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Wireless World

Local Sound Broadcasting

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

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

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

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

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

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

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

Permeability Tuners for

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

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

Types of Tuner

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

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

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

Comparison of Features

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

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

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

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

Permeability Tuners for Bands I and III

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

Television

RADIO FACILITIES

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

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

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

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

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

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

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

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

Tuning and Ganging

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

*Bush Radio Ltd.

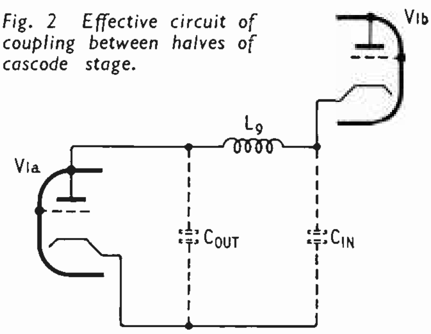


Fig. 2 Effective circuit of coupling between halves of cascode stage.

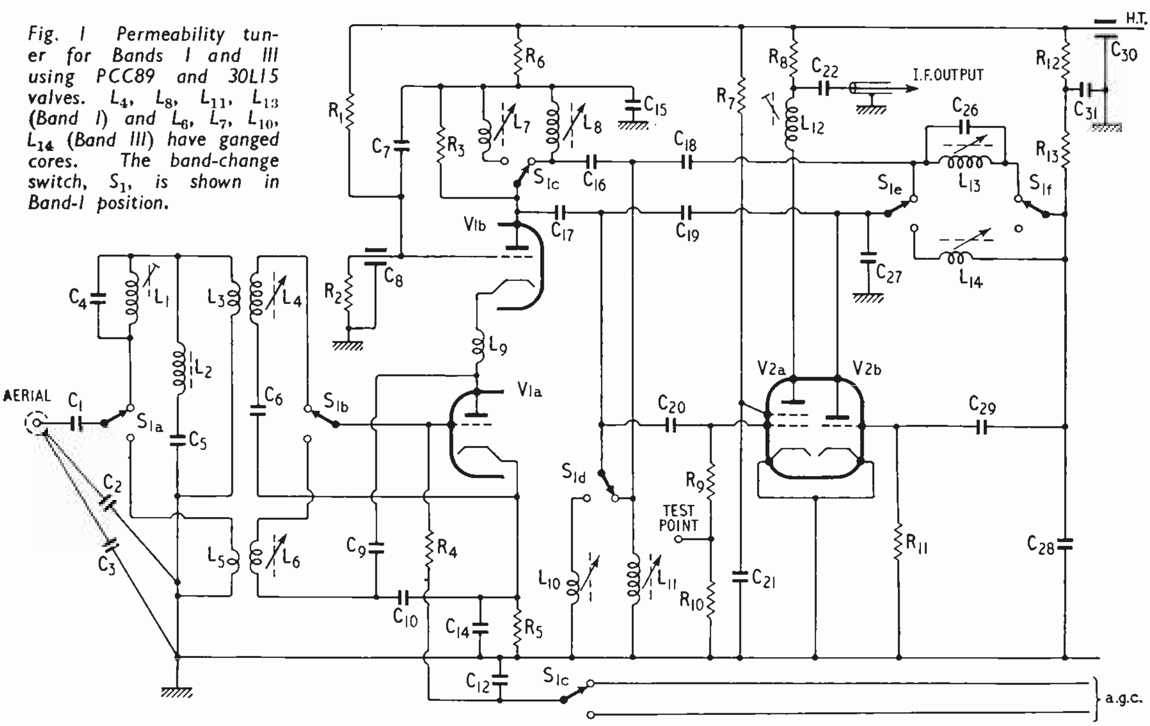


Fig. 1 Permeability tuner for Bands I and III using PCC89 and 30L15 valves. L_4, L_8, L_{11}, L_{13} (Band I) and L_6, L_7, L_{10}, L_{14} (Band III) have ganged cores. The band-change switch, S_1, is shown in Band-I position.

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

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

Noise

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

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

but for correct impedance match,

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

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

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

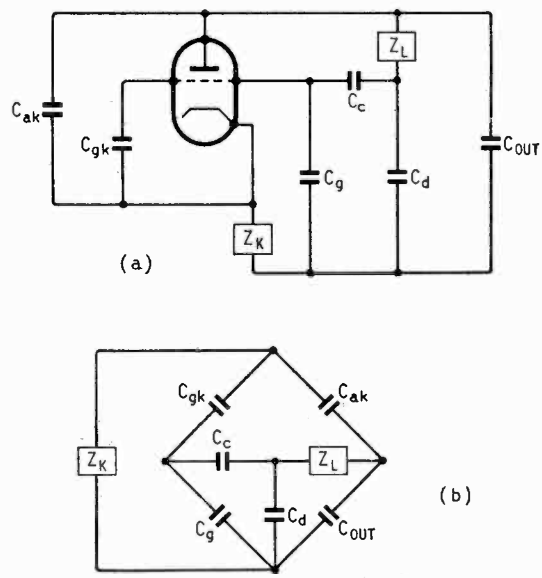


Fig. 3 (a) Effective circuit of earthed-grid stage and (b) its equivalent bridge form.

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_d 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:

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

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

Physical Layout

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

*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 adequate adjacent-channel selectivity, a lower intermediate frequency is required for Band-II operation than is normally used for television sound; thus the i.f. output circuit (which is dealt with later) is required to respond to two frequencies.

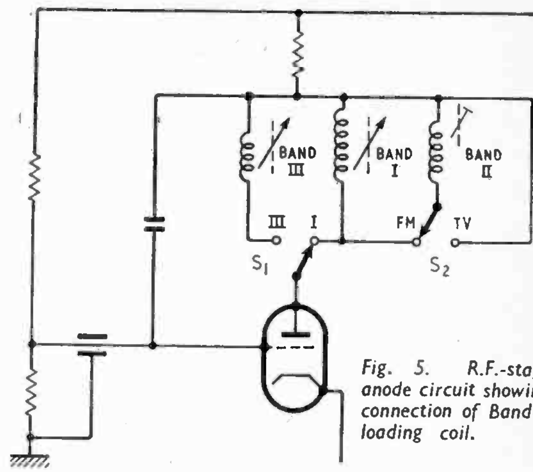


Fig. 5. R.F.-stage anode circuit showing connection of Band-II loading coil.

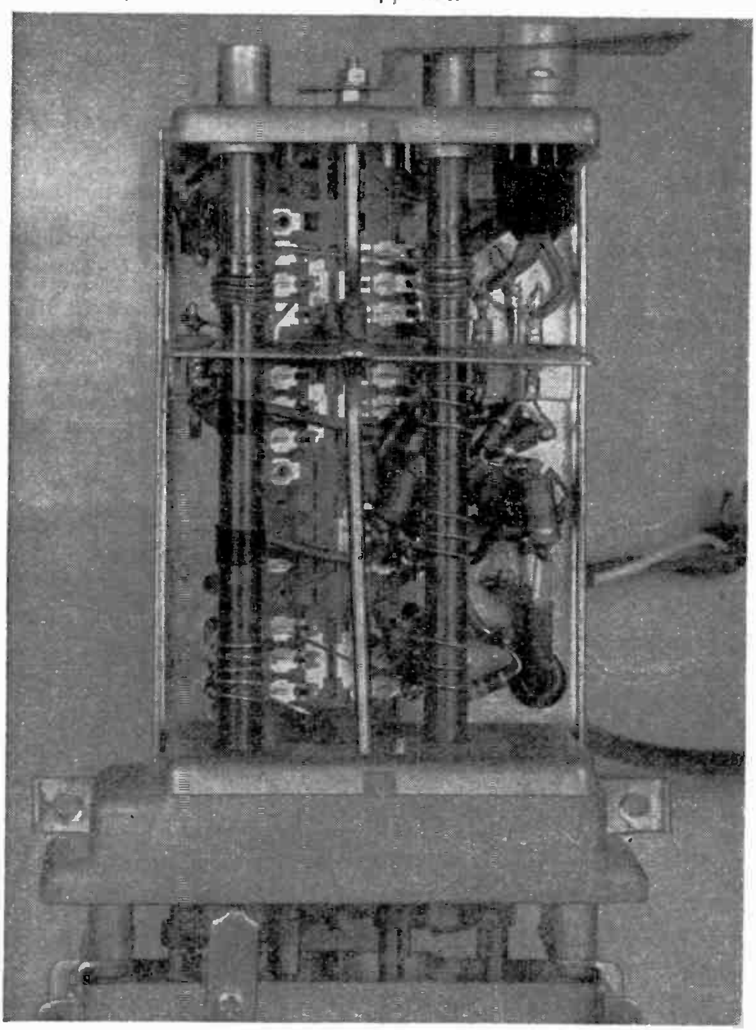


Fig. 4. View of underside of Band I/III permeability tuner. Here the unit is shown in plan, the push buttons are at bottom of picture.

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

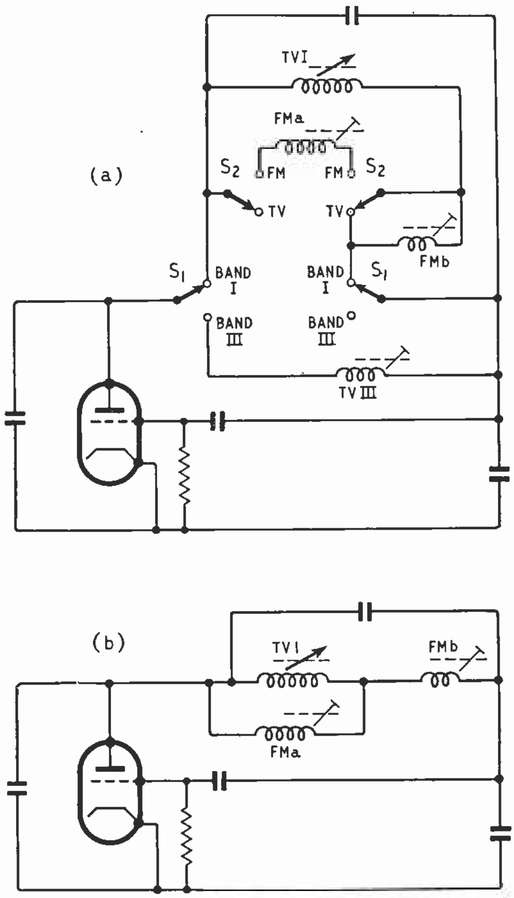
Circuit Description.—Fig. 5 shows the r.f. anode circuit to illustrate the method. The normal Band-I and -III coils, together with a section of the Band-I/III changeover switch, S_1, is shown here. A second switch connects the Band-II loading coil across the Band-I coil, and short-circuits the Band-II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

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

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

TABLE I

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

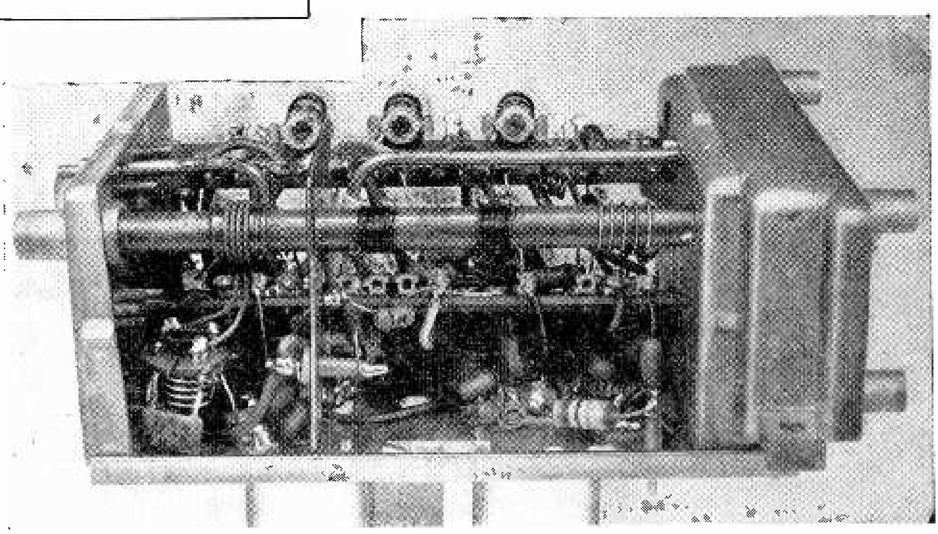


Above: Fig. 6. Simplified oscillator circuit showing (a) Band I/II/III switching and (b) components operating for Band II working.

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

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

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



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

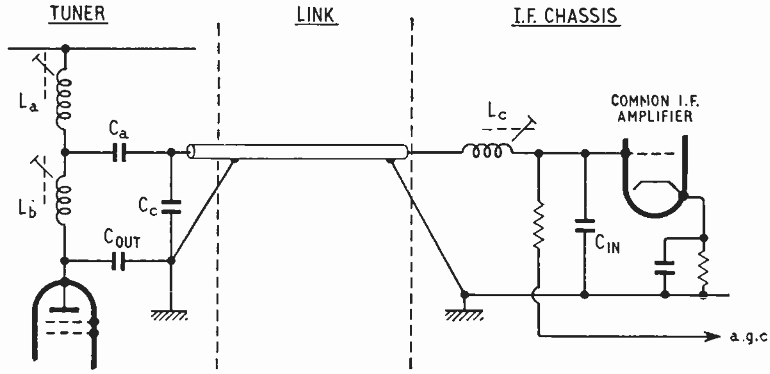


Fig. 8 Dual i.f. (television and 10.7-Mc/s f.m.) coupling circuit.

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

Performance

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

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

Conclusion

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

TABLE II

Channel Number	Gain (dB)	Noise Factor (dB)	Input-impedance Modulus (Ω)
2	51	4.5	100
8	48	6.5	60
I.f. rejection >40dB over whole of vision and sound i.f. band.			

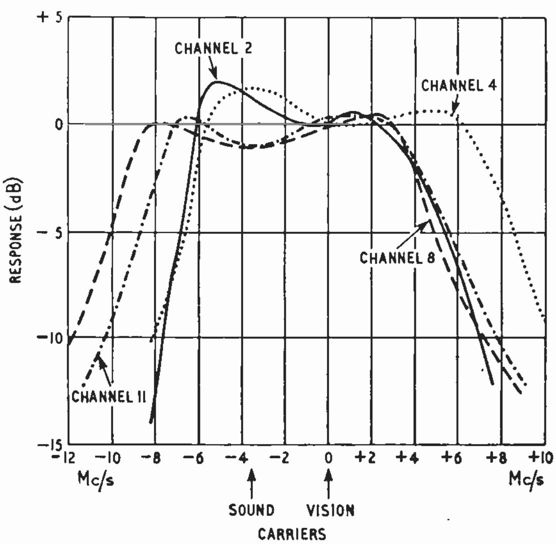


Fig. 9 R.f. response curves for tuner on Channels 2, 4, 8 and 11.

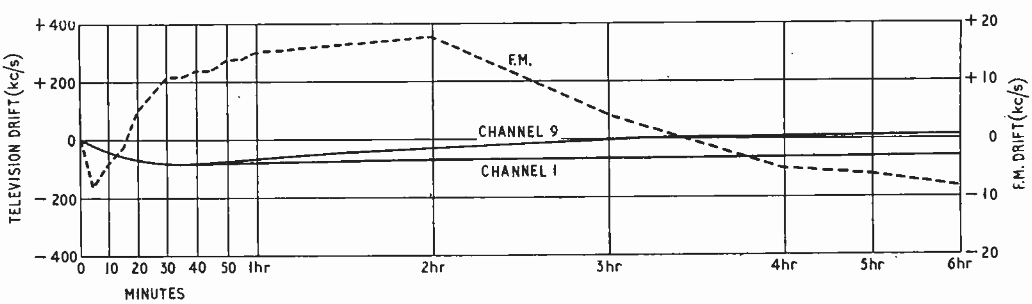


Fig. 10 Oscillator-drift characteristics for Bands I, II and III.

Airshow Electronics

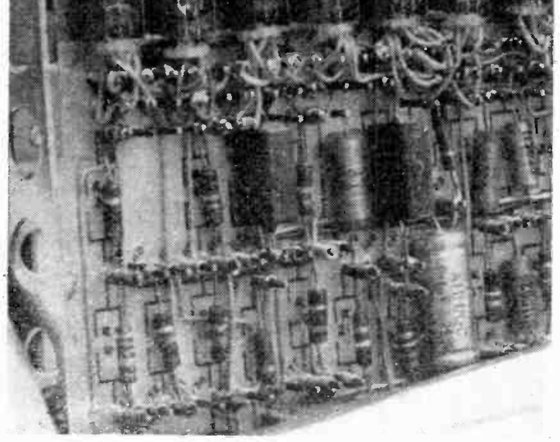
REVIEW OF TRENDS AS SEEN AT FARNBOROUGH

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

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

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

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



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

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

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

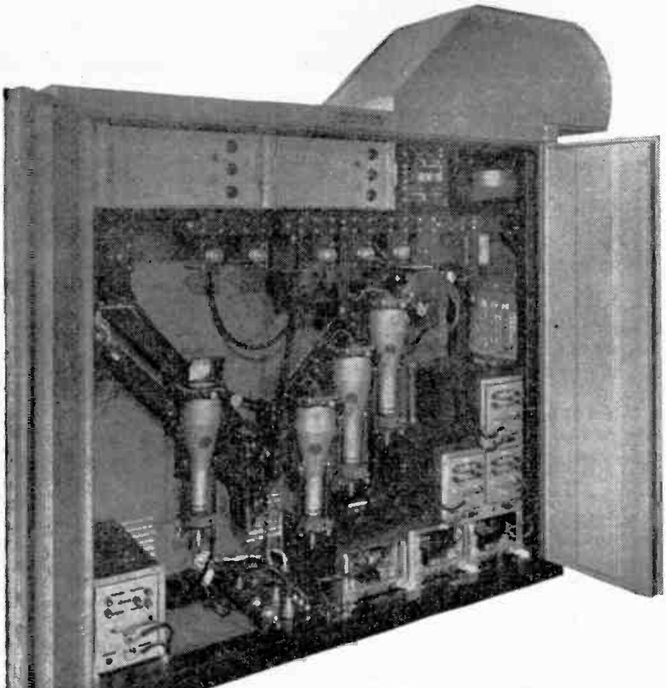
Although it can be seen that complete automatic control, which cannot make mistakes, may result from application of these techniques, this would be of little use if the equipment were not reliable. The efficiency and cool running of transistors can help in the attainment of reliability because they do 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.

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

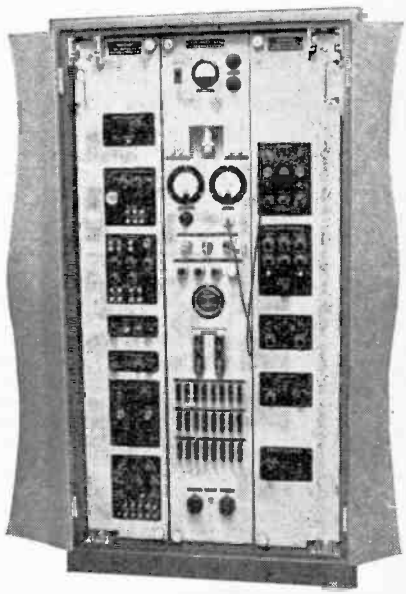


Picture synthesizer of S.T.C. PVT2 v.h.f./d.f. auto-triangulation equipment. Individual c.r.ts each displaying bearing from one station face upwards into optical system employing part-silvered mirrors.

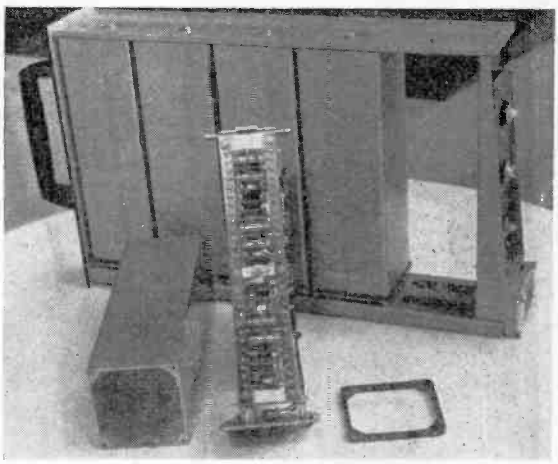
The recording of radar signals is something which has hitherto been confined to film. However, Decca were demonstrating the use of an Ampex video-tape recorder for radar recording. Bearing information from the aerial is recorded on the "cue" track of the tape and the radar sync and video are recorded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

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

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



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



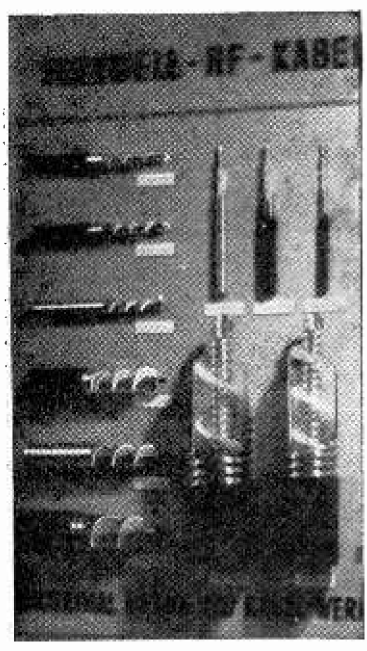
Unit from Marconi "Sixty" series transistor v.h.f. radio and navigation equipment, with module removed and opened.

FIRATO 1960

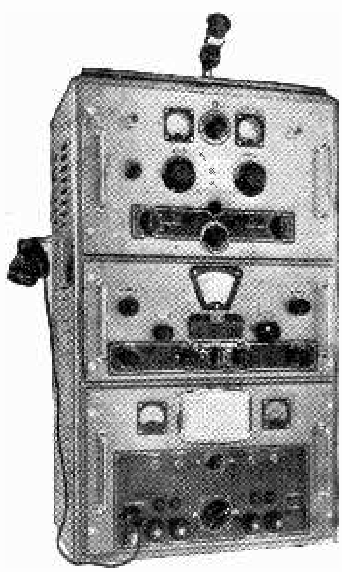
The Amsterdam Radio and Electronics Exhibition

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

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



Hackethal flexible coaxial cables.



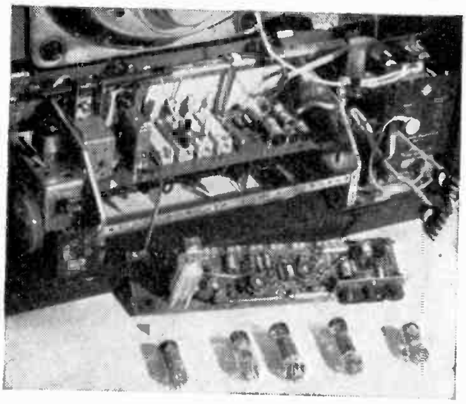
Radio Becker marine R/T transmitter and receiver Type HB-3/75-DSK. The transmitter (135W) operates on 33 channels between 17 Mc/s and 1,600 kc/s, and the receiver has a built-in auto alarm.

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

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

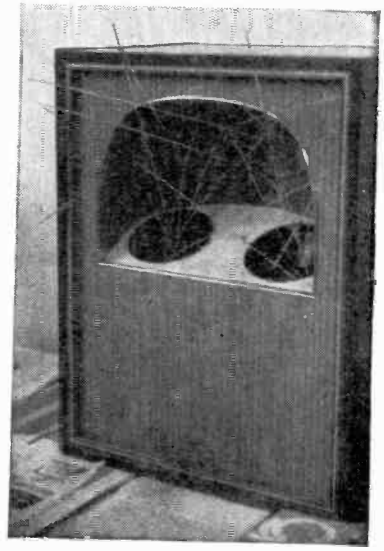
Communications were well represented by firms such as AEG, Siemens, Standard Electric, Racal and Radio Becker. The latter is a firm with branches in all the Dutch ports which specializes in short- and medium-wave transmitter-receivers and echo-sounding equipment for coasters and tugs.

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



Above: Telefunken "servo-chassis" partly dismantled.

Right: Stereovox twin loudspeaker with double elliptical reflector.



Below: Philips AG456 stereo record player.

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

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

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

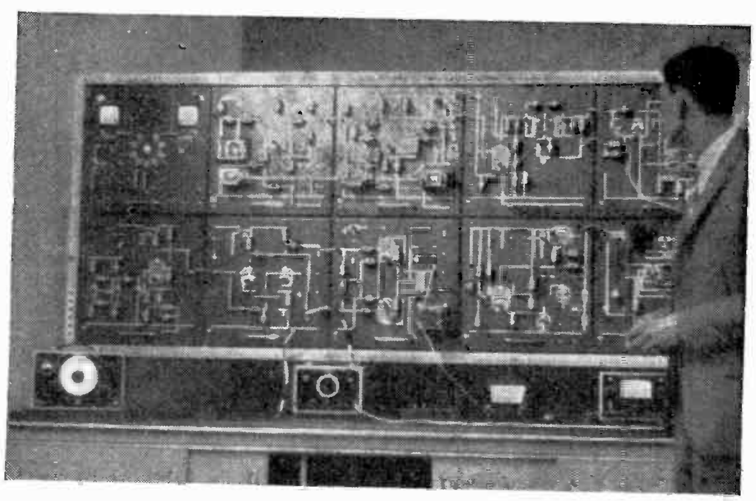
Among sound broadcast receivers the new Telefunken "servo-chassis" attracted a good deal of attention. This is of unit construction with printed circuit panels interconnected by snap contacts along the edges. It is quickly dismantled for easy servicing. The Siemens RB11 small table model with oiled teak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

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

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

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

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



Philips "Elektronica Trainer" in use during a lecture.

WORLD OF WIRELESS

Scientific Radio

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

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

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

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

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

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

"Echo" Tests

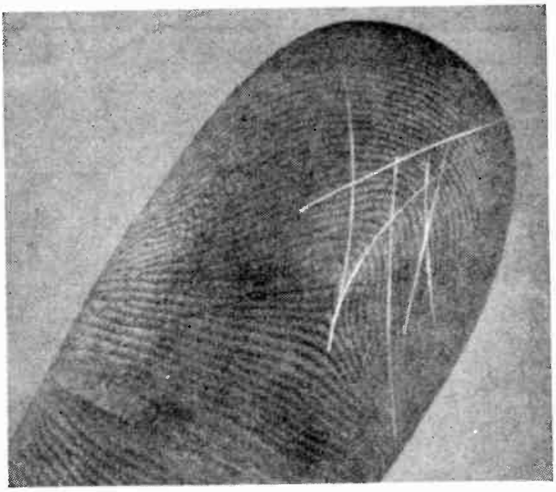
TRANSMISSIONS, both modulated and unmodulated, from the Bell Telephone Laboratories, New Jersey, and reflected from the American balloon satellite "Echo 1," were received at Malvern on August 29th. Although this was not the first occasion (the Jodrell Bank 250ft radio telescope had succeeded a week earlier)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

Amateur Television

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

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

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



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

Pilkington Committee

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

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

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

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

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

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

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

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

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

Personalities

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

Sir Hamish MacLaren

T. B. D. Terron

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

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

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

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

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

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

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

F. S. Barton

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

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

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

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

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

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

OUR AUTHORS

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

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

OBITUARY

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

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

News from Industry

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

EXPORT NEWS

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

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

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

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

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

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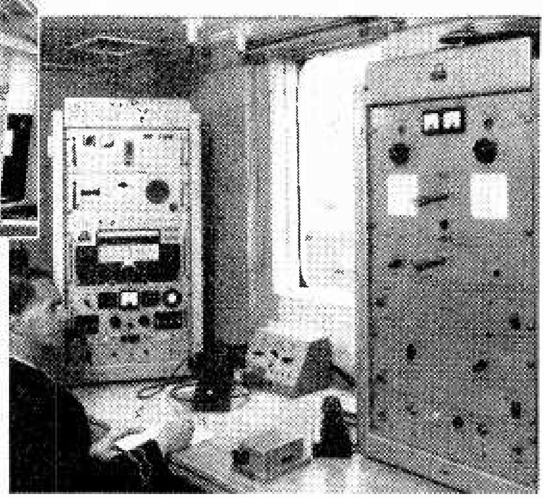
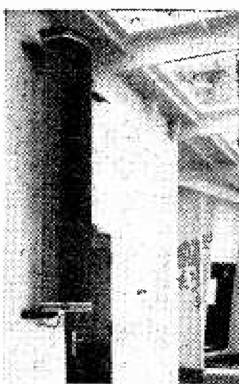
*"**Windsor Castle**".—The radio office in the new Union Castle 38,000-ton liner* Windsor Castle. *Her radio transmitters and receivers, radar, direction-finders and echometers were supplied by Marconi's. Inset is one of the specially designed line-source loudspeakers for the sound reproducing installation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





NATIONAL RADIO SHOW REVIEW

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

TELEVISION

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

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

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

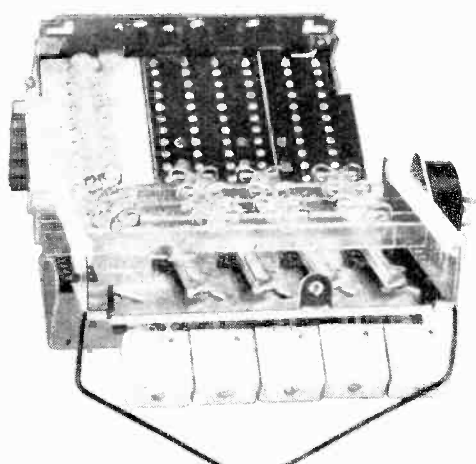
Tuners.—The first set without (as far as the user was concerned) a fine-tuning control was introduced by Murphy in June 1957 and was made possible by building a very stable local oscillator. This used a turret-type tuner and, last year, the principle was extended to f.m., when a.f.c. was applied with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

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

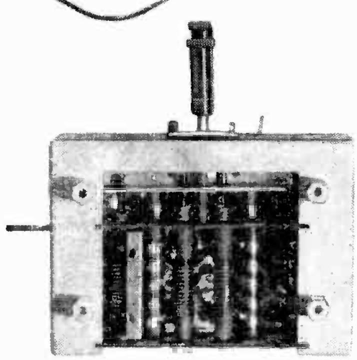
The Ferguson "Golden Glide" uses a modified disc tuner. Linear motion of the selector stud is converted to rotary motion of the spindle. Depressing the stud disengages the click, or detent, mechanism of the tuner and allows the stud to be slid to the desired channel number. The oscillator tuning for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

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

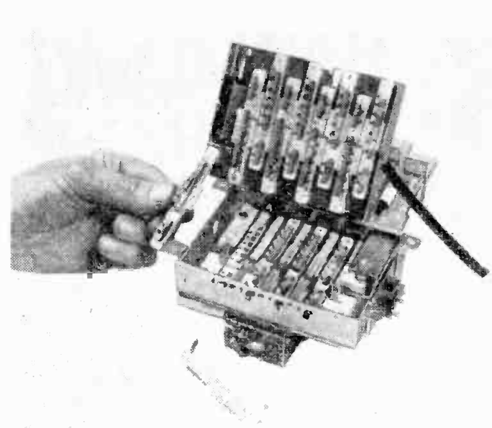
Called "Selectronic" by R.G.D., the Cyldon (made by Sidney Bird) tuner was also found to be used widely. This is of the incremental type and has printed coils on a flat board. The coil terminations are extended



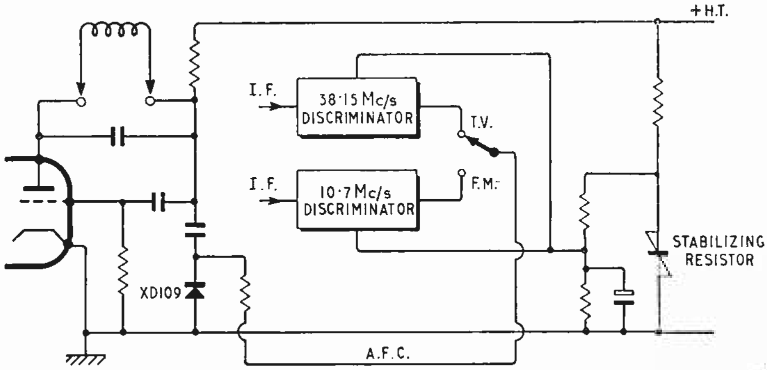
Above: Cyldon push-button tuner with coil panel folded back to show shorting contacts.



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

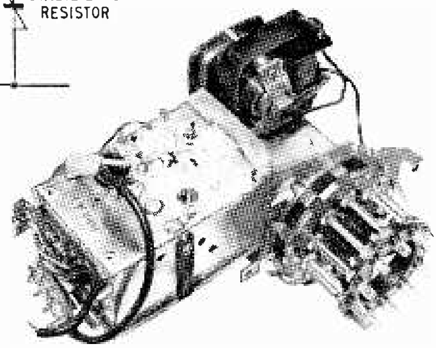


Piano-key switch tuner by A.B. Metal Products (in this case from H.M.V. receiver) has four coil biscuits inserted in the mechanism; those for other channels are housed in a cassette under the tuner.



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

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



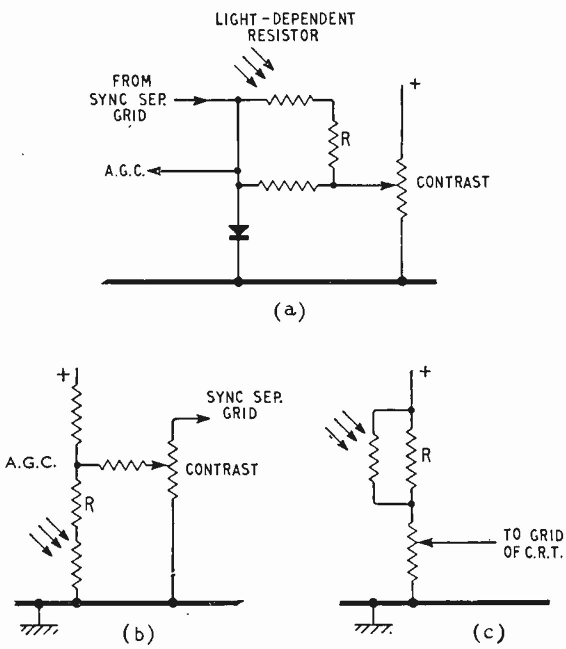
through the boards as contact studs and these are short-circuited by slide bars operated by the four channel-selecting push buttons. Thirteen slots, corresponding to the thirteen channels in Bands I and III, are provided for the slide bars, so choice of channels is accomplished simply by inserting the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

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

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

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

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



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

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

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

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

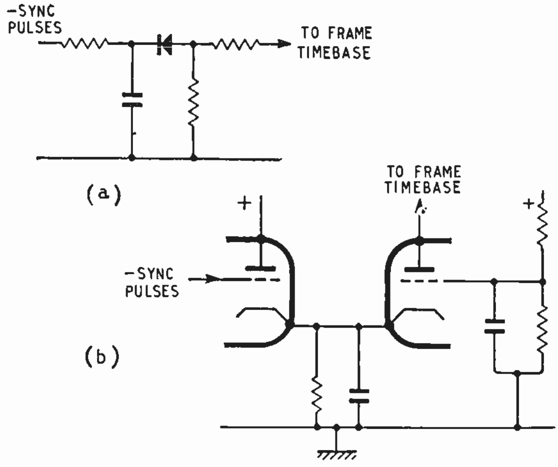
Interlace.—It has long been known that feed-through from line to frame timebase can destroy interlace; this can happen when mutual coupling exists between line and frame coils. With 110° c.r.t.s. the scan coils have to be of very high quality to give satisfactory performance. K-B, to avoid rejection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

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

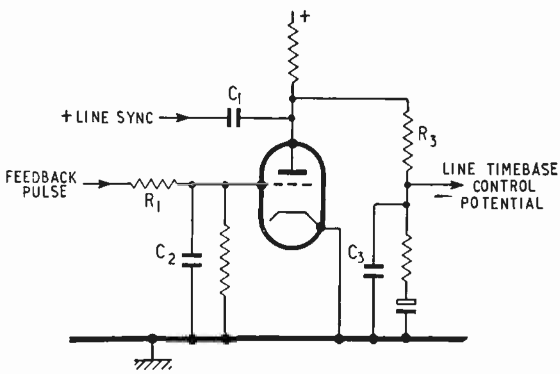
Flywheel Line-sync circuits are hardly renowned for their simplicity, but an extremely simple one has been developed by Philco (see diagram). Positive sync pulses are partially differentiated by C_1 and a positive flyback pulse is delayed by R_1 and C_2. Normally the valve is cut off by bias resulting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

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

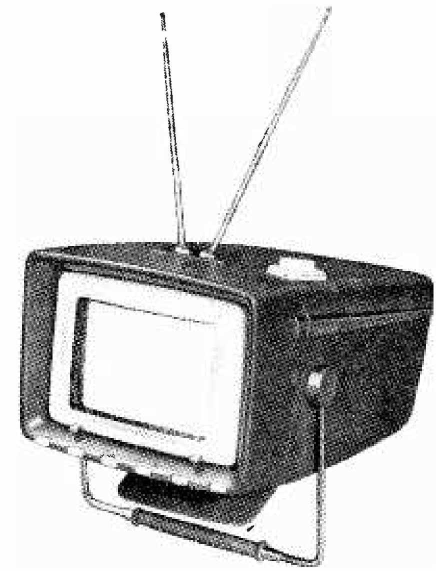
One of the major problems in using transistors is that of obtaining a sufficient amplitude of video signal to modulate the c.r.t. Pye overcome this by using a special 14-in tube, made by Cathodeon, which has a drive re-



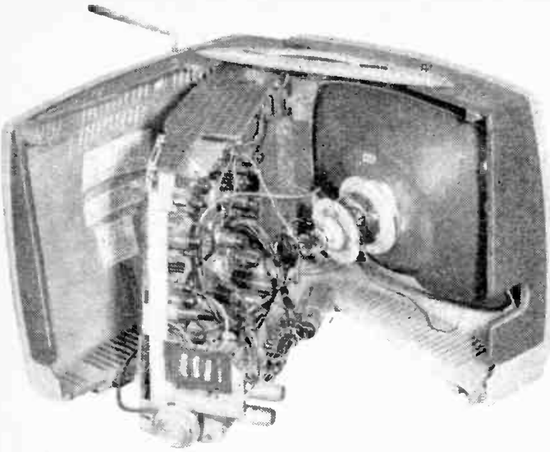
Well-tried simple (a) and relatively complicated (b) frame-pulse separator circuits found to be giving good interlace [(a) Ekco, (b) Peto Scott].



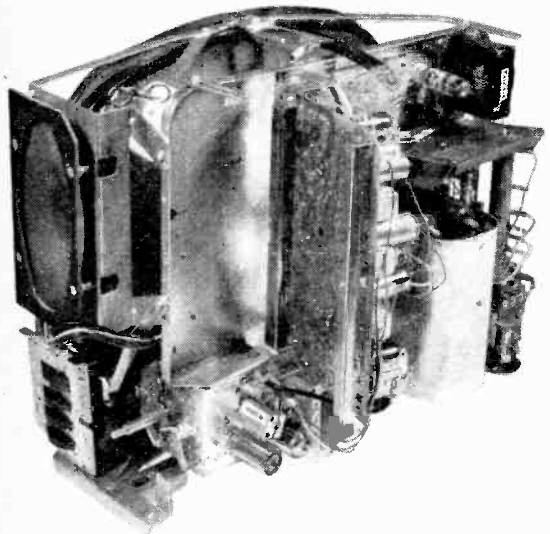
" Philcoloc " flywheel line-sync circuit.



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



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



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

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

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

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

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

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

TELEVISION AERIALS

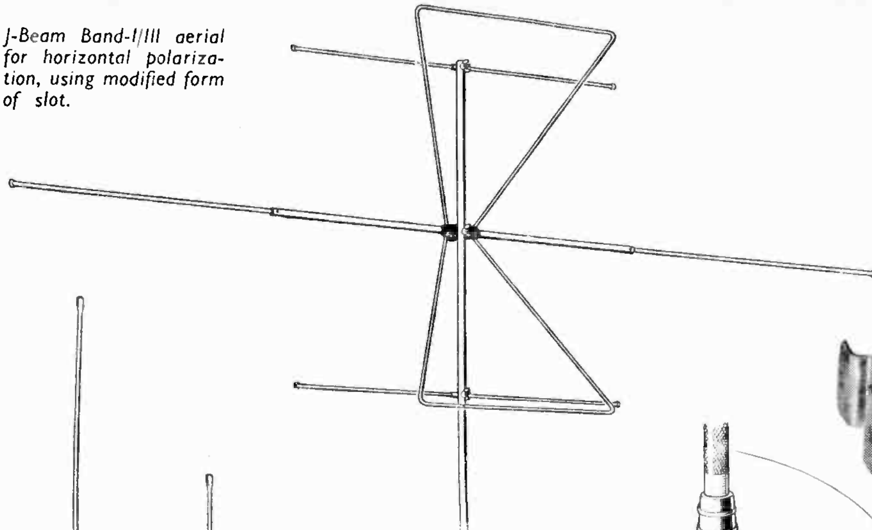
NEW developments tend to be sparse in the aerial field today; but Wolsey's "Collector-Combine" series certainly looks as if yet another method has been found for the inter-connection of Band-I and -III arrays. The aerial uses two half-wave end-fed co-linear radiators for Band III (next to Band III directors)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

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

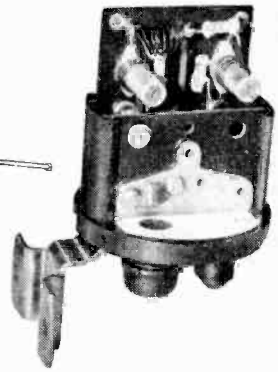
New outdoor aerials from J-Beam have been designed with a view to keeping their outline as compact as possible to reduce wind resistance and skyline "clutter." In the case of the higher-gain combined arrays this has been done by mounting the familiar J-Beam slot behind the Band-I dipole so that the directors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

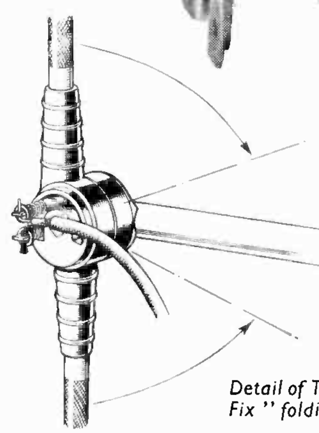
Telerection have designed a new folding Band-I insulator to ease erection and packing problems. This consists of three discs—one grooved to lock on the crossarm, the other two carrying the dipole elements. Locating pegs enable the unit to be used for both the "Paravex" (near "X" form) and plain dipole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

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

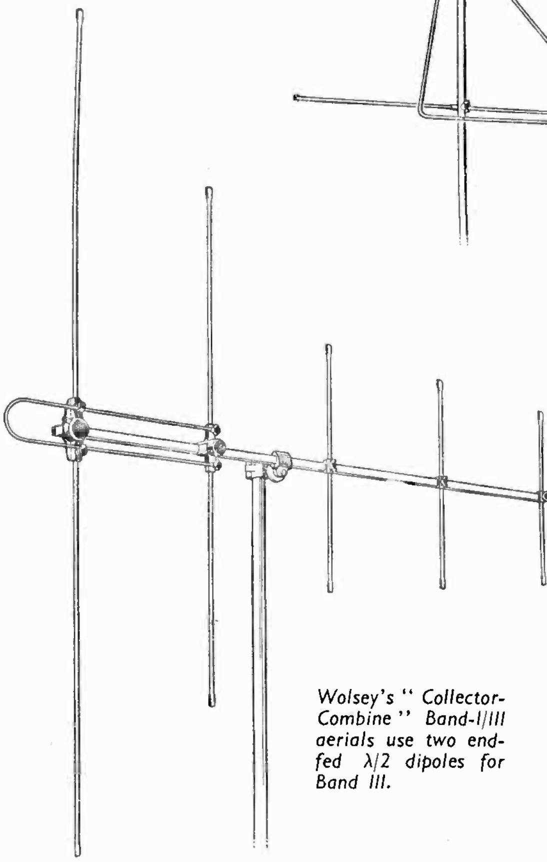


Antiference Y9 aerial feeder combining unit for C.C.I.R. Channels 5, 6 and 7, 8, 9





Detail of Telerection " Finger Fix " folding dipole insulator.



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

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

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

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

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.

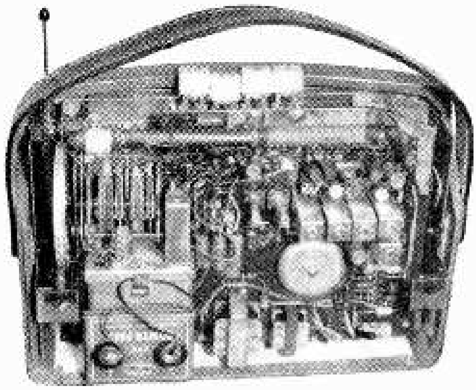
F.m. sensitivities ranging from 2 to 5μV were generally achieved. This is high enough for use with the telescopic swivel aerial which was usually incorporated to allow for possible distortions of the plane of polarization of the signal near the ground.

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

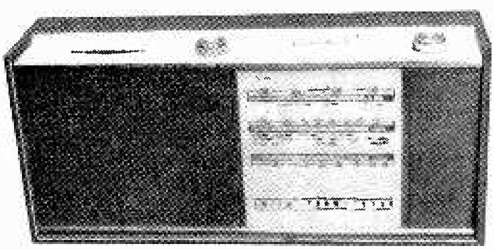
On f.m. often only the first (r.f.) stage was gain-controlled, the a.g.c. voltage being obtained by rectifying the signal at the output of the first i.f. amplifier. Such a.g.c is essential to reduce changes in the local oscillator frequency due to changing signal levels In the Ultra TR81 additional a.g.c.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

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

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



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.

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

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

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

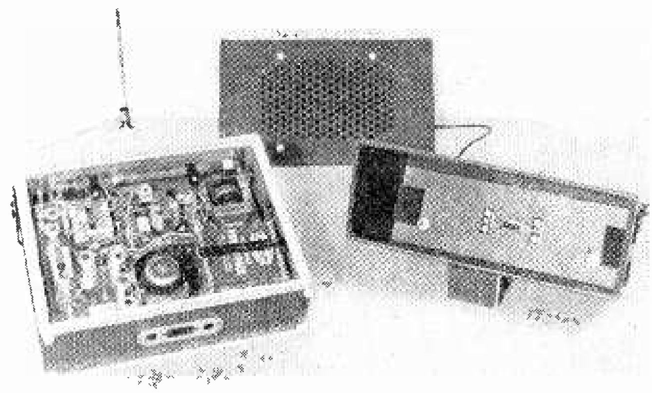
The trend towards dual-purpose portable/car-radio receivers was carried further in the Ever Ready car portable. When this set is plugged into its special container in the car, this automatically connects the car aerial, the car battery and an 8in × 5in loudspeaker in place of the internal aerial, battery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

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

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

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

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



Ever Ready car portable transistor receiver.

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

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

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

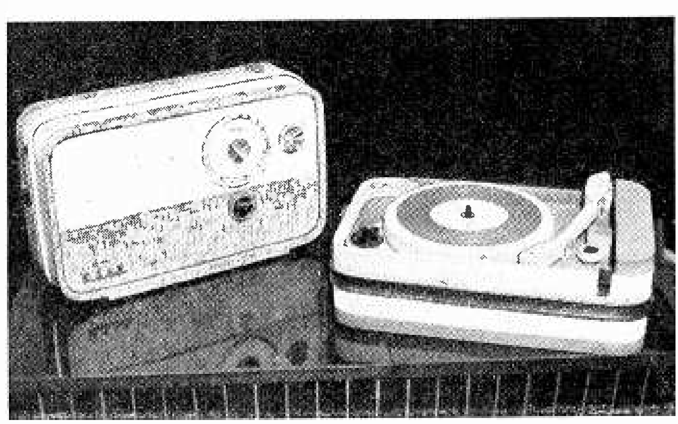
The G.E.C. demonstrated the use of a third centrally placed loudspeaker fed from both stereo channels. This was done to improve the definition of central sound sources and thus reduce the "hole-in-the-middle" effect noticeable with some recordings especially when widely-spaced loudspeakers are used.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

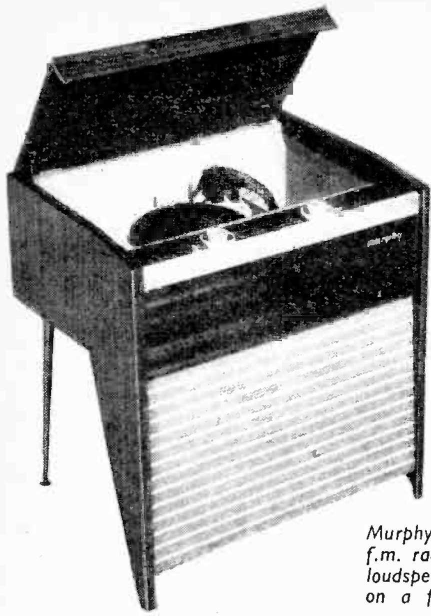
Loudspeaker Mounting.—In horn enclosures the expansion is usually made to follow a simple exponential law. To produce an adequate low-frequency response the horn must then be made unmanageably long unless it is folded, which in its turn introduces additional problems. A somewhat shorter horn can, however,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

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

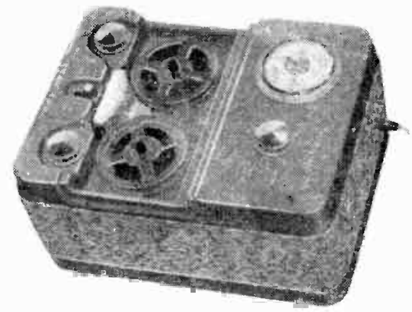
Goodman's hyperbolic-exponential law horn loudspeaker removed from the room corner and viewed from one side to show one of the two horn mouths.

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





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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LETTERS TO THE EDITOR

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

"1910 and all That"

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

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

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

London, W.1. VERNON HARRIS.

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

Servicing in New Zealand

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

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

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

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

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

Wellington, New Zealand. F. W. ASHTON.

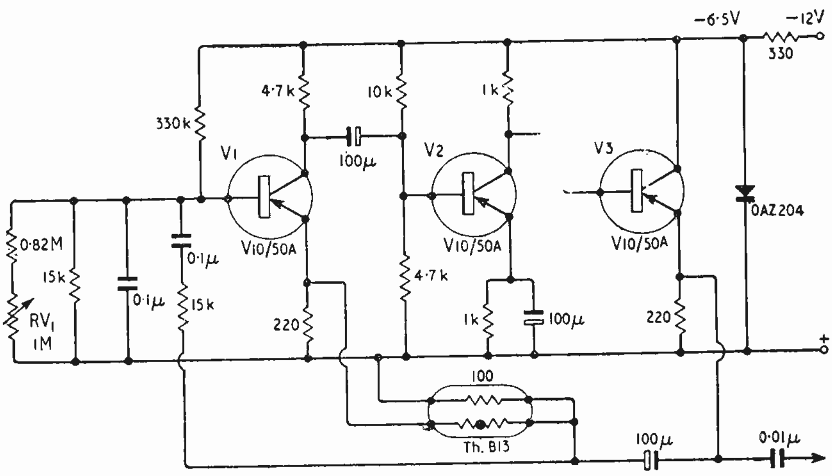
Transistorized Wien Bridge Oscillator

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

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

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

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



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

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

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

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

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

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

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

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

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

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

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

The author replies:

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

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

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

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

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

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

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

F. BUTLER

Television Standards

NOW that the Television Advisory Committee Report is published there is much talk of television standards changing and it seems clear that changes will be made.

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

Northwood, Middlesex. C. H. BANTHORPE.

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

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

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

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

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

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

Ibadan, West Nigeria.

Self-Balancing Push-Pull Circuits

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

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

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

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

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

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

D. R. BIRT.

"Things Great and Small"

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

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

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

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

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

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

Nottingham. D. B. PITT.

Rogue Equipment

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

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

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

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

Hampton, Middlesex. L. CAMPBELL.

Circuit Conventions

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

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

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

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

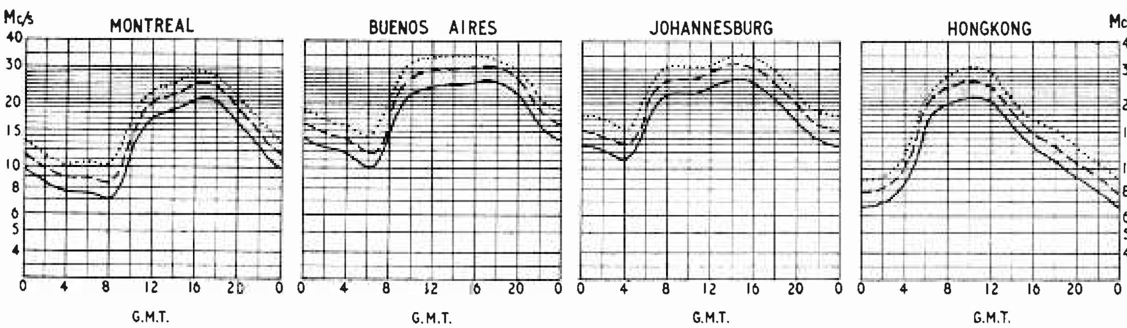
3. It is not always sufficiently realized that the primary purpose of a technical drawing or diagram is to convey information, and no diagrams, however low the cost of production may be, can be regarded as effecting an economy if they do not perform their intended function.

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

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

SHORT-WAVE CONDITIONS

Prediction for October



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

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

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

— — — PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY

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

Equatorial Ionospheric Effects

POST-SUNSET FADING ON LONG-DISTANCE RADIO CIRCUITS

By T. W. BENNINGTON*

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

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

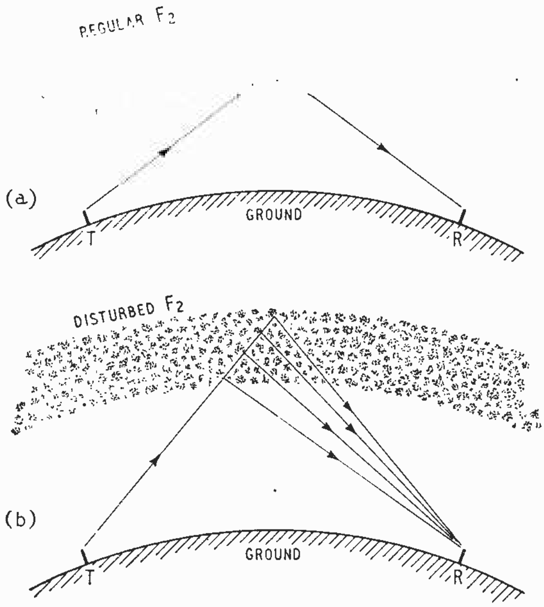


Fig. 1. Illustrating, for a single-hop transmission path, the mode of propagation of a single ray (a) via the normal F2 layer and (b) via the cloud-like structure occurring after local sunset.

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

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

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

*Research Department, British Broadcasting Corporation.

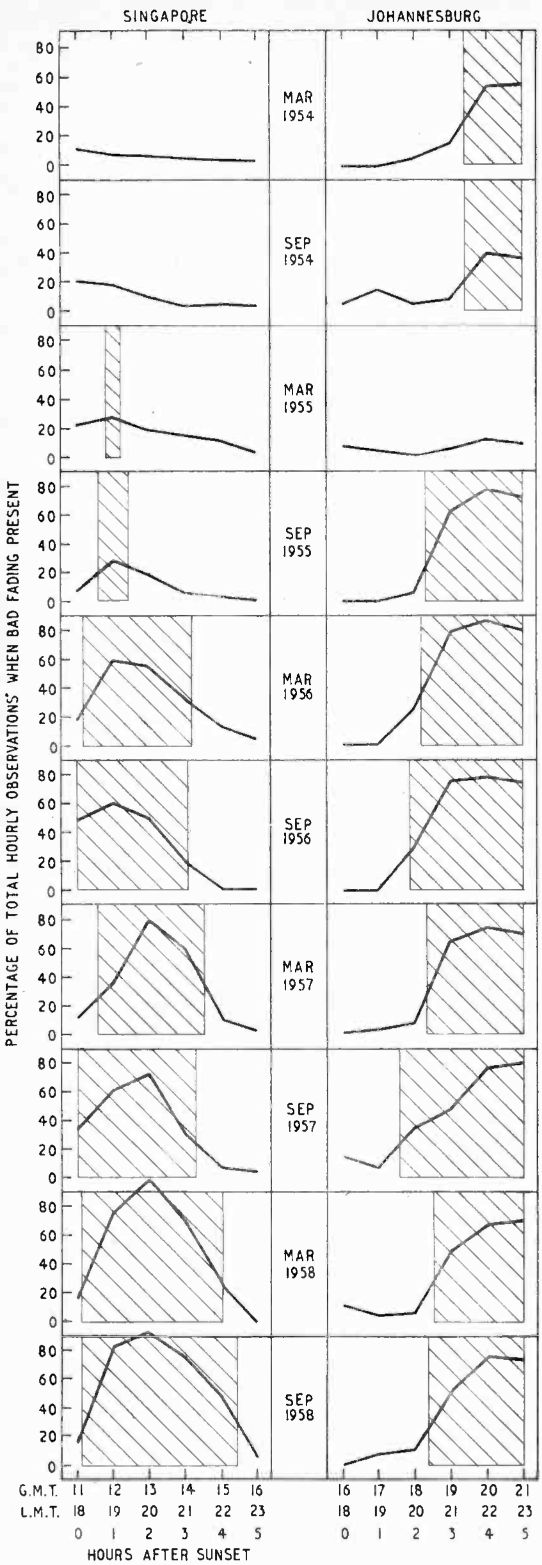


Fig. 2. Incidence of medium-rapid, or worse, fading in reception at Singapore and Johannesburg during 5 hours after sunset—equinoctial months 1954-1958.

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

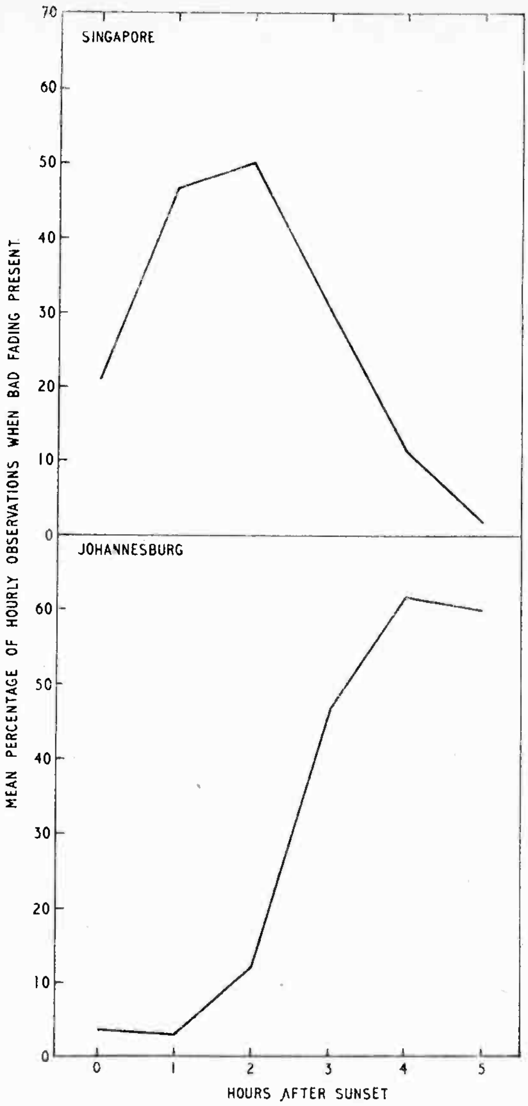
Fading at Johannesburg and Singapore.—In order to obtain some information on the incidence of the fading and of its variation during the hours following on sunset at different places, and also over the sunspot cycle, an examination was made of data received from Singapore and Johannesburg on the reception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

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

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

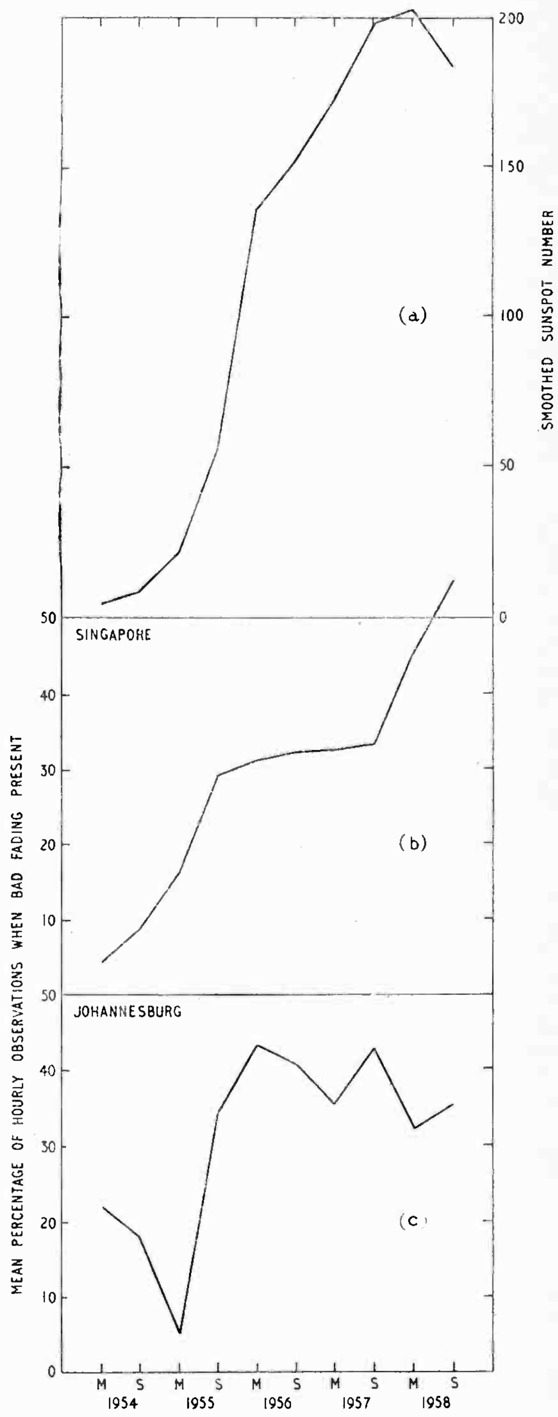
At Johannesburg the fading reached fairly high incidence rates even during sunspot minimum years, though the incidence rate was higher, and the high incidence rate of longer duration, after September 1955 than before that month. Thus the fading increased with increasing sunspot number. What is more peculiar,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

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



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

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



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

Connection between Fading and Observed Ionospheric Phenomena.—It would seem fairly clear that the post-sunset fading observed on these and other circuits is due to ionospheric phenomena occurring in a region near the magnetic equator, through which the radio waves have to pass in reaching these places from the northern hemisphere. And it would also seem probable that the ionospheric phenomenon concerned could be the "spread F" which is observed to occur after sunset at ionospheric observatories near to the magnetic equator. But to say this gives no explanation of several peculiarities in the fading; to mention only one, the difference in the local time of its onset as between Singapore and Johannesburg. It is interesting, therefore, to pursue the matter a little further by examining some of the ionospheric measurements.

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

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

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,[4] which would thus include Ibadan and Huancayo but

(*Continued on page* 505)

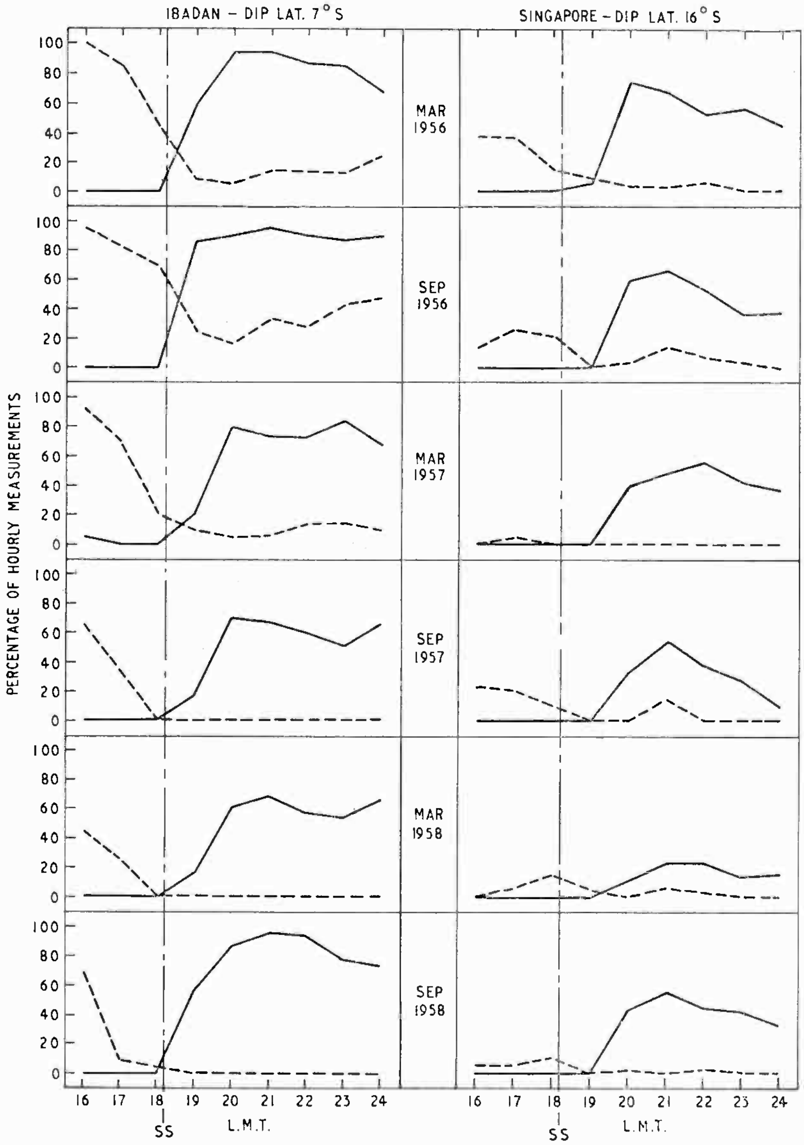


Fig. 5. Percentage of hourly measurements at Ibadan and Singapore. Full-line curves when "spread F" echoes were observed from the F2 layer and dashed-line curves when spradic E with critical frequency ⩾5Mc/s was observed.

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 Ibadan	10.3 29.8	53.4 90.3
September 1958	8	22	Singapore Ibadan	25.6 55.0	52.0 93.6

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

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

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

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

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

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

TABLE 2

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

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

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

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

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

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Crystal-controlled Communications Receiver

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

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

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

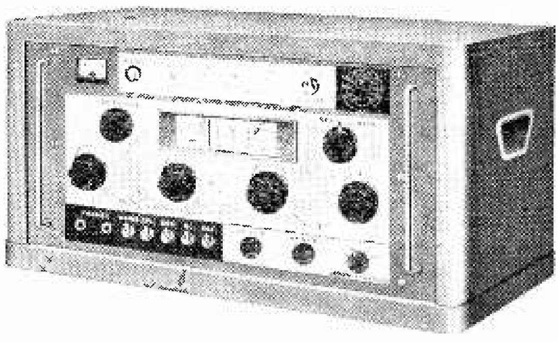
Coil switching in the aerial and r.f. circuits is automatic as it is linked with the crystal-oscillator's decade switching system.

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

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

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

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



Marconi unconventional communications receiver, Type HR120.

Transistor Inverters and Converters

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

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

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

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

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

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

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

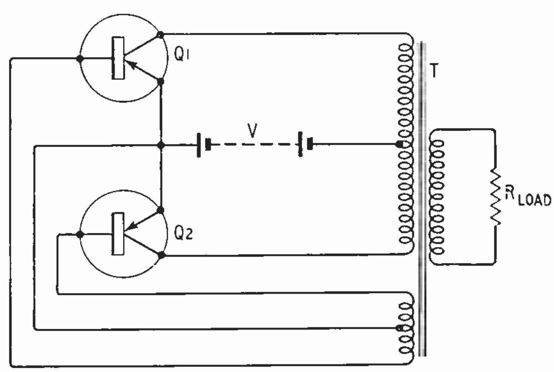


Fig. 1. Standard Uchrin-Royer circuit.

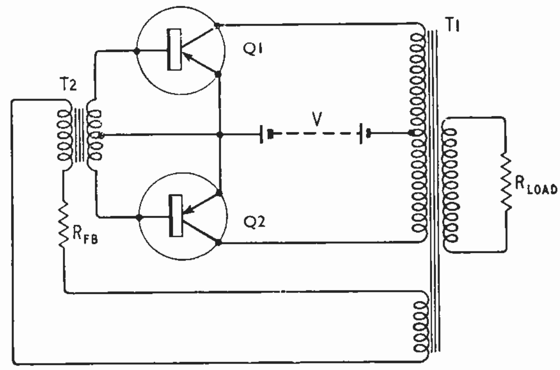


Fig. 2. Jensen introduced a small saturable transformer in the base circuits of Fig. 1.

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

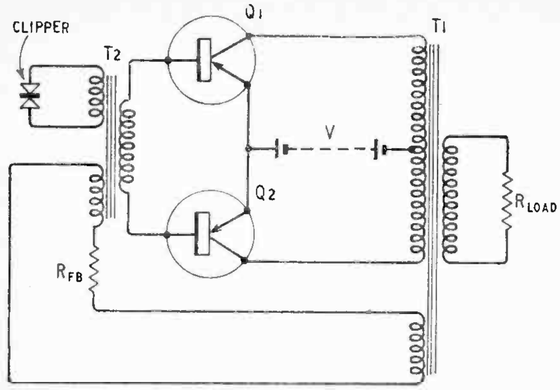


Fig. 3. The addition of a clipper diode pair to the basic Jensen circuit of Fig. 2 stabilizes the frequency.

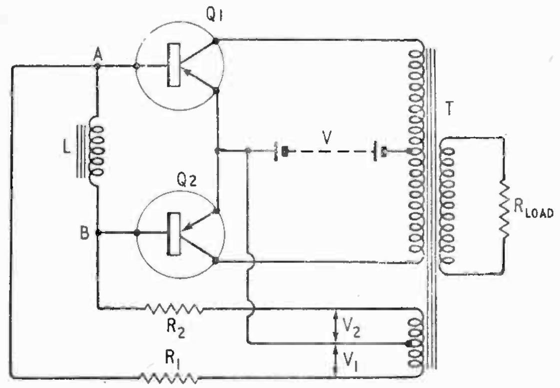


Fig. 4. In this new circuit even less square-loop core material is used and the frequency depends less on transistor properties.

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

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

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

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

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

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

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

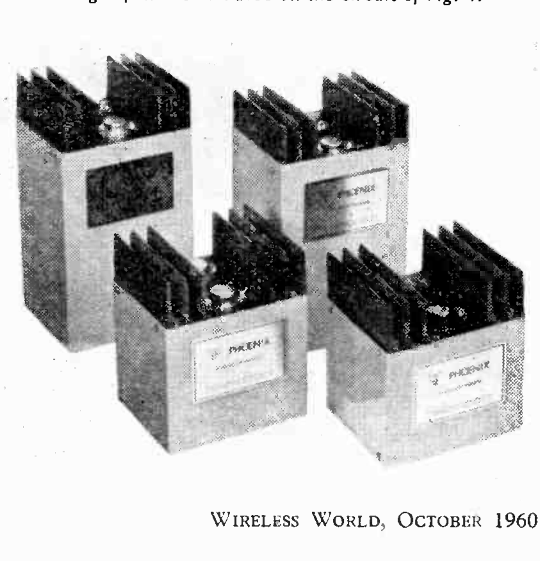
$$\frac{V_1 - V_{be}}{R_1} = \frac{I_c}{\beta(\min)}$$

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

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

In the unclipped version of Jensen's circuit the

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



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

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

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

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

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

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

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

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

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

CLUB NEWS

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

Clerkheaton.—The programme for the meeting on 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

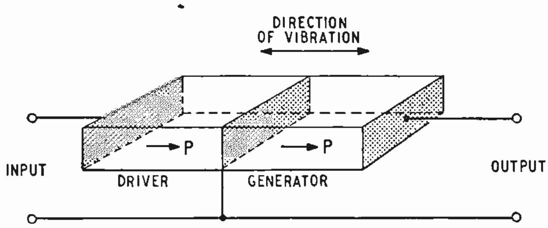


Fig. 1. Ring-type (longitudinal) piezoelectric transformer.

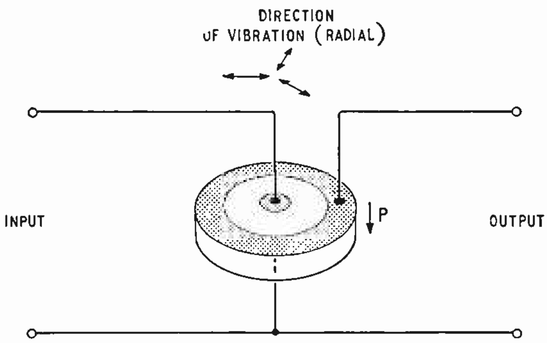


Fig. 2. Ring-type piezoelectric transformer suitable for use as an i.f. filter.

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 polyarystalline mass acts as a single crystal so far as the piezoelectric effect is concerned.

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

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

*Brush Crystal Co. Ltd.

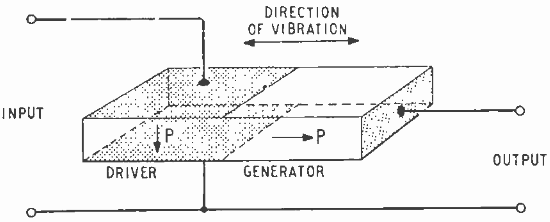


Fig. 3. Transverse-type piezoelectric transformer.

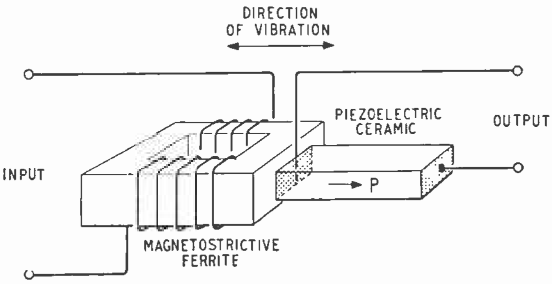


Fig. 4. Composite transformer.

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

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

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

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

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

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

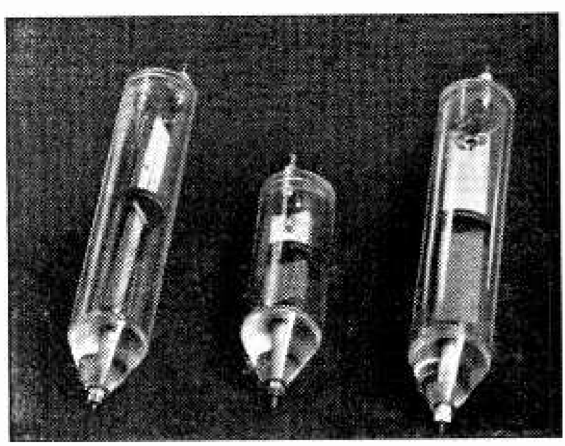
Hybrid Transformers.—The recent development of magnetostrictive ferrite materials has enabled a composite transformer to be constructed, Fig. 4. A suitably shaped and proportioned block of magnetostrictive ferrite is bonded to a length-polarized bar of piezoelectric ceramic. The necessary d.c. polarization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

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

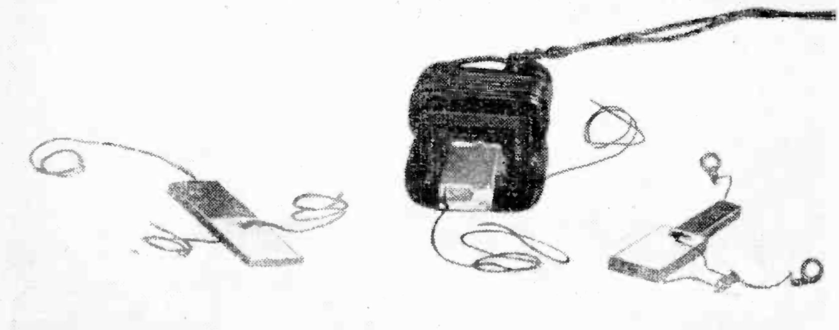
In the past a serious disadvantage has been limitations imposed by unsuitable piezoelectric ceramic materials. The development of the family of ceramics based on lead zirconate-titanate solid solutions by the Clevite Corporation in the U.S.A., and Brush Crystal Company, in England now enables practical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

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

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



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



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

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

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

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

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

Minimum Length

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

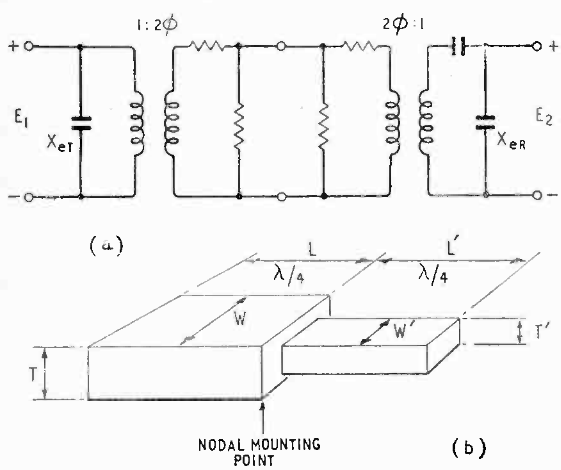


Fig. 5(a). Equivalent circuit and (b) dimensions of transverse transformer.

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

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

Thickness

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

$$A_{vo} = 2A_v$$

then

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

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

Width

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

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

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

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

Combining these equations and solving for W.

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

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

Generator Dimensions

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

(*Continued on page 513*)

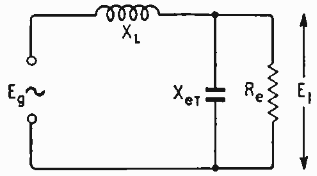


Fig. 6. Simplified circuit of transformer input with resonant inductance.

match the acoustic impedance of the two sections and also to ensure that each section is a ½ wavelength. The difference is determined by the coupling k_{33}.

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

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

Operating Frequency

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

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

Input Impedance Parameters

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

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

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

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:

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

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 μF and meter readings were corrected to give true figures, the output section of the transformer having a capacity of 40 μF.

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

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

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

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

k_{31}	= 0.30	d_{31}	= −130 × 10^{-12} coulomb/newton
k_{33}	= 0.76	g_{33}	= 28.3 × 10^{-3} volt metres/newton.
k_3	= 1200	Y^E_3	= 6.75 × 10^{10}; newtons/metre²
tan δ	= 0.005	c^E	= 3000 metres/sec.
Q_m	= 500	ξ^T_{33}	= 1.2 × 10^{-8} farad/metre

Max. operating temp. = 250°C.

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

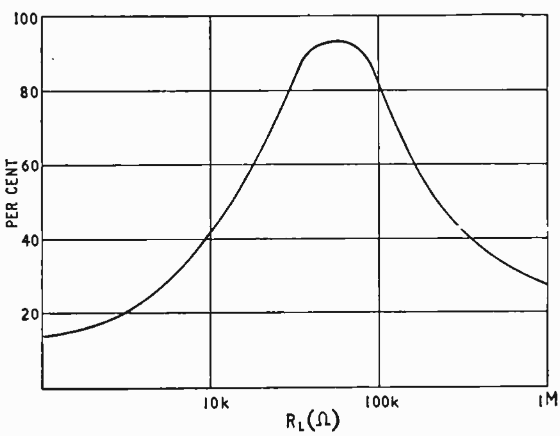


Fig. 7. Variation of efficiency with output load (40-kc/s parallel-element transformer).

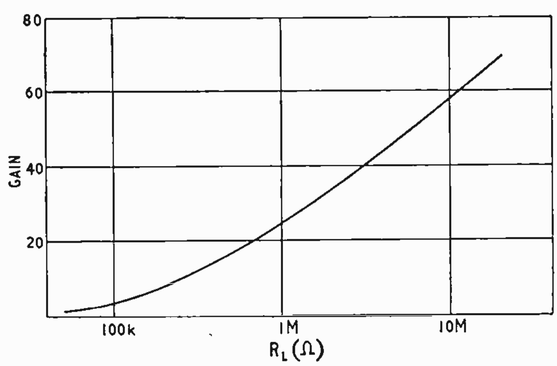


Fig. 8. Variation of gain with output load (40-kc/s parallel-element transformer).

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

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

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

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

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INDUSTRIAL GROUPS

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

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

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

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

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

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

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

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

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

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

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

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

Commercial Literature

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

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

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

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

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

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

KIRCHHOFF'S LAWS

By "CATHODE RAY"

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

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

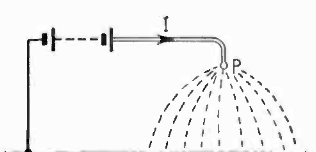


Fig. 1. Even if a "point" P is large enough to have appreciable capacitance, the very small transient current needed to charge it to any reasonable voltage has its counterpart as a displacement current in space.

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

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

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

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

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

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

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

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

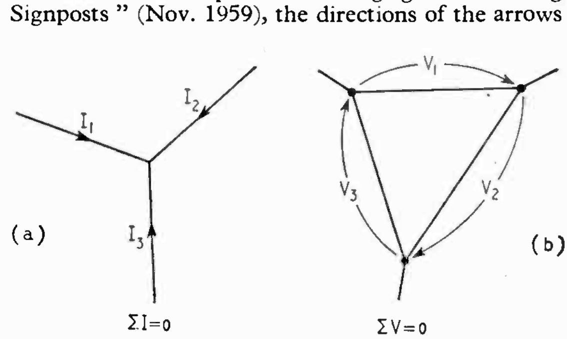


Fig. 2. Symbolic expression of Kirchhoff's two laws. They are duals of one another.

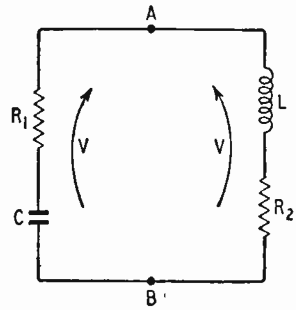


Fig. 3. The fact that the p.d. between two points is the same via any path implies the truth of Kirchhoff's second law.

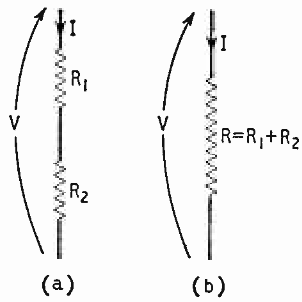


Fig. 4. The well-known principle of combining resistances in series follows from the first law.

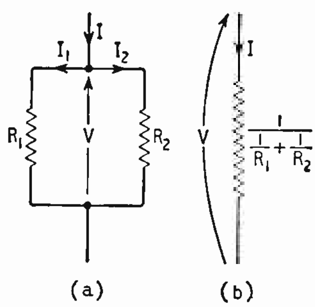


Fig. 5. And the combining of resistances in parallel follows from the second. But a dualist would work this in conductances.

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

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

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

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

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

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

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

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

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

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

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

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

(Continued on page 517)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$I_2 = jE\omega C$$

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

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

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

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

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

That is not quite so simple as it looks, because

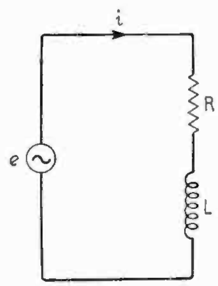


Fig. 6. Simple a.c. circuit for studying how Kirchhoff's laws apply.

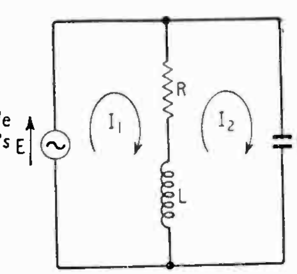


Fig. 7. Analysis of a simple a.c. network by Kirchhoff's laws.

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

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

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

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

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

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

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

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

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

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

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

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

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

A "Kiwi" at Earls Court

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.—PERFORMANCE

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

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

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

The measured value was 16 μV.

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

The measured value was 16 μV.

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

The distortion at 16 μV input level was 1.6%.

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

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

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

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

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

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

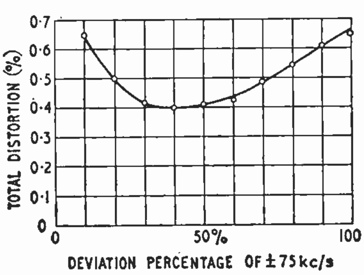


Fig. 8. Variation of harmonic distortion with deviation.

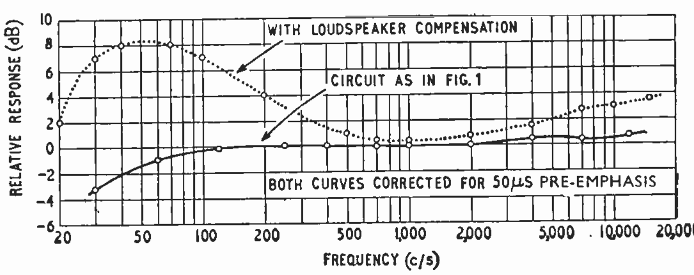


Fig. 9. Modulation-frequency characteristic.

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

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

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

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

TABLE 1

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

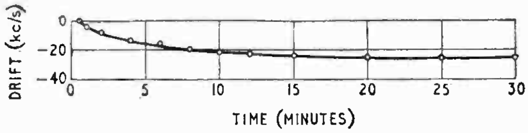


Fig. 10. Oscillator-frequency drift.

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

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

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

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

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

The measured voltage was 0.5 mV.

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

The measured value was −7 dB.

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

TABLE 2

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

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

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

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

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

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

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

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

Discussion of Results

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

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

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

TABLE 3

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

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

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

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.

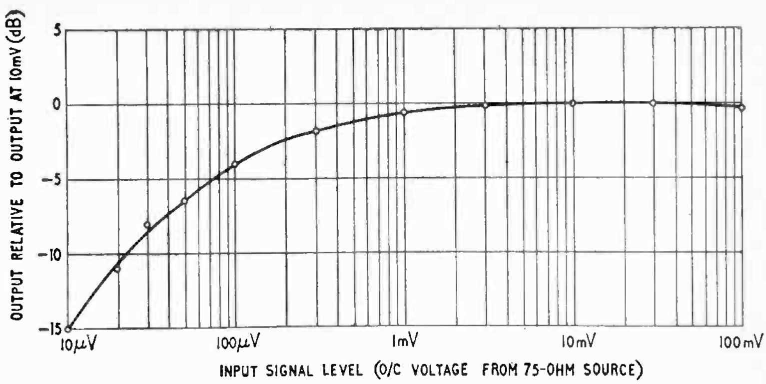


Fig. 11. Variation of a.f. output with signal level.

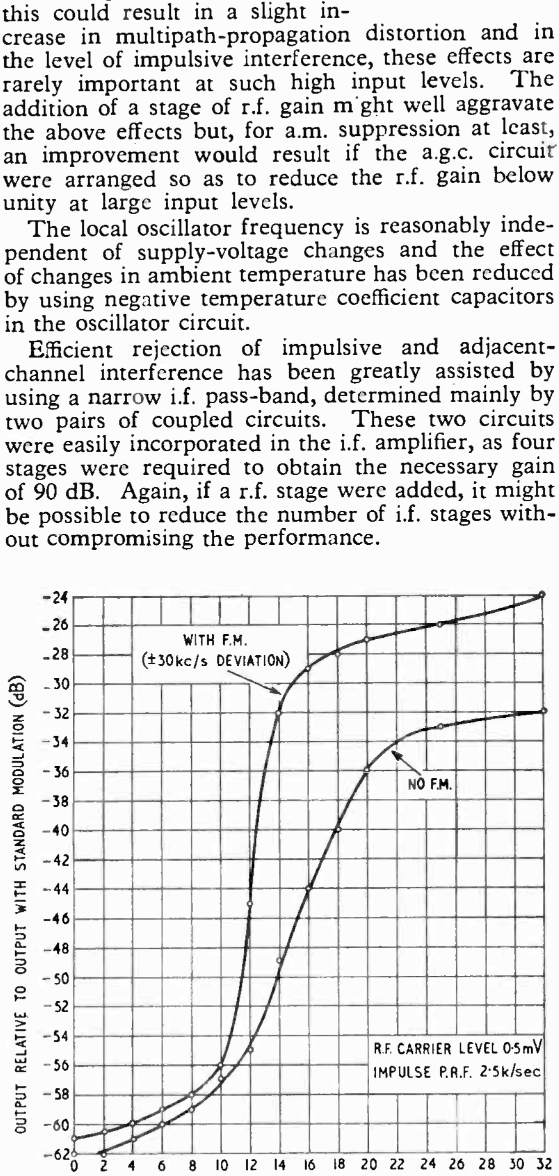


Fig. 12. Input/output characteristic for impulsive interference.

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

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

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

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

Conclusions

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

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

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

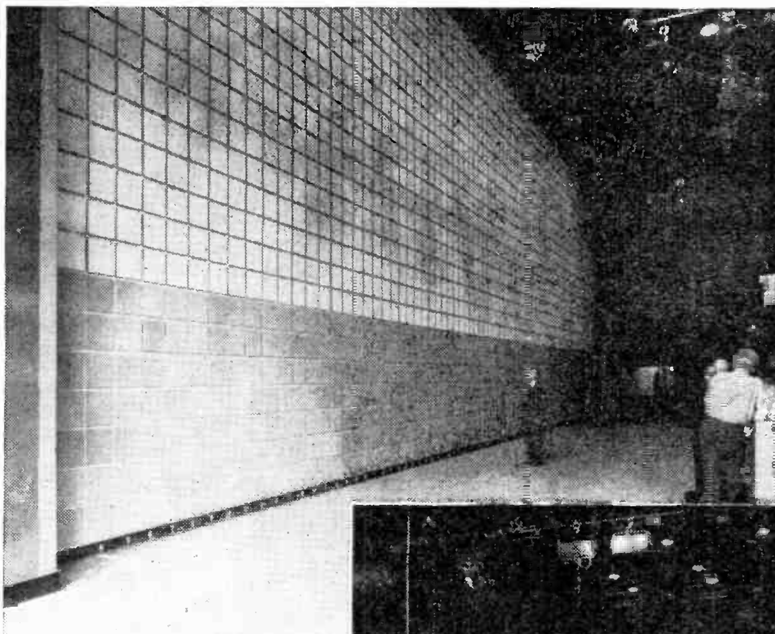
STUDIO 5

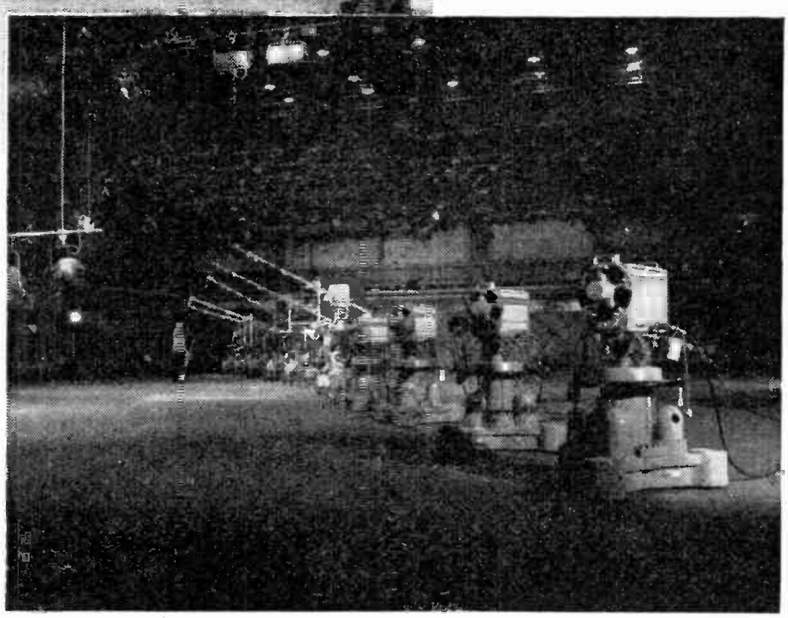
VAST AREA FOR LARGE PRODUCTIONS

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

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

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





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

Right: Some of the studio-floor equipment. First four in the line up are E.M.I. mage-orthicon 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 ($= 327.7 \times 10^6$ yd/sec) and t = the time delay in microseconds between transmission and reception of the pulse, then $R = vt/2 = 164t$ yd.

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

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

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

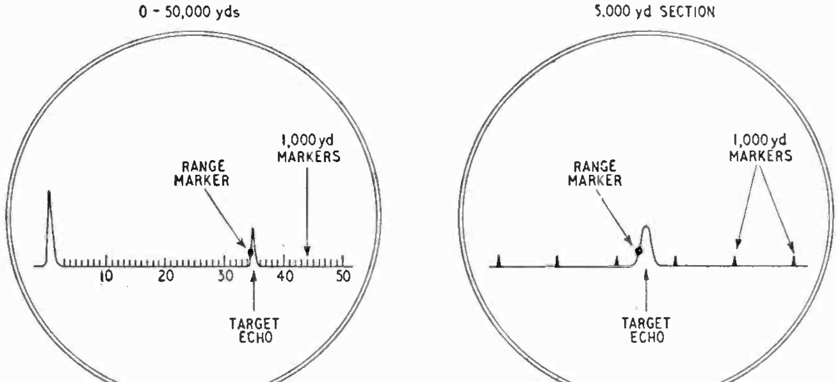


Fig. 1

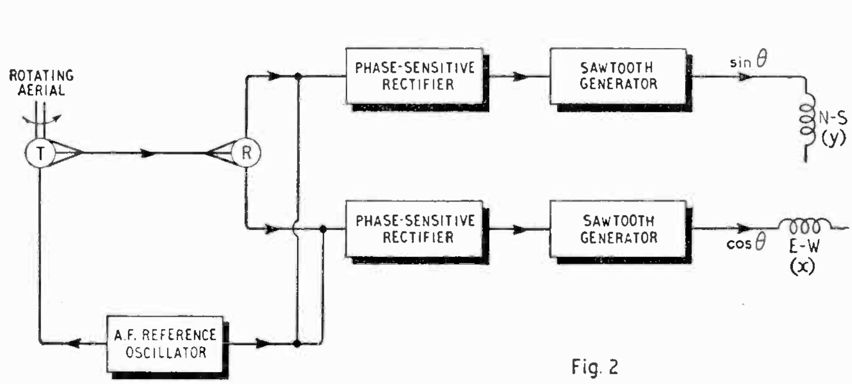


Fig. 2

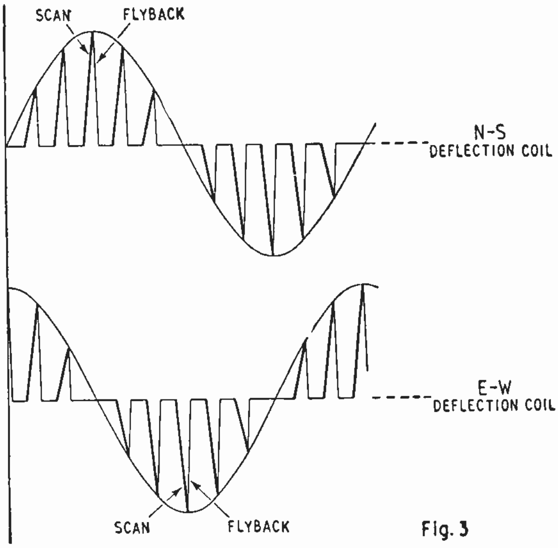


Fig. 3

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

PPI Display

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

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

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

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

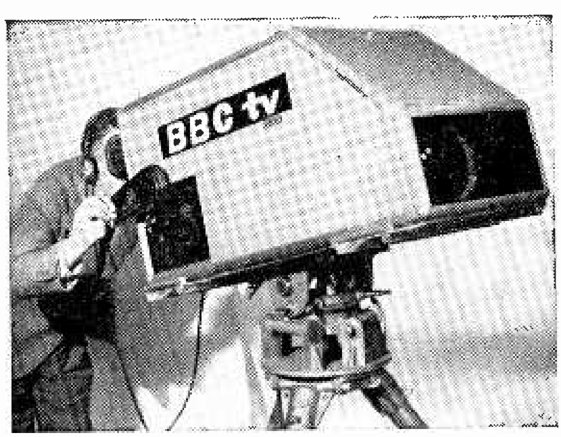
It will be appreciated that during the course of one revolution of the aerial a large number of sawteeth will occur.

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

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

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

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



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

OCTOBER MEETINGS

LONDON

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

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

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

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

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

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

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

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

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

ALDERSHOT

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

BIRMINGHAM

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

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

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

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

BRISTOL

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

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

CARDIFF

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

CHELTENHAM

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

EDINBURGH

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

FAWLEY

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

GLASGOW

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

HARWELL

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

MALVERN

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

MANCHESTER

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

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

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

NEWCASTLE-UPON-TYNE

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

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!

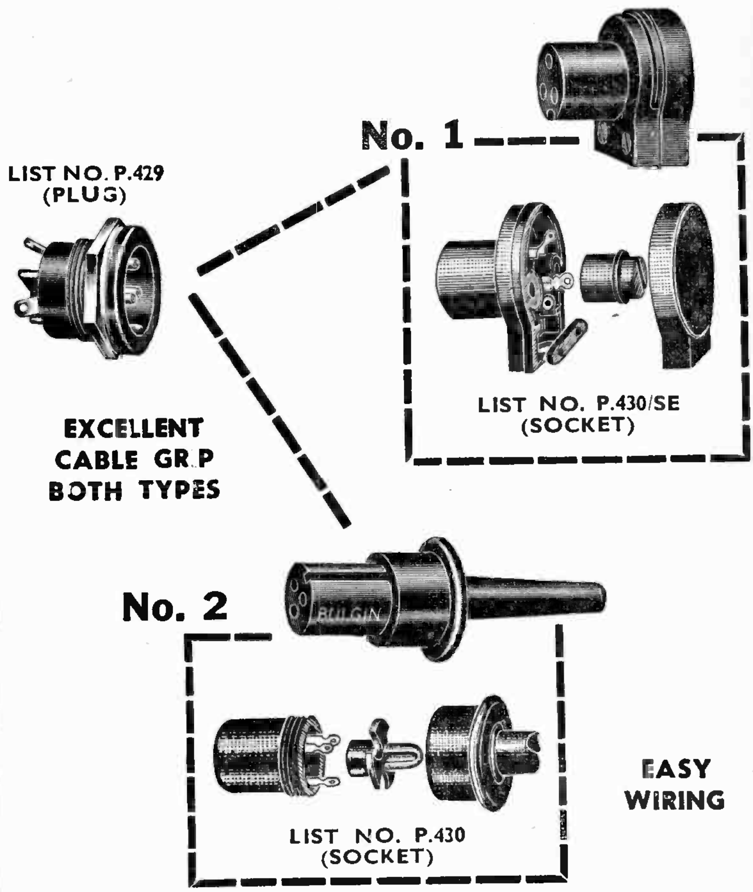
LETTERS continue to pour in from readers who have been successful in receiving 819-line pictures in various parts of south-eastern England and in the Midlands. There have, in fact, been so many of them that we can now take it that such reception is possible fairly regularly in various localities and 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 ($2\times405=810$). Others have sent photos showing that they get a single image just about filling the screen. That may be because their line-hold controls enable the time-base speed to be pushed up sufficiently or because of the sync and line timebase arrangements of their receivers.

Long-Wave TV

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

Colour TV Goes Racing

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



UNBIASED

By FREE GRID

Exhibitiana

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

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

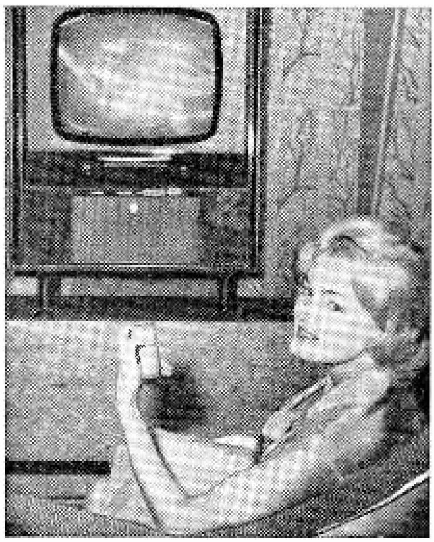
Another thing about this year's television sets is that they have become pleasingly thin in the fore-and-aft direction. But I hope the slimming diet, which the manufacturers have been giving them, does not produce the undesirable side-effects which it does in some women, whom an excessive slimming diet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

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

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

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

I didn't spend more than a few minutes in the piano section; I just couldn't stand the cacophony created by the half a dozen or so pianists (sic) who were vying with one another for a hearing.*



Wire-less control of TV

* "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 365¼ 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.