5kv. 15/-; 10 mfd. 1.5kv. 17/6; 32 mfd. 500v. 17/6. Post extra.

POTTED TRANSFORMERS. 230 volt primary. Secondary 350/310/0/310/350 volts 220ma. Total of 6.3 volts 13 amps; 5 volt 4 amps. 49/6 ea. P/P. 3/-.

110/230 VOLT AUTO TRANSFORMERS. 20 watt, 9/-; 50 watt 12/6; 150 watt 18/6. Post extra.

MIDGET RECORDER MOTORS. Size 1½ x 1 x 2½ in. Operate 12/24 volt AC/DC. Fitted with gear. New boxed, 12/6 ea. P/P. 1/-.

VORTEXION PORTABLE AMPLIFIERS

Operates from 12 volt D.C. or 200/250 volts A.C. 10 watts push-pull output. Mic. or gram input. Output matched to 7.5, 15 or 500 ohm. Supplied in working order, £9/10/0 ea. P/P. 7/6.

"C" CORE E.H.T. TRANSFORMER. 230 volt primary. Secondary 3,850 volts 5.5ma. 4v. 2.5 amp, 4v. 1 amp. New boxed, 52/6 each. P/P. 2/6.

R.1155 IMPROVED GEARED SLOW MOTION DRIVES. Supplied brand new only 12/6 ea. P/P. 1/3.

NEW ELECTROLYTIC CONDENSERS

TUBULAR		
8 mfd. 150v.		1/-
8 mfd. 450v.		1/6
8 mfd. 500v.		1/9
16 mfd. 450v.		2/6
16 mfd. 500v.		3/6
32 mfd. 350v.		2/6
32 mfd. 500v.		3/6
25 mfd. 25v.		1/-
25 mfd. 50v.		1/3
50 mfd. 12v.		1/3
TUBULAR		
50 mfd. 50v.		1/3
100 mfd. 25v.		1/3
200 mfd. 6v.		1/3
800 mfd. 6v.		1/3
8+8 mfd. 400v.		3/6
8+8 mfd. 500v.		4/3
8+16 mfd. 450v.		3/6
16+16 mfd. 450v.		3/6
16+16 mfd. 500v.		4/3
32+32 mfd. 350v.		3/6
CANS		
16+16 mfd. 500v.		4/3
32+32 mfd. 450v.		4/3
50+50 mfd. 275v.		3/9
50+50+50mfd. 350v.		5/3
60 mfd. 450v.		3/6
64+120 mfd. 350v.		7/6
100+200 mfd. 275v.		7/6
100+400 mfd. 275v.		8/6
1000 mfd. 25v.		2/6
2000 mfd. 50v.		7/6

Please add postage.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

LASKY'S RADIO



AMAZING NEW TAPE RECORDER BARGAIN OFFER

A complete Tape Recorder using Collaro Studio 3-speed Deck, 1½, 3½, 7½ i.p.s. Twin track, with pause control, rev. counter, latest type electronic recording indicator. Superimposing switch, volume and tone controls, 7x4 loudspeaker, 4 watts output. Takes 7in. spools. In contemporary design carrying case, 9½x16x16in. Brand new, fully assembled ready for use. Limited number.
LASKY'S 29 GNS. including Acos mike and 1,200ft. Scotch Tape. Carr. & ins. 25/-.

TAPE RECORDERS

Largest stocks in London.

- BRELL, 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 Transcrip-tor. Uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. i.s. jack, superimposing switch. Complete with gold/black knobs. **12 Gns.** Post 3/6.

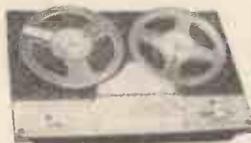
PLASTIC TAPE SPOOLS

3in. 2/9	5in. 2/9	5½in. 2/9	7in. 2/9	8½in. 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, 3½ i.p.s. uses 5in. spools. Lasky's Price including 850ft. Tape £8/19/6. Carr. free.



COLLARO STUDIO TAPE TRANSCRIP-TOR. 3 motors, 3 speed, 1½, 3½, 7½ i.p.s., takes 7in. spools. Push-button controls. £12/19/6 Carr. & Ins. 12/6. Tape extra.

COLLARO TAPE TRANSCRIP-TOR Mk. IV, fitted digital counter. List £25. Lasky's Price £17/16/6 Carr. & ins. 12/6. Tape extra.

LONDON'S LEADING Hi-Fi SPECIALISTS

Visit either of our addresses for selective Demonstrations of the very latest Hi-Fi Equipment.



- AMPLIFIERS
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Our Fabulous Hi-Fi Catalogue NOW AVAILABLE. SEND FOR A COPY TODAY

"Hi-Fi Journey with Lasky's" is the title of our superb new catalogue and it takes you all through the realm of high fidelity reproduction. Nothing like it has ever before been offered. Over 100 large pages, 11½x8½in. 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.

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- GARRARD 4HF stereo and monaural, complete with two plug-in heads, £18/9/-
- Carr. & Ins. 12/6.
- GARRARD 301 £22 7 3
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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**



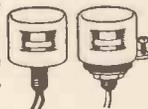
1,200ft. on 7in. spool..... 20/-
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SCOTCH PLASTIC TAPE
 1,200ft. on 7in. spool..... 25/-
 Post: 1 spool, 1/6.
 Orders over 60/- post free.

GEVAERT L.P. TAPE
 1,700ft. on 7in. spool..... 35/-
 850ft. on 5in. spool..... 16/6
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 Post: 1 spool 1/6.
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HIGH FIDELITY TAPE RECORDER HEADS

Leading make, new and un-used. 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, 3/6 low impedance. Lasky's Price, per pair, 39/6 Post free. Worth double. Please specify upper or lower track.



Avantic

For 200-250 v. A.C. mains. Brand new in maker's cartons, fully guaranteed. Full details of any item post free.



SPA11 Stereo Amplifier and Pre-Amplifier, twin 10 watts output. 3-dimensional monaural reproduction by combining both channels. 3 inputs for each channel. Size 14½in. wide, 4in. high, 8½in. deep. List £29/8/-. Lasky's Price **19 Gns.** Carr. & Ins. 7/6.



SP21/2 Stereo Pre-Amplifier Control Unit, twin channel. Designed primarily for use with two DL7-35 Power Amplifiers (as on right). 6 inputs for each channel. Freq. response 40 c/s.-15 Kc/s. List £28/10/-. Lasky's Price **£16/19/6** Carr. & Ins. 7/6.



DL7-35 Power Amplifier. 54 watts peak output. Freq. response 5 c/s.-30 Kc/s. ± 0dB. Two DL7-35 Amplifiers can be used in conjunction with SP21/2 Pre-Amplifier Control Unit for stereophonic reproduction. Size 14½in. long, 9in. wide, 8½in. high. List Price £31/10/-. Lasky's Price **£16/19/6** Carr. & Ins. 12/6.

PL6/21 20-watt Monaural Amplifier and combined Control Unit. 5 inputs. List £29/8/-. Lasky's Price **19 Gns.** 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.

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 x 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 £££ less than an equivalent ready-built player.



BARGAINS IN 4-SPEED AUTO-CHANGERS

New and Unused in Maker's Cartons



- B.S.R. type UA8..... £6 19 6
 - B.S.R. UA8, stereo..... £7 19 6
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 - 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 45P..... £6 19 6
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 - E.M.I. 4-spdl., 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
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PICK-UP CARTRIDGES

ACOS HGP.59 or HGP.37 turnover crystal cartridge with L.P. and standard styli. List 30/7.

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 x 5in. loudspeaker with output transformer mounted. Concentric volume and tone controls. Size of printed circuit: 4 x 3 x 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

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|------|------|-------|------|------|
| 7x4 | 9x6 | 10x2½ | 10x6 | 10x7 |
| 15/6 | 22/6 | 25/- | 25/- | 32/6 |
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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 7½in., front to back 8½in.

LASKY'S PRICE £16.19.6 Carr. & Insr. 12/6.

Available on H.P. terms. Brochure on request.

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.

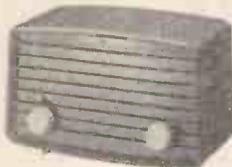
RIBBON MIKE on table stand. High impedance, famous make. £6/16/6. Post 3/6.

BUILD THE "VANCOUVER" 3-TRANSISTOR POCKET RADIO

Employs 3 transistors plus germanium diode, on printed circuit size 3½ x 4 x ½in. 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.

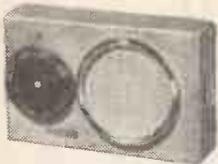
LASKY'S RADIO

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 x 5 x 4½in. deep. FULL DATA, instructions, circuit diagram, shopping list, 1/6.



BUILD THE GOSSOR "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 x 3½ x 1½in. Printed Circuit and easy-to-follow instructions.

LASKY'S PRICE £7.19.6 Post 2/6

All components available separately

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 x 7 x 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

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. x 4in. elliptical speaker.
- Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list 2/6 post free (returned if you order).

LASKY'S RADIO

TAPE RECORDER KITS

- Look at these star features:—
- ★ Very latest Printed Circuit.
- ★ T.C.C. condensers.
- ★ Amplifier can be supplied fully assembled and connected to Deck.
- ★ New Mullard valves: EF86, ECC83, EL84, EM34, magic eye, EZ80 rect.
- ★ Choice of speaker: 7x4, 8x5, 9x4, 6in., 8in., etc.
- ★ Collaro Studio or B.S.R. Monardeck Tape Deck.
- ★ Complete with Acos 39/1 Mike, Tape and Spool.

PRICES FROM

20 GNS. **25 GNS.**

(B.S.R. deck) (Collaro deck)
 All components available separately
 Full details and shopping list post free on request.



TEST METER BARGAIN

"ALFA" MULTI-RANGE RADIO TEST METER. A.C. and D.C. 3,333 ohms per volt. Ohms ranges to 2 megs. Volts A.C. and D.C. up to 1,200. 300 microamps—300 mA. Decibels, 2 ranges —20 to +23 db; +20 to +37 db. Accuracy ±3%. Large full vision dial. Overall size: 5½ x 3½ x 1½ in.

LASKY'S PRICE 89/6
 including Leads.
 Post 2/-.

SEND FOR THE FINEST COMPONENTS CATALOGUE

produced for the "ham" or service man. OVER 100 PAGES, SIZE 8½ in. x 5½ in. COPIOUSLY ILLUSTRATED.

Price 2/- Post 6d.

Our latest 12-page "BARGAIN BULLETIN" free with each copy or available separately by post, price 6d.

LASKY'S F.M. TUNER

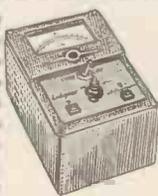
PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION

Uses 5 valves, 2 germanium diodes and brand new T.C.C. condensers. The PRINTED CIRCUIT ensures that the I.F. and R.F. amplifiers are extremely stable at maximum gain and results are consistent on all tuners.

CAN BE BUILT FOR (including valves) 7 GNS.
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G.E.C. FM TUNER BOOK plus our full data and Shopping List 2/6 post free. All parts available separately.

ALIGNMENT SERVICE available.



THE LABGEAR A.F. POWER METER KIT

offers the home constructor a complete kit of parts which together with clear step-by-step instructions will enable an accurate Power Meter to be constructed at very low cost. Printed Circuits eliminate a large proportion of wiring and assembly time is halved. The net result is an instrument of the highest quality at a fraction of normal cost.

SPECIFICATION

Power: 25 mW. to 10 w. in two switched ranges.
 F.S.D.: 1 watt x 10 watts.
 Input Impedance: 2, 15 and 600 ohms unbalanced.
 Accuracy: 5% scale reading and impedance.
 Dimensions: 4½ x 6½ x 3½ in.
 Finish: Silver hammertone enamel with matt aluminium legend plate.
 (Moving Coil Meter, 2½ in. F.S.D. 1 m/a).

LASKY'S PRICE 59/6

Post 3/6.

Complete Kit including full step-by-step instructions, circuits, data, etc.



LARGEST AND MOST COMPREHENSIVE STOCKS FOR ALL CONSTRUCTORS

20,000 VALVES IN STOCK
 Mullard, Brimar, G.E.C., Mazda, Cossor, E.M.I., Philips, Pinnacle, Telefunken, etc. Send for our latest Valve List.

CABINETS
 W/B PRELUDE,
 G. PLAN, NORDYK,
 CAPRIOL, etc., etc.

MAKER'S SURPLUS TELEVISION COMPONENT BARGAINS

- WIDE ANGLE 38 mm.
 Line E.H.T. Trans. Ferroxcube core, 9-16 kV 19/6
 Scanning Coils, low imp. line and frame 19/6
 Ferroxcube core/ Scanning Coils and Line Output Trans., 10-15 kV. EY31 winding Line Trans. with width and linearity controls, circuit dia., pair 50/-
 Frame Output Transformer 6/6
 Frame or line block osc. Transformer 4/6
 Focus Magnets Ferroxcube 12/6
 P.M. Focus Magnets, iron cored 12/6
 Duomag Focallisers 15/-
 300 mA. Smoothing Chokes 10/6

STANDARD 35 mm.

- Line Output Transformers 6.9 kV. E.H.T. and 6.3 v. winding, Ferroxcube 17/6
 Scanning Coils. Low imp. line and frame 7/6
 Frame or line blocking oscillator Transformer 4/8
 Frame Output Transformer 7/6
 Focus Magnets:
 Without Vernier 9/6
 With Vernier 12/6
 200 mA. Smoothing Chokes 7/6

C.R. TUBE BARGAINS NEW AND UNUSED

FERRANTI, 9in. type T9/3, 4 v. heater, or 12 in. types T12/44 and T12/54, 4v. heater.
LASKY'S PRICE 49/6
 Carr. & Insur. 12/6.

FERRANTI 17in. type TR17/10, 6.3 v. 3 amp. heater. Brand new and unused.
LASKY'S PRICE 66.19.6
 Carr. and Insur. 12/6.

16 in. METAL CONE, famous make, type T901/A, 6.3 v., 0.3 amp. heater.
LASKY'S PRICE 66.9.6
 Carr. & Insur. 21/-.

17in. 90 degrees C.R. TUBES
 Seconds but in perfect working order and guaranteed.
 Carr. and insur. 12/6. **79/6**

RE-GUNNED C.R. TUBES GUARANTEED FOR 12 MONTHS

Type	Price	Carr.	Ins.
12in. round	£6 10 0	0	12/6
14in. rect.	£6 10 0	0	12/6
15½. & 16 round	£6 19 6	6	12/6
17in. rect.	£6 19 6	6	12/6
31in. rect.	£7 19 6	6	21/-

12-CHANNEL TURRET TUNERS

Large selection, many by famous makers such as Cyldon, Brayhead, Plessey, Cossor, etc., all I.F.S. New and unused. Let us quote you for the model required. Examples:
 33-33 mc/s., 37/6, 6-9 mc/s., 59/6,
 9-14 mc/s., 59/6, 14-25 mc/s., 59/6.

TRANSISTORS

P.N.P. Junction types.
AUDIO, suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts Double spot—yellow and green. Each **5/-**

R.F. suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.). Double spot—yellow and red. Each **7/6**

Type **TS1**. Suitable for all audio applications. Each **3/6**

One dozen 35/- post free.

Special prices quoted for large quantities.

OC44 15/-; OC45 15/-; OC70 8/6; OC71 8/6; OC78 15/- (Matched Pair 30/-); OC73 14/-; OC18 54/-.

EDIWAN MAZDA TRANSISTORS. The very latest types. XB/102 10/-; XB/103 10/-; XC/101 12/6; XA/101 15/-; XA/102 17/6.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102, XB/103, 2 matched XC/101. Price 79/6.

CRYSTAL DIODES. General Purpose GEX00, each 1/-, Per doz 9/-. All other types in stock.

"GOLDTOP" POWER TRANSISTORS

All types in stock. Example:—V15/10P. Ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/- post free. Suitable Output Transformer for above, correct ratio, matched to 3 ohms. 9/6. Post 1/-.
 Driver Transformer, 9/6. Post 1/-.

RESISTORS. The largest stocks of all types, high stability, wire wound, carbon, vitreous enamel, miniature and submin. Millions in stock. Why buy unwanted assortments? We will send you the types and values you actually want.

SUB-MIN RESISTORS, ½ watt, most values available. Each 3½d. Per doz. 2/6.

5 milliamper **METER RECTIFIERS.** Special offer of limited number at only **8/6** Post 9d.

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Complete ranges in stock, mains and output, by Partridge, Gilson, Parmeko, Ellison, Elstone, Douglas, etc., etc. Let us quote you for the one you require.

RECORD BARGAIN IN ELECTRIC SHAVERS

For use on A.C. mains, 100-250 v. Plug in anywhere and get the smoothest, closest, speediest shave ever! Vibratory action tones up face. Swiss make, cream finish. Limited number only. Worth 7 Gns.



Lasky's Price 49/6
 Post 1/6.

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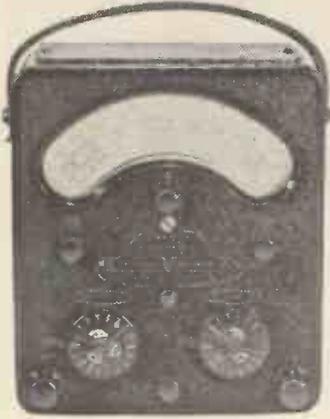
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42 TOTTENHAM COURT ROAD, W.1

Nearest Station: Goodge Street MUSeum 2605

Both Addresses OPEN ALL DAY SATURDAY

Close Thurs. 1 p.m.



AVOMETER MODEL D

£8.19.6 (P. & P. 3/6)

D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
105 mV.	7.5 V.	15 mA.	75 mA.
300 mV.	15 V.	30 mA.	150 mA.
1.5 V.	75 V.	150 mA.	750 mA.
3 V.	150 V.	300 mA.	1.5 Amps.
15 V.	800 V.	1.5 Amps.	7.5 Amps.
30 V.	600 V.	3 Amps.	15 Amps.
150 V.	750 V.	15 Amps.	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. HR0 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 3 1/2 x 3 1/2 x 3 1/2 in. 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. 4 1/2 x 4 1/2 x 5 1/2 in. 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. 6 1/2 x 6 x 7 1/2 in. high. Weight 25 lb. Removed from equipment but in perfect condition, 52/6. Carr. 5/6.

SANGAMO WESTON

VOLTMETERS \$61. 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.

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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 cracked 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 cracked steel cabinet, size 10 1/2 x 1 1/2 x 6 in. 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 GROWD 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 SOLED. A GENUINE BARGAIN. £4/18/6. CARRIAGE 25/6.

T.C.C. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1 1/2 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, 4 c/overs, platinum, M1092 19/6
G.E.C. sealed, wire ends, 5,000Ω, 2 c/overs, platinum, M1052 17/6
Siemens High Speed, 1K + 1KΩ, 1 c/over..... 10/6

GIANT COMPONENT PARCEL

Contains 100 1/2 and 1 watt resistors, 80 HI Stab resistors, wire wound resistors, carbon and W/W pots, 100 capacitors (mica, paper, Sprague, bias, variable, etc.), valveholders, wax strips, metal rectifiers, sleeving, etc. All components are unused. GUARANTEED VALUE. 25/- plus 2/6 post.

CHARLES BRITAIN (Radio) LTD.

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Near Leicester Sq. Station.

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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. 6 1/2 in. reads 5-18.5 Kv. Manufactured 1953. Contained in wooden case 10 x 10 x 9 in. high. £9/19/6. Post paid.

SANGAMO WESTON ANALYSER E772. A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. £7/10/-. Carr. 4/6.

MARCONI TF987/I NOISE GENERATORS. Range 100 Kc/s. to 200 Mc/s. Determines noise factor of AM and FM receivers. Fully stabilised H.T. supply A.C. mains operation. Brand new and in original boxes. £15. Carr. 7/6.

RESISTORS

Morgan "T" (1/2 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. 2 1/2 in. 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.

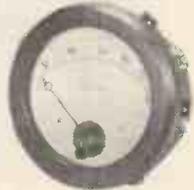
RADIATION METERS. Portable dose-rate meter, containing modern type rectangular 50 micro-amp meter, CVX494 electrometer valve, etc. BRAND NEW. In canvas carrying case, £3/19/6. Post 2/6. For details of other equipment, see our previous adverts.

MICROAMMETERS

R.C.A. 0-500 microamps, 2 1/2 in. 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/-. American 0-100 microamps, 2 1/2 in. square flush panel mounting. BRAND NEW. Boxed. 42/6.

FERRANTI VOLTMETERS

N5. 0-300 volts, 25-100 c/s. Moving iron. 6in. scale. Fl. mtg. Hermetically sealed, grade IN. Made 1955. BRAND NEW. Boxed. 79/6. Post 3/6.



Get Finest Value from IRONGATE—England's Leading Equipment Wholesalers
Bulk Buying means LOWEST PRICES. All Equipment is in TIP-TOP condition



LATEST miniature

EXPORT ONLY

WALKIE TALKIE

"88" sets—just released by Ministry of Supply. Produced to exacting specifications by leading manufacturers E. K. Cole & Co. this Transmitter/Receiver weighs only 5½lb. (approx.) and measures 3½ in. x 5½ in. x 9½ in. It is a 4 frequency channel set, crystal controlled, 38.40/40.42

Mc/s., and operates from a Standard Dry Battery—HT/LT. 94/1, 3 v. (i.e. Ruben Mallory Type 1). 14 of the current series of B7G valves are employed: 1-3A4, 6-1L4, 4-1T4, 1-5S, 2-1A3. Each set is in first class condition.

Only **£10** each.

Special quotations for quantities up to 3000 sets. "22" SETS ALSO—300 available only. New condition £10 each.



SUPPLIED COMPLETE WITH CRYSTALS. Accessories can be supplied to order at extra cost.

1,000,000 YARDS!!
SCREENED WIRE FLEX
FOR ONLY 2d. per yd.



For Immediate Delivery—priced far below cost.
 Specification: Close braided 14/0048in. Covered .024 p.v.c. Tinned Copper. Screened. Assorted colours.
 Applications: Microphone leads, pick-up heads, etc.
ON MAKER'S REELS.
 220 yd. REELS (min. quantity). 36/8. P. & P. 5/-.
 TEN REELS £17. Carr. Paid.

HEAVY DUTY
20 AMP. L.T. SUPPLY UNIT



by **S.T.C.**

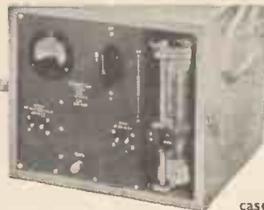
Normal cost over £100
 Essential equipment for Electronic Engineering, research laboratories, schools. Ideal for battery charging etc. Guaranteed for 20 amps.

Output: D.C. Variable up to 20 amps, and 24 v. or trickle charge 125/350/700 ampere hours.

Input: A.C. 100/260 volts 45/65 cycles. Size: 16 x 24 x 32in. high.

In attractive Grey Cabinet. **£22-10-0**
 ex Warehouse
 (Circ. diags. and instr. loaned for 10/- deposit).

ROTARY CONVERTORS.



Input: 12 v. D.C.

Output: 230 v. A.C. 150 watts 50 cycles

Housed in wooden case and fitted

with voltage control slider resistance switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested, £9/19/6 each. P. & P. 10/-.

Special Bulk Purchase makes possible this **UNIQUE OFFER**
 World Famous **"F" TYPE TELEPHONES**
 In Attractive Case

ONLY **£4-19-6** per pair **9/-** carr.

The best portable telephone ever made. Original cost £40! Range up to 5 miles. Ideal for **FACTORIES, BUILDING SITES, FARMS, OFFICES.** 2 perfect case sets with batteries, 100ft. cable, etc.

TELE "F" HIGH POWER as above, but complete with amplifier. **£6/10/-** each. Carr. 12/6.
D3 STRANDED TELEPHONE CABLE. New Mile Drum 85/-, carr. 17/6.
ENGLAND'S LARGEST STOCKS OF TELEPHONE EQUIPMENT.



SUPER POWER AMPLIFIER

TODAY'S BEST PRICE
 —only **£40**, carr. paid.

Complete system with 4 speakers—saves over £100.

MADE TO STRICT GOV'T. SPEC.
 Will take up to 20 speakers. Ideal for **INDOORS or OUTDOORS.** Entire premises—Factories, Warehouses, Sports Grounds, etc.
 Output: 30 to 60 watts. Valves: Four 6L6, parallel push-pull. Input: 200-250 volts A.C. Leads, hand mic., plugs, spares, included. Robust wooden transit case 17½ x 15½ x 12in.
ORDER NOW—WHILE STOCKS LAST.
 Extra speakers 22/- each, carr. paid.

P.A. SYSTEM (EX GOV'T.)

Complete with amplifier unit, 4 speakers, microphone, headphones and all spares packed in wooden cases, 6 or 12 volts D.C. handling capacity 8 watts. Ideal for cars, boats, factories, etc. 15 gns. Carr. 30/-.

AERIAL MASTS
IMPROVED TYPE 50 MK.II
36ft HIGH



Kits comprise—six 2½in. dia. Tubular Steel Sections of 6ft. length, top-section and base Pickets, Guys and Fittings.
YOU can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take aerials for Tx., Rx., F.M. and TV. (especially COMMERCIAL) and has many other uses. Extra 6ft./sections can be supplied at 17/6 per section.
£8.10.0 only Carr. 15/6.

U.S.A. Type 45ft. TELECOM AERIAL MAST. (7 sections, 6ft. 8in. x 2½in., guys, etc.) This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for £25. Carr. extra. British Manufacture only.

ARMY TYPE 32FT. MASTS similar to above but 10 lin. screw-sections, suitable for permanent lightweight installation. Kit in canvas bag, £3/15/- Carr. 7/6.

Limited Quantity **36ft. TELESCOPE MASTS**

Finest quality brass. Non-rusting. Base diameter 2½in. Complete with hand-winding winch for easy, rapid extension; and cable-way bracing stays. One of the best masts ever produced. **£35** each Carr. £1/10.
 Winds down to 9ft.

CONSTANT VOLTAGE TRANSFORMERS

FERRANTI 7½-KVA MOVING COIL
 Stabilized output voltage in the range 200-250 v. Plug-board tappings. The selected output voltage is constant with +1% at all loads 0 to 30/37½ amps when the supply voltage is varying over the range +8% to -12%
 ★ Frequency compensated 45-55 and 54-66 c/s
 ★ Excellent output wave-form.
 ★ Can be used as a variable transformer.
 ★ Unused. Complete with spares and instruction book at a fraction of the normal cost, only
 ★ **A.C. MAINS STABILIZER.**

£65



AUTO TRANSFORMERS

3KVA Air Cooled (100% under-rated). GUARANTEED 230/250 tapped, 12 amps. 6 KVA 105/120 tapped, 28.5 amps. Made by well-known manufacturer and housed in strong metal case. Weight: 2 cwt. Brand new, in original maker's case.

PRICE £15.0.0 Carr. 25/-.

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(M.O.) COMPANY

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PADDINGTON 22312/3

10,000 OHMS PER VOLT TESTMETER

This latest Caby model is a handy pocket sized tester 5 3/4 in. x 3 3/4 in. x 2 1/4 in. Reads low D.C. voltages at 10,000 ohms per volt, up to 1,000 v. A.C. and D.C. at 4,000 o.p.v. Resistance to 20 megohms, D.C. current to 250 milliamps, and also Decibels. Complete with Test Leads, Batteries, and Instruction Book. **ONLY £6/10/-.**



UNIVERSAL AVOMETER 34 RANGE MODEL D

Ex-Air Ministry, but thoroughly reconditioned and checked. Supplied with internal batteries and instructions. Covers ranges as follows:

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mV.	7.5 v.	15 mA.	75 mA.
300 mV.	15 v.	30 mA.	150 mA.
1.5 v.	75 v.	150 mA.	750 mA.
3 v.	150 v.	300 mA.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	
300 v.	1,500 v.	30 amp.	
1,500 v.			Resistance 1,000 Ω 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 2 1/2 in. Tube ACR 10. Front panel 19 in. x 7 in. for rack mounting, depth 12 in., or can be used in Steel Transit Case on bench. Complete with suggested Modification data. **BRAND NEW AND UNUSED. ONLY £12/10/- (carriage 15/-).**

HOA 8in. P.M. SPEAKER in heavy black cracked metal case, size 1 1/2 in. x 1 1/2 in. x 6 in. Designed for use with AR88 Receiver or any set with 3 ohm output. **BRAND NEW IN MAKER'S CARTONS. ONLY 45/- (Post 2/6).**

CANADIAN MOVING COIL PHONES. Low-resistance, fitted noise-excluding chamolac ear muffs, and leather covered head-band. Lead terminates to jack plug. **BRAND NEW. ONLY 19/6 (Post 1/6).**

CARRYING CASES, solid leather. SLIGHTLY USED. Internal dimensions 8 1/2 in. H x 8 1/2 in. W, x 4 1/2 in. D. Fitted lock and key, and shoulder strap. Ideal for Test Instrument, Camera and accessories, etc. **ONLY 25/- (Postage 2/-).**

BC 342 RECEIVERS. A few only of these famous American sets covering 1.5-18.0 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/-).**

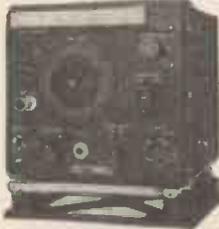
HBO MAINS POWER UNITS. A.C. Input 115/230 volts, Output D.C. (fully smoothed) 230 volts 75 mA., and 6.3 volts 3.5 amps. Complete in black cracked case. **ONLY 50/6.**

12-WAY SCREENED CABLE. In 10ft. lengths, fitted with plugs, originally made for No. 19 Wireless Set. **UNUSED. ONLY 15/- per lead.**

P.M. SPEAKERS. 3in. 19/6, 6in. 17/6, 8in. 21/-, 12in. 29/6.

SPRAGUE CONDENSERS. Metal cased wire ends. New. 0.1 mfd. 1,000 v. and 1 mfd. 500 v. 7/6 per dozen. Special quotes for quantities.

HETERODYNE FREQUENCY METERS TYPE LMI4



Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy Model of the well-known BC221 Frequency Meter, but has many additional features which increase its usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy, and in addition it is fitted with an Internal Modulation switch to allow use as a Signal Generator. Size only 8 1/2 in. x 8 in. x 8 1/2 in. Full information on request.

RIISS 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., 1,500-800 kc/s., 500-200 kc/s., 200-75 kc/s. and is easily and simply adapted for normal mains use, full details being supplied. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Fitted with latest type Super Slow Motion tuning assembly. Have had some use, but are in excellent condition. **ONLY £9/19/6.**

A.C. MAINS POWER PACK OUTPUT STAGE in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 3in. P.M. speaker £6/10/-. **DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.** Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

RC4 RECEIVERS AR88D. Thoroughly re-conditioned and in perfect working order. Cover 500 Kc/s.-31 Mc/s. **ONLY £60 (carriage, etc. 25/-).**

DOUBLE BEAM OSCILLOSCOPE TUBES

Type CV 1596 equivalent to Cossor O9D as used in oscilloscopes by Cossor (339 series). Hartley and Erskine (13 series). Listed at **£12/10/-.**

Our price £2/19/6 (carriage 5/6)
Brand New in makers' crates.

W 1191A WAVEMETER

Crystal controlled heterodyne frequency meter covering 100 kc/s to 20 Mc/s. in 8 switched bands and is virtually the British BC221. Power requirements 2 v. L.T. and 40-60 volts H.T. Complete with Calibration Book, Crystal, Operating Valves and full set of spares. **BRAND NEW IN ORIGINAL TRANSIT CASES. ONLY £9/19/6 (carriage 15/-).**

METERS

F.S.D.	SIZE AND TYPE	PRICE
25 microamps	D.C. 2 1/2 in. Proj. circular	59/6
50 microamps	D.C. 2 1/2 in. Flush circular	59/6
50 microamps	D.C. 3 1/2 in. Flush circular	80/-
100 microamps	D.C. 2 1/2 in. Flush circular	39/6
1 milliamp	D.C. 2 1/2 in. Flush square	22/6
1 milliamp	D.C. 2 1/2 in. Flush circular	30/-
1 milliamp	D.C. 2 1/2 in. Flush circular	25/-
1 milliamp	D.C. 3 1/2 in. Flush circular	50/-
200 milliamp	D.C. 2 1/2 in. 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. 2 1/2 in. Flush circular	25/-
500 volts	A.C. 2 1/2 in. Flush circular	25/-

V.H.F. RECEIVER TYPE R.1392. A superb 15-valve 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. x 10in. x 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).**

HIGH FREQUENCY A.C. VOLTMETER. A first-grade moving iron instrument with 6in. Mirror Scale reading up to 150 volts A.C. at 400 and 1,200-2,400 cycles. In substantial oak case with removable lid, overall size 8 1/2 in. x 8 1/2 in. x 5 1/2 in. Recently made for the Air Ministry by Everett Edgcombe Ltd., and in perfect order. Brand new and unused. **ONLY £7/10/-.** Can also be supplied for 60 cycles use, either 0-150 volts or 0-300 volts, same price.

POWER UNIT TYPE 3. Primary 200/250 volts A.C., 50 cycles. Outputs of 250 volts 100 mA., and 6.3 volts 4 amps. Fitted double smoothing and 2 meters to read H.T. current and voltage. For normal rack mounting (or bench use) having grey front panel size 19in. x 7in. **BRAND NEW. ONLY 79/6 (carriage 7/6).**

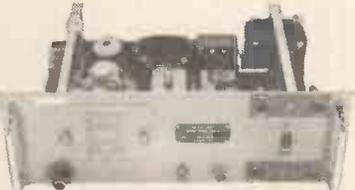
INTERCOM. TELEPHONE SET. Two pairs of Brand New Headphones connected to Breast Microphones, with leads, etc., in fitted carrying cases. Supplied with 4 1/2 volt battery, 10 yards twin flex, and full instructions for connecting to make super intercom. **ONLY 27/6 (Post 3/6).** Extra flex 3d. per yard.

RECEIVER E107. A few more of these fine receivers, 9 wavebands covering 1.2-17.0 Mc/s. (18-250 metres), incorporating built-in speaker and 2 power packs for use on 100-250 volts A.C. or 12 volts D.C. In magnificent condition, the finest we have yet had. **ONLY £15 (carriage £1).** A few sealed sets at lesser prices to callers only.

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 ma. Size 6 1/2 x 3 1/2 in. diameter. Ideal for running Radio and Electric Shaver, etc., from car battery. **ONLY 32/6.**

MARCONI SIGNAL GENERATOR TF 1440/7. Coverage 85 kc/s.-2.5 Mc/s. and 8 Mc/s.-70 Mc/s. Complete, and in AS NEW CONDITION. **ONLY £95.**

AMPLIFIER N24



Utilises 4 valves, 1 each 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 x 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. x 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 24/9/6 (carriage 10/6).**

Cash with order please, and print name and address clearly
PLEASE ADD POSTAGE OR CARRIAGE COSTS ON ALL ITEMS

HARRIS ELECTRONICS (LONDON) LTD.

Radio Corner, 138 Gray's Inn Road, London, W.C.1. Phone: TERMINUS 7937

Open until 1 p.m. Saturdays.

We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

★ FOR IMMEDIATE DISPOSAL ★

★ THE FOLLOWING GOODS AT A FRACTION OF COST ★

BRAND NEW Television Tubes (**NOT REBUILDS**). Sealed Maker's Cartons.

12in. Emiscope 3/31 30/- each.

12in. Ferranti 12/44 12/549 2 40/- each.

17in. Mullard Types 43/64 43/69 £5 each.

RECLAIMED (RECEPTION TESTED) **PROJECTION TUBES MW 6-2 10/- each.**

RADIO AND TELEVISION VALVES NEW, COMMERCIAL AND EX-GOVT. TYPES 2/6 each.

2D21, *6AG5, 6J6, *EB91, *EF91, *6K7G, 1625, 12SR7, VR150, *12SK7, 12A6, 1626, 1629, *AC/TT4, *AC/NHL, *PEN46, *VU111, *KT44, *ATP4, *VPT4, *ARP37, *KT2, *VP2, *TDD2, *VHT2A, 6SN7, *12SL7, KTZ41, *HL2, *LP2, VMS4.

Reclaimed types SP41, SP61, EF50, VV6, PEN45 (Starred valves * special bulk prices on request).

THE FOLLOWING NEW VALVES AT 5/- EACH.

PX4, PENA4, TDD4, AC2PENDD, SPT4, UF41, 12K8, KT74, DL74M, 6J8, 6V6GT, DH77, EF37A, U76, W76.

DISTLER "TOWN AND COUNTRY" DRY BATTERY SHAVER COMPLETE 40/-.

ELECTRIC "HEALTH AND BEAUTY" FACE AND BODY MASSAGER. 110-250 volts. FULL SET 20/-.

ELECTROSTATIC ISOPHON **STHB7** SPEAKER. APPROX. 3½in. SQUARE 30/- DOZEN.

WAVOX "INVISIBLE" ALL WAVE RADIO AERIAL 2/-. EACH £5 GROSS LOTS.

VIDOR "HORNET" CYCLE HOOTERS (7/6 list). COMPLETE WITH BATTERY 2/6. GROSS LOTS (LESS BATTERIES) £5.

EVER READY CYCLE REAR LAMPS (NEW SEALED BEAM) WITH BULB 2/-. (BATTERY 1/3 IF REQUIRED. 12/- DOZEN). £10 GROSS.

ROLL FILMS OUTDATED. DUFAY 127 AND ENSIGN 620 1/- ROLL. £5 GROSS (MIXED IF DESIRED).

GRAMOPHONE NEEDLES SONGSTER 200 IN TIN 1/- TIN.

MINIATURE. LONG PLAYING 10 IN PACKET 99s and SILENT STYLUS TYPES 1/- PACKET.

COLUMBIA "STANDARD" LONG PLAYING NEEDLES. 10 in PACKET. RED TIPPED 1/- PACKET.

8 MFD. ELECTROLYTIC CAPACITORS 450 V. 550 V. PEAK. CF19P. 1/-.

STAAR "GALAXY" (BLUE) REPLACEMENT STYLUS COMPLETE WITH DUAL NEEDLES 10/-.

COSSOR AMPLIFIER KIT. MODEL 562K WITH 2 SPEAKERS, A.C. MAINS, £5.

GARRARD BA1 45 R.P.M. (BATTERY OPERATED) PLAYER WITH CABINET (NO AMPLIFIER) £3 SET.

CAR RADIO AERIALS CHROME 3 SECTIONAL PULL-UP WITH CABLE AND FITTED PLUS, 20/- COMPLETE.

.001 VISCONOL 25KV TELEVISION CONDENSERS, 1/- each.

BAIRD ALL SPEEDS PORTABLE TRANSISTOR RECORD PLAYER (22 GNS. MODEL), £10.

COLLARO "JUNIOR" 4 SPEED A.C. MOTOR WITH DUAL-HI-FI PICK UP (2 ITEMS) 70/- SET.

B.S.R. "MONARDECK" TAPE DECK, A.C. MAINS. COMPLETE £7/10/-.

CAR RADIO VIBRATORS, 12 volt 4 pin G629C, 2/- each. £5 HUNDRED.

CREAM CO-AXIAL CABLE 75/80 OHMS 6d. YARD. 100 YARD COIL 40/-.

LINE CORD. .360 OHMS PER FT. 2 AND 3 WAY, 6d YARD.

FERRITE ROD AERIAL. MW. FULLY WOUND 5in., 5/-.

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Small, non-inductive, insulated, high-grade Capacitors
150 v. Wkg., 15 Mfd. 5%, 10d. 22 Mfd. 10% 9d. 2 Mfd. 10% 1/10. 250 v. Wkg., .068 Mfd. 9d. 1 Mfd. 1/1. 22 Mfd. 2% 1/4. 1 Mfd. 10% 1/7. 500 v. Wkg., 680 pF., 1,000 pF., 1,500 pF., 2,200 pF., 7d. each. 3,300 pF., 8d. 5,000 pF., 6,800 pF., .01 Mfd. 9d. each. 8,200 pF., 1/- .022 Mfd. .08 Mfd. 10d. each. .047 Mfd. 2%. .05 Mfd. 11d. each. .1 Mfd. 11d. .25 Mfd. 1/7. .5 Mfd. 1/3. 750 v. Wkg., .470 pF., .820 pF., 1,500 pF., 2,000 pF., 9d. each. 3,000 pF., 6,800 pF., 9d. each. .022 Mfd. 10d. 1,000 v. Wkg., 1,500 pF., 9d. 6,800 pF. 10d. .01 Mfd., 1,500 v. 1/-. .12 Mfd. .15 Mfd. 1/1 each.

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4 pin UK, 7d. 5 pin Brit. Pax. 2d. 7 pin Brit. Pax. 3d. 7 pin Brit. Amp. 4d. Int. Octal Pax. 3d. Mazda Octal Pax. 3d. Locals Amp. 8d. B7G Pax. 6d. B7G P.T.F.E. 8d. B7G Cer. with saddle and valve retaining spring 1/-. B8A Pax. 4d. B8A Amp. 6d. B8A Cer. 8d. B9A Pax. 6d. B9A Cer. 10d. B9A Cer. with saddle and valve retaining spring 1/-. (Internat. Octal McMurdo 6d.). B9A printed circuit 10d. B7G Valve Cans 6d. EX36 High voltage holders 1/3.

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Twin Gang 20 pF. Ideal for F.M. 2in. x 1½in. x 1in. 2/-. Twin Gang .0005 MFD. 2½in. x 2in. x 1½in. Spindle ½in. Min. Twin Gang .0005 MFD. 2½in. x 1½in. x 1½in. Spindle ½in. 5/6 (with Trimmers). Twin Gang .0005 MFD. Geared with S.M. 3/6. AM/FM 2-Gang Condensers. 500+20 pF. 3/6.

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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. 3 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
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490 volts at 65 mA.
Non Tropicalised.

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Input: 12 volts or switched to 24 volts.

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500 volts at 26 mA.

Also 12 volt vibro Pack Rectified OZ4 Valve.
Mallory Type G634C Vibrator.
All these units are smoothed.

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22/6 Post free.

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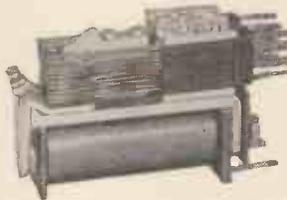
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BUILT UP TO YOUR REQUIREMENTS

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COMPONENT PARTS ALL PLATED

Yokes, 4/- each. Top plates, 3d. each. Fixing Screws (with insulators), 2d. each.
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						Single	Twin
1. C/O.....	1/3	4/-	9/-	500	3/-	5/-	
2. C/O.....	2/6	9/-	12/-	1,000	4/-	6/-	
3. C/O.....	3/6	12/-	16/-	5,000	5/-	7/-	
4. C/O.....	4/6	16/-	24/-	10,000	6/6	8/6	
6. C/O.....	6/6	24/-	32/-	20,000	9/-	—	
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Other build ups to order; all types of relays built to your specification.				80,000	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

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4184GD	700	2C	24	19 6
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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.



Carriage and packing 7/6.

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Delivery ex stock. Quotations on application.

H.T. 31
Input 11.5 v.
Output 250 v. at 125 mA.

H.T. 32
Input 11.5 v.
Output 490 v. at 65 mA.

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Made by DELCO

TYPE 1. 27/6. P. & P. 3/6.

TYPE 2. 37/6. P. & P. 3/6.

Type 1. Dual voltage 12 or 24 v., input 265 v., 120 mA. output: 500 v., 26 mA. output.
Type 2. 12 v. input 275 v., 110 mA. output; 500 v., 50 mA. output.

Both types dual output.

MADE IN U.S.A.



DYNAMOTOR ROTARY TRANSFORMER NEW AND BOXED

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.



UNREPEATABLE OFFER LESS THAN HALF MANUFACTURER'S COST

Brand new single phase motors suitable for tape recorders, radiograms, workshops, etc., etc. Has many uses. Reversible 200-230 v. 5in. oz. torque. 1,400 r.p.m. Capacitor start. Weight 4½lb. Length overall 5in., spindle both ends. ½in. x ¼in., ½in. x ¼in. Price, incl. P.P. and capacitor, 55/-.

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Good Condition.

50/- each. P. & P. 5/- or £4/10/0 pair.

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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.

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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.

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★ ★ 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
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 - High "Q" Internal Ferrite Aerial
 - Car Radio Adaptation Aid AVC
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 - Size 9½ x 7½ x 3½in. Weight 4½lb
- ALL COMPONENTS AVAILABLE SEPARATELY**

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ALL THE CONTINENTAL AND LOCAL STATIONS AT YOUR FINGERTIPS
CALL FOR DEMONSTRATION

- ★ STEP BY STEP FULLY ILLUSTRATED INSTRUCTIONS
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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
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DESCRIPTIVE LEAFLET FREE ON REQUEST

MAJOR-3

(3-Transistor Pocket Radio)

- ★ 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.

All parts sold separately.

TOTAL **87/6** P.P. 1/6. BOOKLET FREE

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RESULTS GUARANTEED ANYWHERE

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(2-Transistor Pocket Radio)

- ★ 4-stage reflex.
- ★ Medium wave; tunable.
- ★ Very sensitive. No aerial or earth required.
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- ★ Over 6 months on one battery. 4½ x 3 x 1½in.
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- ½ x ½in. IK. Hearing aid type 15/-.
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- BRAND NEW.**

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TELESCOPIC CHROME AERIALS

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ALL GUARANTEED.
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PLY CONTROL UNIT
1.2 mA. movement, 6 inch dial; Bridge connected.
"High-stab" controls. Only 85/-, P.P. 5/-.

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 - XC101 325 mw. push-pull, pairs 25/-
 - XC121 400 mw. push-pull, pairs 34/-
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 - XAI03 4 Mc/s. R.F./I.F. 12/6
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 - XC141 12 watt push-pull 30/-
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"ELECTRONIC DESIGNS" famous VALVE VOLTMETER

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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.

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Input 110-250 volts A.C.

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QUARTZ CRYSTALS FROM 5/- EACH
From 6 Kc/s-47 Mc/s. FT243, FT241, 10XJ and B7G.
All types for all purposes.
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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.
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- ★ Tone, balance and volume controls.
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Completely built and tested with knobs and calibrated dials, speaker sockets, etc. **£57/6.**
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★ **BARGAIN OFFER** ★

9 x 6in. speakers for use with above 18/6 ea.
Collaro Stereo 4-speed auto-change crystal pick-up—**BRAND NEW £7/10.** P.P. 3/6.

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Army Type 17 Mk. II
Complete with Valves, High Resistance Headphones. Handmade 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.
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HENRY'S RADIO LTD

5 HARROW RD., PADDINGTON, W.2

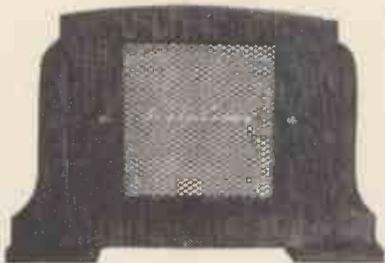
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Our SPECIALITIES: Transistors, Quartz Crystals, Tubes, Valves and Miniature Components

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83 HIGH STREET, MERTON, S.W.19. CHERRYWOOD 3985/6/7



EXTENSION SPEAKER

An attractive cabinet 8 x 6 x 2in. fitted with 3 ohm 5in. speaker complete with lead, a few only 19/6. P. & P. 2/6.

HARVERSON T.R.F. EASY FOUR KIT

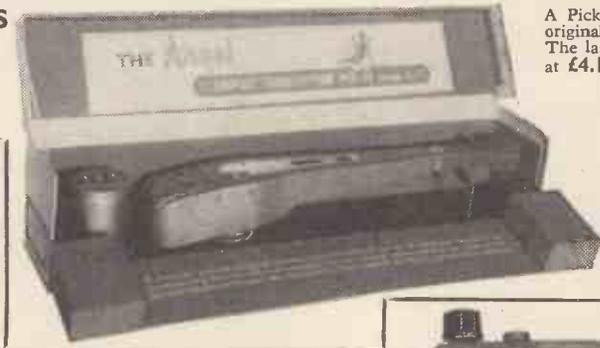
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Superhet version of above using Valves UCL83, UCH81, UBF89, UY85. Price £6.19.6 Plus P. & P. 3/6.



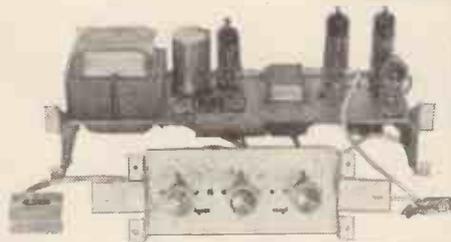
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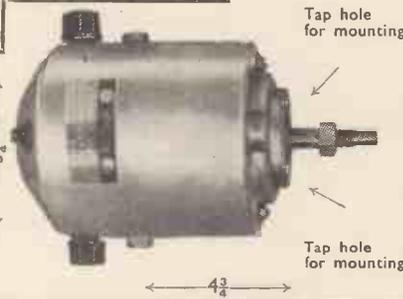
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 - ★ MAGIC EYE tuning.
 - ★ INPUTS for RADIO and MIKE.
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Complete with 2 Loudspeakers

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This is a compact amplifier embodying the latest features and giving a high standard of reproduction, with ample volume. Supplied complete with valves (ECL82, ECL82, EZ80), panel, knobs, etc., and two specially selected 3Ω matched loudspeakers. We only have a few, and we will never be able to repeat this offer at such a low price! Don't risk disappointment! Order now!

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- E.U. POWER POINT 12/6
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THIS MONTH'S OFFER

Plessey 6 x 4in. 3Ω Loudspeaker, 14/- each. 7 x 4in. Goodmans, 16/6.

25 amp. 2½in. flush mounting meters, new, 7/6.

12 Assorted Pots. Wire wound and carbon. Switched and unswitched—all useful sizes at 15/- the dozen, Plus P. & P. 1/-.

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DL7-35 Power Amplifier.
An amplifier faultless in performance. 50 watt peak, intermodulation distortion .7% at 20 watts. Power response: 20 w. linear from 30 c/s to 20 Kc/s. Frequency response: 5 c/s. to 30 Kc/s. 4, 8 and 16 ohms switch selected load impedance. Sensitivity: 220 M/V for 20 W. output. Maker's price of amplifier £31/10/-. **OUR PRICE 16 gns.** Post and packing 12/6.

SPECIAL OFFER for Stereo Enthusiasts

2 Avantic DL7-35 power amplifiers as above and the Avantic SP21 stereo pre-amp. control unit as below, the 3 items—our price now 47 gns. Carriage and packing 30/-.
The last of this wonderful offer.

AVANTIC SP21 Stereo Pre-amp Control.
A twin channel pre-amp. control unit. Can be used with the Avantic stereo tape pre-amp. STEP21. The SP21 has six inputs for each channel. Input sensitivity: for 250 M/V or 1.5 V. output. Tuner: 100 and 250 M/V. Tape: 100 M/V. Flar: 250 M/V. Pick-up: 5 and 50 M/V. Frequency response: 40 c/s to 15 Kc/s. Tape output: 50 M/V. Continuously variable bass and treble, loudness control, stereo balance control, power needed 6.3 V. at 1.3 A. A.C. 350 V. at 5 M/A. D.C. This can be used with DL7-35 power amp. Manufacturer's price £28/10/-. **OUR PRICE £16/19/6.** Post and packing 12/6.

PL6-21 AMPLIFIER AND PRE-AMP.
Combined unit. Compactly designed and fully enclosed. Ideal for shelf mounting for monaural reproduction. 30 watt peak power. Intermed distortion 1% at 10 w., output impedance 4, 8 and 16 ohms. Radio, tape, p/up, etc. Inputs. Separate bass and treble controls. High and low pass filter. **Our price £19/19/6.** Carriage and packing 7/6.

ANOTHER SNIP FOR TAPE RECORDER CONSTRUCTORS

The new Collaro studio tape deck, using 3 motors, 3 speeds at 1, 3½ and 7½ I.P.S., will take 7in. spools, push button controls, £12/19/6, 5/- post and pkg. Well designed tape recorder amplifier (not a kit) for the studio deck, incorporating Mic/Gram/Radio inputs, ext. loudspeaker, super imposing switch, with matching knobs, separately mounted mains transformer. Frequency response 60-10K/c 3DB at 7.5 I.P.S., magic eye level indicator. Using ECC83, ECL82, and EM85 and metal rectifier. Assembly instructions. The 2 units, £25/10/- complete Crating and Insurance, 17/6. Suitable Acos mic. 40 for above, 25/-.
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EVEREST as above but more powerful. Complete kit, £15/18/9. 2/6 Post and Packing on all the above. S.A.E. for details.

A NEW TRANSISTOR PORTABLE RECEIVER. Build this mighty six transistor superhet battery portable. Circuit description; 6 Mullard transistors, OC44, 2-OC45, 1-OC81D, 2 matched OC81, 1-X1 diode, printed circuit, internal ferrite aerial, Sin. loudspeaker, assembled. Dial assembly, medium and long wave coverage, 500 M/V output, attractive blue/cream two tone cabinet, size 8½in. x 6½in. x 3in. Weight approx. 3 lb. Detailed point to point and theoretical diagram, including all components for easy construction. **Only £9/15/- plus 3/- post and pkg. E/ready PP7 battery 3/3.** Instructions and circuit 1/6 post free.

THE VERDIK "QUALITY TEN"

10 watt push-pull ultra linear hi-fi amplifier with hi gain pre-amp. Mic., radio, gram and tape inputs, bass and treble controls. Beautifully finished. Control panel in gold lettering on grey green. Fully guaranteed. Original price 23 gns. **Our price £14/19/6.** P. & P. 7/6.

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Circuit description; 4 transistors (OC44, OC45, OC45, OC72), two OA70 diodes, two AGC systems, coverage 190-550 metres. Power output 30 m/w. Ferrite slab aerial, 2½in. moving coil speaker, printed circuit, attractive tuning control knob, leatherette case 6 x 3½ x 1½in. All components including theoretical and point-to-point diagram for easy construction. **ONLY £7/19/6.** Post & Pkg. 2/6. Limited supplies. This offer now coming to an end.

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The New American Audio Tape with plastic base. Also supplied in green or blue at no extra cost.
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Made by famous manufacturer. Brand new. Upper or lower track, record/play-back, high impedance giving up to 12,000 c.p.s. at 7½ I.P.S. output 5 mvolts at 1 KC at 7½ I.P.S. Erase heads low impedance. **Only 39/6 per pair.** Post 1/- State upper or lower track.

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Can erase a spool of magnetic tape in a few seconds. Demagnetises oxide deposits on tape heads. **Only 27/6, post free.**

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*Proceedings of the Second
International Conference Paris 1959*

Medical Electronics

*Edited by C.N. Smyth M.A., B.Sc. ENG., B.CH., M.I.E.E. and published
for the International Federation for Medical Electronics*

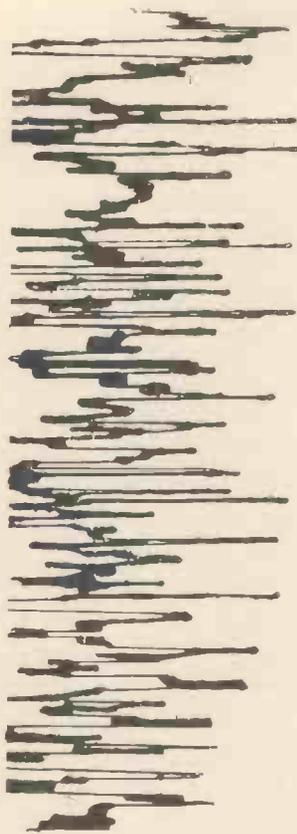
Electronic techniques, are becoming increasingly important in the medical sphere, because they provide extremely sensitive and versatile means of measuring or examining physiological effects which often cannot be detected by other methods. The growing importance of medical electronics was first recognized on a world scale when the First International Conference was held in Paris in 1958. This was an exploratory meeting, which led to the organization of the full-scale Second International Conference on Medical Electronics, held at the UNESCO building in Paris in 1959. This book is a record of the proceedings.

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OUR LATEST SUPERIOR PRODUCT. Type A2.
High quality. Low capacity. 10/15 p.f. **16/6** each
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15,000 ohms.—50,000 ohms. 5 w., 1/9; 10 w., 2/3
WIRE-WOUND POTS, 3 w. Standard size Pots, long
Pre-cut Min. T.V. type Spindle High Grade. All
Knurled. Slotted knob. values 100 ohms to 50 K.

3/- ea. 30 K. 50 K., 4/-
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Push-pull 10 watts, 15/6. Push-pull 20w. 5k. or 8k. 30/-
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GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5,
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ALADDIN FORMERS and cores, 1/4in., 3/8in., 1/2in., 10d.
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Precision engineered. Size only 1 x 1 1/2 in.

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9/-; less trimmers 8/- Midget 7/6; Single 50 pf. 2/6;
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Cascade circuit using Valve ECC84. 17db
gain. Kit 2/6 less power; or 4/9 with
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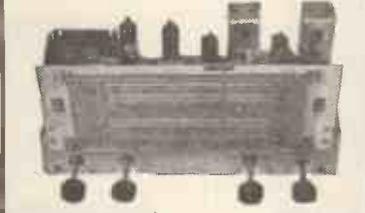


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NEON MAINS TESTER SCREWDRIVERS, 5/-
CORED SOLDER RADIOGRADE, 4d. per lb. 2/-
PAXOLIN 1/16in. x 8in. x 10in., 1/6. ION TRAPS 5/6.

P.V.C. PLASTIC RECORDING TAPE

Long Play 7in. reel, 1,500ft.	32/6	ALL
5in. reel, 1,200ft.	22/6	Spare
6in. reel, 850ft.	22/6	Plastic
3in. reel, 225ft.	7/6	Becla
Standard 7in. Reel, 1,200ft.	21/-	3/6
6in. reel, 850ft.	17/6	Metal
5in. reel, 600ft.	15/-	Becla
"Instant" Bull. Tape Eraser and Head Defuzzer	7in.	
300/250 v. A.C. 27/6. Leaflet, S.A.E.	2/- ea.	

RECTIFIERS. RM1, 5/-; RM2, 6/-; RM3, 8/-; BM4, 16/-;
RMS, 20/-; FC31, 27/6; 1A48, 17/6; 1A4100, 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. Add dust core from 4/- each. All ranges.
TELETRON, L. and M.T.R.P. with reaction, 3/6.
FERRITE ROD AERIALS. M.W. 8/9; M. & L. 12/6.
I.R.F. COILS. A/HF, 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 28/-. 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. 28/5/-
With new Jason Cabinet, FMT2, 30/- extra.

CONDENSERS. New Stock. 001 mfd. 7kV. T.O.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., 6d.; 0.1, 1/-; 0.25
1/6; 0.5, 1/8; 0.1/550 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 CONDENS. 500 v. 0.3 pf. to 0.01 mfd., 6d.
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 1/2 pf. to 815 pf., 1/9; 1,000 pf. to 2,000 pf., 2/-
TUBES. 6X4, 6X5, 6X6, 6X8, 6X9, 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. 5/8	8/500 v. 3/-
2/350 v. 2/3	100/225 v. 3/-	16/500 v. 4/-
4/450 v. 2/3	250/225 v. 3/6	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/-
18/450 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. 5/8	32+32/450 v. 6/-
25/74 v. 1/9	10+16/450 v. 4/3	50+50/350 v. 7/-
50/225 v. 2/-	16+16/500 v. 8/-	64+120/350 v. 11/6
50/500 v. 2/-	32+32/350 v. 4/6	100+200/275v. 12/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2.6 or
12 v. 11 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., 11 a., 15/6; 2 a., 17/6; 4 a., 22/6
Charger circuit free. AMPMETERS, 4 a., and 6 a., 13/6.

NEW and boxed VALVES 90 day guarantee

1R5	7/6	616G	10/6	RA50	1/6	EY51	1/6
1A5	7/6	6N7M	8/6	RACB80	8/6	EY86	9/6
1T4	4/6	6Q7G	7/6	EB91	6/6	HAB08	12/6
2X2	3/6	68A7M	6/6	EBC33	8/6	HY124	6/6
354	7/6	68J7M	6/6	EBE41	8/6	HY124	9/6
374	7/6	68N7	6/6	EBE80	10/6	PE1	9/6
504	7/6	6V6G	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6X4	7/6	ECP80	9/6	PCC80	9/6
5Z4	9/6	6X5	6/6	ECH42	10/6	PL62	11/6
6AM6	5/-	12A6	7/6	ECL80	10/8	PEN35	5/6
6BE6	7/6	12AT7	8/-	ECL82	10/8	PL82	10/6
6BE8	9/6	12AU7	5/6	EBF99	5/6	PL80	9/6
6BW6	9/6	12AX7	8/-	EF41	9/6	PY81	9/6
6D6	6/-	12BA6	8/6	EP50	5/6	PY82	7/6
6E6	7/6	12BE6	8/6	EP80	8/-	SP61	9/6
6BE6T	3/6	12K7	6/6	EP86	14/6	UB041	3/6
6J5	5/6	12Q7	6/6	EP92	5/6	UCB42	9/6
6K6	5/6	316	5/6	EP99	5/6	UB1	9/6
6G7	9/6	35Z4	7/6	EL41	9/6	UL41	9/6
6K6GT	6/6	80	9/6	EL84	8/6	UY41	8/6
6K7G	5/-	807	5/6	EZ40	7/6	UZ2	8/6
6E8G	7/6	954	1/6	EZ80	7/6	UZ2	7/6

RADIO COMPONENT SPECIALISTS

POSTAL SERVICE 1/-. OVER £2 FREE. C.O.D. 1/6. (EXPORT C.W.O. POST EXTRA). Wed. 1 p.m. THO 1665 Buses 133 or 68

Tubes

HIGHEST QUALITY—NEW LOW PRICES
Carr & Ins. 12/6
GUARANTEED

	6 Months REVACUUMED	12 Months REGUNNED	12 Months NEW TYPES
9/10in.	£2-0-0	£3-10-0	Mw 31/74 £5-0-0
12in.	£2-10-0	£4-10-0	Mw 36/24 £6-15-0
14in.	£3-0-0	£5-0-0	Mw 43/64 £7-15-0
15/17in.	£3-10-0	£5-15-0	
21in.	£4-10-0	£6-15-0	

4-SPEED RECORD PLAYERS

Latest Turntable, together with light-weight Staar Galaxy dual sapphire crystal turnover pick-up head. Amazing value (Pick-up only 19/-). £3/10/-. Carr. 3/-.
B.S.R. Monarch (WA8) £8 15 0
COLLARO CONQUEST £6 19 0
B.S.R. Latest UA14 £7 19 0

13 CHANNEL TV'S

TABLE MODELS, FAMOUS MAKES. Absolutely complete
These sets are unequalled in value due to huge purchase direct from source. They are untested and are not guaranteed to be in working order. CARR. ETC. 15/-
12" — £3.19
14" — £6.19
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ALSO 12" 5 CH. TV'S 55/-

TRANSISTORS: RED 4/6
49/- doz. WHITE SPOT 6/6, 69/- doz.
PM SPEAKERS Top Makes Guaranteed
6in. 8/- 5in. 11/- 10in. 13/-
8in. 7x4

I.T.V. CONVERTERS
with power pack. Very compact External/Internal fitting. Band change 39/- switch. Manuf. cartons. Listed £7

STEREO OUTFITS

Consisting of two 3 valve (10F3, 10P14, UU9) 3-watt mains amplifiers each complete with 8in. loudspeaker in neat bakelite cases with independent controls, together with UA8 Stereo changer and screened leads. Unrepeatable
£11/10/-!

AMPLIFIERS ONLY 49/- EACH.

UA8 STEREO CHANGERS
B.S.R. Monarch Autochangers fitted with quality Stereo Cartridge. Truly amazing value at **£6/19/-**

VALVES

10% DISCOUNT SPECIAL OFFER TO PURCHASERS
of any SIX VALVES marked in black type (15% in dozens). Post: 1 valve, 6d.; 2-11, 1/-.

BY RETURN OF POST
GUARANTEED 3 MONTHS
NEW LOW PRICES

FREE TRANSIT INSURANCE. All valves are new or of fully guaranteed ex-Government or ex-equipment origin. Satisfaction or Money Back Guarantee on goods if returned unused within 14 days.

OZ4	5/-	6K8G	5/9	20F1	11/6	EB34	1/8	EN31	16/-	T41	7/6
1A7GT	11/9	6K8GT	11/-	20P3	12/6	EB41	7/-	EY1	9/-	U14	8/-
1C5GT	10/6	6K25	7/6	20P4	17/-	EB91	3/9	SMALL	9/-	U18	8/6
1H9GT	9/9	6L1	12/6	20P5	16/-	EBC33	5/-	EY86	8/6	U22	6/9
1L4	3/9	6L6	9/6	25A6G	8/-	EBC41	8/6	EZ40	6/9	U24	7/6
1NGT	9/9	6L6G	8/9	25L6G	6/9	EBC51	7/9	EZ41	7/9	U25	13/6
1R5	6/6	6E6	9/-	25L6GT	9/-	EBC90	8/6	EZ80	6/9	U26	10/-
1R8	8/9	6L18	9/-	25Z4G	8/-	EBCF8	6/6	EZ81	7/3	U31	11/-
185	5/9	6L19	11/6	27SU	16/-	EBL21	14/-	GT1G	7/-	U33	11/-
1T4	4/9	6LD29	8/6	30F5	7/-	EBL31	18/-	GZ32	8/9	U35	8/9
2D21	4/6	6P25	9/-	30FL1	9/6	ECS2	3/9	GZ34	12/6	U37	26/6
3A4	5/6	6P28	9/-	30F4	12/6	ECC31	9/6	HABC80	9/6	U50	6/-
3Q4	7/3	6P30	6/9	31P12	8/-	ECC32	9/6	HLADD9	6/6	U52	5/6
384	6/6	6Q7GT	9/3	30FL1	10/6	ECC34	9/-	HVR5	7/8	U51	9/6
3V4	6/6	6SA7	5/9	35L6GT	9/-	ECC35	6/6	KT33C	6/6	U281	8/6
5E4G	11/-	6S97	4/9	35W4	6/6	ECC81	5/6	KT36	9/-	U282	15/-
5U4G	5/6	6SHT	4/6	25Z4GT	6/-	ECC82	6/6	KT44	6/6	U301	14/6
5V4G	9/9	6SHT	6/6	50CD6G16	-	ECC83	7/8	KT45	8/6	U309	12/6
6Y3G	6/-	6SHT	5/3	50L6GT	9/3	ECC84	8/9	KT81	9/-	U329	12/6
5Y8T	6/6	6SL7GT	6/6	61SPT	11/-	ECC85	8/3	KT65	12/6	U339	11/-
5Z4G	8/6	6SN7GT	4/9	90	9/6	ECC86	10/8	KT81	14/-	U403	9/6
5Z4GT	11/-	6RQ7	6/3	90AV	4/6	ECC87	9/9	KTW61	5/6	U801	29/6
6A8G	9/6	6SST	8/6	185BT	16/-	ECH21	14/-	KTW63	4/9	UABC80	8/6
6AC7	4/3	6A8T	10/6	80A	5/-	ECH35	7/6	KTZ63	5/3	UAC42	9/-
6AC5	4/3	6V6G	5/6	80TE	3/9	ECH42	8/9	MU14	8/-	UB41	8/6
6AG7	8/6	6V6GT	6/6	955	3/9	ECH81	8/3	N37	11/-	UBC41	8/3
6AK5	6/9	6X4	5/-	956	2/9	ECL80	8/3	N78	15/-	UBC81	10/6
6AL5	3/9	6X6G	5/6	2050	3/6	ECL82	10/-	P41	4/6	UBF80	8/9
6AM8	3/9	6X8GT	6/6	9001	4/-	ECL83	14/6	P61	2/3	UBF89	8/6
6A86	6/-	6X8	9/6	9003	4/-	EP22	12/-	PABC8011	-	UAC21	14/6
6AT6	7/-	7B7	7/3	ATP4	2/9	EP36	3/3	PCC84	7/9	UCB21	14/6
6AU6	8/6	7C5	7/6	AZ31	9/-	EP39	4/3	PCC85	9/3	UCB42	8/6
6B8G	3/6	7C6	7/3	B36	8/6	EP40	13/6	PCC89	13/9	UCH81	9/6
6BA6	6/-	7HT	7/6	B65	4/9	EP41	8/9	PCF80	7/6	UCI83	11/3
6B26	6/-	7E6	9/6	CEL31	23/3	EF42	7/6	PCF82	9/-	UCI83	13/6
6B96G	12/6	7V4	7/6	CV31	9/9	EF50-AM2/8	-	PCL82	9/3	UT41	8/6
6BW6	8/-	10C1	11/-	D63	1/6	EF54	3/3	PCL83	11/6	UF42	7/9
6BW7	6/9	10C2	13/6	DA90	2/6	EF54	3/3	PCL84	9/9	UF80	9/-
6C4	3/6	10F1	6/9	DAC32	9/9	EF80	5/9	PEN25	4/6	UF85	9/-
6C8	4/3	10F9	10/3	DAF91	6/9	EP85	7/-	PEN45	7/3	UF88	14/6
6C9	11/6	10F13	9/6	DAF96	8/3	EP86	11/-	PEN46	5/3	UF89	7/3
6CD6G	18/6	10P14	9/6	DF33	9/9	EP89	9/9	PL31	8/-	UL4	7/6
6CH6	8/3	12AH8	9/9	DF91	5/-	EP91	3/9	PL36	11/-	UL44	12/6
6D6	4/9	12AT6	7/9	DP96	3/3	EP92	4/9	PL38	14/6	UL46	9/9
6F1	6/9	12AT7	5/6	DE77	7/-	EL32	4/6	PL81	9/9	UL84	8/-
6F6G	6/3	12AU7	8/6	DK32	11/9	EL33	9/-	PL82	7/9	UM90	9/6
6F13	6/9	12AX7	7/6	DAF91	6/9	EL33	8/6	PL83	8/-	UUG	12/6
6F14	11/6	12BYGT	6/6	DK92	8/6	EL37	11/6	PL84	11/-	UV7	9/6
6F15	11/6	12K7GT	6/-	DK96	8/3	EL38	12/6	PY31	8/3	UY11	11/-
6H6	2/-	12K8GT12	-	DL33	9/9	EL41	8/6	PY32	11/-	UY41	6/6
6J5G	2/9	12Q7GT	6/-	DL35	10/6	EL42	9/6	PY80	7/-	UY85	7/-
6J5GT	3/8	12K7	5/6	DL91	8/9	EL54	7/9	PY81	7/-	VR150/305/8	-
6J6	4/-	12S7GT	3/6	EL12	6/6	EL91	4/9	PY82	7/-	X65	11/-
6K7G	5/-	14B7	14/9	DL94	7/6	EM34	8/6	PY83	8/-	X66	11/6
6J7GT	7/9	18BG6G15	-	DL96	8/3	EM80	8/6	PZ30	11/-	X78	14/6
6K6GT	6/6	20D1	9/6	EA50	9/4	EM81	9/3	R19	12/6	X79	16/6
6K7G	2/3	20P2	8/6	EABC80	7/6	EM84	9/9	SP41	2/6	Y63	8/3
6K7GT	4/9	20L1	9/6	EAF42	8/6	EM85	10/6	SP61	2/6	Z68	7/6

List of 1000 Special Offers 6d. Callers always welcome.

TECHNICAL TRADING CO.

350-352 FRATTON ROAD, PORTSMOUTH

POST: 2 lbs. 1/6, 4 lbs. 2/-, 7 lbs. 2/9, 15 lbs. 3/6. No C.O.D.

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brings out the best in any recorder

Even the most expensive recorder will only give its best performance if a good quality, reliable microphone is used. In the DP4, with a uniform wide frequency response from 50 c/s to 15,000 c/s, Gramplan have developed an outstanding, moderately priced instrument which will please the most exacting recordist. The DP4 is equally suitable for Public Address, Broadcasting, Call Systems etc.

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DP4/L low impedance 25 ohms 86 dB below 1 volt/dyne/2CM.
DP4/M, medium impedance 600 ohms 70 dB below 1 volt/dyne/2CM.
DP4/H, high impedance 50,000 ohms 52 dB below 1 volt/dyne/2CM.

Retail Price: DP4/L complete with connector and 18ft. screened lead, £7/11. (Medium or High Impedance models, £1 extra).

A complete range of stands, swivel holders, etc., is available also.

A matching Unit (Type G) can be supplied for adapting the microphone for a Recorder having a different input impedance, or when a long lead is required. Retail Price £3/5/-.

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7 COILS FROM 500Ω TO 20 KΩ
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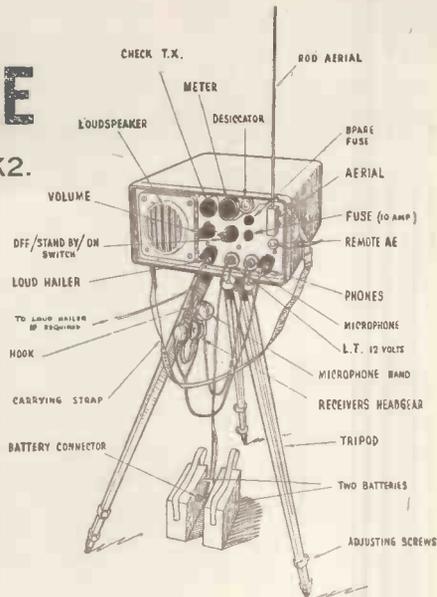
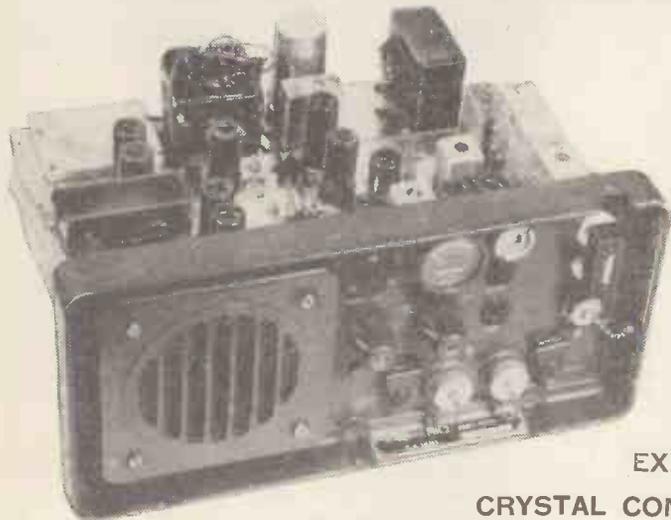
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Portable/Mobile V.H.F RADIO TELEPHONE

TYPE W.S B44 MK2.



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CRYSTAL CONTROLLED 60-95mc/s.

A modern 14-valve superhet receiver and AM transmitter using current series of B7g valves. Valve line-up: 2-CV136/7D9, 1-CV137/EAC91, 7-CV138/EF91, 4-CV416/6F17. Robust cast aluminium case includes 5in. loudspeaker. Internal vibrator pack (synchronous type) provides operation from 12-volt accumulators or vehicle or boat 12-volt supply, in fixed or mobile use. Available, less crystals and accessories, but with connecting plugs, ex-stock. Accessories and crystals for specified frequencies in the range 60-95 Mc/s can be supplied to order at extra cost.

Each unit is fully tested and in good condition. Price (including packing FOB London), £20 each.

Special quotation for quantities up to 500 sets.

50 MICRO AMP MOVING COIL METERS

Brand New & Boxed—Large Stocks available

Made on Government Contract by Famous British Maker

3½in. Square—800 ohms resistance. 4 Scales operated by lever "Set-zero"—"0-3"—"0-30"—"0-300." Easily coupled to rotary range switch by cord or lever. Ideally suitable for transistor tester, output meter, volt-milliammeter. Adjustable to work as centre-zero 25-0-25 µA.

A RANGE OF METER BOXES

Useful for all kinds of testgear, a quality job in welded steel, finished in grey hammer stoved enamel. Standard panel size 4½" x 7¼", available in depths 2", 3", 4" and 6".

UNDRILLED: 2" 12/6: 3" 13/-: 4" 13/6: 6" 15/-. With panel punched to take one 50µA meter, add 1/6, or to take two meters 2/6.



Complete with data

ONE METER **19/6** (plus post 6d in U.K.)

TWO METERS **35/-** (plus post 1/- in U.K.)

SPECIAL PRICES FOR 100 LOTS

TEST GEAR COMPONENTS (LONDON) LTD

15 ARCANY ROAD, SOUTH OCKENDON, ESSEX TEL: SOUTH OCKENDON 2610

T.C.C. "CATHODRAY" VISCOSAL TYPES. 1 mfd., 2 kV. wkg., 7/6 each. 0.25 μ F., 4 kV. wkg. 6/- each. 0.05 μ F., 5 kV. wkg., 7/6 each. 0.1 μ F., 5 kV. wkg., 6/6 each. 0.05 μ F., 5 kV. wkg., 6/6 each. 0.1 μ F., 6 kV. wkg., 7/6 each. 0.5 μ F., 2.5 kV. wkg., 6/6 each. 0.25 μ F., 2.5 kV. wkg., 6/- each. 0.0025 μ F., 6 kV. wkg., 5/- each. 0.0025 μ F., 5 kV. wkg., 4/6 each. 0.005 μ F., 5 kV. wkg., 5/- each. 0.0025 μ F., 3 kV. wkg., 4/- each. 0.025 μ F., 2.5 kV. wkg., 4/6 each. 0.0025 μ F., 2.5 kV. wkg., 4/- each. 0.005 μ F., 2.5 kV. wkg., 4/- each. 0.025 μ F., 3 kV. wkg., 4/6 each. All the above are tubular and mounting.

BLOCK PAPER TYPES. 10 mfd., 1,500 v. wkg., 15/- each. post 3/6. 8 mfd., 1,200 v. wkg., 11/6 each. 8 mfd., 500 v. wkg., 5/- each. 6 mfd., 500 v. wkg., 5/6 each. 4 mfd., 500 and 750 v. wkg., 4/6 each. 4 mfd., 1 kV., 5/6 each. 4 mfd., 2 kV. wkg., 8/6 each.



POWER UNITS

100-250 v. A.C. input, 24 v. D.C. at 3 amps. or 12 v., twice at 3 amps. each winding. Continuous tropical rating switched and fused etc., in metal case that fits 19in. rack, size 19 x 7 x 7in. Brand new, £3/15/- Carr. 7/6 (with circuit).

SMOOTHING UNIT

for the above power supply 2 chokes and 0.1 mA meter (grade 1) metal case, same as the p.u. £2. Carr. 7/6.

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(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.

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115 v. A.C., 1/6th H.P., variable speed box 0-166. Size of unit 14 x 9 1/2 x 8in., £8/10/- Carr. 10/-.

INDICATOR UNIT Type I-152-c (U.S.A.) 3in. tube 3DP1, 1 rectifier 2 x 2, and 3 x 6AG5, with controls, etc., in a neat metal box 11 x 6 x 6 1/2in., 50/- each. Post 2/6.

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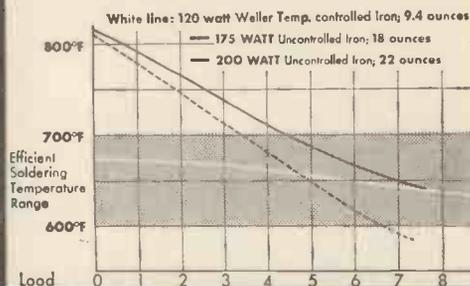
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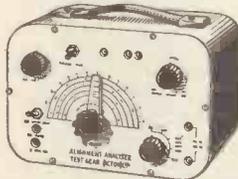


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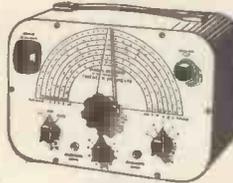
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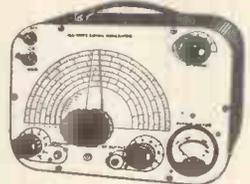
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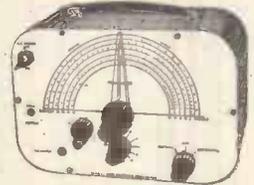


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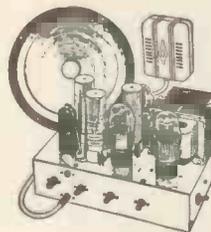
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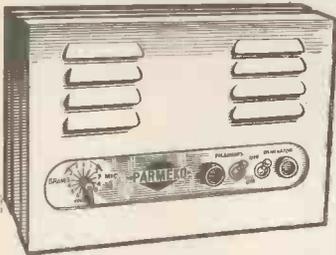
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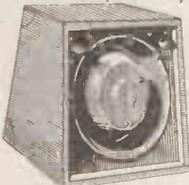


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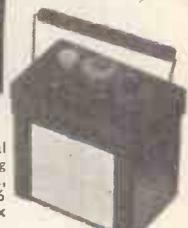
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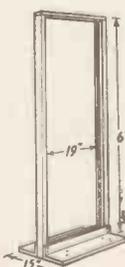
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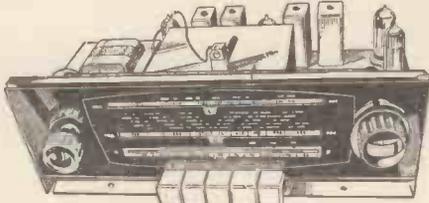
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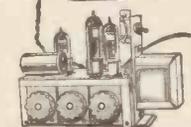


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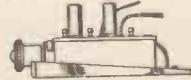
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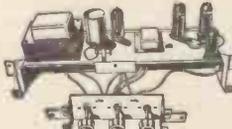
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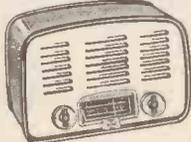


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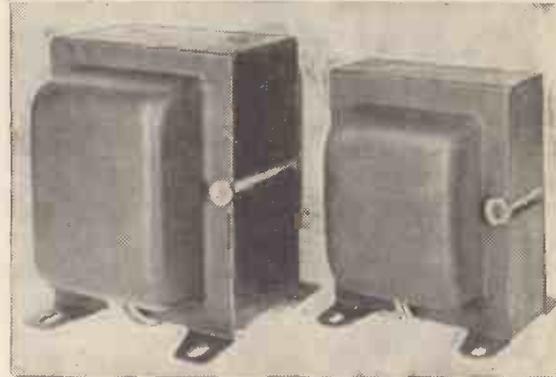
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5 Milliamp	2 in.	MC/FR	27/6
10 Milliamp	2 in.	MC/FR	27/6
20 Volts	2 in.	MC/FR	27/6
30 Volts	2 in.	MC/FR	27/6
40 Volts	2 in.	MC/FR	27/6
15 Amps	2 in.	MC/FR	12/6
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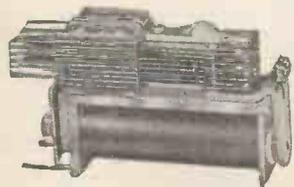
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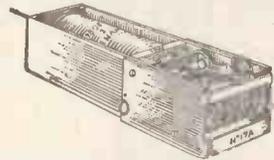
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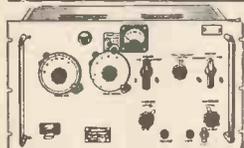
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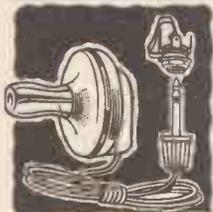
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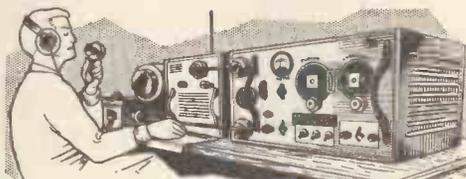
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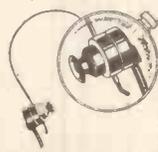
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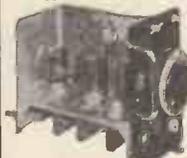


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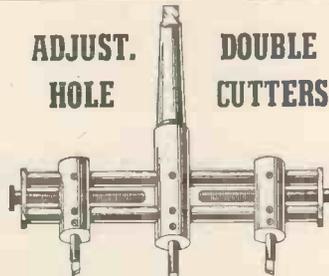
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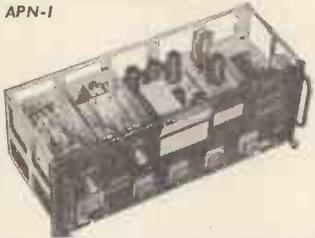
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AUDIO AMPLIFIER

Self-contained RC coupled 12SH7, 12SH7 and 12SJ7. Size 3 × 5 × 1½in. Amplifies the received signal which is passed to detector circuit giving a D.C. voltage proportional to the difference between the transmitted and received (reflected) signal to operate internal relays which pass appropriate correction signals to autopilot and supply external indicator (5 mA meter).

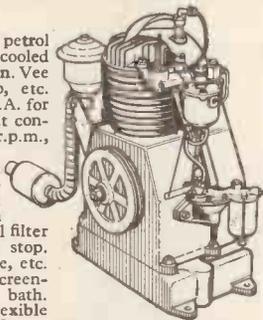
MAIN CHASSIS

The main chassis carries the 3 sub-units and has a further three 12SH7, one 12SJ7, two 12H6 and one VR150 regulator, three 1% wire-wound resistors, one 4-pole changeover relay, two SPCO relays, three twin-ganged pre-set potentiometers, trimmers, fuses, etc. Power supply is derived from a 27-volt dynamotor (charging rate for 24v. supply) delivering 285 volts at 75 mA.

BRAND NEW, a very useful buy indeed at only **£2** plus 7/6 carriage.

PORTABLE POWER

Neat, lightweight but really sturdy petrol engine. Completely self contained, air-cooled pedestal-based unit with 5in. dia. × ½in. Vee pulley for driving generator, pump, etc. Made by Lauson Engines in the U.S.A. for easy transport in a special lightweight container. Developing 1.8 h.p. at 2,700 r.p.m., this very fine unit is only 17in. high × 14in. × 12in. and can be carried in one hand. It has stilled valves to suit any petrol, a totally enclosed carburettor with air filter and a mechanical fuel pump with glass bowl filter. Flywheel cord start. Push-button stop. Adjustable throttle. Butterfly choke, etc. Standard 14 m.m. spark plug with screened HT harness. Crankcase oil bath. Supplied complete with 3ft. flexible exhaust pipe and detachable 9 × 3½in. dia. silencer, driving belt and 10ft. of high-grade flexible fuel hose. A genuine quality engine offered at the remarkable price of only **£17.10.0** carriage paid (inland only).



BC.929 SCOPE UNIT

Neat, modern indicator unit especially suitable for quick conversion to attractive general servicing scope. (Suitable circuit diagram and all component values supplied.) Contains fully metal screened 3BP1 tube, intensity and focus controls, 3-position rotary switch and 8 pre-set potentiometers, plus 2 × 6SH7, 2 × 6H6, 6G6, 6X5 and 2X2 valves. Designed for 24 v. D.C. or 400 c/s A.C. input. Size 14 × 8½in. square. Well known and deservedly popular buy. Offered new, less (unwanted) motor driven aerial switching unit, for post paid. **50/-**



AMERICAN COWL GILL MOTORS
Smaller and neater than British counterpart. Split-field, reversible, 12-24 volts.

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EVERETT EDGUMBE SYNCLOCKS

Grade 1 industrial process timer with 3 inch dial covering ¼ to 10 minutes in one tenth divisions. Driven by a 16 volt 50 c/s synchronous clock. A metal rectifier provides D.C. to pull in a relay that engages the drive until the time set on the dial elapses. As it reaches zero heavy duty contacts snap shut to close the external circuit (at the same time other contacts break to arrest the clock). Switching off the power trips the relay and the spring loaded dial returns to the time set ready for the next cycle. Whole totally enclosed in a heavy cast wall mounting case, stove enamelled black, size 6½ × 7 × 4 inches. Brand new in original packings **55/-** post paid.

VENNER TIME SWITCHES

Type T.S.2, first grade precision time switches as supplied to G.P.O. Comprises absolutely silent self starting 250 volt 50 c/s synchronous clock, mechanism totally enclosed in heavy gauge brass case. Central drive takes detachable dial that revolves to operate sensitive on and off trips for external mains operated circuit. Self contained clock is easily detachable from rear mounting panel (self starting down to 80 v. and keeps running down to 15 v.). Brand new, in original packings, and with dial and adjustable stops **37/6** post paid.

D.C. LINEAR ACTUATOR

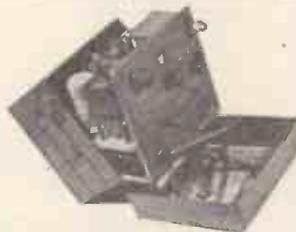
Precision heavy-duty 24-volt linear actuator by Airesearch of Arizona. Rated loads over 5½in. piston rod travel, Static 2,800 lb. Tension 1,750 lb. Compression 850 lb. Size 13½in. x 4in. dia. Incorporates adjustable limit switches and thermal load protection.



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NOMOTRON DECADE COUNTER TUBES

STC Type G10/241, latest type cold cathode, gas-filled, single pulse, uni-directional decade counter which illuminates numerals on tube face. Operating range -20 kc/s. Cathode output 40 volts, 3.7 mA. HT supply 310v. plus. Applications include; tachometers, counting and batching, frequency and time measurement, direct operation of electro-magnetic relays, sequential monitoring of up to 10 different waveforms, etc. Brand New, complete with special base and instructions. **32/6** post paid.



CLASS D WAVEMETERS

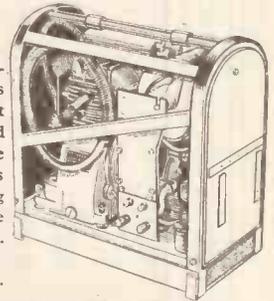
Popular, neat, heterodyne wavemeter with 1 Mc/s and 100 kc/s reference crystals for zero setting directly calibrated illuminated dial covering two switched basic ranges of 1,900-4,000 kc/s and 4-8 Mc/s with appropriate harmonics and 100 kc/s and 1 Mc/s reference points. Press-button shifts frequency a few cycles for positive identification of signal heard. Phone monitoring through output transformer

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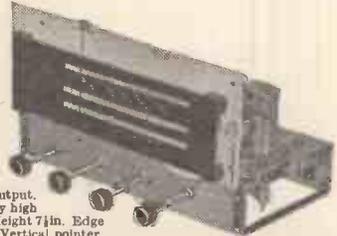
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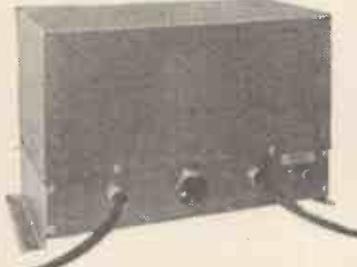
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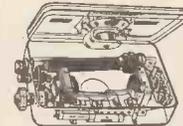


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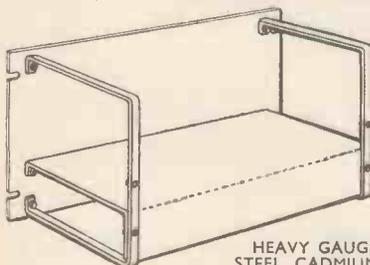
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St. John Street, E.C.1.

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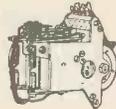
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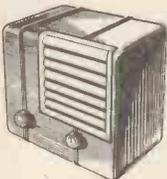
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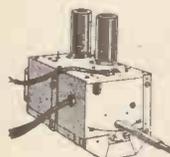


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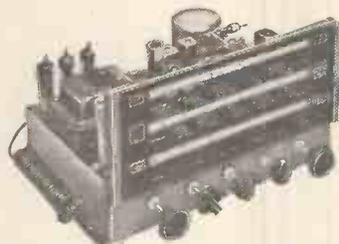
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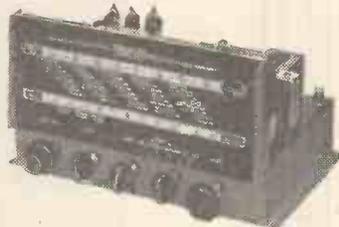
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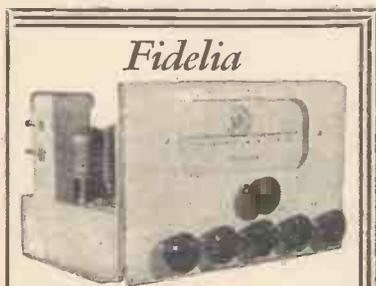
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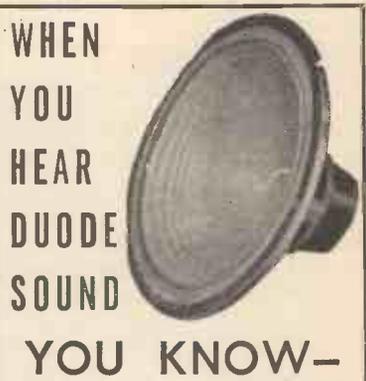
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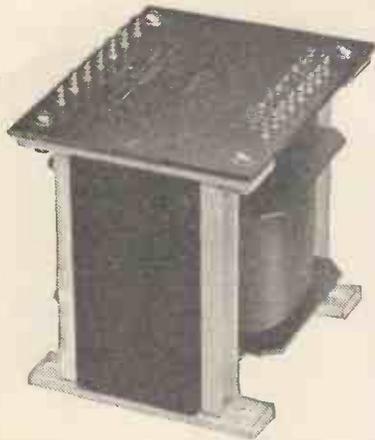
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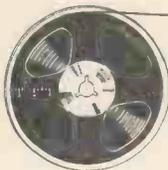
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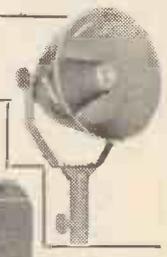
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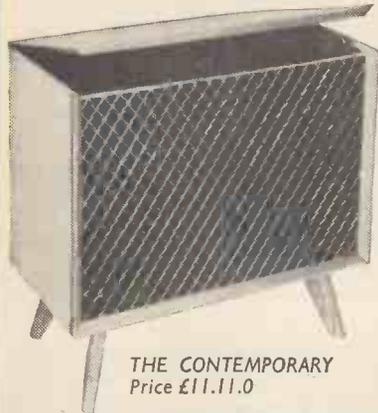
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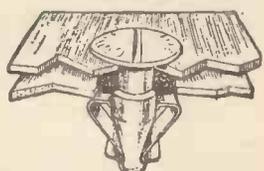
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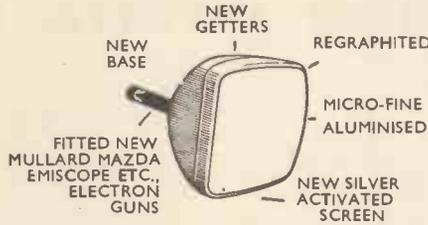
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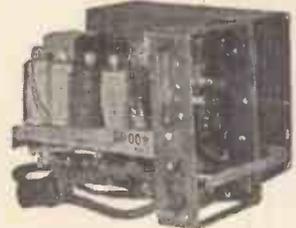
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	PAGE		PAGE		PAGE
Acoustical Mfg. Co., Ltd.	59	Gladstone Radio	160	Quartz Crystal Co., Ltd.	168
Adcola Products, Ltd.	50	Glaser, L. & Co., Ltd.	191	Radio & Electrical Mart	182
Advance Components, Ltd.	35, 46	Goodmans Industries, Ltd.	25, 174, 196	Radio & T.V. Components (Acton), Ltd.	157
Aircraft Marine Products, Ltd.	67	Goodwin, C. C. (Sales), Ltd.	119	Radio Component Specialists	147
Airmec, Ltd.	77	Gopalco	170, 174	Radio Exchange Co., The	168
Alpha Radio Supply Co., Ltd.	131	Govt., Comm. H.Q.	176	Radio Experimental Products Co.	186
Aluminium Laboratories, Ltd.	178	Govt. of Nyasaland	38	Radio Mailing, Ltd.	166
Anders Electronics, Ltd.	55	Gramophone Co., Ltd., The	154, 190	Radio Resistor, Ltd.	47
A.N.T.E.X., Ltd.	84	Gramplan Reproducers, Ltd.	184	Radiospares, Ltd.	152
Appointments Vacant 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182	54	Grayshaw Instruments	184	Radostructor	106
Arcoelectric Switches, Ltd.	52	Grey & Marten, Ltd.	172	Radio Supply Co. (Leeds), Ltd.	128, 129, 130
Ardente Acoustic Laboratories, Ltd.	52	Grimsby Education Committee	172	Rank Cintel, Ltd.	5
Armstrong Wireless & Television Co., Ltd.	49, 185	Harris, P.	73	Reading Windings, Ltd.	174
Associated Electrical Industries, Ltd.	cover II, 29, 103, 104	Hall Electric, Ltd.	66	Record Housing	64
Audex B.B., Ltd.	120	Harmsworth, Townley & Co.	188	Redifon, Ltd.	107
Automatic Telephone & Electric Co., Ltd.	180	Harridge, H. C.	188	Reida Radio, Ltd.	163
Avco, Ltd.	1, 120	Harrington Supplies, Ltd.	145	Reproducers & Amplifiers	28
		Harris Electronics (London), Ltd.	184	Riveting Systems, Ltd.	94
		Harverson Surplus, Ltd.	150	Röhrenwerke	87
Batey, W., & Co.	191	Hatfield Instruments, Ltd.	78	Rollet, H. & Co., Ltd.	191
Belling & Lee, Ltd.	92, 101	Henry's (Radio), Ltd.	149		
Benson, W.	162	Hivac, Ltd.	58	Salford Electrical Instruments, Ltd.	92
Bentley Acoustic Corporation, Ltd.	158	Home Radio (Mitcham), Ltd.	188	Samson Surplus Stores, Ltd.	130
Berry's Radio	118	H.P. Radio Services, Ltd.	84	Sander, W. H.	154
Borough Polytechnic	170	Hunt, A. H. (Capacitors), Ltd.	75	Sanders, W. H. (Electronics), Ltd.	44
Box 1372	178	Hunton, Ltd.	54	Saunders-Roe, Ltd.	190
Bradford Institute of Technology	176			Savage Transformers, Ltd.	188
Bradmatic Productions	166	IBM, Ltd.	175	Savage, W. Bryan, Ltd.	68
Brandaeur	118	Iliffe Books	152, 160, 164, 166	S.C.E.E., Ltd.	199
Brenell Engineering, Ltd.	71	International Correspondence Schools	173, 179, 182	Scottish Scandinavian Co.	190
Bribond, Ltd.	24	Irongate (M.O.), Co.	142	Service Trading Co.	126, 127
Britain, Chas. (Radio), Ltd.	143			Servo & Electrical Sales, Ltd.	182
British Communications Corporation, Ltd.	6	Kenure, Holt Electronics, Ltd.	90	Sifam Electrical Instrument Co., Ltd.	166
British Institute of Engineering Technology	180	Keyswitch Co., The	69	Sim-Tech Book Co.	187
Brookes Crystals, Ltd.	92			Smith, A. K. & L. G., Ltd.	184
Brown, N. C. Ltd.	86	Lasky's Radio, Ltd.	140, 141, 142	Smith, G. W. (Radio), Ltd.	138, 139
Brown, S. G., Ltd.	96	Lawson, Tubes	191	Smith, M. L. & Co., Ltd.	189
Burslin, A. F. & Co., Ltd.	Edit. 52	Leak, E. J., & Co., Ltd.	111	Smith, S., & Sons, Ltd.	172, 176
Bulvers, Ltd.	74	Ledon Instruments, Ltd.	182	Solartron Electronic Group, Ltd.	45
Bush Radio, Ltd.	179	Lee Products (Gt. Britain), Ltd.	35	Sound Sales, Ltd.	168
		Leavers-Rich Equipment, Ltd.	43	South Midland Construction, Ltd.	190
Canadian Westinghouse Co., Ltd.	27	Lewis Radio Co.	189	South Supplies (Electrical), Ltd.	185
Candler System Co.	182	Light Soldering Developments, Ltd.	189	Southern Radio Supply, Ltd.	191
Central Electricity Generating Board	178	Linear Products, Ltd.	88	Southern Technical Supplies	160
C.G.S. Resistance Co., Ltd.	156	Livingston Laboratories, Ltd.	48, 91	Stamford, A. L.	187
Channel Electronic Industries, Ltd.	78, 156	Londex, Ltd.	72	Standard Telephones & Cables, Ltd.	7, 8, 11, 13, 15, 17
Chapman, C. T. (Reproducers), Ltd.	90	Londex, Ltd.	72	Stearite & Porcelain Products, Ltd.	39
Clyne Radio, Ltd.	134, 135, 136	London Central Radio Stores	184	Stearite Insulations, Ltd.	82
Cosmocord, Ltd.	100	Lucas, Joseph, Ltd.	2	Stern Radio, Ltd.	132, 133
Coventry Radio	164	Ludfry, Ltd.	164	Straiton & Co., Ltd.	Cover III
Crawshaw, P. B.	168	Lyons Radio, Ltd.	170	Sturgeon, A. R. & Co. (Engineers), Ltd.	62
C.R.E.I. (London)	171			Super Radios, Ltd.	82
				Swindon Condenser Co., Ltd.	25
Dale Electronics, Ltd.	190	McCarthy Radio & Electronics, Ltd.	168	Tannoy Products, Ltd.	186
Daly (Condensers), Ltd.	90	McMurdo Instruments Co., Ltd.	72, 86	Technical Trading Co.	154
Davies, A. & Co.	191	Malvyn Engineering Works	134	Telemechanics, Ltd.	114
Davis, Jack (Relays), Ltd.	86	Marconi Instruments, Ltd.	63	Teleph. Ltd.	114
Daystrom, Ltd.	62	Marconi's Wireless Telegraph Co., Ltd.	40, 53, 99	Telequipment, Ltd.	12
Denco (Clifton), Ltd.	62	Marrlott, P. A., & Co., Ltd.	116	Tele-Radio (1943), Ltd.	74
Dependable Radio Supplies, Ltd.	148	Mazei Radio	146	Teleton Co., The	190
Dickinsons of Pall Mall, Ltd.	188	Midland Silicones, Ltd.	32	Test Gear Components, Ltd.	155
Direct T.V. Replacements	121	Mills, W.	156	Thompson, J.	166
Duke & Co.	137	Ministry of Aviation	172	Tri-Electrical Co., Ltd.	Edit. 526
Duode Natural Reproducers	186	Minnesota Mining & Mfg. Co., Ltd.	8	T.R.S. Radio Co.	167
		Modern Book Co.	164	Truvox, Ltd.	41
		M.R. Supplies, Ltd.	84	Tyer & Co., Ltd.	70
E.I.R. Instruments, Ltd.	164	M.S. Radiopost Co.	122		
Eitel-McCulloch, Inc.	85	M.S.S. Recording Co., Ltd.	3, 19, 37, 57, 98, 176	U.K.A.E.A.	170, 174, 178
E.K. Electronics	158	Mullard, Ltd.	184	Unicam Instruments, Ltd.	120
Electrical & Wireless Supply	166	Multicore Solders, Ltd.	Cover IV	United Components	172
Electro-Acoustic Developments	186	Multitone Electric Co., Ltd.	176	Universal Book Co.	184
Electro-Acoustic Industries, Ltd.	79				
Electro-Methods, Ltd.	20, 58	Neo Mail Order Supplies	190	Vacuum Electronics, Ltd.	191
Electronic Components	115	Newnes, George, Ltd.	32A, 32B	Vacwell Engineering Co., Ltd.	14
Electronic Engineering Association	123	Northampton College of Advanced Tech-	174, 178	Vairadio, Ltd.	122
Electronic Precision Equipment, Ltd.	113	Northern Polytechnic	182	Verner Accumulator Co., Ltd.	42
"Electronic Technology"	112	Nottingham Valve Co., Ltd.	84	Verner Electronics Co., Ltd.	23
Electronics (Fleet Street), Ltd.	151	Nu-Gun Teletubes	186	Vitality Bulbs, Ltd.	94
Electro-Winds, Ltd.	164			Vortexion, Ltd.	109
Electromessteletric	117	Oddie, Bradbury & Cull, Ltd.	190	V.Z. Electrical Service	188
Elthor Bros. (London), Ltd.	51, 162				
E.M.I. Electronics, Ltd.	106, 172	Palmer, G. A., Stanley, Ltd.	76	Watts, Cecil E.	190
English Electric Valve Co., Ltd.	22, 179	Partridge Transformers, Ltd.	83	Webb's Radio	94
Enthoven Solders, Ltd.	16, 60	P.C.A. Radio	162	Weller Elektro-Werkzeuge	158
Erle Resistor, Ltd.	85	P.C. Radio	169	Wellington Acoustic Laboratories, Ltd.	190
		Period High Fidelity, Ltd.	60	Westinghouse Brake & Signal Co., Ltd.	93
		Phillips, N.V.	30, 31	Weymouth Radio Mfg. Co., Ltd. The	64
Fane Acoustics, Ltd.	152	Plessey Co., Ltd.	83, 89, 108, 174, 176	Wharfedale Wireless Works	68
Ferranti, Ltd.	81, 95, 177	Post Radio Supplies	158	White, S. Dental Mfg. Co. (G.B.), Ltd.	50
Fibre Form, Ltd.	86	Premier Radio, Ltd.	124, 125	Whiteley Electrical Radio Co., Ltd.	170
F.N.I.E.	56	Proops Bros., Ltd.	165	Wilkinson, L. (Croydon), Ltd.	161
Fortiphone, Ltd.	76	Pye, Ltd.	10, 61	Wirecomp Electronics	120
Frazier & Hansen, Ltd.	70	Pye, Telecommunications, Ltd.	96	Wireless On Tap, Ltd.	178
Frangivision, Ltd.	52			Wireless Supplies Unlimited	168
				Wright, J. F.	170
Gardners Radio, Ltd.	80				
Garrard Eng. & Mfg. Co., Ltd., The	35, 80				
General Electric Radio, Ltd.	159				
General Electric Cos. Ltd.	102, 110, 172				
General Sonic Radios	191				
Ghillan, R. & Co., Ltd.	186				
Gilson, R. F., Ltd.	88				

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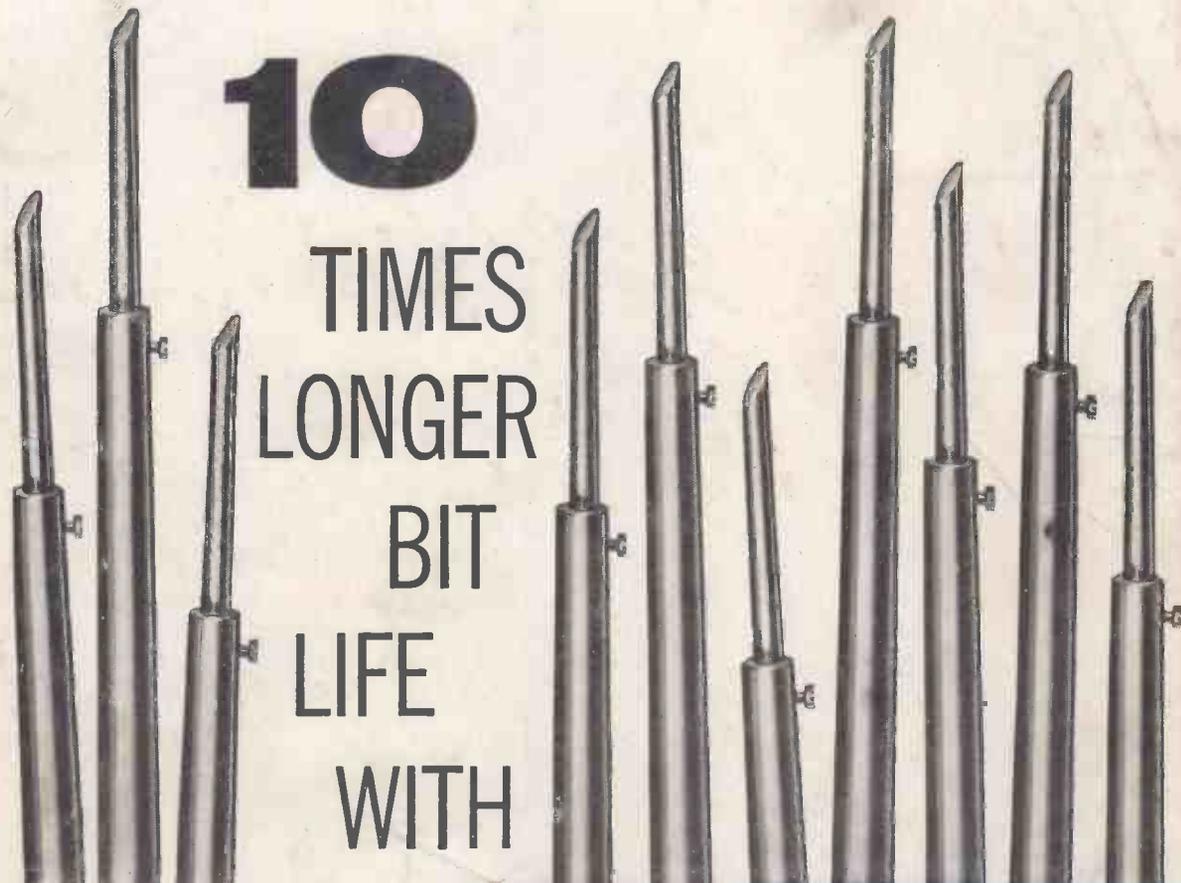
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